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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 2003 BUDGET ESTIMATES

NASA'S VISION FOR THE FUTURE

NASA is an investment in America's future. Since 1958 when NASA was created, the Agency has pursued a fundamental mandate--to pioneer the 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. NASA's primary charter is to explore the new frontiers of science and technology using innovative technologies.

NASA's unique mission of exploration, discovery, and innovation has preserved the United States' role as both a leader in world aviation and as the preeminent spacefaring nation. It is NASA's mission to:

- Advance human exploration, use and development of space;
- Advance and communicate scientific knowledge and understanding of the Earth, the Solar System, and the Universe;
- Research, develop, verify and transfer advanced aeronautics and space technologies.

The outcomes of NASA's activities contribute significantly to the achievement of America's goals in five key areas:

- Economic growth and security - NASA conducts aeronautics and space research and develops technology in partnership with industry, academia, and other federal agencies to keep America capable and competitive.
- Increased understanding of science and technology – NASA communicates widely the content, relevancy, and excitement of our mission and discoveries to inspire and increase the understanding and the broad application of science and technology.
- Protection of Earth's Environment - NASA studies the Earth as a planet and as a system to understand global climate change, enabling the world to address environmental issues.
- Educational Excellence - NASA involves the educational community in our endeavors to inspire America's students, create learning opportunities, and enlighten inquisitive minds.
- Peaceful Exploration and Discovery - NASA explores the Universe to enrich human life by stimulating intellectual curiosity, opening new worlds of opportunity, and uniting nations of the world in this quest.

Achieving our goals and objectives over the first quarter of the 21st century will contribute to national priorities: the protection of Earth's fragile environment, educational excellence, peaceful exploration and discovery, and economic growth and security.

STRATEGY FOR ACHIEVING OUR GOALS

The NASA budget request for FY 2003 reflects a strong commitment and emphasis to continue to build on the Agency's core foundation of aeronautics and aerospace research and development. In its pursuit of science and technology, NASA will continue to use its missions of exploration and discovery to educate and inspire—all for the benefit of life on Earth.

Included in this request are both near-term priorities–flying the Space Shuttle safely and continuing to build and operate the International Space Station–and longer-term investments in America's future–developing more affordable, reliable means of access to space and conducting cutting-edge scientific and technological research. It draws on NASA's strengths in engineering and science and reflects the revolutionary insights and capabilities on the horizon in areas such as biotechnology, nanotechnology, and information technology. It describes our vision for expanding air and space frontiers, serving America, and improving life on Earth. This budget request also fully supports the President's Management Agenda which calls for all Federal agencies to measure performance and results. NASA will examine its Agency management practices including its operational and institutional infrastructure, its workforce, and its cost/resources management, and identify and implement needed improvements in Agency management and performance.

The President's FY 2003 budget request for NASA supports the above goals through the following three appropriations:

Human Space Flight (HSF) - provides funding for HSF activities, and for safety, mission assurance and engineering activities supporting the Agency. HSF activities include development and operation of the Space Station and operation of the Space Shuttle. This includes development of high priority investments to improve the safety of the Space Shuttle, revitalization of aging Shuttle infrastructure, and required construction projects in direct support of the Space Station and Space Shuttle programs. This appropriation also provides for salaries and related expenses (including travel); design, repair, rehabilitation, and modification of facilities and construction of new facilities; maintenance, and operation of facilities; and other operations activities supporting human space flight programs; and space operations, safety, mission assurance and engineering activities that support the Agency.

Science, Aeronautics and Technology (SAT) - provides funding for the science, aeronautics and technology activities supporting the Agency. These activities include Space Science, Biological and Physical Research, Earth Science, Aerospace Technology, and Academic Programs. This appropriation also provides for salaries and related expenses (including travel); design, repair, rehabilitation, and modification of facilities and construction of new facilities; maintenance, and operation of facilities; and other operations activities supporting science, aeronautics, and technology programs.

Inspector General – provides funding for the workforce and support required to perform audits and evaluations of NASA's programs and operations.

The NASA FY 2003 budget request helps position the Agency to explore and possibly answer fundamental questions outlined in the NASA Strategic Plan:

- How did the Universe form and evolve, and does life exist elsewhere?

- How do we best observe and understand our home planet, learn how it is changing, and help determine and understand the consequences for life on Earth?

- Can we enable safe and permanent human habitation of space, creating a laboratory to test the fundamental principles of physics, chemistry, and biology?

- What cutting-edge technologies, processes, techniques, and engineering capabilities must we develop to enable our research agenda?

- How can we enable revolutionary technological advances to provide faster, safer and less expensive air and space travel?

- How can we most effectively transfer knowledge and technology for commercial benefit and to better the quality of life for all Americans?

The NASA Strategic Plan describes how we will pursue our vision, implement our mission, and seek answers to fundamental questions of science and technology that provide the foundation for our goals and objectives. NASA's strategic architecture consists of the following five Strategic Enterprises: Space Science, Earth Science, Human Exploration and the Development of Space, Biological and Physical Research, and Aerospace Technology. These Strategic Enterprises are NASA's primary mission areas.. These goals and objectives represent a balanced set of science, exploration, and technology development outcomes that we believe can be accomplished over the next 25 years.

ENTERPRISE PLANS AND ACCOMPLISHMENTS

Human Exploration and the Development of Space (HEDS)

The HEDS Enterprise seeks to expand the frontiers of space and knowledge by exploring, using, and enabling the development of space. HEDS asks questions to improve human possibilities both on Earth and in space. How do we design systems to make possible safe and efficient human exploration and commercial development of space? What are the resources of the solar system? Where are they? Are they accessible for human use? How can we ensure that humans can be productive in and beyond Earth orbit? HEDS is building the International Space Station to provide a continuously operating research platform and to prepare the way for robotic and human exploration even farther into space.

Space Station

The International Space Station (ISS) is a complex of research laboratories in low Earth orbit in which American, Russian, Canadian, European, and Japanese astronauts are conducting unique scientific and technological investigations in a microgravity environment. The goal of the Station is to support activities requiring the unique attributes of humans in space and establish a permanent human presence in Earth orbit. The President's Budget request provides funding for continued development of the vehicle and for operations in support of continued assembly, logistics resupply, crew exchange, research operations and other utilization. As required by both the Authorization Act (PL 106-391) and the 2002 Appropriations Act (HR 2620), the ISS research budget is transferred to the BPR Enterprise in FY 2002.

Since July 2000, 20 (9 U.S. and 11 Russian) successful Space Station missions have been completed. Flights in calendar year 2001 deployed the U.S. Laboratory, research equipment necessary for conducting experiments on the Space Station, the Canadian robotic arm, the Russian docking compartment, and transported the 3rd and 4th crew expeditions. By mid-calendar year 2001, the U.S. Airlock had been installed, allowing spacewalks to be conducted without the Space Shuttle present, and marking completion of Phase 2 of the Station assembly. The first utilization flight in December 2001 greatly expanded the number of research payloads on-orbit, and raised the number of research investigations initiated to over 40. Crew training, payload processing, hardware element processing, and mission operations were supported without major ground anomalies, and all but two on-orbit subsystems performed above predicted levels.

During 2002, three of the major truss elements constituting the power block will be deployed to orbit, Expeditions 5 and 6 will be deployed, and a second utilization flight will further expand science capabilities. In calendar year 2003, activation of the thermal system will be completed, two of the three remaining solar array modules will be deployed, and both the S6 truss and Node 2, the final components of the U.S. Core, should be delivered to NASA for final integration and pre-flight test and checkout to support planned launches in calendar year 2004.

Consistent with the recommendations from the ISS Management and Cost Evaluation (IMCE) Task Force and the Administration, NASA will develop a Cost Analysis Requirements Description (CARD) to support cost estimates of the U.S. core complete baseline. NASA will also develop an integrated management action plan based on recommendations of the IMCE Task Force, and begin implementation of those actions. A NASA cost estimate, and an independent cost estimate (ICE) of the cost to assemble and operate the U.S. core complete will be completed by September 2002. NASA will also report to the Administration and to Congress its plans for a non-governmental organization (NGO) for ISS research, identify and pursue innovative approaches such as automation and increased crew availability to improve Space Station's research productivity, and the results of discussions with the International Partners regarding ways to increase on-orbit resources for station research.

Space Shuttle

The Space Shuttle is a partially reusable space vehicle that provides several unique capabilities to the United States space program. These include: retrieving payloads from orbit for reuse; servicing and repairing satellites in space; safely transporting humans to and from space; launching ISS components and providing an assembly platform in space; and operating and returning space laboratories. In FY 2001 and FY 2002, the Space Shuttle launched seven flights per year, all of which were assembly and servicing missions for the International Space Station, except for a Hubble Space Telescope Servicing Mission (HST SM-3B). In FY 2003, four flights are planned, all of which are ISS assembly and servicing missions. The President's Budget supports key Space Shuttle safety investments as part of NASA's Integrated Space Transportation Plan, allocates additional funding for infrastructure revitalization and will aggressively pursue Space Shuttle competitive sourcing as an important step in transitioning NASA to purchasing space transportation services where possible.

Payload and Expendable Launch Vehicle (ELV) Support

The Payload Carriers and Support program is the “one-stop shopping provider” for all customer carrier needs and requirements for safe and cost effective access to space via the Space Shuttle. During FY 2001 and 2002, Payload Carriers and Support provided services for every Space Shuttle mission. The ELV Mission Support budget provides funds for technical and management insight of commercial launch services inclduing advanced mission design and analysis and leading-edge integration services for the full range of NASA missions under consideration for launch on ELVs. During FY 2001, eight ELV missions were launched. Integration and technical management of 11 launches, including one secondary, are planned in FY 2002, and in FY 2003, support for ten launches, including one secondary, is planned.

Investments and Support

The Rocket Propulsion Test Support activity will continue to ensure NASA's rocket propulsion test capabilities are properly managed and maintained in world class condition. Engineering and technical base (ETB) activity will continue to support the institutional capability in the operation of space flight laboratories, technical facilities, and testbeds; to conduct independent safety, and reliability assessments; and to stimulate science and technical competence in the United States. The Crew Health and Safety program was transferred from the Biological and Physical Research Enterprise beginning in FY 2003. Funding for other direct costs associated with Human Space Flight, which were funded in the Mission Support account prior to FY 2002, are also funded within investments and support. This includes research and program management costs and non-programmatic construction of facilities costs.

Space Communications and Data Systems

This program supports NASA’s Enterprises and external customers with Space Communications and Data System (SCDS) services that are responsive to customer needs. In addition, the program performs infrastructure upgrades and replenishment efforts necessary to maintain the service capability that satisfy NASA’s approved missions, and conducts technology and standards infusion efforts to provide more efficient and effective services. NASA Headquarters manages and directs an integrated Agency-wide Space Communications and Data Systems program.

Beginning in FY 2002, consistent with NASA’s moves towards full cost, NASA will transfer management and budget responsibility for Space Communications and Data Systems capabilities to those Enterprises that are the primary users of those capabilities. Beginning in FY 2003, the Deep Space Network, Ground Network and Western Aeronautical Test Range will be managed by the Space Science, Earth Science, and Aerospace Technology Enterprises, respectively. The HEDS Enterprise will continue to perform overall program coordination, including the management of Consolidated Space Operations Contract, which is now in its fourth year.

The TDRS-H spacecraft, which completed on-orbit checkout in September 2000, is working well and meets all user service telecommunications performance requirements except for a Multiple Access (MA) performance anomaly. Modifications to the TDRS-I and ¬J spacecraft flight hardware and test program as a result of the MA investigation have been implemented. TDRS-I launch is currently planned for February 2002. The launch of TDRS-J is slated for October 2002.

Safety, Mission Assurance and Engineering

The Safety and Mission Assurance program invests in the safety and success of NASA missions by assuring that sound and robust policies, processes, and tools for safety, reliability, quality assurance, and engineering disciplines are in place and applied throughout NASA. The program also examines long-term technology requirements for NASA's strategic objectives. The Engineering program, managed by the Office of the Chief Engineer (OCE), oversees the conduct and improvement of NASA's engineering practice and independently evaluates ongoing programs, proposed concepts, and options for new programs.

Space Science

The activities of the Space Science Enterprise seek to chart the evolution of the universe, from origins to destiny, and understand its galaxies, stars, planetary bodies, and life. The Enterprise asks basic questions that have eternally perplexed human beings: How did the universe begin and evolve? How did we get here? Where are we going? Are we alone? The Space Science Enterprise develops space observatories and directs robotic spacecraft into the solar system and beyond to investigate the nature of the universe.

The quest for this information, and the answers themselves, maintains scientific leadership, excites and inspires our society, strengthens education and scientific literacy, develops and transfers technologies to promote U.S. competitiveness, fosters international cooperation to enhance programs and share their benefits, and sets the stage for future space ventures.

The Space Science program seeks to answer fundamental questions concerning: the galaxy and the universe; the connection between the Sun, Earth and heliosphere; the origin and evolution of planetary systems; and the origin and distribution of life in the universe. The program is comprised of a base program of' many research and development activities, including flight missions, major space-based facilities, technology and mission development programs, and research and data analysis.

In 2001, the Space Science program produced many notable scientific results.

- The Hubble Space Telescope discovered a supernova blast that occurred very early in the life of the Universe, bolstering the case for the existence of a mysterious form of "dark energy" pervading the Universe.
- Chandra took the deepest X-ray images ever and found the early Universe teeming with black holes, probed the theoretical edge of a black hole's event horizon, and captured the first X-ray flare ever seen from the supermassive black hole at the center of our own Milky Way galaxy.
- Detailed scientific analysis of high-resolution images obtained by the BOOMERANG (Balloon Observations of Millimetric Extragalactic Radiation and Geophysics) mission provided the most precise measurements to date of several of the key characteristics cosmologists use to describe the Universe.

- NASA and National Science Foundation-funded astronomers discovered eight new extrasolar planets, bringing the total number of extrasolar planet detections to about eighty.
- The Deep Space-1 spacecraft successfully navigated past comet Borrelly, giving researchers the best look ever inside a comet's glowing core of ice, dust and gas.
- The NEAR (Near Earth Asteroid Rendezvous) Shoemaker spacecraft achieved the first ever soft landing on an asteroid.
- A pair of spacecraft, the Mars Global Surveyor and the Hubble Space Telescope, provided astronomers with a ringside seat to the biggest global dust storm seen on Mars in several decades.
- The Mars Odyssey 2001 spacecraft successfully achieved orbit around Mars following a six month, 286 million mile journey. Following aerobraking operations, this spacecraft will be placed in its science mapping orbit in early 2002 and will characterize composition of the Martian surface at unprecedented levels of detail.
- The Solar and Heliospheric Observatory (SOHO) observed the largest sunspot in ten years, with a surface area as big as the surface area of thirteen Earths.
- The year was capped by the successful launch of the TIMED (Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics) mission on December 7, 2001 to study a region of the Earth's atmosphere that has never been the subject of a comprehensive, long-term scientific investigation.

The NASA budget request for FY 2003 features two very significant changes from the previous baseline program: a reformulated planetary program and the inclusion of a nuclear power and propulsion program. In the field of planetary exploration, the FY 2003 budget takes a fundamentally different approach from previous years. Given cost growth and schedule delays, all funding for the Pluto-Kuiper Belt mission and the Europa Orbiter mission has been eliminated in FY 2003 and subsequent years. These missions will be replaced by a revamped planetary program that will incorporate the following principles: clear science priorities that support key goals in understanding the potential existence of life beyond Earth and the origins of life,open competition and rigorous reviews of cost, schedule, and risk to minimize future overruns and delays per the highly successful Discovery Program; and an architectural approach that balances science return in this decade with investments in high-leverage technologies that will enable faster and more frequent missions with greater science return in the next decade. It is envisioned that the new planetary program will be structured and managed along the lines of the highly successful Discovery program. A key element of this new program will be the development and incorporation of nuclear power and propulsion technologies. Building upon ongoing NASA investments in advanced electric propulsion and instrument and electronics miniaturization, investments in nuclear power and nuclear-electric propulsion will enable much faster and more frequent planetary investigations with greater science capabilities. These investments will allow NASA to undertake fundamentally new approaches to planetary exploration. In the next decade, nuclear electric propulsion technology will enable affordable missions that: can reach targets in half the time it would take using today's propulsion systems, are not limited by today's power and mass constraints; and can conduct long-term observations of multiple targets.

Nuclear power technology will also be incorporated into the Mars Exploration Program, specifically in the Mars Smart Lander/Mobile Laboratory mission. This mission will now be launched in 2009 to allow the incorporation of nuclear power, instead of 2007 as previously planned. By using nuclear power, the time during which the Mars Mobile Laboratory can conduct science operations will be extended from several months to several years. The nearer-term missions in the Mars Exploration Program remain essentially unchanged. In May and June of 2003, two highly capable surface rovers will be launched to Mars, with landings on the surface expected in April and May of 2004. The Mars Reconnaissance Orbiter (MRO) will be launched in 2005. This powerful scientific orbiter will analyze the surface of Mars at unprecedented levels of detail to follow tantalizing hints of water detected in images from the Mars Global Surveyor spacecraft. MRO will measure thousands of Martian landscapes at 20- to 30-centimeter (8 to 12-inch) resolution. It will be followed by a competitively selected Mars Scout mission in 2007, and then the Smart Lander/Mobile Laboratory in 2009. This robust program of orbiters, landers, and rovers is poised to unravel the secrets of the red planet's past environments, the history of its rocks, the many roles of water and, possibly, evidence of past or present life.

This budget supports the completion of development of many significant missions, including Gravity Probe-B (GP-B), the Space Infrared Telescope Facility (SIRTF), and the Stratospheric Observatory For Infrared Astronomy (SOFIA). GP-B, which will verify a key aspect of Einstein's theory of general relativity, will be launched in October 2002. SIRTF, the fourth and final of the Great Obervatories, is scheduled for launch in FY 2003. SOFIA development activities will continue, with the aircraft door and the telescope being installed and tested in 2003.

Development activities supporting the Solar Terrestrial Relations Observatory (STEREO), the Gamma-ray Large Area Space Telescope (GLAST), the final Hubble Space Telescope servicing mission, as well as several key missions in the payloads program such as Solar-B and Herschel, will also continue in 2003.

In the Explorer progam, the Microwave Anisotropy Probe successfully launched on June 30, 2001, and development of Swift, a multi-wavelength observatory for gamma-ray burst astronomy, remains on schedule for a September, 2003 launch. Another MIDEX mission, the Full-sky Astrometric Mapping Explorer (FAME), did not pass confirmation review due to cost increases and was not approved for full-scale development. Selection of the MIDEX-5 and MIDEX-6 missions will occur in 2002, and an Announcement of Opportunity for MIDEX-7 and MIDEX-8 will be released in 2003. In the Small-class (SMEX) mission series, three NASA missions and two non-NASA Missions of Opportunity are supported. The NASA missions include the Galaxy Evolution Explorer (GALEX), Two Wide-Angle Neutral Atom Spectrometers (TWINS), and the High Energy Solar Spectroscopic Imager (HESSI). The Missions of Opportunity are the Coupled Ion Neutral Dynamics Investigation (CINDI) which is a cooperative mission with the Air Force, and ASTRO E-2, an X-ray astronomy mission (in cooperation with Japan) that will be a rebuild of ASTRO E, which was lost due to a failure of the Japanese launch vehicle in February 2000.

In the Discovery program, the Comet Nucleus Tour (CONTOUR), launched in July 2002, will encounter two comets, comet Encke in 2003 and comet Schwassman Wachman-3 in 2006.

The New Millennium program is providing flight demonstrations of critical new technologies that will reduce the mass and cost of future science and spacecraft subsystems, while maintaining or improving mission capabilities. In 2003, the Nanosat Constellation Trailblazer (Space Technology-5, or ST-5) will undergo spacecraft and instrument integration and test in preparation for launch in 2004. Also in 2003, the Critical Design Review for ST-6, the Confirmation Review for ST-7, and the initial confirmation for ST-8 will be conducted.

The FY 2003 budget also provides funding for focused technology programs in each of the following four major Space Science themes: the Astronomical Search for Origins; Structure and Evolution of the Universe; Solar System Exploration; and Sun-Earth Connections, which includes both the Living With A Star Program and the Solar Terrestrial Probes Program. These funds provide for early technology development in support of strategic missions such as the Next Generation Space Telescope and the Space Interferometry Mission. The goal is to retire technology risk early in a mission's life-cycle, before proceding to full-scale development. Funds are also provided to continue on-going operations of approximately thirty spacecraft, and to conduct robust reasearch and analysis, data analysis, and suborbital research campaigns.

Biological and Physical Research

The Biological and Physical Research (BPR) Enterprise affirms NASA's commitment to the essential role biology will play in the 21^{st} century, and supports the high-priority biological and physical sciences research needed to achieve Agency strategic objectives. BPR will foster and enhance rigorous interdisciplinary research, closely linking fundamental biological and physical sciences in order to develop leading-edge, world-class research programs. BPR is dedicated to using the unique characteristics of the space environment to understand biological, physical, and chemical processes, conducting science and technology research required to enable humans to safely and effectively live and work in space, and transferring knowledge and technologies for Earth benefits. BPR also fosters commercial space research by the private sector towards new or improved products and/or services on Earth, in support of the Agency's mandate to encourage the commercial use of space.

In FY 2001, BPR was created as an independent research organization and a fifth strategic enterprise. During the year, BPR expanded its already significant interagency research efforts, and a BPR investigator received the Nobel Prize in physics for ground-based research that he plans to extend and expand on the ISS. Outfitting the ISS for research began with the delivery of the Human Research Facility in March 2001. Two research equipment racks were delivered to the ISS in mid-April, and an additional two at the beginning of Expedition 3 in August. BPR initiated a program of research on the ISS to take advantage of available resources during the construction phase. The ISS Expedition 1 and 2 Teams were able to meet the research objectives of the planned experiments, with only one unsuccessful experiment (due to technical reasons).

BPR will continue to increase knowledge and demonstrate key technology capabilities for humans in space, address critical questions in crew health and safety, and materials science and commercial research payloads will be flown. The Space Station research program is on-track to deliver added equipment racks to help achieve these goals. BPR is presently working toward completing definition studies and awarding a contract to manage ISS utilization to a Non-Governmental Organization (NGO). Working with the scientific community, its advisory committees, and the Administration, BPR plans to complete the development of research priorities across its portfolio of research endeavors to provide a basis for critical resource allocation decisions and optimize the use of ground- and space-based research capabilities. In the area of public outreach and education, this Enterprise plans to develop electronic and printed educational materials that focus on biological and physical research.

In FY 2003, BPR will implement its research priorities and develop ISS flight facilities to achieve a balanced and productive research program. Lab outfitting will continue with the planned delivery of three racks: the Window Observational Research Facility, Human Research Facility-2, and one EXPRESS Rack. Expeditions 6, 7, and 8 will carry out a variety of investigations in the areas of biomedical, biotechnology, microgravity, materials science, and agriculture research, and conduct Earth observations. Through the “Space Radiation” and “Generations” initiatives, BPR will accelerate its efforts to understand and mitigate the effects of radiation exposure in space, and explore the ability of organisms to evolve in and adapt to the space environment over several generations. BPR will also work with Space Research Museum Network members to explore opportunities for the development of projects, special events, or workshops focused on the life sciences- and biology-related research themes to attract and engage public audiences. In addition, BPR will make available to wide audiences an online database of Commercial Space Center activities, including publications listings, patents, and other information useful to the general public.

Earth Science

The mission of NASA’s Earth Science Enterprise (ESE) is to develop a scientific understanding of the Earth system and its response to natural and human-induced changes to enable improved prediction of climate, weather and natural hazards for present and future generations. The unique vantage-point of space provides information about the Earth's land, atmosphere, ice, oceans, and biota as a global system, which is available in no other way. ESE seeks to answer a question of fundamental importance to science and society: *How is the Earth system changing, and what are the consequences for life on Earth?* To do so, ESE has pioneered the interdisciplinary research field of Earth System Science, which recognizes that the Earth’s land surface, oceans, atmosphere, ice sheets, and life itself all interact in a highly dynamic system. Earth system science is an area of research with immense benefit to the Nation, leading to new knowledge and tools that improve weather forecasting, agriculture, urban and regional planning, environmental quality, and natural disaster management.

ESE has established three goals to pursue in order to fulfill its mission: (1) Science – observe, understand, and model the Earth system to learn how it is changing, and the consequences for life on Earth; (2) Applications – expand and accelerate the realization of economic and societal benefits from Earth science, information, and technology; (3) Technology – develop and adopt advanced technologies to enable mission success and serve national priorities. ESE data products and research are a major contribution to the US Global Change Research Program.

In ESE Science, 2001 was another year of substantial accomplishment toward understanding the Earth system, with new global views of the Earth’s biosphere and global land cover, of changes in the Antarctic and Greenland ice sheets, and of the role of atmospheric aerosols in inhibiting regional rainfall and influencing global climate. ESE also made major advances in computing for climate modeling, using a partnership among two NASA Centers and Silicon Graphics, Inc. to simulate 900 days of Earth's climate in one day, up from the prior capability of 70 days per day; performance on end-to-end climate simulation improved ten-fold. This greatly enhances the climate modelers' ability to perform the multiple runs of many years of climate simulations needed to generate useful projections of climate change. ESE will continue on this trajectory of improvement in computational climate modeling via a new partnership with 3 other agencies and 16 universities to define a shared modeling framework, and partnerships with industy to acquire the needed high-end computing capacity. With these tools, researchers can provide government and industry with the climate projections they need to make sound investment decisions in the years ahead.

In ESE Applications, ESE has entered into a variety of partnerships that will demonstrate the goods and services made possible by ESE’s research. ESE provides QuikSCAT data in real time to the National Oceanic and Atmopsheric (NOAA) Administration to improve marine weather forecasting, and has used these data to show that severe storms forming over the oceans can be predicted two days in advance. ESE is working with the Federal Emergency Management Agency (FEMA) to use remote sensing tools to update their flood plain maps throughout the U.S.. In a partnership called AG 2020 with U.S. Department of Agriculture (USDA) and four growers associations representing 100,000 farmers, ESE is demonstrating how to increase crop productivity, reduce risks to crop health, and manage environmental impacts. With National Institutes of Health (NIH), ESE is exploring the use of satellite data to predict spread of infectious diseases such as malaria that are highly influenced by weather and climate. Throughout the summer, three ESE satellites tracked devastating wildfires in the western U.S., providing data to the U.S. Forest Service (USFS) and regional authorities. As a result, USFS is investing in direct broadcast receiving stations to rapidly acquire data from NASA's Terra satellite.

In ESE Technology, the first ESE New Millennium Program satellite to demonstrate a variety of new technologies for Earth Science successfully completed all of its demonstration tasks except for one high risk propulsion task which is scheduled for near the end of mission life. These include a new instrument to produce a Landsat-type sensor one-fourth the size of the current Landsat 7 instrument, and the first hyper-spectral imager in space, which views the Earth’s land surface in hundreds of spectral channels rather than the conventional 5 to 7. ESE is now working in partnership with the U.S. Navy and NOAA on its next New Millennium mission to make atmospheric temperature and humidity measurements from geostationary orbit. A host of partners in academia and other government labs are working with ESE to develop the next generation of new instruments and smaller, more capable spacecraft.

ESE is in the midst of deployment of the Earth Observing System (EOS), a set of spacecraft and associated interdisciplinary science investigations to initiate a long-term data set of key parameters required for the study of global climate change. The first six EOS satellites are already in orbit, including Jason-1 and Stratospheric Aerosol and Gas Experiment (SAGE) III launched in December 2001. The remaining EOS satellites will be launched through 2004, including Aqua (2002) to study the water cycle and atmospheric circulation to enable the next great advances in weather prediction, and Aura (2004) to probe the chemistry of the upper and lower atmosphere, the latter globally for the first time. Complementing EOS is a series of small, focused Earth System Science Pathfinder missions to explore Earth system processes never before examined globally from space, such as the first precise measurements of the distribution of mass in the interior of the Earth. Data from the EOS satellites already in orbit are being acquired, processed, and distributed by the EOS Data and Information System (EOSDIS), which is currently handling more than 1 terabyte of data per day. EOSDIS handled 12.3 million user queries for over 15 million products in 2000. EOSDIS continues to evolve as new satellites are launched, and as new partners are added to produce data products with innovative applications.

As it deploys EOS, ESE is also planning for the future. ESE and U.S. Geological Survey (USGS) released a request for proposal for Landsat Data Continuity Mission to succeed Landsat 7; it is being implemented as a commercial data purchase. ESE is also planning for the transition of several of its key research observations to the Nation’s weather satellite system. The Department of Defense (DoD), NOAA, and NASA have established an Integrated Program Office (IPO) to create a converged civilian and military weather satellite system called the National Polar-orbiting Operational Environmental Satellite System (NPOESS) to replace the present generation of separate systems. NASA and the IPO are jointly funding the NPOESS Preparatory Project (NPP) that will simultaneously continue key measurements begun by EOS and demonstrate instruments for NPOESS. The NPP will save funding for NASA, DoD, and NOAA by combining essential atmospheric and Earth surface observations on a single platform, and by seeking to meet both climate science and operational weather requirements with the same advanced instruments.

Earth Science is science in the national interest. ESE leading-edge research and technology gives the world a new view of itself, generating new understanding and myriad practical applications in the economy and society. By combining observations from space with computational models of the Earth system, ESE enables predictions of future climate, weather, and natural hazards that government and industry leaders need to make sound decisions in the years ahead.

Aerospace Technology

This Enterprise works to advance U.S. preeminence in aerospace research and technology. The Enterprise aims to radically improve air travel, making it safer, faster, and quieter as well as more affordable, accessible, and environmentally sound. The Enterprise is also working to develop more affordable, reliable, and safe access to space; improve the way in which air and space vehicles are designed and built; and ensure new aerospace technologies are available to benefit the public. NASA, and its predecessor, the National Advisory Committee for Aeronautics, have worked closely with U.S. industry, universities, and other Federal agencies to give the United States a preeminent position in aeronautics. Activities pursued as part of this Enterprise emphasize customer involvement, encompassing U.S. industry, the Department of Defense, the Federal Aviation Administration, and other NASA Enterprises. NASA is playing a leadership role as part of a Government-industry partnership to develop breakthrough technology that will help the aviation community cut the fatal accident rate five-fold within ten years and ten-fold within twenty years. NASA also supports the development of technologies to address airport crowding; aircraft engine emissions, aircraft noise, and other issues that could constrain future U.S. air system growth. NASA's program to advance space transportation is developing new technologies aimed to create a safe, affordable highway through the air and into space. The targeted technologies will reduce launch costs dramatically over the next decade and increase the safety and reliability of current and future generation launch vehicles. NASA's ability to inspire and expand the horizons of present and future generations rests on the success of these efforts to maintain this nation's leadership in aerospace.

The mission of the Aerospace Technology Enterprise is to pioneer the identification, development, verification, transfer, application, and commercialization of high-payoff aerospace technologies. Through its research and technology accomplishments, this Enterprise promotes economic growth and national security by supporting a safe, efficient national aviation system and affordable, reliable space transportation. In addition, the Aerospace Technology Program supports the development of crosscutting technology to serve the needs of all NASA Enterprises.

To meet this challenge, three main technology goals and one goal for commercialization have been established. Within the three technology goals, a set of objectives has been defined to address current and future National needs. The technologies associated with these objectives are pre-competitive, long-term, high-risk research endeavors with high payoff in terms of market growth, safety, low acquisition cost, consumer affordability and a cleaner environment. The first goal, Revolutionize Aviation, addresses the fundamental, systemic issues in the aviation system to ensure continued growth and development appropriate to the needs of the national and global economies. These systemic issues–safety, capacity, environmental compatibility, and mobility–cut across markets including large subsonic civil transports, air cargo, commuter and general aviation. NASA coordinates its investments and technology objectives in this area with the Federal Aviation Administration (FAA) and the DoD through the National Research and Development Plan for Aviation Security, Efficiency, and Environmental Compatibility. The second goal, Advance Space Transportation, will create a safe, affordable highway through the air and into space by improving safety, reliability, and operability, while significantly reducing the cost of space transportation systems. With the creation of the Integrated Space Transportation Plan (ISTP), NASA defined a single, integrated investment strategy for all its diverse space transportation efforts, including: Space Shuttle safety investments and competitive sourcing in this decade; the Space Launch Initiative to replace the Space Shuttle with commercially competitive, privately operated reusable launch systems in the next decade, and far-term investments in revolutionary space transportation technologies. NASA is also working closely with the DoD to coordinate requirements and technology developments for reusable launch vehicles. The third goal, Pioneer Technology Innovation, is unique in that it focuses on broad, crosscutting innovations critical to a number of NASA missions and to the aerospace industry in general. Pursuing technology fields that are in their infancy today, developing the knowledge bases necessary to design radically new aerospace systems, developing technologies to radically improve vehicle and science sensor performance and efficiency, and developing tools for efficient, high-confidence design and development, will enable a revolution in aerospace. The fourth goal, Commercialize Technology, is to extend the commercial application of NASA technology for economic benefit and improved quality of life. By partnering with both aerospace and non-aerospace industry as well as academia, the full range of NASA's assets -- technological expertise, new technologies, and research facilities -- are made available to help the Nation.

The Administration's request includes a significant investment in computing and information technology developments and also increases the investment in biotechnology and nanotechnology -- the revolutionary technologies of the 21st Century. To ensure the highest quality research and strong ties to NASA's mission, these investments will be guided by technology development agreements signed by customers in other NASA Enterprises and subject to external, independent reviews. A significant portion of these investments will be externally competed. The Administration's request supports the implementation of six University-based Research, Education, and Training Institutes (RETIs). This will strengthen NASA's ties to the academic community through long-term sustained investment in areas of science and technology critical to NASA's future. To ensure the highest quality research and training and infusion of new ideas, these RETIs will be subject to independent, external reviews and re-competition at regular intervals, including mandatory sunsets after ten years. The Administration's request also supports a 21st Century aerospace vehicle technology effort. This research will develop and verify critical technologies that provide leapfrog capabilities for aerospace vehicles that will be able to change their shape in flight like birds, to optimize performance, perform complex maneuvers in complete safety, and be capable of self-repair when damaged.

Academic Programs

Academic Programs consists of two components, the Education Program and the Minority University Program. Together, these two components of the Academic Programs budget provide guidance for the Agency's interaction with both the formal and informal education community. Since the creation of NASA, the agency has made a substantial commitment to education. NASA's contribution to education has been and is based on the Agency's inspiring mission, specialized workforce, close working relationship with the research and education community, and unique world-class facilities. Based on these attributes, NASA has created a comprehensive education program containing a portfolio of activities directed toward education at all levels. The guidance for the Education Program stated in the NASA Strategic Plan: "Educational Excellence: We involve the educational community in our endeavors to inspire America’s students, create learning opportunities, and enlighten inquisitive minds.” NASA’s Education Program brings students and educators at all levels into its missions and its research as participants and partners, providing opportunities for a diverse group of students and educators to experience first hand involvement with NASA personnel, facilities, and research and development activities.

The Minority University Research Program has a goal to: expand NASA's research base by strengthening the research capabilities of minority universities and colleges; to contribute to the scientific and technological workforce; and to promote educational excellence. The range of activities conducted under this program will continue to capture the interest of all students in science and technology, develop talented students at the undergraduate and graduate levels, provide research opportunities for students and faculty members at NASA centers, and strengthen and enhance the research capabilities of the Nation's colleges and universities.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
FISCAL YEAR 2003 ESTIMATES
(IN MILLIONS OF REAL YEAR DOLLAR)

	FY 2001* OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
HUMAN SPACE FLIGHT	**7,153.5**	**6,830.1**	**6,130.9**
INTERNATIONAL SPACE STATION	2,127.8	1,721.7	1,492.1
SPACE SHUTTLE	3,118.8	3,272.8	3,208.0
PAYLOAD & ELV SUPPORT	90.0	91.3	87.5
HEDS INVESTMENTS AND SUPPORT	1,247.8	1,214.5	1,178.2
SPACE COMMUNICATIONS & DATA SYSTEMS	521.7	482.2	117.5
SAFETY, MISSION ASSURANCE & ENGINEERING	47.4	47.6	47.6
SCIENCE, AERONAUTICS & TECHNOLOGY	**7,076.5**	**8,047.8**	**8,844.5**
SPACE SCIENCE	2,606.6	2,867.1	3,414.3
BIOLOGICAL & PHYSICAL RESEARCH	362.2	820.0	842.3
EARTH SCIENCE	1,762.2	1,625.7	1,628.4
AEROSPACE TECHNOLOGY	2,212.8	2,507.7	2,815.8
ACADEMIC PROGRAMS	132.7	227.3	143.7
INSPECTOR GENERAL	**22.9**	**23.7**	**24.6**
TOTAL AGENCY	**14,253.2**	**14,901.7**	**15,000.0**

*FY 2001 restructured to reflect two-appropriation structure

NOTE: Full funding for Federal retiree costs not included (see next page)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
FISCAL YEAR 2003 ESTIMATES
(IN MILLIONS OF REAL YEAR DOLLAR)
FEDERAL RETIREE COST DISTRIBUTED BY ENTERPRISE IN FY 2003

	FY 2001* OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
HUMAN SPACE FLIGHT	**7,153.5**	**6,830.1**	**6,172.9**
INTERNATIONAL SPACE STATION	2,127.8	1,721.7	1,492.1
SPACE SHUTTLE	3,118.8	3,272.8	3,208.0
PAYLOAD & ELV SUPPORT	90.0	91.3	87.5
HEDS INVESTMENTS AND SUPPORT	1,247.8	1,214.5	1,220.2
SPACE COMMUNICATIONS & DATA SYSTEMS	521.7	482.2	117.5
SAFETY, MISSION ASSURANCE & ENGINEERING	47.4	47.6	47.6
SCIENCE, AERONAUTICS & TECHNOLOGY	**7,076.5**	**8,047.8**	**8,918.5**
SPACE SCIENCE	2,606.6	2,867.1	3,428.3
BIOLOGICAL & PHYSICAL RESEARCH	362.2	820.0	851.3
EARTH SCIENCE	1,762.2	1,625.7	1,639.4
AEROSPACE TECHNOLOGY	2,212.8	2,507.7	2,855.8
ACADEMIC PROGRAMS	132.7	227.3	143.7
INSPECTOR GENERAL	**22.9**	**23.7**	**25.6**
TOTAL AGENCY	**14,253.2**	**14,901.7**	**15,117.0**
[TOTAL AGENCY INCLUDING RETIREES COST]	**[14,357.2]**	**[15,012.7]**	**15,117.0**

*FY 2001 restructured to reflect two-appropriation structure

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
FISCAL YEAR 2002 ESTIMATES
SUMMARY RECONCILIATION OF APPROPRIATIONS TO BUDGET PLANS
(IN MILLIONS OF REAL YEAR DOLLARS)

	TOTAL	Human Space Flight	Science, Aero & Technology	Mission Support	Inspector General
FISCAL YEAR 2001	**14,035.3**	**5,499.9**	**5,929.4**	**2,584.0**	**22.0**
VA-HUD Independent Agencies Appropriations Act, FY 2001 (P.L. 106-377) as passed by Congress, Direction included in Conference Report (H.R. 106-988)	250.0	-37.0	261.3	24.7	1.0
FY 2001 RESCISSION (P.L. 106-554)	-31.4	-12.0	-13.6	-5.7	-0.05
TRANSFER TO OTHER AGENCIES (P.L. 106-554)	-0.7			-0.7	
LAPSE OF FY 2001 UNOBLIGATED FUNDS	-1.8			-1.79	-0.05
TOTAL FY 2001 BUDGET PLAN	**14,251.4**	**5,450.9**	**6,177.1**	**2,600.5**	**22.9**
FISCAL YEAR 2002 REQUEST	**14,511.4**	**7,296.0**	**7,191.7**	**--**	**23.7**
VA-HUD Independent Agencies Appropriations Act, FY 2002 (P.L.107-33) as passed by Congress, direction included in Conference Report (H.R, 107-272)	281.8	-383.6	665.4		
TRANSFERS PER NATIONAL AERONAUTICS AND SPACE ACT AS AMENDED BY P.L. 106-377	--	-158.3	158.3		
DOD APPROPRIATIONS ACT, FY 2002 (HR 3338)	108.5	76.0	32.5		
TOTAL FY 2002 BUDGET PLAN	**14,901.7**	**6,830.1**	**8,047.9**	**--**	**23.7**

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROPOSED APPROPRIATIONS LANGUAGE

ADMINISTRATIVE PROVISIONS

Notwithstanding the limitation on the availability of funds appropriated for "Human space flight", or "Science, aeronautics and technology" by this appropriations Act, when any activity has been initiated by the incurrence of obligations for construction of facilities as authorized by law, such amount available for such activity shall remain available until expended. This provision does not apply to the amounts appropriated for institutional minor revitalization and construction of facilities, and institutional facility planning and design.

Notwithstanding the limitation on the availability of funds appropriated for "Human space flight", or "Science, aeronautics and technology" by this appropriations Act, the amounts appropriated for construction of facilities shall remain available until September 30, **[**2004**]** *2005.*

Notwithstanding the limitation on the availability of funds appropriated for the "Office of Inspector General", amounts made available by this Act for personnel and related costs and travel expenses of the National Aeronautics and Space Administration shall remain available until September 30, **[**2002**]** *2003* and may be used to enter into contracts for training, investigations, costs associated with personnel relocation, and for other services, to be provided during the next fiscal year. Funds for announced prizes otherwise authorized shall remain available, without fiscal year limitation, until the prize is claimed or the offer is withdrawn.

[No funds in this or any other Appropriations Act may be used to finalize an agreement prior to December 1, 2002 between NASA and a nongovernment organization to conduct research utilization and commercialization management activities of the International Space Station.**]** *(Departments of Veterans Affairs and Housing and Urban Development, and Independent Agencies Appropriations Act, 2002)*

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROPOSED APPROPRIATIONS LANGUAGE

HUMAN SPACE FLIGHT*
(INCLUDING TRANSFER OF FUNDS)

For necessary expenses, not otherwise provided for, in the conduct and support of human space flight research and development activities, including research, development, operations, support and services; maintenance; construction of facilities including repair, rehabilitation, revitalization and modification of facilities, construction of new facilities and additions to existing facilities, facility planning and design, environmental compliance and restoration, and acquisition or condemnation of real property, as authorized by law; space flight, spacecraft control and communications activities including operations, production, and services; program management; personnel and related costs, including uniforms or allowances therefor, as authorized by 5 U.S.C. §§ 5901- 5902; travel expenses; purchase and hire of passenger motor vehicles; not to exceed **[**$20,000**]** *$24,000* for official reception and representation expenses; and purchase, lease, charter, maintenance and operation of mission and administrative aircraft, **[**$6,912,400,000**]** *$6,172,900,000* to remain available until September 30, **[**2003**]** *2004*, of which amounts as determined by the Administrator for salaries and benefits; training, travel and awards; facility and related costs; information technology services; science, engineering, fabricating and testing services; and other administrative services may be transferred to the "Science, aeronautics and technology" in accordance with section 312(b) of the National Aeronautics and Space Act of 1958, as amended by Public Law 106-377. *(Departments of Veterans Affairs and Housing and Urban Development, and Independent Agencies Appropriations Act, 2002; additional authorizing legislation required.)*

** - (includes Federal Retiree Costs – see Special Issues section)*

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROPOSED APPROPRIATIONS LANGUAGE

SCIENCE, AERONAUTICS AND TECHNOLOGY*
(INCLUDING TRANSFER OF FUNDS)

For necessary expenses, not otherwise provided for, in the conduct and support of science, aeronautics and technology research and development activities, including research, development, operations, support and services; maintenance; construction of facilities including repair, rehabilitation, revitalization and modification of facilities, construction of new facilities and additions to existing facilities, facility planning and design, environmental compliance and restoration, and acquisition or condemnation of real property, as authorized by law; space flight, spacecraft control and communications activities including operations, production, and services; program management; personnel and related costs, including uniforms or allowances therefor, as authorized by 5 U.S.C. §§ 5901- 5902; travel expenses; purchase and hire of passenger motor vehicles; not to exceed $20,000 ***[****$24,000****]*** for official reception and representation expenses; and purchase, lease, charter, maintenance and operation of mission and administrative aircraft, **[**$7,857,100,000**]** *$8,918,500,000*, to remain available until September 30, **[**2003**]** *2004*, of which amounts as determined by the Administrator for salaries and benefits; training, travel and awards; facility and related costs; information technology services; science, engineering, fabricating and testing services; and other administrative services may be transferred to the Human Space Flight account in accordance with section 312(b) of the National Aeronautics and Space Act of 1958, as amended by Public Law 106-377**[**, except that no funds may be transferred to the program budget element for Space Station**]**. *(Departments of Veterans Affairs and Housing and Urban Development, and Independent Agencies Appropriations Act, 2002; additional authorizing legislation required.)*

OFFICE OF INSPECTOR GENERAL*

For necessary expenses of the Office of Inspector General in carrying out the Inspector General Act of 1978, as amended, **[**$23,700,000**]** *$25,600,000*. *(Departments of Veterans Affairs and Housing and Urban Development, and Independent Agencies Appropriations Act, 2002; additional authorizing legislation required.)*

** - (includes Federal Retiree Costs – see Special Issues section)*

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 2003 ESTIMATES

DISTRIBUTION OF PROGRAM AMOUNT BY INSTALLATION
(Millions of Dollars)

	Total			Human Space Flight			Science, Aeronautics and Technology		
	2001	2002	2003	2001	2002	2003	2001	2002	2003
Johnson Space Center	4,297.0	4,209.3	3,687.4	4,086.5	3,933.8	3,394.7	210.5	275.5	292.7
Kennedy Space Center	931.9	1,058.5	921.9	699.0	797.8	664.5	232.9	260.7	257.4
Marshall Space Flight Center	2,202.4	2,327.9	2,526.9	1,602.9	1,349.6	1,207.0	599.5	978.3	1,319.9
Stennis Space Center	245.2	198.9	173.8	83.0	89.6	91.2	162.2	109.3	82.6
Ames Research Center	722.2	739.0	708.6	80.9	14.3	7.2	641.3	724.7	701.4
Dryden Flight Research Center	217.6	200.0	193.3	36.9	22.1	10.1	180.7	177.9	183.2
Langley Research Center	664.8	735.3	722.7	19.4	13.8	14.3	645.4	721.5	708.4
Glenn Research Center	641.2	632.8	731.3	125.3	42.2	46.5	515.9	590.6	684.8
Goddard Space Flight Center	2,467.6	2,645.5	2,560.4	183.9	198.0	69.0	2,283.7	2,447.5	2,491.4
Jet Propulsion Laboratory	1,390.8	1,368.6	1,416.4	147.6	185.6	15.2	1,243.2	1,183.0	1,401.2
Headquarters	449.3	762.1	1,332.7	88.1	183.3	611.2	361.2	578.8	721.5
Undistributed:									
Inspector General	22.9	23.7	24.6						
TOTAL NASA	14,253.2	14,901.7	15,000.0	7,153.5	6,830.1	6,130.9	7,076.5	8,047.8	8,844.5

*FY 2001 restructured to reflect new FY 2002 Two Appropriation Structure
**Full funding for Federal Retiree Cost are not included (see Special Issues)

Note: totals may not add due to rounding

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 2003 ESTIMATES
(IN MILLIONS OF REAL YEAR DOLLARS)

	2001 REVISED OP PLAN*	2002 INITIAL** OP PLAN	2003 PRES BUDGET	2004	2005	2006	2007
HUMAN SPACE FLIGHT	**7,153.5**	**6,830.1**	**6,130.9**	**5,868.9**	**5,783.2**	**5,772.7**	**5,886.7**
INTERNATIONAL SPACE STATION	2,127.8	1,721.7	1,492.1	1,195.9	1,072.0	1,091.9	1,110.4
SPACE SHUTTLE	3,118.8	3,272.8	3,208.0	3,301.0	3,305.0	3,258.0	3,287.0
PAYLOAD AND ELV SUPPORT	90.0	91.3	87.5	91.0	92.7	94.6	98.0
INVESTMENTS & SUPPORT	1,247.8	1,214.5	1,178.2	1,159.9	1,185.1	1,201.5	1,262.0
SPACE COMMUNICATIONS & DATA SYSTEMS	521.7	482.2	117.5	73.3	80.6	78.9	81.5
SAFETY, MISSION ASSURANCE, & ENGINEERING	47.4	47.6	47.6	47.8	47.8	47.8	47.8
SCIENCE, AERONAUTICS AND TECHNOLOGY	**7,076.5**	**8,047.8**	**8,844.5**	**9,679.0**	**10,059.7**	**10,474.9**	**10,873.9**
SPACE SCIENCE	2,606.6	2.867.1	3.414.3	3,906.9	4,194.7	4,330.8	4,516.0
BIOLOGICAL & PHYSICAL RESEARCH	362.2	820.0	842.3	883.0	921.8	925.2	954.8
EARTH SCIENCE	1,762.2	1,625.7	1,628.4	1,620.5	1,629.3	1,681.5	1,721.1
AEROSPACE TECHNOLOGY	2,212.8	2,507.7	2,815.8	3,124.9	3,170.3	3,393.7	3,538.3
ACADEMIC PROGRAMS	132.7	227.3	143.7	143.7	143.7	143.7	143.7
INSPECTOR GENERAL	**22.9**	**23.7**	**24.6**	**25.5**	**26.5**	**27.4**	**28.4**
FULL FUNDING FEDERAL RETIREES COST* **	**[104.0]**	**[111.0]**	**117.0**	**117.0**	**117.0**	**117.0**	**117.0**
TOTAL INCLUDING FEDERAL RETIREES COST	**[14,357.2]**	**[15,012.7]**	**15,117.0**	**15,690.4**	**15,986.4**	**16,392.0**	**16,906.0**
TOTAL EXCLUDING FEDERAL RETIREES COST	**14,253.2**	**14,901.7**	**15,000.0**	**15,573.4**	**15,869.4**	**16,275.0**	**16,789.0**

*FY 2001 restructured to reflect new FY 2002 Two Appropriation Structure
**FY 2002 includes $108.5M for Emergency Response Fund
***Funding for Federal Retirees Cost FY04 thru FY07 is a placeholder estimate

Note: totals may not add due to rounding

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 2003 ESTIMATES
(IN MILLIONS OF REAL YEAR DOLLARS)

For display purposes only – appropriated budgets for FY 2001 and FY 2002 are different	2001 RESTRUCTURED*	2002** RESTRUCTURED*	2003 PRES BUDGET	2004	2005	2006	2007
HUMAN SPACE FLIGHT	**6,366.9**	**6,604.2**	**6,130.9**	**5,868.9**	**5,783.2**	**5,772.7**	**5,886.7**
INTERNATIONAL SPACE STATION	1,670.5	1,721.7	1,492.1	1,195.9	1,072.0	1,091.9	1,110.4
SPACE SHUTTLE	3,118.8	3,272.8	3,208.0	3,301.0	3,305.0	3,258.0	3,287.0
PAYLOAD AND ELV SUPPORT	90.0	91.3	87.5	91.0	92.7	94.6	98.0
INVESTMENTS & SUPPORT	1,106.8	1,194.5	1,178.2	1,159.9	1,185.1	1,201.5	1,262.0
SPACE COMMUNICATIONS & DATA SYSTEMS	333.4	276.3	117.5	73.3	80.6	78.9	81.5
SAFETY, MISSION ASSURANCE, & ENGINEERING	47.4	47.6	47.6	47.8	47.8	47.8	47.8
SCIENCE, AERONAUTICS AND TECHNOLOGY	**7,863.1**	**8,273.7**	**8,844.5**	**9,679.0**	**10,059.7**	**10,474.9**	**10,873.9**
SPACE SCIENCE	2,748.8	3,021.4	3.414.3	3,906.9	4,194.7	4,330.8	4,516.0
BIOLOGICAL & PHYSICAL RESEARCH	940.5	820.0	842.3	883.0	921.8	925.2	954.8
EARTH SCIENCE	1,815.8	1,685.3	1,628.4	1,620.5	1,629.3	1,681.5	1,721.1
AEROSPACE TECHNOLOGY	2,225.3	2,519.7	2,815.8	3,124.9	3,170.3	3,393.7	3,538.3
ACADEMIC PROGRAMS	132.7	227.3	143.7	143.7	143.7	143.7	143.7
INSPECTOR GENERAL	**22.9**	**23.7**	**24.6**	**25.5**	**26.5**	**27.4**	**28.4**
FULL FUNDING FEDERAL RETIREES COST* **	**[104.0]**	**[111.0]**	**117.0**	**117.0**	**117.0**	**117.0**	**117.0**
TOTAL INCLUDIDNG FEDERAL RETIREES COST	**[14,357.2]**	**[15,012.7]**	**15,117.0**	**15,690.4**	**15,986.4**	**16,392.0**	**16,906.0**
TOTAL EXCLUDING FEDERAL RETIREES COST	**14,253.2**	**14,901.7**	**15,000.0**	**15,573.4**	**15,869.4**	**16,275.0**	**16,789.0**

* FY 2001 and FY 2002 have been restructured to reflect the program and institutional transfers that were made in FY 2003. The following transfers were made: 1) ISS Research transferred from Space Station and corresponding institutional support from HEDS Investment & Support to Biological & Physical Research; 2) Deep Space Network was transferred from Space Communication & Data Systems to Space Science; 3) Ground Network was transferred from Space Communication & Data Systems and institutional support from HEDS Investment to Earth Science; and 4) Western Aeronautical Test Range was transferred from Space Communication & Data Systems and institutional support from HEDS Investment to Aerospace Technology.

**FY 2002 includes $108.5M for Emergency Response Fund

Note: totals may not add due to rounding

***Funding for Federal Retirees Cost FY04 thru FY07 is a placeholder estimate

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
FISCAL YEAR 2003 ESTIMATES
(IN MILLIONS OF REAL YEAR DOLLAR)
FEDERAL RETIREES COST DISTRIBUTED BY ENTERPRISE

For Display Purposes Only

	FY 2001	FY 2002 EXCLUDES EMERGENCY RESPONSE FUNDS	FY 2002 INCLUDES EMERGENCY RESPONSE FUNDS	FY 2003
HUMAN SPACE FLIGHT	**7,198.5**	**6,797.1**	**6,873.1**	**6,172.9**
INTERNATIONAL SPACE STATION	2,127.8	1,721.7	1,721.7	1,492.1
SPACE SHUTTLE	3,118.8	3,272.8	3,272.8	3,208.0
PAYLOAD & ELV SUPPORT	90.0	91.3	91.3	87.5
HEDS INVESTMENTS AND SUPPORT	1,292.8	1,181.5	1,257.5	1,220.2
SPACE COMMUNICATIONS & DATA SYSTEMS	521.7	482.2	482.2	117.5
SAFETY, MISSION ASSURANCE & ENGINEERING	47.4	47.6	47.6	47.6
SCIENCE, AERONAUTICS & TECHNOLOGY	**7,134.5**	**8,082.3**	**8,114.8**	**8,918.5**
SPACE SCIENCE	2,617.6	2,872.7	2,880.1	3,428.3
BIOLOGICAL & PHYSICAL RESEARCH	365.2	823.5	828.0	851.3
EARTH SCIENCE	1,771.2	1,631.2	1,635.7	1,639.4
AEROSPACE TECHNOLOGY	2,247.8	2,527.6	2,543.7	2,855.6
ACADEMIC PROGRAMS	132.7	227.3	227.3	143.7
INSPECTOR GENERAL	**23.9**	**24.7**	**24.7**	**25.6**
SUBTOTAL AGENCY	**14,357.2**	**14,904.2**	**15,012.7**	**15,117.0**
EMERGENCY RESPONSE FUND		**108.5**		
TOTAL AGENCY		**15,012.7**		

*FY 2001 restructured to reflect new FY 2002 Two Appropriation Structure

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

HUMAN SPACE FLIGHT

FISCAL YEAR 2003 ESTIMATES
(IN MILLIONS OF REAL YEAR DOLLARS)

SUMMARY OF RESOURCE REQUIREMENTS

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
		(Millions of Dollars)	
International Space Station *	2,127.8	1,721.7	1,492.1
Space Shuttle	3,118.8	3,272.8	3,208.0
Payload and ELV Support	90.0	91.3	87.5
Space Communications and Data Systems**	521.7	482.2	117.5
Investments and Support***	1,247.8	1,214.5	1,178.2
Safety, Mission Assurance and Engineering****	47.4	47.6	47.6
Total	**7,153.5**	**6,830.1**	**6,130.9**
Distribution of Program Amount by Installation			
Johnson Space Center	4,086.6	3,933.7	3,372.6
Kennedy Space Center	669.1	797.9	664.5
Marshall Space Flight Center	1,602.8	1,349.4	1,239.5
Stennis Space Center	82.9	89.6	91.1
Ames Research Center	81.1	14.3	7.2
Dryden Flight Research Center	36.8	22.0	10.1
Glenn Research Center	125.3	42.3	46.5
Langley Research Center	19.3	13.8	14.3
Goddard Space Flight Center	183.9	198.1	68.9
Jet Propulsion Laboratory	147.7	185.7	15.3
Headquarters	88.0	183.3	600.9
Total	**7,153.5**	**6,830.1**	**6,130.9**

** - In FY 2002 and outyears, funding for International Space Station Research is included in the Science, Aeronautics, and Technology Appropriation (as part of Biological and Physical Research)*
*** In FY 2001, Space Communications and Data Systems was included in the Science, Aeronautics and Technology Appropriation (as Space Operations). In FY 2003, budget reflects the transfer of management of several major networks (Deep Space Network, Ground Network, Western Aeronautical Test Range) to other enterprises.*
**** In FY 2002, Investments and Support includes other-than-direct costs for Human Space Flight which were previously included in the Mission Support appropriation*
*****In FY 2001, SMA&E were included in the Mission Support Appropriation*

STRATEGIC PLAN LINKAGE TO THIS BUDGET

As America enters a new millennium, people the world over are reflecting on the accomplishments of the past and speculating about opportunities of the future. Some of the most inspiring and important accomplishments of the past four decades have resulted from the space program. Events such as the planet-wide impact of the Apollo landings on the moon and images of the Earth; discoveries such as the astonishing Hubble Space Telescope (HST) photos of solar system formation; achievements such as the sending of the first human-built spacecraft—Pioneer and Voyager spacecraft—beyond our solar system; and new capabilities such as communications and weather satellites. Space has touched the lives of many hundreds of millions worldwide.

The mission of HEDS is to expand the frontiers of space and knowledge by exploring, using, and enabling the development of space for human enterprise. To achieve this mission, NASA's Human Exploration and Development of Space (HEDS) Enterprise is pursuing four strategic goals:

- Explore the space frontier
- Enable humans to live and work permanently in space
- Enable the commercial development of space, and
- Share the experience and benefits of discovery

HEDS begins with the foundation of the Space Shuttle and the International Space Station, now fully functional and supporting scientific research while continuing construction in Earth orbit, and look to the future by fostering technology development and commercialization in space.

HEDS also aspires to make possible U.S. leadership of international efforts to extend permanently human presence beyond the bounds of Earth, involving both machines and humans as partners in innovative approaches to exploration. HEDS engages the private sector in the commercial development of space in order to enable the continuation of current space business and the creation of new wealth and new jobs for the U.S. economy.

Accomplishment of these goals will enable historic improvements in our understanding of nature, in human accomplishment, and in the quality of life. The Human Exploration and Development of Space Strategic Plan is a first step. The performance plan shows how we plan to measure our success.

Goal 1 - Explore the Space Frontier

There are certain ideas that many believe to be inherent in the human psyche and integral to American culture: ambition for progress, curiosity about the unknown, the need to pose profound questions and to answer them, the concept of new frontiers that—once achieved—promise a better quality of life for all peoples. Space is such a frontier. Earth orbit, the Moon, near-Earth space, Mars and the asteroids, eventually the moons of the giant planets of the outer solar system, and someday more distant worlds—these are collectively the endless, ever-expanding frontier of the night sky under which the human species evolved and toward which the human spirit is inevitably drawn. It is a fundamental goal of NASA to expand the space frontier progressively through human exploration, utilization of space for research, and commercial development.

Strategic Objectives

- Invest in the development of high-leverage technologies to enable safe, effective and affordable human/robotic exploration.
- Conduct engineering research on the International Space Station to enable exploration beyond Earth orbit.
- Enable human exploration through collaborative robotic missions. (funded in Science, Aeronautics, and Technology appropriation)
- Define innovative human exploration mission approaches.
- Develop exploration/commercial capabilities through private sector and international partnerships.

Goal 2 - Enable Humans to Live and Work Permanently in Space

Advances in technology notwithstanding, the human element continues to be the major factor in the success or failure of most terrestrial enterprises. In many cases, innovative technologies are most effective when used to leverage or enhance the productivity of humans. Moreover, the human element is a quintessential component in the public's continuing interest in, and support for the space program. Human presence will be an essential factor in successfully opening the space frontier and expanding knowledge through research in space. As our activities in space grow, so too must human involvement. In this way, we open the door to an array of benefits, tangible and intangible, for the people of the United States and the world. It is, therefore, a goal of NASA to enable and establish permanent and productive human presence in space, to advance America's aspirations and opportunities in space through new technologies and new ways of doing business.

Strategic Objectives

- Provide and make use of safe, affordable, and improved access to space.
- Operate the International Space Station to advance science, exploration, engineering, and commerce.
- Ensure the health, safety, and performance of humans living and working in space.
- Meet sustained space operations needs while reducing costs.

Goal 3 - Enable the Commercial Development of Space

Commerce is essential to human society; free market transactions are the foundation of the dramatic progress humankind has made during the past several centuries. Wherever humans go and wherever they live, there too is commerce. Moreover, the free market is an effective mechanism for delivering tangible benefits from space broadly to the American people.

If humanity is to explore and develop space, to better exploit the space environment for profound scientific discoveries, and someday to settle the space frontier, it may be through the continuing expansion of the private sector—of individuals and of industry—into space. As the space frontier opens, it is important must therefore seek to expand the free market into space.

It is a goal of NASA to enable the commercial development of space.

Strategic Objectives

- Improve the accessibility of space to meet the needs of commercial research and development.
- Foster commercial endeavors with the International Space Station and other assets.
- Develop new capabilities for human space flight and commercial applications through partnerships with the private sector.

Goal 4 - Share the Experience and Benefits of Discovery

Americans—of all backgrounds—should have the opportunity to share in the experience and benefits of space exploration and development. During the past four decades, ambitious human space flight missions have inspired generations of young people to undertake careers in science, mathematics, and engineering— benefiting both themselves and society. The space program can enrich society by directly enhancing the quality of education. Terrestrial applications of technologies developed for space have saved many lives, made possible medical breakthroughs, created countless jobs, and yielded diverse other tangible benefits for Americans. The further commercial development of space will yield still more jobs, technologies, and capabilities to benefit people the world over in their everyday lives. A goal of NASA is therefore to share the experience, the excitement of discovery, and the benefits of human space flight with all.

Strategic Objectives

- Engage and involve the public in the excitement and the benefits of and in setting the goals for the exploration and development of space.
- Provide significantly more value to significantly more people through exploration and space development efforts.
- Advance the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROPOSED APPROPRIATION LANGUAGE

HUMAN SPACE FLIGHT
(INCLUDING TRANSFER OF FUNDS)

For necessary expenses, not otherwise provided for, in the conduct and support of human space flight research and development activities, including research, development, operations, support and services; maintenance; construction of facilities including repair, rehabilitation, revitalization and modification of facilities, construction of new facilities and additions to existing facilities, facility planning and design, environmental compliance and restoration, and acquisition or condemnation of real property, as authorized by law; space flight, spacecraft control and communications activities including operations, production, and services; program management; personnel and related costs, including uniforms or allowances therefore, as authorized by 5 U.S.C. §§ 5901- 5902; travel expenses; purchase and hire of passenger motor vehicles; not to exceed **[**$20,000**]** *$24,000* for official reception and representation expenses; and purchase, lease, charter, maintenance and operation of mission and administrative aircraft, **[**$6,912,400,000**]** *$6,172,900,000* to remain available until September 30, **[**2003**]** *2004*, of which amounts as determined by the Administrator for salaries and benefits; training, travel and awards; facility and related costs; information technology services; science, engineering, fabricating and testing services; and other administrative services may be transferred to the "Science, aeronautics and technology" in accordance with section 312(b) of the National Aeronautics and Space Act of 1958, as amended by Public Law 106-377. *(Departments of Veterans Affairs and Housing and Urban Development, and Independent Agencies Appropriations Act, 2002; additional authorizing legislation required.)*

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

HUMAN SPACE FLIGHT

FISCAL YEAR 2003 REIMBURSABLE ESTIMATES
(IN MILLIONS OF REAL YEAR DOLLARS)

	FY 2001 OPLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
International Space Station	--	0.1	0.1
Space Shuttle	9.4	4.4	4.4
Payload and ELV Support	9.2	1.3	1.1
Space Communications and Data Systems*	--	49.6	46.5
Investments and Support**	157.6	191.8	97.2****
Safety, Mission Assurance and Engineering***	--	0.3	0.3
Total	**176.2**	**247.5**	**149.6**

]

** In FY 2001, Space Communications and Data Systems was included in the Science, Aeronautics and Technology Appropriation (as Space Operations*

*** In FY 2002, Investments and Support includes other-than-direct costs for Human Space Flight which were previously included in the Mission Support appropriation*

**** In FY 2001, SMA&E were included in the Mission Support Appropriation*

***** In FY 2003, reimbursable estimates for Investments and Support are understated by $92.6M due to omission of estimates for reimbursables from the 45th Space Wing at Patrick Air Force Base and Cape Canaveral Air Force Station.*

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 2003 ESTIMATES

DISTRIBUTION OF HUMAN SPACE FLIGHT BY INSTALLATION
(Millions of Dollars)

Program		Total	Johnson Space Center	Kennedy Space Center	Marshall Space Flight Center	Stennis Space Center	Ames Research Center	Dryden Flight Research Center	Langley Research Center	Glenn Research Center	Goddard Space Flight Center	Jet Propulsion Lab	Headquarters
Space Station	2001	2,127.8	1,549.5	113.2	288.9		61.5	6.2	4.1	71.0	13.0	13.8	6.6
	2002	1,721.7	1,500.5	97.0	75.1		0.2	1.0	0.1	3.8	2.5		41.5
	2003	1,492.1	1,162.9	95.3	61.9		0.2		0.1	4.2			167.5
Space Shuttle	2001	3,118.8	1,847.8	174.8	1,035.2	39.8	2.0	4.8	0.3		10.9		3.2
	2002	3,272.8	1,989.8	209.1	1,002.6	44.3	2.0	4.6			8.0		12.4
	2003	3,208.0	1,778.2	164.7	887.1	45.4		5.5			3.0		324.1
Paylaod and ELV Support	2001	90.0	1.4	73.6	3.9						11.1		
	2002	91.3	1.3	76.4	2.7						10.9		
	2003	87.5	1.3	74.3	1.8						10.1		
Investments and Support	2001	1,247.8	433.0	299.9	262.2	43.1	16.3	12.9	9.1	43.2	53.4	2.6	72.1
	2002	1,214.5	408.1	340.4	193.3	45.1	11.5	3.9	8.2	32.4	53.4	2.7	115.5
	2003	1,178.2	422.6	320.6	195.5	45.4	6.0	3.6	8.4	36.8	29.0	0.4	109.9
Space Communications and Data Systems	2001	521.7	247.6	37.1	9.5			12.8		8.6	79.9	123.9	2.3
	2002	482.2	26.9	74.2	72.8			12.4		3.5	111.0	175.2	6.2
	2003	117.5	21.0	8.9	57.1					3.4	14.3	7.5	5.3
Safety, Mission Assurance and Engineering	2001	47.4	7.2	0.4	3.2	0.1	1.2	0.2	5.9	2.5	15.6	7.3	3.9
	2002	47.6	7.2	0.7	3.1	0.2	0.6	0.2	5.5	2.5	12.2	7.7	7.7
	2003	47.6	8.7	0.7	3.6	0.4	1.0	1.0	5.8	2.1	12.6	7.3	4.4
TOTAL HUMAN SPACE FLIGHT	2001	7,153.5	4,086.5	699.0	1,602.9	83.0	80.9	36.9	19.4	125.3	183.9	147.6	88.1
	2002	6,830.1	3,933.8	797.8	1,349.6	89.6	14.3	22.1	13.8	42.2	198.0	185.6	183.3
	2003	6,130.9	3,394.7	664.5	1,207.0	91.2	7.2	10.1	14.3	46.5	69.0	15.2	611.2

*FY 2001 restructured to reflect new FY 2002 Two Appropriation Structure

**Full funding for Federal Retiree Cost are not included (see Special Issues)

Note: totals may not add due to rounding

HUMAN SPACE FLIGHT

FY 2003 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE FLIGHT | **SPACE STATION**

SUMMARY OF RESOURCE REQUIREMENTS

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET	Page Number
	(Millions of Dollars)			
Vehicle	751.9	369.1	292.3	HSF 1-5
Operations Capability	824.7	1,312.6	1,199.8	HSF 1-11
[Construction of Facilities included]	[0.3]	[5.0]	--	
Research *	457.4	[371.3]	[347.2]	HSF 1-20
Russian Program Assurance	24.0	--	--	HSF 1-21
Crew Return Vehicle	69.8	40.0	--	HSF 1-23
Total	2,127.8	1,721.7	1,492.1	

Distribution of Program Amount by Installation

	FY 2001	FY 2002	FY 2003
Johnson Space Center	1,549.5	1,500.5	1,162.9
Kennedy Space Center	113.2	97.0	95.3
Marshall Space Flight Center	288.9	75.1	61.9
Ames Research Center	61.5	0.2	0.2
Langley Research Center	4.1	0.1	0.1
Glenn Research Center	71.0	3.8	4.2
Goddard Space Flight Center	13.0	2.5	--
Jet Propulsion Laboratory	13.8	--	--
Dryden Flight Research Center	6.2	1.0	--
Stennis Space Center	--	--	--
Headquarters**	6.6	41.5	167.5
Total	2,127.8	1,721.7	1,492.1

* The International Space Station Research program and funding was transferred to the Biological and Physical Research (BPR) enterprise, beginning in FY 2002 and now is included in the Science, Aeronautics and Technology appropriation account. FY 2002 and 2003 funding is shown for comparison purposes only on a non-add basis.

** Headquarters funding in FY 2002-2003 consists largely of program reserves that will ultimately be provided to the performing centers.

STRATEGIC PLAN LINKAGE TO THIS BUDGET

The mission of the HEDS is to expand the frontiers of space and knowledge by exploring, using, and enabling the development of space for human enterprise. The Space Station program plays a vital role meeting the following goals: Goal 1 - Explore the space frontier; Goal 2 – Enable humans to live and work permanently in space; Goal 3 – Enable the commercial development of space; and Goal 4 – Share the experience and benefits of discovery.

The International Space Station (ISS) is a complex of research laboratories in low Earth orbit in which American, Russian, Canadian, European, and Japanese astronauts are conducting unique scientific and technological investigations in a microgravity environment. The goal of the Station is to support scientific research and other activities requiring the unique attributes of humans in space and establish a permanent human presence in Earth orbit. The President's Budget request provides funding for continued development of the vehicle and for operations in support of continued assembly, logistics resupply, crew exchange, research operations and other utilization. With nine assembly missions successfully completed, the budget includes funding to keep subsequent assembly missions on schedule through U.S. Core Complete (Flight 10A), currently planned for calendar year 2004, to support early research commensurate with the build-up of on-orbit utilization capabilities and resources.

The ISS will vastly expand the human experience in living and working in space, encourage and enable commercial development of space, and provide a capability to perform unique, long duration, space-based research in cell and developmental biology, plant biology, human physiology, fluid physics, combustion science, materials science and fundamental physics. ISS will also provide a unique platform for making observations of the Earth's surface and atmosphere, the sun, and other astronomical objects. The experience and dramatic results obtained from the use of the ISS will guide the future direction of the Human Exploration and Development of Space (HEDS) Enterprise. The International Space Station is critical to NASA's ability to fulfill its mission to explore, use, and enable the development of space for human enterprise.

The ISS represents an unprecedented level of international cooperation. Space Station Partnership agencies include NASA, the Russian Aviation and Space Agency (Rosaviakosmos), the Canadian Space Agency (CSA), the European Space Agency (ESA), and the National Space Development Agency of Japan (NASDA). Additionally, there are several bilateral agreements between NASA and other nations such as Italy and Brazil, resulting in a total number of fifteen U.S. international partners. International participation in the program has significantly enhanced the capabilities of the ISS.

Extensive coordination with the user community is well underway, and payload facilities development and research and technology activities are coordinated with the Office of Biological and Physical Research (OBPR), the Office of Earth Science (OES) and the

Office of Space Science (OSS). OBPR gained administrative responsibility for the ISS Research program starting in FY 2000, and, as required by both the Authorization Act (PL 106-391) and the 2002 Appropriations Act (HR 2620), the ISS research budget is transferred to the Office of Biological and Physical Research (OBPR) in FY 2002. The remaining ISS budget supports operations and completion of the U.S. core complete and allows the program to press ahead with the integration of the partners' research modules. A NASA cost estimate, and an independent cost estimate (ICE) of the cost to assemble and operate the U.S. core complete will be completed by September 2002. The 2002 appropriation directed a general reduction in the station budget of $75M, which eliminated reserves fenced for guaranteed carryover into 2003. The appropriation also earmarked $40M for X-38 efforts that was originally planned to cover X-38 plus continued work on Node 3 and the advanced environmental control system. NASA plans to fund the Node 3 and environmental control work into the 2nd quarter of 2002, when a decision will be made to continue those efforts or to cancel them.

In early calendar year 2001, NASA launched the U.S. Laboratory and the first major set of U.S. research equipment necessary for conducting experiments on the Space Station. Subsequent flights enabled the installation of the Canadian robotic arm, additional research equipment for the U.S. laboratory, installation of the Russian docking compartment, and transport of the 3rd and 4th crew expeditions. By mid-calendar year 2001, the U.S. Airlock had been installed, allowing spacewalks to be conducted without the Space Shuttle present, and marking completion of Phase 2 of the station assembly. The first utilization flight in December 2001 greatly expanded the number of research payloads on-orbit, and raised the number of research investigations initiated to over 40. Crew training, payload processing, hardware element processing, and mission operations were supported without major ground anomalies, and all but two on-orbit subsystems performed above predicted levels, resulting in a lower than expected maintenance work load. This lower maintenance workload, coupled with the commitment of the expedition crews to dedicate time for conducting research experiments, resulted in research activities that exceeded expectations. During 2002, 3 of the major truss elements constituting the power block will be deployed to orbit, Expeditions 5 and 6 will be deployed, and a second utilization flight will expand science capabilities even further. In calendar year 2003, activation of the thermal system will be completed, two of the three remaining solar array modules will be deployed, and both the S6 truss and Node 2, the final components of the U.S. Core, should be delivered to NASA for final integration and pre-flight test and checkout to support planned launches in calendar year 2004.

Consistent with the recommendations in the ISS Management and Cost Evaluation (IMCE) Task Force, and direction from the Administration, NASA will develop a Cost Analysis Requirements Description (CARD) to support cost estimates of the U.S. core complete baseline. NASA will also develop an integrated management action plan based on recommendations of the IMCE Task Force, and begin implementation of those actions. NASA will also report to the Administration and to Congress its plans for a non-governmental organization (NGO) for ISS research, and the results of discussions with the International Partners on ways to increase on-orbit resources for station research, in particular innovative methods for increasing crew availability. The ISS Program is pressing ahead with final flight hardware deliveries, and completion of the current Prime contract in December 2003. Requirements for follow-on support are being reviewed and estimated, and a plan to competitively award contracts for the station's operations phase will be released this Spring.

COMPLIANCE WITH COST LIMITATIONS

NASA's evaluation of this budget is that the Space Station is within the $25 billion cost limitation imposed in the NASA Authorization Act of 2000 (P.L. 106-391), and that the Space Shuttle flights supporting the ISS are within the $17.7 billion cost limitation imposed by that Act. This is based on the assumption that the point at which substantial completion will be reached will occur in FY 2004 when the U.S. Core capability is reached. Total Space Station program from FY 1994 through FY 2004 is projected at $23.4 billion in this budget (values are based on direct program budgets, including the ISS Research budgets in the Biological and Physical Research enterprise). Approximately 23 Shuttle flights are projected to be required to reach this point (Flight 10A), and another 9 flights to support ISS logistics and the assembly flights of the international partners' elements. Based on the $380 million per flight valuation in H.R. 1654, the value of 32 Shuttle flights is approximately $12.2 billion. Of the $17.919 billion appropriated for space station activities from FY 1994 through FY 2001, only $115 million remained unobligated as of September 30, 2001, and these funds are expected to be obligated in the course of FY 2002 ISS performance. A separate report required by the Act will be prepared and submitted.

BASIS OF FY 2003 FUNDING REQUIREMENT

VEHICLE

	FY 2001	FY 2002	FY 2003
Flight hardware	702.0	318.7	250.0
Test, manufacturing and assembly	47.5	50.4	42.3
Transportation support	2.4	--	--
Total	751.9	369.1	292.3

DESCRIPTION/JUSTIFICATION

Vehicle development of the International Space Station (ISS) provides an on-orbit, habitable laboratory for science and research activities, including flight and test hardware and software, flight demonstrations for risk mitigation, facility construction, Shuttle hardware and integration for assembly and operation of the station, mission planning, and integration of Space Station systems.

Responsibility for providing Space Station elements is shared between the U.S. and our international partners from Russia, Europe, Japan, and Canada. The U.S. elements include nodes, a laboratory module, airlock, truss segments, photovoltaic arrays, three pressurized mating adapters, unpressurized logistics carriers, and a cupola. Various systems are also being developed by the U.S., including thermal control, life support, navigation, command and data handling, power systems, and internal audio/video. The U.S. funded elements also include the Zarya propulsion module provided by a Russian firm under the Boeing prime contract. Zarya was the first ISS element launched to orbit. Other U.S. elements being provided through bilateral agreements include the pressurized logistics modules provided by the Italian Space Agency, Nodes 2 and 3 provided by ESA, and the centrifuge accommodation module (CAM) and centrifuge provided by the Japanese.

Canada, member states of ESA, Japan, and Russia are also responsible for providing a number of ISS elements. The Japanese, ESA, and Russia will provide laboratory modules. Canada will provide a remote manipulator system, vital for assembly and maintenance of the station. The Russian Aviation and Space Agency (Rosaviakosmos) is also providing significant ISS infrastructure elements including the Service Module (SM), science power platform, Soyuz crew transfer and emergency crew return vehicle, Progress resupply vehicles, and universal docking modules.

FY 2001 activities established a permanent crew on the ISS, deployed the first U.S. solar array to provide power, launched and activated the U.S. Lab, including the capability for control and communication, and deployed the airlock, completing Phase 2 of the program and allowing spacewalks to be conducted without the Space Shuttle present.

The Boeing Company is the prime contractor for the design and development of U.S. elements of the International Space Station. It also has prime responsibility for integration of all U.S. and International Partner contributions and for assembly of the ISS. At their Huntington Beach site location (formerly McDonnell Douglas), Boeing is developing and building the integrated truss segments that support station elements and house essential systems, including central power distribution, thermal distribution, and attitude control equipment. Additionally, major components of the communications and data handling, thermal control, and the guidance, navigation and control subsystems are being developed at Huntington Beach.

U.S. pressurized modules were developed by Boeing at their Huntsville site location, and by ESA. Flights to ISS have successfully deployed Unity, a pressurized node which contains four radial and two axial berthing ports, three pressurized mating adapters (PMAs), which serve as docking locations, the U.S. Laboratory Module and the Multi-Purpose Pressurized Logistics Module. Under a bilateral agreement, ESA is providing Nodes 2 and 3 and a cupola to the U.S. Node 2 is currently manifested for flight during the second quarter of FY 2004. The remaining elements are under discussion with ESA in the context of the Core Complete configuration.

The power truss segments and power system, essential to the Station's housekeeping operations and scientific payloads, are being built by Boeing at their Canoga Park location (formerly Rocketdyne Division, Rockwell International). Four photovoltaic (PV) elements, each containing a mast, rotary joint, radiator, arrays, and associated power storage and conditioning elements, comprise the power system. The first PV element was deployed in November 2000 and is successfully operating. The launch date for the fourth power array was accelerated and is now part of the U.S. Core configuration, planned as early as the second quarter of FY 2004.

The vehicle program also includes test, manufacturing and assembly support for critical NASA center activities and institutional support. These “in-line” products and services include: test capabilities; the provision of government-furnished equipment (GFE) (including flight crew systems, environment control and life support systems, communications and tracking, and extravehicular activity (EVA) equipment); and engineering analyses. As such, they support the work of the prime contractor, its major subcontractors and NASA system engineering and integration efforts.

Transportation support provides those activities that allow the Space Shuttle to dock with the Space Station. This budget funded the development and procurement of two external Shuttle airlocks, and upgrade of a third airlock to full system capability, which were required for docking the Space Shuttle with the Russian Mir as well as for use with the Space Station. Other items in this budget included: the Shuttle Remote Manipulator System (RMS) and Space Shuttle mission training facility upgrades; development of a UHF communications system and a laser sensor; procurement of an operational space vision system; procurement of three docking mechanisms and Space Station docking rings; EVA/Extravehicular Mobility Units (EMU) services and hardware; and integration costs to provide analyses and model development.

In order to ensure that the Space Station budget remains within the President’s five-year budget plan, funds for U.S. elements after U.S. core complete (flight 10A in the planned assembly sequence) have been redirected to address cost growth in the program. NASA is continuing program assessment activities, implementing management actions, and supporting an independent cost estimate that will seek to reduce the projected growth in cost estimates. Future decisions to develop and deploy additional U.S.

elements or enhancements beyond U.S. core complete will depend on NASA's success at demonstrating implementation of management actions as well as the quality of cost estimates, resolution of technical issues, and the availability of funding through efficiencies in Space Station or other Human Space Flight programs and institutional activities.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported:

Goal 2: Enable humans to live and work permanently in space

Strategic Plan Objectives Supported:

Objective: Operate the International Space Station to advance science, exploration, engineering, and commerce

Performance Plan Metrics Supported:

1H10: Successfully complete the majority of the planned development schedules and milestones required to support the Multi-Element Integration Testing

1H11: Successfully complete the majority of the ISS planned on-orbit activities such as delivery of mass to orbit and enhanced functionality

2H10 & 3H11: Demonstrate ISS on-orbit vehicle operational safety, reliability, and performance

2H11 & 3H12: Demonstrate and document the ISS program progress and readiness at a level sufficient to show adequate support of the assembly schedule

Milestones	FY 03 Budget Date	FY 02 Budget Date	Baseline Date	FY02-FY03 Change	Comment
Flt UF1 (MPLM)	12/01	11/01	10/98	+1 mos.	Impact of minor delays in Summer-Fall 2001
Flight 8A (SO Truss)	3/02	1/02	9/98	+2	Impact of minor delays in Summer-Fall 2001
Flt 9A (S1 Truss)	8/02	5/02	12/98	+2	Impact of minor delays in Summer-Fall 2001
Flt 11A (P1 Truss)	9/02	10/02	8/99	-1	Moved prior to ULF-1 flight
Flt 12A (P3/P4 PVAs)	4/03	12/02	10/99	+4	Minor 2001 delay impact, reduced FY 2003 flight rate
Flt 13A (S3/S4 PVAs)	8/03	4/03	12/99	+4	Minor 2001 delay impact, reduced FY 2003 flight rate
Flt 15A (S6 PVAs)	1/04	3/06	12/00	-26	4th photovoltaic array launch planned acceleration
Flt 10A (Node 2) U.S. Core Complete	2/04	11/03	6/99	+3	Minor 2001 delay impact, reduced flight rate, minor resequencing

Lead Center: JSC	**Other Centers: MSFC, KSC, GRC, LaRC, ARC, DFRC &JPL**	**Interdependencies:** Canada, European Space Agency (ESA) member states, Japan, Russia; Italy and Brazil
Major Instruments/Subsystem	**Builder**	
Truss Structures, Pressurized Mating Adapters, Comm & Tracking, C&DH, External Thermal Control Node	Boeing Huntington Beach, CA	With completion of Phase 2 of the ISS, the vehicle is a fully functional, autonomous spacecraft. Subsequent flight in FY 2002 through FY 2004 will continue to build-out the on-board systems and capabilities.
US Lab Module, Life Supt. Sys.	Boeing Huntsville, AL	
Primary Electrical Power System	Boeing Canoga Park, CA	
Program Integration, Software	Boeing Houston	
Launch Vehicle: **Shuttle for U.S. elements**	**Tracking/Comm:** TDRS	**Data:** TDRS

PROGRAM STATUS/NOTIFICATIONS PLANS THROUGH 2002

- Flight 3S: The launch of Soyuz flight 3S in October 2001.
- Flight 6P: The launch of Russian Progress logistic flight 6P in November 2001.
- Flight UF-1, the first U.S. utilization flight mission, carried the MPLM "*Rafaello*" in December 2001, and performed a crew exchange (Expedition #4).
- Flight 8A scheduled for March 2002 launch, carrying S0 truss.
- Flight UF-2 scheduled for May 2002 launch, the second U.S. utilization flight carrying an MPLM, performing crew exchange (Expedition #5).
- Flight 9A scheduled for August 2002 launch, carrying S1 truss and 3 radiators.
- Flight 11A scheduled for September 2002 launch, carrying P1 truss and 3 radiators.
- Soyuz flight 4S, Progress flights 7P, 8P & 9P.
- Completion of Multi-Element Integrated Test (MEIT2) conditions for flight elements required for assembly flights 8A through 12A.

- Final integration and testing of truss segments P3/P4 and S3/S4 with their solar arrays for construction of the outboard truss in FY 2003.

- Demonstration of station-based EVA to support EVA's from the U.S. Airlock.

- Conduct permanent on-orbit operations, providing an estimated 8,000 hours of ISS crew support to station assembly, operations, and research.

PROGRAM PLANS FOR FY 2003

- Flight hardware assembly of truss segments P3/P4 and S3/S4, planned for April 2003 and August 2003.

- ULF-1 (utilization and logistics) flight in January 2003.

- Flight 12A.1, logistics flight, including P5 truss assembly in May 2003.

- Start of Multi Element Integrated Test (MEIT3) for flights 10A and 1J.

- Conduct permanent on-orbit operations and research.

SPACE STATION VEHICLE FUNDING DATA ($ in millions)

	FY94-00	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	BTC	TOTAL
FY 2003 President's Budget	10,518.2	751.9	369.1	292.3	105.8	58.2	27.9	17.7		12,141.1
Flight Hardware	9,213.4	702.0	318.7	250.0	157.9	84.0	50.6	17.7		10,794.3
Test, Manufacturing & Assembly Supt.	423.1	47.5	50.4	42.3						563.3
Transportation Support	411.6	2.4								414.0
Flight Technology Demo	43.2									43.2
Program Management Support/Other	426.9									426.9
Savings to be realized *					-52.1	-25.8	-22.7			-100.6
[Estimated Civil Servant FTE]		[830]	[745]	[650]	[591]	[165]	[141]	[134]		

* Savings to be realized: Current ISS funding is based on realization of savings to baseline Vehicle and Operations estimates, while maintaining the U.S. Core capability and reserve funding levels. Vehicle allocation is estimated; actual will be subsequently determined.

Among the estimated savings in FY 2004-2006:

- Rates reductions from contract consolidation and workforce distribution -- $90 million.
- Flight integration & processing savings -- $140 million.
- Savings from prospective process re-engineering -- $330 million.

It is critical to act on these, and other areas, in order to realize reductions and ensure compliance with the President's budget. Assessments and studies of these areas are actively underway to validate reduction estimates. Targets will be incorporated in budget guidance to the performing centers. Consideration of the impact of reductions and savings will be made in conducting an internal cost estimate in Spring 2002, and in the independent cost estimate due to be completed in September 2002.

BASIS OF FY 2003 FUNDING REQUIREMENT

OPERATION CAPABILITY

	FY 2001	FY 2002	FY 2003
Operations capability & construction	45.0	28.0	22.6
Vehicle operations	352.5	779.6	675.1
Ground operations	427.2	505.0	502.1
[Construction of Facilities included]	[0.3]	[5.0]	
Total	824.7	1,312.6	1,199.8

DESCRIPTION/JUSTIFICATION

The first crew was launched to the ISS in October 2000. From this point forward, a progression of international crews will permanently inhabit the ISS. The logistics of providing the crew with what is needed for them to live and productively work in the isolated and harsh environment of space for 24 hours a day, 365 days per year is now a nominal part of ISS activities. The ISS assembly period will span half a decade, with infrastructure and logistics deployed over multiple flights from launch vehicles across the globe. Because of the program's complexity, the Space Station team has done extensive planning for operations of several different ISS vehicle configurations on-orbit. Each time an element is added to the current Station, the flight characteristics and internal systems change, and the ISS stack on-orbit becomes a different vehicle with different thermal constraints and drag coefficients. The Space Station Program is drawing on the experience derived from Skylab, the Shuttle-Mir program, and that gained from operating the Space Shuttle for nearly two decades to address the unique circumstances of building and operating an ever-changing vehicle.

The operations concept emphasizes multi-center and multi-program cooperation and coordination. Operations capability and construction provides the development of facilities, systems, and capabilities to conduct the operations of the Space Station. For the U.S. segment, the current and future operations development work will primarily be performed at the Johnson Space Center (JSC); facilities, systems, and capabilities were also developed at the Kennedy Space Center (KSC) as well as at JSC. KSC has developed launch site operations capabilities for conducting pre-launch and post-landing ground operations. JSC has developed space systems operation capabilities for conducting training and on-orbit operations control of the Space Station. As ISS partners become operational, their respective ground operations functions will be integrated by NASA into the unified command and control architecture. The Mission Control Center-Houston (MCC-H) is the prime site for the planning and execution of integrated system operations of the Space Station. Communication links from both Mission Control Center-Moscow (MCC-M) and MCC-H will support control activities, using the Tracking and Data Relay Satellite system (TDRSS) system and Russian communication assets.

Space Station vehicle operations provides systems engineering expertise and analysis to sustain the performance and reliability of Space Station hardware and software systems, spares provisioning, maintenance and repair, and operations planning and cargo integration. Engineering has been consolidated under the Integration and Operations (I&O) segment of the prime contract, performed at the Johnson Space Center (JSC). Part of the contract restructuring accomplished in 2000-2001, I&O activities, including multi-element integration testing, have been fully transitioned from the ISS vehicle budget to the operations budget in FY 2002. Maintenance and repair costs continue to be minimized by the application of logistics support analysis to the design, resupply/return and spares procurement processes. Flight hardware spares and repair costs will continue to be controlled by establishing a maintenance and repair capability including hardware depots that effectively utilize Kennedy Space Center (KSC) and original equipment manufacturers or other certified industry repair resources.

Ground operations provides training, mission control operations, operations engineering support, launch site processing, and center and enterprise program support. Flight controllers are trained to operate the Space Station as a single integrated vehicle, with full systems capability in the training environment. Crewmembers are trained in the Neutral Buoyancy Lab (NBL) and Space Station Training Facility (SSTF) on systems, operations, and other activities expected during a mission. Engineering support provides ground facility requirements and test support, ground display and limited applications development, resource planning, station/shuttle integration, crew systems and maintenance, extravehicular activity (EVA), photo/TV training, operations safety assessments, medical operations tasks, and mission execution and systems performance assessment. Launch site processing includes requirement definition and processing planning, post delivery inspection/verification, servicing, interface testing, integrated testing, close-outs, weight and center of gravity measurement, and rack/component to carrier installation.

The primary objective of the operations program is to safely and reliably assemble, activate, integrate, and operate the ISS. This requires a significant level of planning, coordination, and execution. Most of the hardware engineering, manufacturing, and testing – leading to the final acceptance and launch of the ISS elements – have successfully been completed. As these final components are integrated on the ISS, the program is transitioning into the operations phase. A detailed integration of the capabilities and constraints between ISS elements and ground systems is occurring across the partnership to ensure that the pieces and the people operate as one system. Additionally, ground controllers and the ISS crew continue to train for nominal and off-nominal activities.

The secondary goal of the operations program is to perform operations in a simplified and affordable manner. To do this, operational procedures/processes are constantly being evaluated – and in many cases streamlined – to improve efficiency. The program has also adopted a 'Distributed Operations' baseline. With this, each International Partner is responsible for integrating and operating their own elements. This greatly simplifies ISS operations.

LINKAGES TO STRATEGIC AND PERFORMANCE
Strategic Plan Goal Supported:
Goal 1: Explore the space frontier
Goal 2: Enable humans to live and work in space
Goal 3: Enable the commercial development of space
Goal 4: Share the experience and benefits of discovery

Strategic Plan Objectives Supported:
Objective: Conduct engineering research on the ISS to enable exploration beyond Earth orbit
Objective: Operate the International Space Station to advance science, exploration, engineering, and commerce
Objective: Meet sustained space operations needs while reducing costs
Objective: Improve the accessibility of space to meet the needs of commercial research and development
Objective: Foster commercial endeavors with the International Space Station and other assets
Objective: Provide significantly more value to significantly more people through exploration and space development efforts

Performance Plan Metrics Supported:
1H10: Successfully complete the majority of the planned development schedules and milestones required to support the Multi-Element Integration Testing
1H11: Successfully complete the majority of the ISS planned on-orbit activities such as delivery of mass to orbit and enhanced functionality
1H12: Successfully complete the majority of combined ISS planned operations schedules and milestones as represented by permanent human on-orbit operations
2H10 & 3H11: Demonstrate ISS on-orbit vehicle operational safety, reliability, and performance
2H11 & 3H12: Demonstrate and document the ISS program progress and readiness at a level sufficient to show adequate support of the assembly schedule
2H12 & 3H13: Successfully complete 90% of the ISS planned mission objectives
2H17: Provide an average of at least five mid-deck lockers on each Space Shuttle mission to the International Space Station
2H19: Develop and execute a management plan and open future Station hardware and service procurements to innovation and cost-saving ideas through competition, including launch services and a Non-Government Organization for Space Science Research
2H24 & 3H22: Expand public access to HEDS missions information (especially ISS) by working with industry, academia, and the media to create media projects and public engagement initiatives that allow “first-hand” public participation using telepresence for current missions, and virtual reality or mock-ups for future missions beyond Earth orbit
3H02: Provide for science and technology research on the ISS a minimum average of five mid-deck lockers for each Space Shuttle mission to the ISS and maintain 80% availability of Space Station resources to support science and technology research
3H15: Develop and execute a management plan and open future Station hardware and service procurements to innovation and cost-saving ideas

SCHEDULE & OUTPUTS

Prior to each mission or the start of an increment a series of reviews, Increment Operations Reviews (IOR) and Certificate of Flight Readiness Reviews (CoFR), are conducted to ensure readiness. These reviews are held according to a "launch minus" template with dates driven by major milestones such as final installation of cargo into the Shuttle. Below are a summary table of reviews conducted in 2001 and a table of reviews planned in 2002 and 2003.

2001 reviews conducted

	Flight	MRR or SCRR	LPRR (CoFR 1)	PRR	SORR (CoFR 2) (see note 1)	FRR (see note 1)	Launch	PFR	PIR
INC0	2A.2b/106		27-Jul-00	3-Aug-00	16-Aug-00	29-Aug-00	8-Sep-00	7-Dec-00	N/A
	3A/92	02-Jun-00	11-Aug-00	5-Sep-00	22-Sep-00	28-Sep-00	11-Oct-00	7-Dec-00	N/A
INC1	2R	26-Sep-00	N/A	N/A	12-Oct-00	19-Oct-00	30-Oct-00	N/A	25-Jan-01
	2P		N/A	N/A	16-Aug-00	N/R	16-Nov-00	N/A	N/A
	2P - Cont				Delta 9-Nov				
	4A/97	No MRR	2-Oct-00	7-Nov-00	9-Nov-00	17-Nov-00	30-Nov-00	14-Dec-00	N/A
	5A/98	No MRR	28-Nov-00	14-Dec-00	5-Jan-01	10-Jan-01	7-Feb-01	22-Feb-01	N/A
	3P		N/A	N/A	9-Feb-01	N/R	26-Feb-01	N/A	N/A
INC2	5A.1/102	20-Sep-00	26-Jan-01	13-Feb-01	9-Feb-01	27-Feb-01	8-Mar-01	22-Mar-01	26-Apr-01
	6A/100	20-Oct-00	13-Mar-01	29-Mar-01	27-Mar-01	5-Apr-01	19-Apr-01	3-May-01	N/A
	2S		N/A	N/A	27-Mar-01	N/R	28-Apr-01	TBD	N/A
	4P			N/A	27-Mar-01	N/R	20-May-0	N/A	N/A
	7A/104		1-May-01	7-May-01	18-May-01	28-Jun-01	12-Jul-01	26-Jul-01	N/A
	7A Delta				19-Jun-01				
INC3	7A.1/105		N/R	9-Jul-01		19-Jul-01	10-Aug-01	10-Aug-01	23-Aug-01
	5P			N/A		02-Aug-01	21-Aug-01	21-Aug-01	N/A
	4R	23-Aug-01		N/A		23-Aug-01	15-Sep-01	15-Sep-01	N/A

Note 1: Shaded boxes indicate Progress reviews were combined with the meetings for Shuttle or Soyuz flight.

Reviews planned for the next several increments

	Flight	Russian Assessment Review	LPA	PRR	SORR (CoFR 1&2) (see note 1)	FRR	Launch	PFR	PIR
	3S			N/A		02-Oct-01	21-Oct-01	21-Oct-01	TBD
	6P			N/A	30-Oct-01 A	N/R	26-Nov-01	N/A	
									7-Feb-02
INC4	UF1/108		09-Oct-01 A	23-Oct-01 A	30-Oct-01 A	15-Nov-01	5-Dec-01	13-Dec-01	
	7P			N/A	22-Jan-02	N/R	Feb-02	N/A	
	8A/110		18-Dec-01	TBD	26-Feb-02	7-Mar-02	Mar-02	4-Apr-02	
	4S			N/A	14-Mar-02	N/R	Apr-02	TBD	
									13-Jun-02
INC5	UF2/111		14-Mar-02	TBD	9-Apr-02	18-Apr-02	May-02	16-May-02	
	9A/112		23-May-02	TBD	18-Jun-02	27-Jun-02	Aug-02	25-Jul-02	
	11A/113		3-Jul-02	TBD	30-Jul-02	8-Aug-02	Sep-02	5-Sep-02	
									TBD
	5S		15-Jul-02	N/A	29-Aug-02	9-Sep-02	Oct-02	10-Oct-02	
	ULF-1		3-Oct-02		29-Oct-02	7-Nov-02	Jan-03	5-Dec-02	
	12A		5-Dec-02		30-Dec-02	9-Jan-03	Apr-03	6-Feb-03	
	6S		11-Feb-03	N/A	6-Mar-02	18-Mar-03	May-03	15-Apr-03	
									TBD
Note 1: Shaded boxes indicate Progress reviews will be combined with the meetings for a Shuttle or Soyuz flight.									

MRR- Mission Readiness Review, **SCRR**- Station Cargo Readiness Review, **LPRR**- Launch Package Readiness Review, **LPA**- Launch Package Assessment, **PRR**- Payload Readiness Review, **SORR**- stage Operations Readiness Review, **FRR**- Flight Readiness Review, **PFR**- Post Flight Review, **PIR**- Post Increment Review

FY 2001 ACCOMPLISHMENTS

The ISS is made up of thousands of components and dozens of complex systems. These systems are operated and monitored by flight controllers on the ground 24 hours a day, 365 days a year. As might be expected with such complex equipment, several of the components have not operated as planned. Strenuous simulations and challenging training prepared both the crew and ground controllers for the difficult tasks. Flight controllers have been able to isolate the problems and develop operational workarounds. Perhaps, the greatest successes in the ISS program are seen when the crew and ground controllers work together to solve problems that seem impossible to solve. Throughout 2001, the crew and ground controllers located at JSC and MSFC met each system or payload anomaly with a successful solution.

Operations provided the support for the numerous deliveries of flight hardware, crew and supplies that increased ISS capabilities and provided for its operational necessities.

Assembly flight 3A provided Z1 truss assembly, control moment gyros (CMGs), PMA3 – Oct-00.

Soyuz flight (2R) established the first permanent international crew, Expedition #1 – Oct-00.

Assembly flight 4A provided the P6 photovoltaic power assembly – Nov-00.

Assembly flight 5A (Feb-01) provided delivery and installation of the U.S. Destiny Laboratory onto the ISS including the following:

- Five racks of core system components that provide life-sustaining functions – such as electrical power, cooling water, data collection, air revitalization, and temperature/humidity control.
- Racks that house micro-gravity research, human life science, and fundamental biology experiments.
- 25 rack capacity
- Transfer of ISS lead operations from the Russian Mission Control Center to NASA's Mission Control Center in Houston.
- More habitable volume than Mir.

Assembly flight 5A.1 (Mar-01) provided the following elements and new capabilities:

- Delivery of new system racks containing electrical power and control equipment for the ISS robotic arm.
- Delivery of new payload racks.
- Delivery of new crewmembers (Expedition #2).
- Demonstrated capability of the Italian-built Multipurpose Logistics Module (MPLM).
- Delivery of the Human Research Facility (HRF) experiment, which demonstrated capability of the Payload Operations Center (POC), located at the MSFC. Additionally, Payload Developers (PDs) began supporting the POC from locations across the U.S..

Assembly flight 6A (Apr-01) delivered the following capabilities:

- Canadian built robotic arm (Canadarm2), successfully installed and checked-out on the ISS.
- Two payload experiment racks.

- Ultra-High Frequency (UHF) communications antenna.
- Spare electronics, and supplies

Assembly flight 7A (Jul-01) delivered the Joint Airlock, and marked the completion of Phase 2 of the ISS assembly.

- Allows the crew – using either Russian or American spacesuits – to perform space walks without a Shuttle being docked with the ISS.

Assembly flight 7A.1 (Aug-01) delivered the following to ISS:

- Payload experiments, including Materials International Space Station Experiments (MISSE) Project experiment, the first externally mounted experiments conducted on the ISS.
- Supplies
- installation of the Early Ammonia Servicer equipment to be used on future assembly flights.
- New crewmembers to the ISS (Expedition #3).

Other Flights:

- Four Russian Progress flights
- Two Soyuz (including 2R)

PROGRAM STATUS/NOTIFICATIONS PLANS THROUGH 2002

The ISS transformation into a world-class research facility will continue through 2002 and 2003. Payload racks loaded with experiments will be carried to the ISS several times throughout the period. As the number and complexity of experiments increases, the crew and ground controllers will spend more of the ISS resources conducting experiments onboard. The level of coordination between the Mission Control Center-Houston, the Payload Operations Center-Huntsville, and the Payload Developers will also become more complex.

Future flight crews and controllers on the ground will continue to utilize the training facilities developed for the program. The Space Station Training Facility (SSTF) – now fully functional – will continue to be a vital resource used in the ISS flight controller certification process. Using the SSTF, future ISS hardware/software configurations will be loaded into the system to mimic the actual ISS on-orbit configurations. Controllers will practice sending commands, configuring flight hardware, and developing operational procedures.

Using Artificial Intelligence (AI) and Knowledge Based (KB) systems, engineers at the Mission Control Center-Houston and the Payload Operations Center are exploring better ways of operating the Station. All processes and procedures are being analyzed to insure that all systems are operated efficiently and safely. These improved processes will be integrated into nominal and off-nominal operations procedures throughout the year. This is a part of NASA's commitment to Continuous Improvement (CI).

Operations will continue to provide support for the numerous deliveries of flight hardware, crew and supplies that increased ISS capabilities and provided for its operational necessities.

Five Shuttle flights to station during 2002 will provide three crew exchanges, supplies, critical spares and repairs, High Rate Communications Outage Recorder, central truss segment, right truss segment, left truss segment, Mobile transporter, Mobile Base System, and payload experiments:

- Flight UF-1, the first U.S. utilization flight mission, carried the MPLM "*Rafaello*" in December 2001, and performed a crew exchange (Expedition #4).
- Flight 8A scheduled for March 2002 launch, carrying S0 truss.
- Flight UF-2 scheduled for May 2002 launch, the second U.S. utilization flight carrying an MPLM, performing crew exchange (Expedition #5).
- Flight 9A scheduled for August 2002 launch, carrying S1 truss and 3 radiators.
- Flight 11A scheduled for September 2002 launch, carrying P1 truss and 3 radiators, performing crew exchange (Expedition #6).

<u>Other Flights</u>
Four Progress resupply flights to Station during 2002
Two Soyuz flights to Station during 2002

<u>Life Cycle Cost Data</u>
NASA is currently developing internal and independent Life Cycle Cost estimates per the IMCE task force (Young Commission) recommendations that will be complete by September 2002. See table below for budget estimates.

PROGRAM PLANS FOR FY 2003

Four Shuttle flights to station during 2003 will provide:

- Crew exchange- 2 crew exchanges are planned during the year
- Logistics- Critical spares and repairs
- Supplies
- Data Systems
- Payload Experiments
- Core components- second port truss segment, third port truss segment, second starboard truss segment, central cooling radiators, second and third sets of solar arrays, additional set of nickel-hydrogen batteries.

Other Flights:
Four Progress resupply flights to Station during 2003
Two Soyuz flights to Station during 2003

SPACE STATION OPERATIONS FUNDING DATA ($ in millions)

	FY94-00	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	BTC	TOTAL
FY 2003 President's Budget	2,735.7	824.7	1,312.6	1,199.8	1,090.1	1,013.8	1,064.0	1,092.7	cont.	10,333.4
Operations Capability & Construction	835.9	45.0	28.0	22.6	25.3	3.7	2.7	1.6		964.8
Vehicle Operations	899.3	352.5	779.6	675.1	659.2	689.6	699.0	603.7		5,358.0
Ground Operations	1,000.5	427.1	505.0	502.1	494.8	489.3	487.9	487.4		4,394.1
Savings to be realized *					-89.2	-168.8	-125.6			-383.6
[Estimated Civil Servant FTE]		[674]	[913]	[865]	[947]	[1,380]	[1,376]	[1,408]		

* Savings to be realized: Current ISS funding is based on realization of savings to baseline Vehicle and Operations estimates, while maintaining the U.S. Core capability and reserve funding levels. Operations allocation is estimated; actual will be subsequently determined.

Among the estimated savings in FY 2004-2006:

- Rates reductions from contract consolidation and workforce distribution -- $90 million.
- Flight integration & processing savings -- $140 million.
- Savings from prospective process re-engineering -- $330 million.

It is critical to act on these, and other areas, in order to realize reductions and ensure compliance with the President's budget. Assessments and studies of these areas are actively underway to validate reduction estimates. Targets will be incorporated in budget guidance to the performing centers. Consideration of the impact of reductions and savings will be made in conducting an internal cost estimate in Spring 2002, and in the independent cost estimate due to be completed in September 2002.

BASIS OF FY 2003 FUNDING REQUIREMENT

Research

	FY 2001	FY 2002*	FY 2003*
Research Projects	288.4	[221.3]	[208.3]
Utilization Support	169.0	[150.0]	[138.9]
Total	457.4	[371.3]	[347.2]

***** The ISS Research program and funding was transferred to the Biological and Physical Research (BPR) enterprise, beginning in FY 2002 and now included in the Science, Aeronautics and Technology appropriation account, shown here for comparison purposes only on a non-add basis.

DESCRIPTION/JUSTIFICATION

The ISS is utilized as an interactive laboratory in space to advance scientific, exploration, engineering and commercial activities. As a microgravity laboratory, the ISS will be used to advance fundamental scientific knowledge, foster new scientific discoveries for the benefit of the U. S., and accelerate the rate at which it develops beneficial applications derived from long-term, space-based research. The ISS is a premier facility for studying the role of gravity on biological, physical and chemical systems. The program will deliver the capability to perform unique, long-duration, space-based research in molecular, cellular, comparative, and developmental biology, human physiology, biotechnology, fluid physics, combustion science, materials science and fundamental physics. The experience and knowledge gained from long-duration human presence on the ISS will help us learn how to more safely and effectively live and work in space. ISS also provides a unique platform for making observations of the Earth's surface and atmosphere, the sun and other astronomical objects, as well as the space environment and its effects on new spacecraft technologies.

At the beginning of FY 2002, this activity and funding was transferred to the Biological and Physical Research (BPR) enterprise. See the BPR International Space Station Research Capability Program (ISSRC) for further program description/justification, and current status, notifications, and plans for this budget.

BASIS OF FY 2003 FUNDING REQUIREMENT

Russian Program Assurance

	FY 2001	FY 2002	FY 2003
Russian Program Assurance	24.0	--	--

DESCRIPTION/JUSTIFICATION

NASA's approach to contingency planning has been to incrementally fund only those activities that permitted the United States to continue to move forward should the planned contributions of our ISS partners not be delivered as scheduled, rather than to assume the responsibilities of other ISS partners. Russian Program Assurance (RPA) funding provided contingency activities to address ISS program requirements resulting from potential delays or shortfalls on the part of Russia in meeting its commitments to the ISS program. These contingency activities were not intended to protect against the complete loss of Russian contributions. That impact would have caused an extended delay to the program, necessitating additional crew return, life support, reboost, and guidance and control capabilities to replace planned Russian contributions, and result in a significantly more costly and less robust space station.

For several years Russia experienced significant economic challenges resulting in the Russian Aviation and Space Agency (Rosaviakosmos) receiving only a fraction of its approved budget. These shortfalls resulted in schedule slips of the ISS hardware and operations support that Russia was responsible for funding and providing. To accommodate this shortfall, the U.S. developed a three step contingency plan and initiated specific developments to protect the ISS schedule and capabilities in the event of further Russian delays or shortfalls. In spring 1997, NASA embarked on the initial steps of a contingency plan to provide U.S. capabilities to mitigate the impact of further Russian delays. Step one consisted primarily of the development of an Interim Control Module (ICM), built by the U.S. Naval Research Laboratory for NASA, to provide command, attitude control, and reboost functions to provide a backup capability in the event the Russian Service Module was significantly delayed or not successfully provided. Over the next year further delays continued on the Russian elements. During summer 1998, NASA initiated activities to implement additional contingency plans to provide flexibility for the United States in the event of further Russian delays or shortfalls. These consisted primarily of development of a U.S. Propulsion Module, enhancing logistics capabilities, modifying the Shuttle fleet for enhanced Shuttle reboost of ISS, and procurement of needed Russian goods and services to support Russian schedules for the Service Module and early ISS Progress and Soyuz launches.

With the successful deployment of the Russian Service Module, and Russia's positive performance overall, NASA has reassessed its contingency plans, and determined that much of the Russian assurance efforts were no longer a priority relative to other program needs. Based on the increasing costs to planned RPA elements and the baseline program, and the reduced impact of future Russian non-performance, NASA placed the ICM in "call-up" mode in FY 2000. The ICM is stored at the Naval Research Lab while plans to remove NASA-owned components are implemented, and custody of the retrograde vehicle is transferred to the Navy. NASA expects the transfer to occur in the second quarter of FY 2002. In FY 2001, the Propulsion Module Project was ended, and most RPA funds were transferred to the Vehicle program. Remaining FY 2001 funds are reserved for Propulsion Module contract closeout, other contingency activities, and the potential procurement of safety-related Russian goods and services. A decision to implement the remainder of the RPA Program, or to request that remaining funds be reprogrammed to support baseline program needs, will be made after further consultation with the Administration and the Congress.

BASIS OF FY 2003 FUNDING REQUIREMENT

Crew Return Vehicle

	FY 2001	FY 2002	FY 2003*
X-38/Crew Return Vehicle	69.8	40.0	--

* FY 2002-2003 funding is currently under review and allocations to X-38/Crew Return Vehicle (CRV) will be determined as part of program assessments.

DESCRIPTION/JUSTIFICATION

The safety of the crew for the International Space Station is of critical importance. The Russian Soyuz vehicle provides a capability to return the crew from orbit if needed for life threatening emergencies that may arise on orbit. Continued sole reliance on a single Soyuz capability limits the crew size for the ISS and poses operational and programmatic impacts. Each Soyuz can only transport a crew of three and has to be changed out after about six months on orbit. A more capable crew return vehicle that overcomes the limitations of the Soyuz is the most desirable long-term approach for ensuring crew safety. A goal of the Crew Return Vehicle (CRV) project is to leverage the technologies, processes, test results, and designs developed in the preliminary technology development work carried out in the X-38 project and related contractor studies of a CRV.

The Crew Return Vehicle (CRV) project will initiate work towards an independent U.S. crew return capability for the ISS. The CRV would accommodate safe return for up to seven crew under the following scenarios:

- Crew member(s) ill or injured while the space shuttle orbiter is not at the station.
- Catastrophic failure of the station that makes it unable to support life and the space shuttle orbiter is not at the station or is unable to reach the station in the required time.
- Problem with the space shuttle that makes it unavailable to re-supply the station or change-out crew in a required timeframe.

NASA has funded the X-38 project to reduce the risk of developing a CRV. The X-38 design has a strong foundation from the lifting body research and technology developments carried out since the 1960's. The previous plan to transition from X-38 research and development to CRV design and development was comprised of the following phases:

- Phase 0 - An unfunded observation period in which contractors interact with the X-38 project team. This effort began 20 July 1998 and is now complete. Five companies participated in this phase which was performed with X-38 Advanced Projects funding.

- Phase 1a – Selected contractor(s) will perform delta design tasks to convert the X-38 design into an operational CRV design and participate in the X-38 flight test program as a part of CRV verification and validation. Phase 1a is fixed cost, runs for about 12 months and includes tasks and deliverables up through Preliminary Design Review and Interim Design Review.
- Phase 1b – After Phase 1a, one contractor will continue the CRV design development and test program support up through the X-38 vehicle 201 space flight test and CRV Critical Design Review. This phase will also be fixed cost and will last about 20 months.
- Phase 2a – This phase of CRV production is a cost-plus-incentive-fee contract for delivery of the first two operational CRVs, one of which will be a refurbished space flight test vehicle (201R). It is expected to last for about 24 months.
- Phase 2b – This phase is a fixed-cost contract for delivery of the third and fourth operational CRVs and is slated to run about 27 months.

These phases would have included three primary tasks:
- Perform delta design tasks necessary to convert the X-38 design into an operational CRV design, and perform necessary system integration internally and with STS and ISS.
- Support atmospheric and space flight tests of X-38 prototype vehicles as part of CRV validation.
- Perform production of the CRV operational vehicles.

As a result of cost growth on the ISS program, X-38/CRV funds were allocated back to the Space Station HSF budget to address this growth, these plans are not being pursued, and no Phase 1a contract was awarded. NASA will continue to assess the affordability of continued investment in the X-38/CRV relative to other program priorities. Future decisions to develop and deploy additional U.S. elements or enhancements beyond U.S. core complete, like the CRV, will depend on NASA's success at demonstrating implementation of management actions as well as the quality of cost estimates, resolution of technical issues, the availability of funding through efficiencies in Space Station or other Human Space Flight programs and institutional activities, and possible increased international partner participation in the CRV project in particular.

FY 2001 ACCOMPLISHMENTS

The X-38 project continued with atmospheric vehicle and parafoil flight-testing, and the space flight vehicle build as the prototype for the ISS Crew Return Vehicle (CRV). X-38 flight-testing has successfully demonstrated numerous technologies needed for the operational CRV. Among the more important of these is flight of the operational body shape and full operational scale parafoil, advanced flight control software, electro-mechanical actuators and laser activated pyrotechnics.

The first of two 80% scale atmospheric test vehicles, vehicle 131R, was modified to match the expected CRV production vehicle body shape and successfully completed its first free flight test in November of 2000. Free flight tests progressively match larger portions of the CRV operational reentry flight profiles to enhance performance validation as X-38 testing plays an important role in the overall CRV flight certification plan. Two more atmospheric flights are planned for this year.

In addition to the atmospheric flight test progress, several important X-38/CRV reviews were successfully completed. The Shuttle Payload Safety Review, the X-38 Entry Safety Review, the KSC Ground Safety Review, an Aerodynamics Peer Review and a Landing Site review were all completed with several minor issues cited but no significant issues identified.

Buildup of the space reentry flight unit X-38, vehicle 201, continued with subsystem integration and testing. Structural design changes to the X-38 flight unit Deorbit Propulsion Stage (DPS) were completed, all components were installed, and all acceptance tests were completed in preparation for delivery to NASA in the second quarter of FY02.

PROGRAM STATUS/NOTIFICATIONS PLANS THROUGH 2002

Thus far in FY 2002, the X-38/CRV project has successfully completed the eighth X-38 atmospheric flight test, further drogue parachute testing, multiple string subsystem power-up testing on the space flight reentry vehicle, the fourth flight of the INS/GPS navigation system (on Shuttle STS-108), and final transonic aerodynamics simulations at USAF facilities. Highlights of continuing work in FY 2002 include integration and testing of reentry vehicle subsystems, body flap aerothermal testing, full scale parafoil testing, full four string avionics power up testing on the space flight reentry vehicle, F-15 flight testing of the X-38 electro-mechanical actuators, reentry test vehicle structural tests, aerodynamic and aerothermal simulations and analyses, and two additional atmospheric flight tests. Additional work will include continued development of the CRV inertial guidance system (SIGI - System of Interactive Guidance and Information); avionics instrumentation; radiation-hardened computer system network elements; operating and flight system software; and communication system signal processors. Flight dynamics work will include simulation-based development and verification of the CRV flight controls. Mechanisms work would include verification of electro-mechanical actuators (EMAs) and laser pyros. Parafoil work will continue with testing, new parafoil procurements, and integrated structural dynamic modeling. Thermal Protection System component procurement will also continue.

Operations tasks include analyses of CRV separation (from Space Station) dynamics, continuing development of landing site and site selection requirements, and development of crew displays and controls requirements. Mission operations tasks include Mission Control Center and facility design requirements, modeling, and development of flight and ground procedures and flight rules. Logistics and maintenance tasks would focus on development of a spares program. Kennedy Space Center tasks include development of launch support and logistics flight operations requirements.

PROGRAM PLANS FOR FY 2003

No funding is being requested in this budget for X-38/CRV, however NASA is holding talks with our international partners regarding increased participation in X-38/CRV development and procurement as a part of ISS program reassessment and restructuring activities. In September 2002, NASA will be reporting on the results of these talks. In the event that X-38 work is carried into FY 2003, the FY 2002 tasks mentioned above would continue to mature - with possible international partner support.

HUMAN SPACE FLIGHT

FISCAL YEAR 2003 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE FLIGHT **SPACE SHUTTLE**

Web Address: http://spaceflight.nasa.gov/shuttle/

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET	Page Number
		(Millions of Dollars)		
Flight Hardware	1970.6	2028.1	1844.3	HSF 2-5
Ground Operations	581.6	610.9	589.3	HSF 2-13
Flight Operations	273.0	238.0	266.6	HSF 2-18
Program Integration	293.6	395.8	507.8	HSF 2-23
(Safety Allocation - non-add)	[245.9]	[311.7]	[240.7]	
Total	3,118.8	3,272.8	3,208.0	
Distribution of Program Amount by Installation				
Johnson Space Center	1849.3	1890.2	1778.2	
Kennedy Space Center	173.7	167.3	167.3	
Marshall Space Flight Center	1034.9	977.8	887.1	
Stennis Space Center	38.8	43.8	43.4	
Dryden Flight Research Center	4.8	4.9	4.9	
Ames Research Center	2.3	0.1	--	
Langley Research Center	0.2	--	--	
Glenn Research Center	--	0.4	--	
Goddard Space Flight Center	10.9	6.9	3.0	
Headquarters	3.9	181.4	324.1	
Total	3,118.8	3,272.8	3,208.0	

Space Shuttle Linkage to Strategic Plan

The Space Shuttle program plays a vital role in NASA's strategic goal to advance human exploration, use and development of space by providing safe, routine access to space in support of both permanent commercial and human operations in low-earth orbit. The Space Shuttle program provides launch services to a diverse set of customers, supporting launch, on-orbit operations, and return to earth, of payloads that range from small hand-held experiments to large laboratories. While most missions are devoted to NASA-sponsored payloads, others including industry, partnerships, corporations, academia, national and international agencies exercise wide participation. NASA, and the U.S. and international scientific communities are beneficiaries of this approach. The Space Shuttle is a domestically and internationally sought-after research facility because of its unique ability to provide on-orbit crew operations, rendezvous/retrieval and payload provisions, including power, telemetry, pointing and active cooling.

The Space Shuttle continues to prove itself to be the most versatile launch vehicle ever built. This has been demonstrated by (1) assembling of the International Space Station (ISS); (2) advancing life sciences and technology through long-duration Spacehab missions; and (3) repairing and servicing the Hubble Space Telescope, enabling many new discoveries in Space Science. The Space Shuttle has also performed rescue and retrieval of spacecraft.

The Space Shuttle program engages the private sector in the commercial development of space by providing flight opportunities to NASA's Centers for Commercial Development of Space. These non-profit consortia of industry, academia and government were created to conduct commercially applied research activities by encouraging industry involvement leading to new products and services through access to the space environment. Cooperative activities with the National Institutes of Health (NIH), the National Science Foundation (NSF), the Department of Defense (DoD) and other U.S. agencies are advancing knowledge of health, medicine, science and technology.

In FY 2001, the Space Shuttle launched seven flights, all of which were ISS assembly and servicing missions. Seven flights are planned during FY 2002 including a dedicated microgravity research flight and another HST Servicing Mission (HST-3B) and five ISS assembly and servicing missions. In FY 2003, four flights are planned, all of which are ISS assembly and servicing missions. In support of the research objectives of the Space Station, the Space Shuttle will commit a minimum of five powered mid-deck lockers on each mission to deliver necessary research equipment and specimens.

NASA will aggressively pursue Space Shuttle competitive sourcing as an important step in transitioning NASA to purchasing space transportation services where possible. This effort was called 'privatization' in the Budget Blueprint last year, and has changed in name to 'competitive sourcing' to be consistent with the President's Management Agenda that was released last August. The challenges to complete Space Shuttle competitive sourcing are centered on ensuring that the safety is not compromised while at the same time avoiding future cost growth. An independent business review team is being established to evaluate market potential, competitive sourcing opportunities, insurance, financing, and indemnification issues associated with transitioning the Space Shuttle to private industry. Following the results of the Shuttle business review team, comprised of private industry and academia experts in the fields of investments, insurance, and finance, the Space Shuttle and will actively pursue a number of avenues to assess industry issues and interest. NASA will seek industry comment on competitive outsourcing plans early this year. NASA will prepare, as appropriate, a cost analysis requirements document (CARD) to support NASA and independent cost estimates of Space Shuttle operations and safety investments, similar to estimates being done for the Space Station. These estimates, to be completed by September 2002, will provide an important baseline from which to assess competitive sourcing options.

The roles and missions of the contractor and government relationships have been defined to ensure program priorities are maintained and goals are achieved. The SFOC contractor is responsible for flight, ground and mission operations of the Space Shuttle. The accountability of its actions and those of its subcontractors are evaluated and incentivized through the use of a combined award/incentive fee structure of the performance-based contract. NASA, as owner of assets, customer of operations services and director of launch/flight operations, is responsible for (a) surveillance and audit to ensure compliance with SFOC requirements and (b) internal NASA functions. Further, NASA retains chairmanship of control boards and forums responsible for acceptance/rejection/waiver of Government requirements while the SFOC contractor is responsible for requirement implementation. The SFOC contractor is required to document and maintain processes/controls necessary to ensure compliance with contract requirements and to sign a certification of flight readiness (CoFR) to that effect for each flight.

The primary goals of the Space Shuttle Program in priority order are: (1) fly safely; (2) meet the flight manifest; (3) improve supportability and (4) improve the system.

NASA policy planning assumes the Space Shuttle will need to be capable of supporting the critical transportation requirements for at least this decade including the assembly of the International Space Station and International Space Station operations. In order to maintain a viable human transportation capability to support NASA's launch requirements, NASA is also making specific program investments. These investments are consistent with NASA's strategy of ensuring the Space Shuttle remains viable until a new transportation system is operational.

The overall strategy for the Shuttle budget is to request funding levels sufficient to allow the Space Flight Operations Contract to meet the intended flight rates. This includes appropriate contingency planning in both budget and schedule allowances to assure transportation and assembly support to the International Space Station program. At the same time it also incentivizes the contractor to identify opportunities for reductions in operations costs while still ensuring the safe and reliable operation of the Space Shuttle.

This budget is based on a baseline of four flights annually. In a change from previous years, Shuttle users requiring additional flights will be budgeting for those flights within their budgets. In FY 2001 seven flights were flown and seven are planned for FY 2002. FY 2002 includes five ISS flights, a Hubble Space Telescope servicing mission, and a dedicated microgravity research mission. This manifest supports the Nation's science and technology objectives through scheduled science missions and continued assembly and operations of the ISS.

In addition to flying safely, restructuring the program and conducting a single prime consolidation, we are continuing to refine the Shuttle program's strategy for the Shuttle Safety allocation. We are funding high priority safety upgrades for modifications and improvements that will provide the greatest safety improvement per dollar, to ensure continuous and affordable operations of the

Space Shuttle system for at least the next decade. This budget supports key Space Shuttle safety investments as part of NASA's Integrated Space Transportation Plan. NASA will seek to accelerate the implementation of safety investments, to begin achieving safety gains in Shuttle operations as quickly as possible. This is an essential element of the launch strategy required for continuing supportability to the ISS.

This budget also includes supportability upgrades to develop systems, which will combat obsolescence of vehicle and ground systems in order to maintain the program's safety and viability into this new century. Vendor loss, aging components, high failure rates of older components, high repair costs of Shuttle-specific devices and negative environmental impacts of some outdated technologies are areas being addressed.

This budget also supports investments in the Space Shuttle infrastructure, as necessary to address safety issues and critical repair and revitalization activities to maintain safe operations through the life of the Shuttle. This includes funding for infrastructure revitalization to meet urgent needs to revitalize and repair critical facilities, systems and equipment.

BASIS OF FY 2003 FUNDING REQUIREMENT

FLIGHT HARDWARE

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
External Tank Production	318.8	291.9	265.4
Space Shuttle Main Engine Production	263.4	250.0	215.9
Space Shuttle Main Engine Test Support	31.4	30.6	33.1
Reusable Solid Rocket Motor	377.7	382.1	374.9
Solid Rocket Booster	125.8	150.6	156.3
Vehicle and EVA	672.0	688.0	636.1
Flight Hardware Upgrades (Safety Allocation)	181.5	234.9	162.6
Total	1970.6	2028.1	1844.3

DESCRIPTION/JUSTIFICATION

The Space Shuttle program plays a vital role in NASA's strategic goal to advance human exploration, use and development of space by providing safe, routine access to space in support of both permanent commercial and human operations in low-earth orbit. The goal of Flight Hardware programs is to produce and maintain the various components of the Space Shuttle vehicles and provide for the upgrades required for safe, reliable and effective access to space.

The Flight Hardware program provides for enhancements of the Space Shuttle and produces space components that are not susceptible to damage and maintains core skills and capabilities required for modifying and maintaining the Orbiter as a safe and effective transportation and science platform. These activities are provided by Boeing Reusable Space Systems (as a major subcontractor to United Space Alliance (USA)) in two major locations: the Huntington Beach, California facility provides engineering support the Palmdale, California operation provides Orbiter Maintenance Down Period (OMDP) support as discussed below, as well as manufacturing and testing. Other activities that support this effort are subsystem management engineering and analysis conducted by Lockheed-Martin Corporation and development and modifications required for support to the extravehicular capability conducted by Hamilton Sundstrand.

The Flight Hardware program performs hundreds of modifications throughout the year related to design changes to improve reliability, supportability, or meet new program requirements. These changes are a result of hardware failures or design enhancements identified through ground checkouts or in-flight. Additional Orbiter modifications are approved as the International Space Station development advances and risk mitigation options are identified and implemented. The modifications are implemented either during a standard Orbiter processing flow at Kennedy Space Center in Florida or during Orbiter Maintenance Down Period at Palmdale, California. Orbiter Maintenance Down Periods (OMDPs) occurs when an Orbiter is taken out of service periodically for detailed structural inspections and thorough testing of its systems before returning to operational status. This period also provides opportunities for major modifications and upgrades.

The Marshall Space Flight Center (MSFC) manages the External Tank Project Office. Lockheed Martin Corporation produces External Tanks in the Government-Owned/Contractor-Operated (GOCO) facility near New Orleans, LA. This activity involves the following:

(1) Procurement of materials and components from vendors and production of ETs;
(2) Engineering and manufacturing personnel and necessary environmental manufacturing improvements;
(3) Support personnel and other costs to operate the GOCO facility; and
(4) Sustaining engineering for flight support and anomaly resolution.

The Space Shuttle Main Engine (SSME) Project is managed by the Marshall Space Flight Center (MSFC) and supports the Orbiter fleet with flight-qualified main engine components and the necessary engineering and manufacturing capability to address any failure or anomaly quickly. The Boeing-Rocketdyne and Propulsion Power is responsible for operating three locations that provide engine manufacturing, major overhaul, and component recycle and test. They are:

(1) Canoga Park, California that manufactures and performs major overhaul to the main engines;
(2) Stennis Space Center (SSC), Mississippi for conducting engine development, acceptance and certification tests; and
(3) Kennedy Space Center (KSC), Florida where the engine inspection checkout activities are accomplished at the KSC engine shop.

The Marshall Space Flight Center (MSFC) SSME Program manages engine ground test and flight data evaluation, hardware anomaly reviews and anomaly resolution. The Alternate Turbopump project is also managed by the MSFC under contract with Pratt Whitney of West Palm Beach, FL.

The Stennis Space Center (SSC) manages the SSME Test Support. This includes development, green run, and reliability demonstration (fleet leader) testing for the Space Shuttle Main engines. All engines certified for flight are tested here prior to being shipped to KSC for pre-launch processing.

The Solid Rocket Booster (SRB) project managed out of MSFC supports:

(1) Procurement of hardware and materials needed to support the flight schedule;
(2) Work at various locations throughout the country for the repair of flown components;
(3) Workforce at the prime contractor facility for integration of both used and new components into a forward and an aft assembly; and
(4) Sustaining engineering for flight support.

USA is the prime contractor on the SRB and conducts SRB retrieval, refurbishment and processing at KSC.

The Reusable Solid Rocket Motor (RSRM) project managed out of MSFC has ATK Thiokol Propulsion of Brigham City, Utah as the prime contractor for this effort. This activity involves the following:

(1) Purchase of solid rocket propellant and other materials to manufacture motors and nozzle elements;
(2) Workforce to repair and refurbish flown rocket case segments, assemble individual case segments into casting segments and other production operations including shipment to the launch site;
(3) Engineering personnel required for flight support and anomaly resolution; and
(4) New hardware to support the flight schedule required as a result of attrition.

The Vehicle and EVA project element managed out of Johnson Space Center (JSC) consists of the following items and activities:

(1) Orbiter logistics: spares for the replenishment of Line Replacement Units (LRUs) and Shop Replacement Units (SRUs) along with the workforce required to support the program; procurement of liquid propellants and gases for launch and base support;
(2) Production of External Tank (ET) disconnects hardware;
(3) Flight crew equipment processing as well as flight crew equipment spares and maintenance, including hardware to support Space Shuttle extravehicular activity;
(4) The sustaining engineering associated with flight software and the Orbiter vehicles;
(5) Various Orbiter support hardware items such as Pyrotechnic-Initiated Controllers (PICs), NASA Standard Initiators (NSI's) and overhauls and repairs associated with the Remote Manipulator System (RMS); and

The major contractors for these Orbiter activities are United Space Alliance for operations; and Hamilton Sundstrand for extravehicular mobility unit (EMU) operations.

Other support requirements are also provided for in this budget, including tasks, which support flight software development and verification. The software activities include development, formulation and verification of the guidance, targeting and navigation systems software in the Orbiter. The Global Positioning System will replace the current TACAN navigational system in the Orbiter navigation system when the military TACAN ground stations are phased out. The GPS certification for the Space Shuttle Operation will be completed in second quarter of FY 2002.

A major area of concern for the last decade has been the Space Shuttle Main Engine Safety Improvements. Introduction of the Block I and Block II changes into the Space Shuttle's Main Engine (SSME) program has significantly improved the SSME margin of safety. The interim Block IIA configuration (Block II without the ATP High-Pressure Fuel Turbo Pump (HPFTP)) implemented the safety and performance margins provided by the Large Throat Main Combustion Chamber (LTMCC) while the HPFTP development problems were solved. The Block II engines flew successfully on STS-104.

To help ensure continued safe operations of the Space Shuttle by improving the margin of safety, the Space Shuttle program is investing in high priority safety upgrades. NASA will seek to implement all safety investments as quickly as possible, to begin realizing the benefits of those improvements.

A Safety Allocation was provided in FY 2001 to address Shuttle safety improvements through hardware/software upgrades, personnel, facility and infrastructure, or other investments. NASA conducted an external review to assess how the Safety Allocation funds can most effectively be used to improve safety of the Space Shuttle. The highest priority safety upgrades are all part of the Flight Hardware budget element, and include the following: the Cockpit Avionics Upgrade and Advanced Health Management System Phase I for the Space Shuttle Main Engines (SSME).

The Cockpit Avionics Upgrade, among the highest priority upgrades, is for improved avionics in the Shuttle cockpit. This will improve the situational awareness of the crew, and better equip them to handle potential flight anomalies. This new safety upgrade improves crew situational awareness and reduces flight crew workload. It provides automated control of complex procedures and increases the level of flight crew autonomy. Functional capabilities include enhanced Caution & Warning (a system to monitor critical instrumentation parameters), abort situation monitoring and trajectory assessment, improved integrated vehicle instrumentation displays, Remote Manipulator System (RMS) safety enhancements for the robotic arm, and rendezvous and proximity operations.

The Space Shuttle Advanced Health Management System (AHMS) is another high priority safety upgrade. This project entails a suite of instrumentation, software, and computational capabilities for real-time engine assessment, rapid turnaround, and reduction in invasive, manual processing and testing. The system includes vibration monitoring, engine performance monitoring, and overall health analysis. It consists of two phases. Phase 1 reduces pump failures, and is proceeding well.

The External Tank (ET) Friction stir weld (FSW) will provide superior welds with a highly repeatable process for the External tank production. The superior welds should provide a 20% increase in weld strength and a 95% reduction in weld repairs.

The Electric Auxiliary Power Unit (EAPU) for the Orbiter would allow the program to have battery powered electric motors replace turbines powered by hydrazine, a highly flammable and environmentally hazardous fluid. The turbines are used to drive the hydraulic pumps providing control for the orbiter such as engine movement, steering, and braking functions. The upgrade eliminates hydrazine leakage/fire hazards, eliminates turbine overspeed hazards, and reduces toxic materials processing hazards. The requirement definition and system trade studies of the EAPU have been developed. However, the EAPU has been cancelled as recommended by NASA's Space Flight Advisory Committee (SFAC) because of the lack of technical maturity.

This budget includes $148 million for safety investments as part of the safety allocation, a reduction of $125 million below what was previously planned. Reasons for this reduction include lack of performance in ongoing upgrade programs such as EAPU, and a necessary and appropriate adjustment to meet the priority of safely flying the Space Shuttle. Cost increases in many areas of Shuttle operations required additional funds. Most of the increased operations costs were offset by the reduction in planned flight rate. However, NASA determined that based on the program priorities, some funds from the safety allocation should be redirected to help pay for those increased operations costs.

Additional upgrades are being assessed by the SFAC as part of the external review, and candidates include additional upgrades to the SSME, advanced thrust vector control for the solid rocket boosters and investments in space shuttle infrastructure and others.

Prior to commitment on specific additional investments, the unspecified Safety Allocation funding is kept under Flight Hardware, although it may shift to other Space Shuttle budget elements after investment decisions are made.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Enable humans to live and work permanently in space.

Strategic Plan Objectives Supported: Provide and make use of safe, affordable, and improved access to space

Performance Plan Metrics Supported:
- 3H05: Assure public, flight crew, and workforce safety for all Space Shuttle operations.
- 3H06: Safely meet the FY 2003 manifest and flight rate commitment.
- 3H08: Have in place a Shuttle safety investment program that ensures the availability of a safe and reliable Shuttle system for ISS assembly and operations.

Milestones	Plan in FY 2003 Budget	Plan in FY 2002 Budget	Plan in FY 2001 Budget	FY 2002-FY 2003 Change	Comment
TACAN Removal	TBD	TBD	1st Qtr FY 2002		Project under assessment. Select flights will be flown with both systems until GPS flight hardware is certified.
Complete Discovery (OV-103) OMDP	TBD	3rd Qtr FY 2002	3rd Qtr FY 2000		Project under assessment. Conduct routine maintenance and structural inspection. Also, install the Multifunction Electronic Display System (MEDS) upgrade, hardware for GPS capability.
Cockpit Avionics Upgrades (CAU) "Authority to Proceed" for implementation Phase	4th Qtr FY 2001	3rd Qtr FY 2001	3rd Qtr FY 2001	1 Qtr later	Granted approval of "Authority To Proceed" from NASA Human Exploration and Development of Space (HEDS) Program Management Council in July 2001.
CAU Preliminary Design Review	3rd Qtr FY 2002	TBD	4th Qtr FY 2001	3 Qtrs later	Project under review.

Milestones	Plan in FY 2003 Budget	Plan in FY 2002 Budget	Plan in FY 2001 Budget	FY 2002-FY 2003 Change	Comment
CAU Critical Design Review	Under Review	4th Qtr FY 2002	4th Qtr FY 2002	1 Qtr later	Project is under review.
SSME Advanced Health Management (AHM) Phase I first flight	3rd Qtr FY 2004	3rd Qtr FY 2003	3rd Qtr FY 2003	1 year later	Project in the implementation Phase
External Tank Friction Stir Weld Critical Design Review	1st Qtr FY 2002	3rd Qtr FY 2001	3rd Qtr FY 2001	2 Qtrs later	Project in the implementation phase
High Pressure Fuel Turbopump Design Certification Review	2nd Qtr FY 2001	2nd Qtr FY 2001	3rd Qtr FY 1996	--	Completed March 15, 2001 - Certified Block II engine with alternate high-pressure fuel turbopump for flight.
First flight of Block II engine	4th Qtr FY 2001	3rd Qtr FY 2001	4th Qtr FY 2000	1 Qtr later	Completed - flew on STS-104 in July 2001 which was one month later than planned.
Electric Auxiliary Power Unit (EAPU) authority to proceed for implementation phase	Cancel	Under Review	4th Qtr FY 2001	Cancel	Cancelled due to a lack of technological maturity
EAPU Preliminary Design Review	Cancel	Under Review	3rd Qtr FY 2001	Cancel	Cancelled due to a lack of technological maturity
EAPU Critical Design Review	Cancel	Under Review	2nd Qtr FY 2002	Cancel	Cancelled due to a lack of technological maturity

Lead Center:	Other Centers:	
Johnson Space Center	Marshall Space Flight Center Stennis Space Center Kennedy Space Center	
Subsystem: External Tank	**Subsystem:** Space Shuttle Main Engine	**Subsystem:** Solid Rocket Booster
Major Contractors Lockheed Martin Corporation	**Major Contractors** Boeing-Rocketdyne Propulsion & Power Systems	**Major Contractors** United Space Alliance
Subsystem: Vehicle	**Subsystem:** Extravehicular Mobility Unit (EMU)	**Subsystem:** Reusable Solid Rocket Motor
Major Contractors United Space Alliance	**Major Contractors** United Space Alliance and Hamilton Sundstrand	**Major Contractors** ATK Thiokol Propulsion

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

Due to the lack of technological maturity , the Electric Auxiliary Power Unit (EAPU) has been reduced to a technology effort in FY 2002 and is not funded beyond that. The EAPU would have replaced the hydrazine-powered units by using battery-powered electric motors but due to technology development required before initiating the implementation, this project was cancelled. In addition, the Solid Rocket Booster Advance Thrust Vector Control upgrade, (which if implemented could replace the hydrazine power turbines), was also delayed due to cost growth in operations .

PROGRAM PLANS FOR FY 2003

Perform all flight and ground hardware and software processing to support four Space Shuttle missions to the International Space Station. These activities include multiple processing of Space Shuttle Orbiters, External Tanks, Solid Rocket Boosters, and Space Shuttle Main Engines. In addition, Mission Operations flight planning template, mission training and payload integration activities are planned. Line replaceable unit and material supportability activities for hardware replacement and modifications will continue to support delivery of hardware and software to ensure readiness for launch. Six external tank deliveries are planned along with the completion of the External Tank Paperless Manufacturing Effort at the Michoud facility. This paperless effort will include the interface development and system configuration, acceptance testing and user training, factory pilots, final configuration and factory implementation. The solid rocket booster forward skirts, aft skirts and solid rocket motor segments will be delivered to replenish the hardware used to support the four FY 2003 missions. The program will continue with solid rocket motor testing to certify incorporated design changes and environmentally sensitive material changes. The Orbiter mid-deck cooling enhancement mission kits will be delivered in FY 2003 and the program will continue software updates to accommodate changes to support the STS missions. Orbiter major modifications, wiring inspections, structural inspections, and mandatory safety modifications and inspections will continue. The Space Shuttle Main Engine project will complete the Block II high-pressure fuel turbopump delivery to KSC and continue engine testing as needed.

ALTERNATE TURBOPUMP LIFE CYCLE COST

	PRIOR	FY 01	FY 02	FY 03	FY 04	BTC	TOTAL
DEVELOPMENT	751.4	14.0	6.5				771.9
PRODUCTION	173.9	22.5	21.8	2.9			221.1
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	925.3	36.5	28.3	2.9			993.0
(ESTIMATED CIVIL SERVICE FTEs)	(539)	(21)	(7)	(5)			(572)
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	34.0	1.9	1.0	0.8			39.8

ADVANCED HEALTH MONITORING PHASE 1 LIFE CYCLE COST

	PRIOR	FY 01	FY 02	FY 03	FY 04	BTC	TOTAL
DEVELOPMENT	6.0	16.0	16.0	8.0	3.0	6.0	55.0
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	6.0	16.0	16.0	8.0	3.0	6.0	55.0
(ESTIMATED CIVIL SERVICE FTEs)	(2)	(2)	(2)	(2)	(2)		(10)
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	0.3	0.3	0.3	0.3	0.3		1.5

BASIS OF FY 2003 FUNDING REQUIREMENT

GROUND OPERATIONS

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Launch and Landing Operations..	531.5	547.6	527.9
Ground Operations Upgrades (Safety Allocation)	50.1	63.3	61.4
[Checkout and Launch Control System] [included above]	[49.0]	[61.0]	[52.1]
Total..	581.6	610.9	589.3

DESCRIPTION/JUSTIFICATION

Ground Operations is primarily comprised of launch and landing operations, and also includes the launch site operational infrastructure, of facilities and Ground Support Equipment (GSE) at KSC and their required upgrades. The major launch site operational facilities at KSC include three Orbiter Processing Facilities (OPFs), two launch pads, the Vehicle Assembly Building (VAB), the Launch Control Center (LCC) and three Mobile Launcher Platforms (MLPs). The most significant upgrade in this account is the Checkout and Launch Control System (CLCS) at KSC.

These infrastructure upgrades support pre-launch and post-launch processing of the four-Orbiter fleet. Key enhancements funded in ground operations upgrades include: significant upgrades to the two 40-year old crawler transporters used to move a fully assembled Shuttle mounted on the MLP from the VAB to the launch pad; replacement of 16-year old ground cooling units that support all Orbiter power-on testing; replacement of communications and tracking Ku-band radar test set for the labs in the Orbiter Processing Facility and High Bays that supports rendezvous capability and the missions; sustaining the life of the existing Checkout, Control and Monitor Subsystem (CCMS) until the transition to the new Checkout and Launch Control System (CLCS) is complete; communications and instrumentation equipment modernization projects that cover the digital operational intercom system, major portions of KSC's 17-year old radio system and the operational television system; replacing failing air core copper communications cables in the Launch Complex-39 (LC-39) area; improvement of the Shuttle Operations data network that supports interconnectivity between Shuttle facilities and other KSC and off-site networks; an improved hazardous gas detection system; fiber optic cabling and equipment upgrades; and activation of various Safety & Health Construction of Facility projects in the LC-39 area.

The Crawler Transporters are approaching 40 years of service at KSC and face several end of service life and obsolescence challenges. Some of the tasks within the Crawler Transporter Upgrades project include performing comprehensive non-destructive examination of critical load path structure, installing new motor control centers, and rebuilding existing jacking cylinders and hydraulic pumps. The upgrades will continue into FY 2007.

CCMS is over 20 years old and suffers from reliability and obsolescence problems. In FY 1997, the CLCS project was initiated to replace the existing Launch Processing System (LPS). The CCMS Survivability project is intended to sustain the life of the existing CCMS through FY 2002. Due to the extended development schedule for CLCS ; CCMS must now be sustained through at least FY 2006.

The goal of the Operational Television System (OTV) Modernization project is to design and implement a state-of-the-art serial digital video surveillance facility that will meet the needs of the Space Shuttle Program today and throughout the expected life of the program. Modernization of the Operational Television System (OTV) is based upon a phased engineering design and implementation strategy, which will enhance and automate the visual surveillance capability at KSC. A key element of the plan includes the integration of video camera operations and positioning, routing switcher, video monitoring and digital recorder control system into one unified control system (UCS) environment. The implementation of the OTV modernization project will operate concurrently with the current analog system and allow for an orderly phased transition to a completely digital video system. Other key elements of the OTV modernization project include, the upgrade from analog to digital video recorders (FY 1998), the purchase and installation of a new serial digital video routing switcher (FY 2000) and the orderly phased replacement of current analog video cameras. Due to the large number of cameras in the OTV system, and the project's funding profile, the purchase and installation of new serial digital CCD cameras will be phased over a 4 to 5 year period starting FY 2002. When completed, in FY 2007, the OTV Modernization project will improve the OTV system reliability while providing the KSC Launch Team a new level of visual surveillance flexibility that promises to greatly enhance the value of the OTV system to the Shuttle program.

The Lead Cable Replacement and Refurbishment project systematically offloads the LC-39 air core copper communications cables that are failing at unacceptable rates. These cables provide basic audio and low bandwidth digital communications infrastructure for LC-39 to support many launch support systems including select Launch Processing Systems (LPS) data, Ground Support Equipment (GSE) data and control, Timing and Countdown, OTV, Range Safety data, Weather data, Paging and Area Warning, Security, and Fire alarm systems. This is a long-term project continuing beyond FY 2007.

The Complex Control System (CCS) is used to monitor and control processing and institutional facilities systems at KSC. The obsolescence of the current CCS makes it difficult and costly to incorporate new measurements and control points as new facilities are built or existing ones are upgraded. CCS infrastructure conversion is scheduled for completion in FY 2004.

Radio Frequency (RF) communications modernization replaces the existing KSC radio communications system with a combination of digital and conventional mobile, portable and fixed stations and associated off-the-shelf equipment. RF communications modernization is scheduled for completion in FY 2003.

A new Checkout and Launch Control System (CLCS) was approved for development at KSC in FY 1997. The CLCS will upgrade the Shuttle launch control room systems with state-of-the-art commercial equipment and software in a phased manner. The new system will provide a safer processing environment, enable more effective and efficient Shuttle checkout, increase future support flexibility, and mitigate future obsolescence. The CLCS development is requiring substantially more time and money to develop than initially estimated.

Ground operations support will include launch countdown and landing for seven Shuttle missions. Ground support for Shuttle landing could include both the KSC and Edwards AFB runways. Three or four orbiters are normally in the hardware processing flow along with External Tanks, Space Shuttle Main Engines and Solid Rocket Booster components to support several missions. In FY02, ground operations will support the processing, checkout and testing of Shuttle hardware to support ISS assembly and servicing missions. Ground operations for FY 2003 also include support for Space Shuttle flights.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Enable humans to live and work permanently in space.

Strategic Plan Objectives Supported: Provide and make use of safe, affordable, and improved access to space.

Performance Plan Metrics Supported: 3H05: Assure public, flight crew, and workforce safety for all Space Shuttle operations.

Milestones	Plan in FY 2003 Budget	Plan in FY 2002 Budget	Plan in FY 2001 Budget	FY 2002-FY 2003 Change	Comment
CLCS Titan Delivery	3rd Qtr FY2001	3rd Qtr FY 2001	3rd Qtr FY 2001		The Titan delivery will provide support for completion of development and the start of validation testing for application software used for Shuttle Orbiter power testing.
CLCS Scout Delivery	3rd Qtr 2003	3rd Qtr FY 2002	3rd Qtr FY 2002	1 Year Later	The Scout phase of CLCS is planned to support operational use in the Orbiter Processing Facility and development of Pad and launch-related application software.

Lead Center:	**Other Centers:**	**Interdependencies:**
Kennedy Space Center	Johnson Space Center, Dryden Flight Research Center	Department of Defense and Foreign Countries in support of all Emergency Landing Sites.

Major Contractors
United Space Alliance

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

CLCS software is being delivered incrementally. The Juno and Redstone phases of the CLCS were delivered in FY 1997. In these phases, the initial integration platform was defined, the engineering platform was installed and the interface with the math models was established. The Thor delivery was completed in FY 1998. During this phase, initial ground data bus interfaces were established and the system software was ported to the production platforms. The Atlas delivery in FY 1999 provided support for the initial applications for the Orbiter Processing Facility, the final applications for the Hypergolic Maintenance Facility (HMF), the math model validation, an interface to the Shuttle Avionics Integration Lab (SAIL) and hardware testing for SAIL. In addition, the Atlas Delivery provided operational capability for forward and aft propulsion system operations at the HMF. In FY 2001, the Titan baseline was delivered to support additional applications software development and validation and to enable initial OPF user acceptance. In FY 2003, the Scout phase of CLCS is planned to support operational use in the Orbiter Processing Facility (OPF) at the Vertical Assembly Building (VAB), and at the pads. The Extended Delivery will provide additional capability that enables multi-flow operational support beginning in 2004.

HMF, CITE, SAIL, and Operational Control Room #1 hardware sets have been delivered. In addition, all of the software development and test environments have been provided. Operational Control Rooms #2 and #3 will be deployed to support shuttle processing no later than 2005.

A revised estimate at completion (EAC) budget and operations-capable schedule baseline was formulated and briefed to OMB in December 2000. The current cost is estimated at $398.5M. This represents an increase of $165.2M over the estimate in the FY 2001 Budget to Congress of $233.3M. The new launch capable date is 4th quarter FY 2005 -- a delta of 39 months. The CLCS project has been executing to its new contract and structure baseline since January 1, 2001.

PROGRAM PLANS FOR FY 2003

In FY 2003, the Scout phase of CLCS is planned to support operational use in the Orbiter Processing Facility (OPF) at the Vertical Assembly Building (VAB), and at the pads. The Extended Delivery will provide additional capability that enables multi-flow operational support beginning in 2004. The CLCS will be operationally capable to support OPF processing in 2004.
The first Shuttle launch using the CLCS and project completion are scheduled for FY 2005.

CHECKOUT AND LAUNCH CONTROL SYSTEM									
	PRIOR	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**BTC**	**TOTAL**
DEVELOPMENT COSTS	157.1	55.8	61.0	52.1	37.5	26.6	8.5		398.5
TOTAL EXCLUDING CIVIL SERVICE COSTS ($M)	157.1	55.8	61.0	52.1	37.5	26.6	8.5		398.5
(ESTIMATED CIVIL SERVICE FTEs)	(378)	(118)	(121)	(110)	(78)	(39)	(7)		(851)
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	34.1	10.6	11.3	10.8	8.1	4.3	0.8		80.0

BASIS OF FY 2003 FUNDING REQUIREMENT

FLIGHT OPERATIONS

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Mission Operations	206.2	171.8	190.0
Flight Crew Operations	59.4	58.5	66.3
Space and Life Sciences Operations	7.4	7.7	8.3
Flight Operations Upgrades (Safety Allocation)	--	--	2.0
Total	273.0	238.0	266.6

DESCRIPTION/JUSTIFICATION

This budget is based on a baseline of four flights annually. In a change from previous years, Shuttle users requiring additional flights will be budgeting for those flights within their budgets. FY 2001 had seven flights. FY 2002 is scheduled for a seven-flight year and includes the third Hubble Space Telescope servicing mission and STS_107, a Biological and Physical research flight. FY 2003 includes four flights, all for the International Space Station. Flights in subsequent years will focus on continuation of assembly and operations of the International Space Station.

Flight Operations include a wide variety of pre-flight planning, crew training, operations control activities, flight crew operations support, aircraft maintenance and operations and life sciences operations support. The primary contractor is United Space Alliance (USA). The planning activities range from the development of operational concepts and techniques to the creation of detailed systems operational procedures and checklists. Tasks include:

(1) Flight planning;
(2) Preparing systems and software handbooks;
(3) Defining flight rules;
(4) Creating detailed crew activity plans and procedures;
(5) Updating network system requirements for each flight;
(6) Contributing to planning for the selection and operation of Space Shuttle payloads; and
(7) Preparation and plans for International Space Station assembly.

Also included are the Mission Control Center (MCC), Integrated Training Facility (ITF), Integrated Planning System (IPS) and the Software Production Facility (SPF). Except for the SPF (Space Shuttle only), these facilities integrate the mission operations requirements for both the Space Shuttle and International Space Station. Flight planning encompasses flight design, flight analysis and software activities. Both conceptual and operational flight profiles are designed for each flight and the designers also help to develop crew training simulations and flight techniques. In addition, the flight designers must develop unique, flight-dependent data for each mission. The data are stored in erasable memories located in the Orbiter, ITF Space Shuttle mission simulators and MCC computer systems. Mission operations funding also provides for the maintenance and operation of critical mission support facilities including the MCC, ITF, IPS and SPF. Finally, Mission and Crew Operations include maintenance and operations of aircraft needed for flight training and crew proficiency requirements.

Funds for other activities include implementing required modifications and upgrades on the T-38 aircraft used for space flight readiness training, capability improvements for weather prediction and enhancements on information handling to improve system monitoring, notably for anomaly tracking.

The major operations facilities at Johnson Space Center (JSC) include the Mission Control Center (MCC), the flight and ground support training facilities, the flight design systems and the training aircraft fleet that includes the Space Shuttle Training aircraft and the T-38 aircraft.

The Flight Operations budget also includes in FY 2001, FY 2002, and FY 2003 reimbursements from training of foreign astronauts that are assumed to be $4.4 million per year. These standard service reimbursements offset the total budget for the Space Shuttle and have been assumed in the NASA direct funding requirements identified above for the FY 2003 budget request.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Enable humans to live and work permanently in space.

Strategic Plan Objectives Supported: Provide and make use of safe, affordable, and improved access to space.

Performance Plan Metrics Supported:
- Assure public, flight crew, and workforce safety for all Space Shuttle operations. (3H05)
- Safely meet the FY 2003 manifest and flight rate commitment. (3H08)

Milestones	Plan in FY 2003 Budget	Plan in FY 2002 Budget	Plan in FY 2001 Budget	FY 2002- FY 2003 Change	Comment
STS-92/Discovery	October 2000	October 2000	June 2000	--	Space Station #5 (ITS-Z1) (ISS-05-3A) Mission completed.
STS-97/Endeavour	December 2000	December 2000	July 2000	--	Space Station #6 (PV Module) (ISS-06-4A). Mission completed.
STS-98/Atlantis	February 2001	February 2001	August 2000	--	Space Station #7 (US Lab (ISS-07-5A). Mission completed.
STS-102/Discovery	March 2001	March 2001	2nd Qtr FY 2000	--	Space Station #8 (MPLM-IP-01) (ISS-08-5A.1) Mission completed.
STS-100/Endeavour	April 2001	April 2001	3rd Qtr FY 2000	--	Space Station #9 (MPLM-2P-01) (ISS-09-6A) Mission completed
STS-104/Atlantis	July 2001	June 2001	4th Qtr FY 2000	1 month	Space Station #10 – Airlock (ISS-10-7A) Mission completed.
STS-105/Discovery	August 2001	July 2001	4th Qtr FY 2000	1 month	Space Station #11 (MPLM-IP-02) (ISS-11-7A.1) Mission completed.
STS-108/Endeavour	1st Qtr FY 2002	1st Qtr FY 2002	April 2001	--	Space Station #12 (MPLM) (ISS-12-UFI). Mission completed in December 2001.
STS-107/Columbia	4th Qtr FY 2002	1st Qtr FY2002	January 2001	3 Qtrs later	Research Mission (Spacehab Double Module). Mission was delayed because of orbiter modifications and necessary wiring repairs to OV-102. This pushed the mission to within one month of the STS-109 mission. A decision was made to give priority to the STS-109 mission due to cost considerations and delay this mission until after the STS-109 HST mission.
STS-109/Columbia	2nd Qtr FY 2002	2nd Qtr FY 2002	May 2001	--	Hubble Space Telescope (HST) Servicing Mission

Milestones	Plan in FY 2003 Budget	Plan in FY 2002 Budget	Plan in FY 2001 Budget	FY 2002-FY 2003 Change	Comment
STS-110/Atlantis	2nd Qtr FY 2002	2ndt Qtr FY 2002	June 2001	--	Space Station #13 (ITS-S0) (ISS-13-8A)
STS-111/Endeavour	3rd Qtr FY 2002	2nd Qtr FY 2002	August 2001	1 Qtr later	Space Station #14 (MPLM) (ISS-14-UF2)
STS-112/Atlantis	4th Qtr FY 2002	3rd Qtr FY 2002	3rd Qtr FY 2002	1 Qtr later	Space Station #15 (ITS-S1) (ISS-15-9A)
STS-113/Endeavour	4th Qtr FY 2002	4th Qtr FY 2002	4th Qtr FY 2002	--	Space Station #16 (ITS-P1) (ISS-16-11A)
STS-114/Atlantis	2nd Qtr FY 2003				Space Station #17 (MPLM) (ISS-17-ULF-1)
STS-115/Endeavour	3rd Qtr FY 2003				Space Station #18 (ITS-P3/P4) (ISS-18-12A)
STS-116/Atlantis	3rd Qtr FY 2003				Space Station #19 (Spacehab Single Module/ICC) (ISS-19-12A.1)
STS-117/Endeavour	4th Qtr FY 2003				Space Station #20 (ITS-S3/S4) (ISS-20-13A)
Number of FY 2001 Shuttle Flights	7	7	9	--	
Number of FY 2001 Days on Orbit	87	81	102	+ 6 days	Several missions were extended an extra day or two due to mission workload.
Number of FY 2001 Primary Payloads	7	7	11	--	
Number of FY 2002 Shuttle Flights	7	7	7		

Milestones	Plan in FY 2003 Budget	Plan in FY 2002 Budget	Plan in FY 2001 Budget	FY 2002-FY 2003 Change	Comment
Number of FY 2002 Days on Orbit	82	77	77	+5 days	Mission workload required additional days on orbit.
Number of FY 2002 Primary Payloads	7	7	7	--	
Number of FY 2003 Shuttle Flights	4				
Number of FY 2003 Days on Orbit	40+				Only STS-114 has officially been baselined for 11-day mission duration. All other flights are ISS flights and mission duration is assumed for at least 10 days.
Number of FY 2003 Primary Payloads	5				

Lead Center:	Other Centers:	Interdependencies:
Johnson Space Center	Kennedy Space Center	Goddard Space Flight Center (HST flight) Marshall Space Flight Center (STS-107 flight) Dryden Flight Research Center (alternate landing site)
Major Contractors United Space Alliance		

PROGRAM STATUS/NOTIFICATION/PLANS THROUGH 2002

In FY 2001, seven flights were flown, all of which were ISS assembly and servicing missions. In FY 2001, 46 U.S. and international crewmembers spent approximately 540 days on-orbit, including time spent while docked the International Space Station. In FY 2002, five ISS flights are planned along with one for the third Hubble Space Telescope servicing mission, and a dedicated microgravity research mission.

PROGRAM PLANS FOR FY 2003

In FY 2003, four ISS flights are planned (ISS-17-ULF-1, ISS-18-12A, ISS-19-12a.1, and ISS-20-13A).

BASIS OF FY 2003 FUNDING REQUIREMENT

PROGRAM INTEGRATION

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Shuttle Integration	148.3	180.2	252.3
Program Management Support	115.3	162.6	150.4
Facilities Construction	15.6	39.5	90.4
Program Integration Upgrades (Safety Allocation)	14.4	13.5	14.7
Total	293.6	395.8	507.8

DESCRIPTION/JUSTIFICATION

The goal of Program Integration is to ensure the integration of the various Shuttle elements occurs successfully. Program Integration performs hundreds of modifications throughout the year related to design changes to improve reliability, supportability, or meet new program requirements. These changes are a result of hardware failures or design enhancements identified through ground checkouts or in-flight. Safety investments made to the shuttle infrastructure to ensure the continued safe operations of the Space Shuttle are funded by Program Integration Upgrades.

The Program Integration budget includes funds for the analysis, management, and the SRM&QA function and is performed here for the entire Space Shuttle Program. In addition, this area includes funds for the infrastructure, taxes and directly funded construction of facilities projects.

Program integration includes those elements managed by the Space Shuttle Program Office at the Johnson Space Center (JSC) and conducted primarily by United Space Alliance, including payload integration into the Space Shuttle and systems integration of the flight hardware elements through all phases of flight.

Shuttle integration provides for the engineering analysis needed to ensure that various payloads can be assembled and integrated to form a viable and safe cargo for each Space Shuttle mission. Shuttle integration includes the necessary mechanical, aerodynamic and avionics engineering tasks to ensure that the launch vehicle can be safely launched, fly a safe ascent trajectory, achieve planned performance and descend to a safe landing. In addition, funding is provided for multi-program support at JSC.

Program management support is institutional and technical support provided by the centers in support of the program operations. The support covers a variety of activities ranging from electricity and roads to routine administrative support for the civil servants working on the Space Shuttle program.

Program Integration upgrades are funded from the Safety Allocation. Potential projects are under review as part of the safety investment prioritization process, and could include improvements and other safety-related infrastructure investments.

Construction of Facilities (CoF) funding for Space Shuttle projects is provided in this budget to refurbish, modify, reclaim, replace and restore facilities at Office of Space Flight Centers to improve performance, address environmental concerns of the older facilities and to ensure their readiness to support Shuttle Operations.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Enable humans to live and work permanently in space.

Strategic Plan Objectives Supported: Provide and make use of safe, affordable, and improved access to space.

Performance Plan Metrics Supported: 3H08: Have in place a Shuttle safety investment program that ensures the availability of a safe and reliable Shuttle system for ISS assembly and operations.

Milestones	Plan in FY 2003 Budget	Plan in FY 2002 Budget	Plan in FY 2001 Budget	FY 2002-FY 2003 Change	Comment
Complete Phase IV of Rehabilitation of 480V Electrical Distribution System at MAF	3rd Qtr FY 2001	2nd Qtr FY 2001	2nd Qtr FY 2001	1 Qtr later	Phase IV, Substations Nos., 7B, 4 & 5 – core system, transformers and switchgear, breakers and oil switches. Project Completed.
Complete Restoration of Pad A PCR Wall and Ceiling Integrity at Launch Complex (LC)-39	1st Qtr FY 2000	1st Qtr FY 2001	1st Qtr FY 2001	1 year early	This project provides for repair and replacement of damaged Payload Change Out Room (PCR) wall panels (Sides 1, 2, 3, & 4), replacement or elimination of deteriorated and leaking access doors, and other needed replacement and restoration. The modification will eliminate degrading flexducts and filter housings, improve pressurization of the PCR, provide an even distribution of airflow, and provide safe personnel access for maintenance and repair. Project Completed.
Complete Convoy Operations refurbishment	2nd Qtr FY 2002	2nd Qtr FY 2001	2nd Qtr FY 2001	1 year later	This project will refurbish the SLF Convoy Operations capability at the SLF.

Milestones	Plan in FY 2003 Budget	Plan in FY 2002 Budget	Plan in FY 2001 Budget	FY 2002-FY 2003 Change	Comment
Complete VAB and Crawlerway Modification, LC-39 (Safe Haven)	3rd Qtr FY 2000	3rd Qtr FY 2001	4th Qtr FY 1999	1 year early	This project restores the crawlerway into VAB highbay 2 and provides an Orbiter towway into Highbay 4. This will allow use of the VAB highbays as a Safehaven during hurricanes, allow for additional manifest flexibility for stacking operations and Orbiter access operations to continue when Highbay 1 and 3 contain full stacks. Project completed.
Complete Repair VAB Elevator Controls	3rd Qtr FY 2002	1st Qtr FY 2002	2nd Qtr FY 2000	2 Qtrs later	This Project replaces the elevator systems in the Vehicle Assembly Building. The controls, cabs and cableway systems are obsolete and parts are no longer available. A recent fire in one of the VAB elevator controls caused a concern with the safety of the systems. This was identified as a safety project.
Complete Phase I Rehabilitation of A Test Stand at SSC for SSME Testing	2nd Qtr FY 2001	2nd Qtr FY 2001	2nd Qtr FY 2001	--	Phase I includes replacing structural member, rehabilitating rolling platforms level 4&5, and repair of electrical panels. Project completed.
Complete Phase II Rehabilitation of A Test Stand at SSC for SSME Testing	3rd Qtr FY 2002	3rd Qtr FY 2001	3rd Qtr FY 2001	1 year later	Phase II includes asbestos abatement, rehabilitating run tank insulation, rehabilitating shop air system, and replacement of 480 volt switchgear. Delay due to testing schedules.
Start Phase II Restoration of Pad A Low Voltage Power System	2nd Qtr FY 2002	2nd Qtr FY 2002	2nd Qtr FY 2002	--	Pad A Phase II includes redesign and refurbish and repair of USS 898 (PTCR Room 103), USS 930A and B (FSS and RSS) and remove/replace first level 480V panel boards, automatic transfer switches, and feeder circuits .
Start Phase II Restoration of Pad B Low Voltage Power System	2nd Qtr FY 2002	2nd Qtr FY 2002	2nd Qtr FY 2002	--	Pad B Phase II includes redesign and replace substation 1052 (PTCR) power systems and remove/replace first level 480V panel boards, and automatic transfer switches and feeder circuits.

Milestones	Plan in FY 2003 Budget	Plan in FY 2002 Budget	Plan in FY 2001 Budget	FY 2002-FY 2003 Change	Comment
Completion of Repair and Upgrade of Substations 20A/20B	2nd Qtr FY 2002	2nd Qtr FY 2002	2nd Qtr FY 2002	--	This project replaces switchgear and 480V distribution system, feeders, MCC, panels, bus duct, and switches in Bldg. 110, VAB, at MAF.
Start Refurbish Air Pressurization System Pads A&B	4th Qtr FY 2001	4th Qtr FY 2001	4th Qtr FY 2001	--	This project repairs/replaces the pressurization tunnels from the Remote Air Intake Facility to the Pad Terminal Connection Room (PTCR) emergency vehicle park area. Provide drainage and lighting for the tunnels, replace pressurization fans, wiring, replace motors and dampers, air intake louvers, filters, racks, seal doors, remove asbestos. Project started on schedule.
Start Repair of the VAB Lowbay Elevator	3rd Qtr FY 2001	3rd Qtr FY 2001	3rd Qtr FY 2001	--	This project refurbishes four VAB lowbay elevators and the roof elevator. Includes replacing the motor-generator set to eliminate commutator, brush and bearing maintenance, replace relay panels. Project started on schedule.
Start Repair of Pad B Flame Deflector and Trench	2nd Qtr FY 2004	4th Qtr FY 2002	4th Qtr FY 2002	6 Qtrs later	This project provides for repair of the fire resistant surface of the Main and SRB flame deflector, repair/replacement of damaged and corroded structural members, and repair/replacement of bricks in the Flame Trench wall. Project scheduled to start 2nd Qtr FY 2004; no open work window available until then.
Start Replacement of Chilled Water/ Steam/Cond. System (FY 02) Phase I	2nd Qtr FY 2002	2nd Qtr FY 2002	2nd Qtr FY 2002	--	This project replaces critical chilled water/steam/condensate systems in Building 110 and 114 at Michoud Assembly Facility . Route piping from mechanical equipment room and tank farm to north side of the VAB and to building 103 central plant mains. Replace chilled water pumps, condensate receiver stations, shutoff valves, circuit setters, strainers, control valves, etc.
Start Refurbish RSS Drive Trucks	4th Qtr FY 2002	2nd Qtr FY 2002	2nd Qtr FY 2002	2 Qtrs later	This project repairs or replaces the RSS Drive Trucks on each Pad. The trucks are used to retract the RSS to park position at about 18 hours before launch. Each of the two trucks consist of two right hand and two left hand bogies of two wheels each that are electric motor driven through gear box and drive train

Milestones	Plan in FY 2003 Budget	Plan in FY 2002 Budget	Plan in FY 2001 Budget	FY 2002-FY 2003 Change	Comment
PAD A/B Low Voltage Power Restoration, Phase 3	2nd Qtr FY 2003				This project removes/replaces first level 480V panel boards, and automatic transfer switches and feeder circuits.
Upgrade LC-39 Area Power Distribution System, Phase 2	2nd Qtr FY 2003				This project replaces all power feeder cabling throughout the LC-39 Area. This project is mandatory to ensure reliability of the power distribution system to support shuttle flight operations.
Replace Chill. Water/Steam/Cond. Sys. Phase 2	2nd Qtr FY 2003				This project provides for the reconfiguration of the chilled water, condensate and seam systems to meet current requirements.
Replace Paint Spray Facility – where?	2nd Qtr FY 2003				This project will replace obsolete Paint Spray Facility and associated components with an efficient state-of-the-art unit.
Replace Cell E AHU's Nos. 1 & 2 (110)	2nd Qtr FY 2003				Replace production critical ET air handling units 1 and 2 supporting Cell E internal and external tank drying systems.
Rehabilitate A-2 Test Stand for SSME Testing	2nd Qtr FY 2002				This project provides repairs to basic infrastructure of the A-2 Test Stand.
Finish Repair of the VAB Lowbay Elevator	4th Qtr FY 2003				This project refurbishes four VAB lowbay elevators and the roof elevator. Includes replacing the motor-generator set to eliminate commutator, brush and bearing maintenance, replace relay panels.
Finish Refurbish Air Pressurization System Pads A&B	4th Qtr FY 2003				This project repairs/replaces the pressurization tunnels from the Remote Air Intake Facility to the Pad Terminal Connection Room (PTCR) emergency vehicle park area. Provide drainage and lighting for the tunnels, replace pressurization fans, wiring, replace motors and dampers, air intake louvers, filters, racks, seal doors, remove asbestos.

Lead Center: Johnson Space Center	**Other Centers:** Kennedy Space Center Marshall Space Flight Center Dryden Flight Research Center White Sands Test Facility
Major Contractors United Space Alliance	

PROGRAM STATUS/NOTIFICATION/PLANS THROUGH 2002

The Shuttle program provides cargo integration and systems integration, which is required for each flight planned in FY 2002 and FY 2003. Cargo integration includes tasks to ensure cargo safety and to develop orbiter cargo interface requirements for each flight. The system integration effort encompasses System Safety and Hazard reviews, integrated avionics, and vehicle/ground integration that are required for each flight as well. In FY 2002, seven flights are planned - ISS will require five missions, a Hubble Space Telescope servicing mission will be performed and a dedicated microgravity research mission will be flown. In FY 2003, the Shuttle is planning

Assessment of potential infrastructure investments as part of the Safety Allocation will continue in FY 2002. Pending investment decisions, potential projects could begin in FY 2002 or FY 2003.

FY 2001 CoF funding will provide for improvements for facilities at JSC, KSC, MAF and SSC. At KSC there are 3 projects that complete the refurbishment of Pad B Payload Change Room (Wall and Ceiling), phase 1 of restoring low volt power system (Pad A and B), and the rehabilitation of high-pressure distribution piping system (LC-39A/B). The JSC project repairs the roofs at Palmdale, Building 150. The SSC project modifies the A-2 Test Stand for Shuttle Testing. The MAF project repairs and upgrades the main electrical distribution system servicing the Vertical Assembly Building (110) and the Mix Room Building (130).

FY 2002 CoF funding will provide for the second Phase of the Pad A & B Low Voltage Power system refurbishment, Restoration of the Pad B Flame Deflector and Trench, Restoration of the Pad A&B RSS Drive Trucks, Third Phase of the Stennis A-2 Stand refurbishment, First phase of the Chilled Water/Steam/Condensator System refurbishment at MAF, and high priority repair work on the VAB, including roof and siding repairs.

PROGRAM PLANS FOR FY 2003

FY 2003 CoF funding will provide for the third Phase of Pad A & B Low Voltage Power system refurbishment, first Phase of LC-39 Area Power Distribution System, second phase of the Chilled Water/Steam/Condensator System refurbishment at MAF, Replace Cell E AHU’s Nos. 1 & e, and the Fourth Phase of the Stennis A-2 Test Stand for Shuttle Testing.

The FY 2003 budget includes $76.4M for Space Shuttle program infrastructure revitalization projects that are urgently needed to revitalize and repair critical facilities, systems and equipment that support the Space Shuttle program. The majority of these projects are located at Kennedy Space Center, but a number of projects are also required at Johnson Space Center, Marshall Space flight Center, the Michoud Assembly Facility, White Sands Test Facility, and the Stennis Space Center. The budget runout for the Space Shuttle infrastructure revitalization projects is $370.6 million through FY 2007. A major component of this funding is the revitalization of the roof, siding, and doors of the Vehicle Assembly Building (VAB) at KSC.

HUMAN SPACE FLIGHT

FISCAL YEAR 2003 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE FLIGHT | **PAYLOAD AND ELV SUPPORT**

SUMMARY OF RESOURCES REQUIREMENTS

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET	Page Number
	(Millions of Dollars)			
Payload Carriers and Support	56.9	57.0	51.7	HSF 4-2
Expendable Launch Vehicle Mission Support	33.1	34.3	35.8	HSF 4-6
Total	90.0	91.3	87.5	
Distribution of Program Amount by Installation				
Johnson Space Center	1.4	1.3	1.3	
Kennedy Space Center	73.6	76.4	74.3	
Marshall Space Flight Center	3.9	2.7	1.8	
Goddard Space Flight Center	11.1	10.9	10.1	
Total	90.0	91.3	87.5	

Payload and ELV Support linkage to Strategic Plan

The mission of the HEDS is to expand the frontiers of space and knowledge by exploring, using, and enabling the development of space for human enterprise. The Payload and ELV programs play a vital role meeting the following goals: Goal 1 – Explore the space frontier; Goal 2 – Enable humans to live and work permanently in space; and Goal 3 – Enable the commercial development of space.

BASIS OF FY 2003 FUNDING REQUIREMENT

PAYLOAD CARRIERS AND SUPPORT

Web Address: http://www.ksc.nasa.gov/carriers

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Payload Carriers and Support	56.9	57.0	51.7
(Construction of Facilities included – non-add)	[0.2]	[0.8]	[1.0]

DESCRIPTION/JUSTIFICATION

The primary goal for Payload Carriers and Support is to be the "one-stop shopping provider" for all customer carrier needs and requirements for safe and cost effective access to space via the Space Shuttle.

The Payload Carriers and Support program provides the technical expertise, facilities and capabilities necessary to perform payload buildup; test and checkout; integration and servicing of multiple payloads; transportation to the launch vehicle; and integration and installation into the launch vehicle. This program also includes operational efficiencies gained to date. Efficiencies already in place have reduced processing time and error rate. The program will seek to achieve further efficiencies through the use of commercial capabilities. It will oversee a transition to commercial operations of the fleet of all common carriers owned by the Agency.

Payload Carriers and Support also funds the mission planning and integration of smaller secondary payloads like the Get-Away Specials (GAS) and Hitchhiker payloads that are managed at Goddard Space Flight Center (GSFC). The GAS payloads are research experiments that are flown in standard canisters, which can fit either on the sidewall of the cargo bay or across the bay on various cross-bay carriers. They are the simplest of the small payloads with limited electrical and mechanical interfaces. Over 165 GAS payloads have been flown. The Hitchhiker payloads are the more complex of the smaller payloads, and provide opportunities for larger, more sophisticated experiments. The Hitchhiker system employs two carrier configurations: (1) a configuration on the Orbiter payload bay sidewall and (2) a configuration across the payload bay using a Multi-Purpose Experiment Support Structure (MPESS). During the mission, the Hitchhiker payloads can be controlled and data can be received using the aft flight deck computer/standard switch panels or from the ground through the Payload Operations Control Center (POCC).

Payload analytical integration for the major carriers is the responsibility of the Flight Projects Directorate at the Marshall Space Flight Center (MSFC), supported by a contract with Boeing. Physical payload integration and processing is the responsibility of the International Space Station and Payload Processing Directorate at the KSC, also supported by a contract with Boeing. This contract is presently being re-competed. Offerers must show how they will commercialize the available capacity of payload processing facilities, integrate commercial activities into mission processing, and identify any potential non-government use of available capabilities.

Payload Carriers and Support also funds a number of carriers as a part of the Flight Support System (FSS) at the Goddard Space Flight Center. The FSS consists of standard cradles with berthing and pointing systems, along with the associated avionics, several pallet-type carriers, and containers for carrying instruments or other items for on-orbit replacement or servicing. The FSS is used for on-orbit maintenance, repair, and retrieval of spacecraft, and is presently being used on the Hubble Space Telescope (HST) repair/revisit missions.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goals Supported:
Goal 2: Enable Humans to Live and Work Permanently in Space
Goal 3: Enable the Commercial Development of Space (added in FY 2003)

Strategic Plan Objectives Supported:
Objective: Provide and make use of safe, affordable, and improved access to space
Objective: Foster commercial endeavors with the International Space Station and other assets (added in FY 2003)

Performance Plan Metrics Supported:
Annual Performance goal 2H08: Maintain a "12 month" manifest preparation time
Annual Performance goal 3H18: Establish mechanisms to enable NASA to utilize commercial processing facilities

FY 2001 Milestones	Actual in FY 2003 Budget	Plan in FY 2002 Budget	Plan in FY 2001 Budget	Change FY 2002- FY 2003	Comment
Number of Space Shuttle Missions	7	7	9	--	
Number of Hitchhiker Experiments	4	6	7	-2	STS-107 delayed to FY 2002
Number of Get-Away Special Payloads	3	2	2	1	GAS payload replaced an active payload that was not ready to fly
Number of Spacehab Missions	0	1	1	-1	STS-107 flight delayed to FY 2002
Other Secondary Payloads	6	8	1	-2	Delay in STS-107
Number of KSC Payload Facilities Operating	5	6	5	-1	Delay in STS-109
KSC Payload Ground Operations Workforce	268	302	334	-34	Manifest Delays (STS-107 and STS-109)

FY 2002 Milestones	Plan in FY 2003 Budget	Plan in FY 2002 Budget	Plan in FY 2001 Budget	Change FY 2002-FY 2003	Comment
Number of Space Shuttle Missions	7	7	7	0	
Number of Hitchhiker Experiments	13	8	8	5	Additional SEM/HH experiments for STS-108
Number of Get-Away Special Payloads	6	8	8	-2	Delay of STS-114 to FY 2003
Number of Spacehab Missions	1	0	0	1	STS-107 Flight delayed from FY 2001
Other Secondary Payloads	8	2	2	6	Release of Shuttle Program Manager's Reserve (weight reserve)
Number of KSC Payload Facilities Operating	5	5	5	0	
KSC Payload Ground Operations Workforce	275	322	322	-47	Cancellation of X-38 Shuttle mission and reduced science opportunities

FY 2003 Milestones	Plan in FY 2003 Budget	Comment
Number of FY 2003 Shuttle Missions	4	
Number of FY 2003 Hitchhiker Experiments	3	
Number of FY 2003 Spacehab Missions	1	
Number of KSC Payload Facilities Operating	4	
KSC Payload Ground Operations Workforce	264	

Lead Center:	**Other Centers:**
Kennedy Space Center	Goddard Space Flight Center, Marshall Space Flight Center, Johnson Space Center

Major Contractors

Boeing Company - Payload Ground Operations Contract (PGOC)
United Space Alliance - Space Flight Operations Contract (SFOC)

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

In FY 2002, Payload Carriers and Support will provide the Flight Support System (FSS) and a pallet, along with integration and testing support activities for the Hubble Space Telescope (HST) Servicing Mission 3B. Launch and landing payload support activities include 7 planned Space Shuttle Missions, encompassing payload processing support activities and facilities for 21 major payloads, including 5 ISS assembly and utilization flights. A number of secondary payloads and ISS Launch on Need Orbital Replacement Units (ORUs) will also be supported. A third Multi-Purpose Experiment Support Structure (MPESS) carrier is being modified to a lightweight version to better support scientific secondary payloads and ISS Launch-on-Need requirements. Funding also provides operations and maintenance of payload facilities at KSC. The Vehicle Processing Facility (VPF) has been reopened to support payload processing for HST. Funding includes a Construction of Facility project in the amount of $750,000 for repair & modernization of the Heating Ventilation and Air Conditioning (HVAC) for the Payload Hazardous Support Facility (PHSF) as well as $160,000 for facility planning and design for future projects. It is planned that reimbursable funds of $1,300,000 will be received in FY 2002 to cover processing costs for GAS and Hitchhiker payloads.

PROGRAM PLANS FOR FY 2003

In FY 2003, Payload Carriers and Support will provide launch and landing support for 4 planned Space Shuttle Missions for ISS assembly and utilization, encompassing payload processing support activities and facilities for 15 major payloads. A limited number of secondary payloads and ISS Launch-on-Need ORUs will also be supported. Operations and maintenance of payload facilities at KSC will be provided. Funding includes a Construction of Facility project in the amount of $1,000,000 for modifications and upgrades to the Multi-Purpose Payload Facility. Reimbursable funds in the amount of $1,100,0000 are anticipated in FY 2003 to cover processing costs for GAS and Hitchhiker payloads.

BASIS OF FY 2003 FUNDING REQUIREMENT

EXPENDABLE LAUNCH VEHICLE SUPPORT

Web Address: http://www.ksc.nasa.gov/elv

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Expendable Launch Vehicle Support	33.1	34.3	35.8
(Construction of Facilities included – non-add)	[0.2]	[1.2]	[2.0]

DESCRIPTION/JUSTIFICATION

The goals of the Expendable Launch Vehicle (ELV) mission support program are to: (1) enhance probability of mission success and on-time cost effective launch services for NASA missions undertaken in support of NASA's strategic plan; (2) provide comprehensive advanced mission analysis and feasibility assessments for NASA payload customers; (3) increase efficiency in launch site operations and countdown management; and (4) provide low-cost secondary payload opportunities.

The ELV Mission Support budget funds the capability for NASA to maintain critical skills to provide technical oversight of launch services across all launch vehicle class (Small, Med-Lite, Medium, Intermediate and NLS) for NASA unique one of a kind science, earth observing and technology payloads. For primary payloads, funding also supports launch site maintenance and sustaining operations at Vandenberg AFB and Cape Canaveral Air Station.

KSC is responsible for acquiring requisite launch services to meet all Enterprise requirements and for increasing the probability of mission success through focused technical oversight of commercially provided launch services. A core team of civil servants and contractors primarily located at KSC performs the technical management. KSC personnel are also resident at key launch sites, launch facilities, and customer facilities. NASA personnel are resident at Vandenberg AFB in California where all launches into a polar orbit, such as those required by the Earth Science Enterprise, are conducted. Resident office personnel are located in launch service contractor plants, specifically, the Lockheed Martin Corporation Atlas/Titan plant in Denver and the Boeing Corporation Delta plant in Huntington Beach, California.

Advanced mission design/analysis and leading edge integration services are provided for the full range of NASA missions under consideration for launch on ELV's. Technical launch vehicle support is provided in the development and evaluation of spacecraft Announcement of Opportunities, to enable cost effective consideration of launch service options and technical compatibility. Early definition of vehicle requirements enables smooth transition to launch service and an excellent cost containment strategy.

Launch site operations and countdown management is being improved through the use of a consolidated launch team, efficient telemetry systems, and close partnership with Boeing and the USAF to assure lowest cost west coast Delta launch complex operations. KSC is transitioning to increased reliance on use of commercial payload processing capability for NASA missions in lieu of NASA owned-operated facilities. Use of NASA facilities for payload processing has been limited to payloads with unique requirements (processing of nuclear power sources, etc) that cannot be met more cost effectively in an off-site commercial facility.

NASA's ELV secondary payload program enables efficient use of excess vehicle performance on selected NASA, USAF and commercial missions through development of requisite secondary payload adapters to support integration of small secondary payloads. University research institutions and international cooperative missions are typical customers for this service and have the flexibility to take advantage of available limited excess space and performance on launch vehicles and accept the primary payload's launch schedule and orbit. NASA has developed a standard Delta secondary launch vehicle capability and has similar efforts under way with other US ELV providers.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goals Supported:
Goal 1: Explore the Space Frontier
Goal 3: Enable the Commercial Development of Space

Strategic Plan Objectives Supported:
Objective: Enable human exploration through collaborative robotic missions
Objective: Improve the accessibility of space to meet the needs of commercial research and development

Performance Plan Metrics Supported:
Annual Performance Goal 2H03: Provide Reliable launch services for approved missions
Annual Performance Goal 2H18: Establish mechanisms to enable NASA access to the use of U.S. commercially developed launch systems

FY 2001 Milestones	Actual in FY 2003 Budget	Plan in FY 2002 Budget	Plan in FY 2001 Budget	Change FY 2002-FY 2003 Budgets	Comment
Number of Primary ELV Missions	8	10	11	-3	3 missions slipped from FY 2001 to FY 2002 (HESSI, Timed/Jason, and NOAA-M
Number of Secondary ELV Missions	1	2	1	-1	One Secondary slipped from FY 2001 to FY 2002 (Proseds)

FY 2002 Milestones	Plan in FY 2003 Budget	Plan in FY 2002 Budget	Plan in FY 2001 Budget	Change FY 2002-FY 2003 Budgets	Comment
Number of Primary ELV Missions	10	8	8	3	Three missions were added from FY 2001 (HESSI, Timed/Jason, and NOAA-M) and cancellation of one mission (Catsat)
Number of Secondary ELV Missions	1	1	1	0	Proseds slipped from FY 2001 to FY 2002; Chips baselined on Icesat mission

FY 2003 Milestones	Plan in FY 2003 Budget	Comment
Number of Primary ELV Missions	9	
Number of Secondary ELV Missions	1	

Lead Center:
Kennedy Space Center

Other Centers:
Goddard Space Flight Center, Marshall Space Flight Center

Major Contractors
Boeing Company

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

In FY 2002 funding supports 10 primary payload missions (including NOAA-M, GALEX, ICESAT/CHIPSAT, SORCE, CONTOUR, SIRTF, TDRS-I, AQUA, JASON/TIMED, HESSI) and 1 Secondary Payload (PROSEDS). This includes three missions that were originally delayed from FY 2001. Funding also includes funding for one construction of facility project totaling $1,200,000 (Modernize Launch Vehicle Data Center at Vandenburg Air Force Base, CA) and two CoF Design Projects totaling $150,000 (Revitalize SLC-2 PAD Ground System and Asbestos Abatement, AE CCAFS). In addition, funding includes a thirty-day transition from Payload Ground Operations Contract (PGOC) to Expendable Launch Vehicle Integrated Support (ELVIS).

PROGRAM PLANS FOR FY 2003

In FY2003, funding supports 9 Primary Mission launches (SCI-SAT, GPB, TDRS J, NOAA N, MER-A, MER-B, AURA, SWIFT, GOES N) and 1 Secondary Payload (Spacetech 5). In addition, funding includes two construction of facility projects totaling $2,000,000: 1) Revitalize Cable Plant, Vandenburg Launch Site, Space Launch Complex-2; and 2) Consolidation of shop facilities, Vandenburg Launch Site, Space Launch Complex-2. Funding also includes one design project totaling $200,000: Vapor Detection System at SLC-2.

HUMAN SPACE FLIGHT

FISCAL YEAR 2003 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE FLIGHT | **HEDS INVESTMENTS AND SUPPORT**

SUMMARY OF RESOURCES REQUIREMENTS

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET	Page Number
		(Millions of Dollars)		
OSF Contribution to Academic Programs*	8.1	--	--	
HEDS Technology and Commercialization Initiative**	5.0	--	--	HSF 4-3
Crew Health and Safety	[5.2]	[6.1]	5.8	HSF 4-7
Engineering and Technology Base	73.3	75.2	72.4	HSF 4-10
Rocket Propulsion Test Support	27.9	27.8	27.9	HSF 4-14
Institutional Support	1,133.5	1,111.5	1,072.1	HSF 4-19
Total	1,247.8	1,214.5	1,178.2	
Distribution of Program Amount by Installation				
Johnson Space Center	433.0	408.1	422.6	
Kennedy Space Center	299.9	340.4	320.6	
Marshall Space Flight Center	262.2	193.3	195.5	
Stennis Space Center	43.1	45.1	45.4	
Ames Research Center	16.3	11.5	6.0	
Glenn Research Center	43.2	32.4	36.8	
Langley Research Center	9.1	8.2	8.4	
Dryden Flight Research Center	12.9	3.9	3.6	
Goddard Space Flight Center	53.4	53.4	29.0	
Jet Propulsion Laboratory	2.6	2.7	0.4	
NASA Headquarters	72.1	115.5	109.9	
Total	1,247.8	1,214.5	1,178.2	

** In FY 2002, OSF funding for academic programs is transferred to Academic Programs in SAT as an agency-wide consolidation of funding in academic programs. Detailed information can be found in the Academic Programs section.*
*** The Office of Space Flight cancelled this activity and transferred $15 million of FY 2001 funding to fund cost growth of the International Space Station, and deleted FY 2002 funding as a result of a Congressional action that directed a general reduction in the HEDS appropriation.*

HEDS Investments linkage to Strategic Plan

The HEDS Investments budget provides resources to support a wide range of activity including: maintenance and modernization of NASA's rocket propulsion test facilities; ensuring the health, safety, and performance of space flight crew members, in training and in flight, for all U.S. Space Shuttle, International Space Station (ISS) and exploration missions; and Engineering and Technical Base (ETB). Agency investments in these strategic areas are essential to ensure maximum return on research investments, thereby reducing operations costs and continuing to implement flight and ground systems improvements, and to support strategic investments in advanced technology needed to meet future requirements and enabling synergistic commercial space development efforts.

BASIS OF FY 2003 FUNDING REQUIREMENT

TECHNOLOGY AND COMMERCIALIZATION

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
HEDS Technology and Commercialization.........................	5.0	--	--

DESCRIPTION/JUSTIFICATION

The Human Exploration and Development of Space (HEDS) Technology/Commercialization Initiative (HTCI) supported HEDS analysis and planned for safe, affordable and effective future programs and projects that advanced science and discovery, human exploration, and commercial development of space. Second, the Initiative would have pursued research, development, and validation of breakthrough technologies and highly innovative systems concepts that opened up new and potentially revolutionary system-, infrastructure- and architecture- level options for HEDS. Third, the HTCI would have pursued technologies, systems and infrastructures that enabled synergistic advancement of science-driven integrated human-robotic space exploration, as well as the commercial development of space. Finally, the Initiative would have improved the affordability and the effectiveness with which HEDS would have been able to achieve it's strategic objectives in the future by creating strong partnerships within NASA, with US industry and universities, and with international partners. By achieving these goals, the HEDS Technology/Commercialization Initiative would have supported better informed decisions by policy-makers concerning a) further research and technology development investments, and b) prospective future HEDS exploration initiatives and related capabilities and infrastructures. It would have also made high-leverage, high-risk incremental progress toward innovative systems concepts and breakthrough technologies that could have supported market-driven, private sector decisions concerning commercial development of space.

The strategic approach to accomplish the program goals of the HTCI involved three types of activities. First, HTCI would have conducted systems analysis and advanced concept studies. These activities would have included the formulation and refinement of new approaches (e.g., architectures, technologies, etc.) and the identification/refinement of advanced systems concepts in order to dramatically increase safety while reducing mission risk and cost for future prospective HEDS programs. Second, the Initiative would have undertaken HEDS-enabling advanced research and technology (HART) projects. These would have been competitively selected (with a goal of 50% cost share from Industry, where appropriate), and would have emphasized increases in safety, reduced risks and costs, and enabling new opportunities. Wherever possible, HART Projects would have leveraged other resources (including investments within NASA, other US government, industry, academia, internationally, etc.). Finally, the HTCI would have conducted flight demonstration projects that would have involved "new millennium-type" experiments for small robotic missions, on the International Space Station, or other carriers. This area would have included flight projects that were competitively selected (with a goal of 50% cost share from Industry, where appropriate).

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported:
Explore the space frontier

Strategic Plan Objectives Supported:
Invest is the development of high-leverage technologies to enable safe, effective, and affordable human/robotic exploration.
Enable human exploration through collaborative robotic missions.
Define innovative human exploration mission approaches.
Develop exploration/commercial capabilities through private sector and international partnerships.

Performance Plan Metrics Supported:
1H1: Complete testing and delivery for spacecraft integration of experiments for the Mars Surveyor Program 2001 missions.
1H26: Support participation in HEDS research.
1H32: Initiate the HEDS Technology/Commercialization program and establish a synergistic relationship with industry.

FY 2001 Milestones	Plan in FY 2003 Budget	Plan in FY 2002 Budget	Plan in FY 2001 Budget	FY 2002 -FY 2003 Change	Comment
FY 2001Enabling Advanced Research and Technology (HART) Projects - NASA Research Announcement (NRA)	2nd Qtr FY 2001	1st Qtr FY 2001	1st Qtr FY 2001	1 Qtr later	Initial solicitation of HEDS systems studies and HART technology projects; coordinated with planning for later flight demonstration projects/options. Solicitation was released in February 2001.
FY 2001 (HART) NRA Project Announcements	Cancelled	3rd Qtr FY 2001	3rd Qtr FY 2001	Cancelled	Announcement of awards from initial HART NRA. Selection was competed, but announcements were not made due to project cancellation.
FY 2001 HTCI NASA Research Announcement for Flight Demonstration Projects	Cancelled	4th Qtr FY 2001	4th Qtr FY 2001	Cancelled	Initial solicitation of HEDS flight demonstration projects, focusing on demonstration project definition studies; coordinated with HCTI studies and HART technology projects. Project was cancelled.

FY 2001 Milestones	Plan in FY 2003 Budget	Plan in FY 2002 Budget	Plan in FY 2001 Budget	FY 2002-FY 2003 Change	Comment
FY 2001 HTCI Competitive Solicitation for Flight Demonstration Project Definition Study Announcement	Cancelled	4th Qtr FY 2001	4th Qtr FY 2001	Cancelled	Initial solicitation of HEDS flight demonstration projects, focusing on demonstration project definition studies; coordinated with HCTI studies and HART technology projects. Project was cancelled.
FY 2002 Milestones					
FY 2002 Enabling Research and Technology (HART) NASA Competitive Solicitation	Cancelled	1st Qtr FY 2002	1st Qtr FY 2002	Cancelled	Second solicitation of HEDS systems studies and HART technology projects; coordinated with planning for later flight demonstration projects/options.
FY 2002 (HART) Competitive Solicitation Announcements	Cancelled	3rd Qtr FY 2002	3rd Qtr FY 2002	Cancelled	Announcement from awards from second HART competitive solicitation.
FY 2002 HTCI Competitive Solicitation for Flight Demonstration Projects	Cancelled	1st Qtr FY 2002	1st Qtr FY 2002	Cancelled	Second solicitation of HEDS flight demonstration projects, focusing on demonstration project definition studies; coordinated with HCTI studies and HART technology projects.

FY 2002 HTCI Competitive Solicitation for Flight Demonstration Project Definition Study Announcement	Cancelled	1st Qtr FY 2002	2nd Qtr FY 2002	Cancelled	Second solicitation of HEDS flight demonstration projects, focusing on demonstration project definition studies; coordinated with HCTI studies and HART technology projects.

Lead Center:	**Other Centers:**	**Interdependencies:**
NASA Headquarters	Johnson Space Center, Kennedy Space Center, Marshall Space Flight Center, Stennis Space Center, Ames Research Center, Glenn Research Center, Langley Research Center, Goddard Space Flight Center, Jet Propulsion Laboratory	

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

During FY 2001 the Office of Space Flight (OSF) Advanced Programs Office (APO) implemented the first year of the HEDS Technology/Commercialization Initiative (HTCI). The solicitation was successful and significant cost sharing was identified, but the projects were not implemented due to the program being cancelled. The Office of Space Flight cancelled this activity and transferred $15 million of FY 2001 funding to the International Space Station. This project was cancelled not due to lack of performance. It was cancelled because of the large cost growth experienced in International Space Station development and operations.

BASIS OF FY 2003 FUNDING REQUIREMENT

CREW HEALTH & SAFETY

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Crew Health and Safety*	[5.2]	[6.1]	5.8

**Note - FY 2001 and FY 2002 data in this section are for comparison purposes only. See Biological and Physical Research section for more details.*

DESCRIPTION/JUSTIFICATION

Crew Health and Safety ensures the health, safety, and performance of space flight crew members, in training and in flight, for all U.S. Space Shuttle, International Space Station (ISS) and exploration missions. This goal encompasses: (1) flight crew health and safety including medical operations; (2) development, integration and configuration management of research requirements for human health, countermeasures and environment systems support; (3) interface to life support technology development; (4) crew health care delivery and crew protection; (5) interface to National Space Biomedical Research Institute (NSBRI) through JSC for operational near-term crew health and safety support.

Within Crew Health and Safety there are five primary elements: (1) medical mission support for the Space Shuttle and ISS programs; (2) astronaut health care; (3) epidemiology (longitudinal studies of astronaut health); (4) Crew Health Monitoring and Risk Mitigation (CHMRM); and (5) Clinical Care Capability Development Program (CCCDP). Crew Health and Safety functions include responsibility for oversight and approval of policies and requirements developed to maintain and provide medical support to optimize the health, safety, and productivity of our astronauts in space. This also includes technology and applications developments. Crew Health and Safety funding provides medical operational support for human space flight and astronaut health care. Crew Health and Safety's scope ranges from the development of astronaut health policies, standards, and requirements for medical operations and medical research, as well as implementation of these requirements, through operational medical support for all human space flight programs.

JSC is the lead center for Crew Health and Safety. JSC manages the clinical medical and psychological support for the astronauts throughout all phases of space flight missions as well as throughout their careers. They also manage medical informatics and health care systems development efforts in support of medical operations activities for the Human Space Flight (HSF) Program. The majority of the participation by academic institutions are Wright State University School of Medicine, Medical College of Virginia at the Virginia Commonwealth University, and the University of Texas Medical Branch at Galveston.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Enable Humans to Live and Work Permanently is Space

Strategic Plan Objectives Supported:
1. Provide and make use of safe, affordable, and improved access to space.
2. Ensure the health, safety, and performance of humans living and working in space.

Performance Plan Metrics Supported: Crew Health and Safety plays a small, but important role in supporting these metrics:
2H01: Begin the development of high leverage technologies to enable safe, effective and affordable human/robotic exploration missions beyond LEO
2H04: Identify and evaluate candidate approaches for 100 to 1000 day human missions capable of a 5 to 10 fold cost reduction while increasing safety and effectiveness (compared to 1990s projections)
2H07: Safely meet the FY 2002 manifest and flight rate commitment.
2H09: Have in place a Shuttle safety investment program that ensures the availability of a safe and reliable Shuttle system for International Space Station assembly and operations

Milestones	Plan in FY 2003 Budget	Plan in FY 2002 Budget	FY 2002-FY 2003 Change	Comment
Prepare and support training and medical hardware for FY 2002 Shuttle missions	7	7		
Support FY 2002 ISS Expeditions	3	3		
Prepare and support training and medical hardware for FY 2003 Shuttle missions	5	5		
Support FY 2003 ISS Expeditions	3	3		

Lead Center:	Other Centers:
Johnson Space Center	None

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

During FY 2002, Crew Health and Safety continues to provide operational support to ISS Expeditions 4, 5, and 6 and to Shuttle Missions (STS 108, 109, 110, 111, 107, 112, and 113) from the Blue Flight Control Room (FCR) and Biomedical Multipurpose Support Room (MPSR). Crew Health Monitoring and Risk Mitigation (CHMRM) continued to support pre-and post-flight crew certifications for ISS and Shuttle missions with key support to the extravehicular activity (EVA), crew countermeasures, pharmacotherapeutics, environmental monitoring, and nutrition Integrated Product Team (IPT) expert teams during real-time operational activities. The Clinical Care Capability Development Program (CCCDP) continued to develop the Patient Condition Database for identifying alternate treatment options and prioritization of resource allocation, to develop prototype Electro-Cardiogram (ECG) Orbital Bioinstrumentation Simulator Systems for EVA and vacuum chamber and to develop the following needed medical devices: ultrasound, ventilator, critical care monitors, medical vacuum, and on-orbit IVF (intravenous fluid) generation. Crew Health and Safety in addition developed a Database Preservation and Disaster Recovery plan based on preliminary evaluation of critical, one-of-a-kind clinical data. Epidemiological efforts continued to develop centralized index among the multiple medical databases and to implement SNOMED (Systemized Nomenclature of Medicine) coding in Longitudinal Studies of Astronaut Health (LSAH) for enhanced data mining and analysis.

PROGRAM PLANS FOR FY 2003

During FY 2003, Crew Health and Safety will continue its support of the needs of the space medicine community for space flight missions including operational medical support for the Space Shuttle and ISS. CHMRM funding will assist in the development, monitoring, and interpretations of operational health-related data from space flight including: support of the implementation and interpretation of Medical Requirements (MRs) for Space Shuttle and ISS, support of rapid responses to clinical questions relative to space medicine issues. Clinical Care Capability Development Program (CCCDP) funding will support the ongoing evolution of space medicine research requirements, procedures and technologies. Epidemiological efforts will continue to evaluate the growing body of astronaut health data to better define the medical risks associated with space flight using an evidenced-based systematic approach. Special emphasis will be placed on clinical medical research, radiation, risk assessment, and psychological/human factors.

BASIS OF FY 2003 FUNDING REQUIREMENT

ENGINEERING AND TECHNICAL BASE

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Engineering and Technical Base	73.3	75.2	72.4

DESCRIPTION/JUSTIFICATION

The focus of the Engineering and Technical Base (ETB) is to support the institutional capability in the operation of space flight laboratories, technical facilities, and testbeds; to conduct independent safety, and reliability assessments; and to stimulate science and technical competence in the United States. ETB activities are carried out at the Johnson Space Center (JSC) including White Sands Test Facility (WSTF), Kennedy Space Center (KSC), and Marshall Space Flight Center (MSFC). Since FY 2000, Rocket Propulsion Test Support has funded these activities at Stennis Space Center. ETB funds are used to maintain the Centers' technical competence, critical skills and unique technical infrastructure. Efforts include system and mission analysis, integrated HSF Research and Technology (R&T) requirements definition and integration, modest R&T investments in an EVA technology demonstration project and investments in R&T supporting the integrated Office of Space Science/HEDS robotic efforts. ETB also provides for applied technology demonstrations and/or technology proof of concepts to improve launch and payload processing operations and for critical, high value, and unique multi program laboratories, test beds, and equipment.

The complex and technically challenging programs managed by OSF are most effectively carried out by sustaining a NASA "core" institutional technical base. It is vital to preserve essential competency and excellence as well as foster innovative technology applications within the ongoing OSF Programs. Since FY 1994, the OSF centers have consolidated activities and have identified ways to economize the resources committed to ETB while maintaining ETB's benefits to the nation's human space flight program. Over the next few years, this consolidation will continue to generate savings through improved information resources management and contract streamlining. A prioritized core capability will include multi-program labs and test facilities, associated systems, equipment, and a full range of skills capable of meeting research, testing and simulation demands.

As the ETB budget remains at steady state level, several activities will continue to refine current business practices. Mandatory equipment repair and replacement will be reassessed. Software applications for multi-program analytical tools will be implemented. The strategy to better manage the NASA investment in information processing resources includes aggressive actions to integrate and consolidate more of these operations. The in-house engineering expertise and technical support is augmented through this program. . A key challenge of the ETB strategy will be to provide a core capability for future human space flight endeavors with fewer resources. Adoption of new innovative processes to meet critical ETB core requirements and streamlining or eliminating non-critical capabilities will be employed to strive for future savings.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Explore the Space Frontier (HEDS); Advance Space Transportation (AST)

Strategic Plan Objectives Supported:
Conduct engineering research on the International Space Station to enable exploration beyond Earth orbit (HEDS), define innovative human exploration mission approaches (HEDS), Mission Affordability (AST).

Milestones	Plan in FY 2003 Budget	Plan in FY 2002 Budget	Plan in FY 2001 Budget	FY 2002-FY 2003 Change	Comment
Maintain science and engineering laboratories at KSC	34	34	34	--	Supports 31 agency programs. The FY 2002 number displayed is an increase over the 11 labs shown in last year's budget, but this is a result of a change in how KSC counts labs, rather than the addition of any new labs.
Maintain science and engineering laboratories at JSC	156	156	156	--	Supports 52 agency programs
Maintain science and engineering laboratories and facilities at MSFC	123	123	123	--	Supports 42 agency programs

Lead Center:	**Other Centers:**
None	Johnson Space Center, Kennedy Space Center, Marshall Space Flight Center

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

In FY 2002 the ETB budget will continue to provide science and engineering lab support to human space flight programs, streamlined technical operations, and additional ADP consolidation activities. This will require that all Centers continue to assess their range of workforce skills, analytical tools and facilities dedicated to ensure their ability to provide space flight institutional engineering support for future human space flight programs and the existing customer base. Center assessments will focus on maintaining core support for design, development, test and evaluations, independent assessments, simulation, operations support, real time anomaly resolution, and systems engineering activities. ETB also works with the programs and the Systems Management Offices to conduct risk management and cost estimating

In FY 2002, MSFC will maintain ETB's institutional base requirements funding; maintain highly skilled Safety and Mission Assurance contractor workforce to conduct assessment of conformance to reliability and quality standards; maintain technical core capability to provide in-depth technical support for research, design, development, mission operations, and evaluation.

In FY 2002, JSC's efforts will continue to focus on maintaining the multi-program use science and engineering laboratories and facilities operational readiness. This effort will include performing scheduled facility infrastructure sustaining maintenance, maintaining analytical tools readiness, and performing the necessary repairs, modifications, and replacements to the facilities infrastructure to accommodate the changes needed to support program commitments. FY 2002 contains many critical programmatic milestones that will require extensive use of our laboratories and facilities. NASA will continue to perform critical studies, test, and analyses for many activities. These include: monitoring human life support and crew health as crews continue to inhabit ISS, ensuring the Shuttle can safely operate and transport Station hardware and astronaut personnel, and ensuring smooth and safe operations of personnel and equipment during the Station assembly EVAs. ETB will also keep the laboratories and facilities operational to perform exploration and development studies.

In FY 2002, KSC Spaceport Engineering Laboratories and Testbeds will continue to provide development, analysis, test and technology demonstrations in support of Shuttle, Space Station, Reusable Launch Vehicles, Expendable Launch Vehicles, Payloads and Life Sciences programs. KSC technical infrastructure sustained through ETB funding will continue to support non-routine real-time problem resolution during Shuttle Launch processing, Space Station processing and Payload Ground Operations. KSC's ETB continues to support unique Center failure analysis capabilities. The labs supporting these capabilities provide independent and objective test and analysis support to NASA Programs, Contractors and customers for highly complex physical anomalies. ETB at KSC also directly supports Shuttle, Station, ELV, and P/L routine operations in the areas of sampling and analysis, non-destructive evaluation, and calibration and standards. ETB indirect support to NASA Programs will continue at KSC through research and development of projects targeted at raising the Technology Readiness Level of high potential technologies for safer, more reliable and cost effective Spaceport operations.

PROGRAM PLANS FOR FY 2003

In FY 2003, MSFC ETB activities will include test area support to MSFC programs and projects that include 2nd Generation RLV and in-house research projects; engineering, science and technical services for core capability tool development and maintenance support to Shuttle, 2nd Generation RLV, and CAD/CAM applications and hardware support to Shuttle, Station, Advanced Space Transportation, Science and in-house projects.

In FY 2003, JSC's efforts will continue to focus on maintaining the multi-program use science and engineering laboratories and facilities operational readiness. NASA will continue to perform critical studies, test, and analyses for many activities. These include: monitoring human life support and crew health as crews continue to inhabit ISS, ensuring the Shuttle can safely operate and transport Station hardware and astronaut personnel, and ensuring smooth and safe operations of personnel and equipment during the Station assembly EVAs. ETB will also keep the laboratories and facilities operational to perform exploration and development studies.

In FY 2003, KSC Spaceport Engineering Laboratories and Testbeds will continue to provide development, analysis, test and technology demonstrations in support of Shuttle, Space Station, Reusable Launch Vehicles, Expendable Launch Vehicles, Payloads and Life Sciences programs. KSC technical infrastructure sustained through ETB funding will continue to support non-routine real-time problem resolution during Shuttle Launch processing, Space Station processing and Payload Ground Operations. KSC's ETB will continue to support unique Center failure analysis capabilities. The labs supporting these capabilities provide independent and objective test and analysis support to NASA Programs, Contractors and customers for highly complex physical anomalies. ETB direct support to Shuttle, Station, ELV, and P/L routine operations in the areas of sampling and analysis, non-destructive evaluation, and calibration and standards will continue. Indirect support to NASA Programs will continue at KSC through research and development of projects targeted at raising the Technology Readiness Level of high potential technologies for safer, more reliable and cost effective Spaceport operations.

BASIS OF FY 2003 FUNDING REQUIREMENT

ROCKET PROPULSION TEST SUPPORT

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Rocket Propulsion Test Support	27.9	27.8	27.9

DESCRIPTION/JUSTIFICATION

The Stennis Space Center (SSC) is the Lead Center for Rocket Propulsion Testing Support to manage this initiative, which includes making test assignments and approval of test facility investments. Funding for this program provides:

1) Sustaining support for propulsion test facilities which include test positions and related infrastructure at SSC, JSC-WSTF, GRC-PB and MSFC;
2) Modernization/upgrades of existing facilities to ensure their capabilities are adequate to meet the demands of our future customers and to optimize their operating efficiency;
3) Administrative/technical support to SSC for scheduling and management of propulsion testing across the agency and coordination of these activities with DoD and commercial customers; and
4) Development of test technologies to improve analytical capabilities, hardware health monitoring, and operational safety and achieve cost savings through enhanced operational efficiencies.

NASA has established a Rocket Propulsion Test Management Board (RPTMB) under Stennis Space Center's purview, which is NASA's Lead Center for Rocket Propulsion Testing. The RPTMB is composed of representatives from all four NASA rocket test centers (SSC, MSFC, JSC-White Sands and GRC-Plum Brook) and is chaired by SSC. The RPTMB has established baseline test roles for each center, resulting in the consolidation of test capabilities and the elimination of redundant facilities and related infrastructure. The roles are tailored to take advantage of existing unique capabilities at each site and to consolidate capabilities where appropriate. The RPTMB makes test assignments, controls investments, and manages personnel and equipment sharing among NASA's test sites.

In addition, NASA has been key to the formation and development of the National Rocket Propulsion Test Alliance (NRPTA). NASA and DoD test sites are cooperating to share people and equipment, review/track investments, and make interagency test assignments that will improve test support and avoid redundant investments in federally owned and operated test facilities. The NRPTA maintains an integrated national rocket test facility schedule and utilization rate, along with detailed data on NASA/DoD test facility capabilities.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Enable the Commercial Development of Space (HEDS); Advance Space Transportation (AST)

Strategic Plan Objectives Supported:
Advance the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets (HEDS), Mission Affordability (AST).

Milestones	Plan in FY 2003 Budget	Plan in FY 2002 Budget	Plan in FY 2001 Budget	FY 2002-FY 2003 Change	Comment
Liquid Nitrogen (N2) system upgrades	3rd Qtr FY 2003	4th Qtr FY 2001	4th Qtr FY 2001	7 Qtrs later	Complete Liquid Nitrogen (N2) system upgrades for Propulsion Test Area at White Sands Test Facility (WSTF). Project delayed due to contractor default; awaiting selection of new contractor pending closeout of existing contract.
Test Stand 4670 repair and activation	3rdt Qtr FY 2002	1st Qtr FY 2002	1st Qtr FY 2002	2 Qtrs later	Initiate repair and activation of Test Stand 4670 at MSFC. Delay in staffing being made available from other center projects.
Mothball Test Facilities at MSFC	2nd Qtr FY 2002	3rd Qtr FY 2000	3rd Qtr FY 2000	7 Qtrs later	De-activation of the Building-4670 and 302 test facilities at MSFC due to insufficient test requirements planned in the near future.
Install diagnostics systems in E Complex at SSC	2nd Qtr FY 2002	4th Qtr FY 2001	4th Qtr FY 2001	2 Qtrs later	Field-test & install wireless miniature accelerometer and fiber-optic strain measurement systems in E Complex at SSC. Successfully developed wireless sensor design, architecture in FY 2001; first unit diverted to safety-critical monitoring of Hydrogen Peroxide propellant drum temperatures (instead of vibration); more units being built. Completed lab evaluation of fiber-optic strain sensors.
Validate field prediction models	3rd Qtr FY 2002	3rd Qtr FY 2002	3rd Qtr FY 2002		Validate acoustic field prediction model for E Complex test cells at SSC. Supporting model development effort by MSFC.

Milestones	Plan in FY 2003 Budget	Plan in FY 2002 Budget	Plan in FY 2001 Budget	FY 2002-FY 2003 Change	Comment
Install advanced test sensors	3rd Qtr FY 2002	3rd Qtr FY 2002	3rd Qtr FY 2002		Install advanced test sensors (e.g. accelerometers, flow meters, etc.) in E complex test cells at SSC. Wireless acceleration, acoustic, strain sensors in work for FY 2002. Identify newly developed sensors at other NASA sites for trials at SSC. Attempt plume signature of Hydrocarbon plumes.
Validate high pressure propellant flow models	4th Qtr FY 2002	4th Qtr FY 2002	4th Qtr FY 2002		Achieve highly accurate characterization of ultra high-pressure cryogenic propellant flows. Began modeling effort in late FY 2001; continuing throughout FY 2002
Complete Steam line replacement	4th Qtr FY 2002	4th Qtr FY 2002	4th Qtr FY 2002		Replace aging Steam lines in Propulsion Test Area at WSTF. Project study completed 4th Qtr 2001; project design is in work. Shuttle Infrastructure funding remaining project activities. Plan completion date still good.
Establish test equipment database	4th Qtr FY 2002	4th Qtr FY 2001	4th Qtr FY 2001	1 year delay	Establish detailed test equipment database to support future development of improved scheduling/integration tools. Development of database required extensive effort; competing priorities resulted in delay of planned completion until the latter part of FY 2002.
Enhanced diagnostic tools	3rd Qtr FY 2003				Implement upgrades of plume effects simulation tools (hardware and software) at SSC. Demonstrate enhanced capabilities for signatures of Hydrocarbon rocket plumes.
Test Area Communication replacement	4th Qtr FY 2003				Complete replacement/upgrade to Test Area Communication Systems at WSTF
Repair Helium Systems	4th Qtr FY 2003				Initiate repair to test facility Helium system at WSTF

Milestones	Plan in FY 2003 Budget	Plan in FY 2002 Budget	Plan in FY 2001 Budget	FY 2002-FY 2003 Change	Comment
Steam Boiler Replacement	4th Qtr FY 2003				Initiate replacement of steam boilers for altitude exhaust system in Building 2 at Glenn Research Center/PlumBrook.
UHP GN Vessels Procurement	4th Qtr FY 2003				Initiate the procurement process of 2 Ultra High Pressure Gaseous Nitrogen bottles for SSC
Spares Procurement	4th Qtr FY 2003				Initiate procurement for spare high pressure valves for SSC E-complex
New Data Acquisition System	4th Qtr FY 2003				Upgrade the test facility Data Acquisition system at MSFC

Lead Center:	Other Centers:	Interdependencies:
Stennis Space Center	Johnson Space Center/White Sands Test Facility, Marshall Space Flight Center, Glenn Research Center	Department of Defense

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

Over the last several years, actions taken by NASA's Rocket Propulsion Test Management Board (RPTMB) have resulted in an estimated total savings of approximately $70 million, while actions taken by the National Rocket Propulsion Test Alliance (NRPTA) have contributed an estimated $2 million in savings. To date, the RPTMB has made 27 propulsion test assignments within NASA, across other agencies, and to industry facilities.

During FY 2002, the RPTMB will continue to implement critical facility upgrades to ensure existing test assets are truly "world-class", thus providing flexible and robust testing capabilities operated by a highly experienced and trained cadre of test personnel. Test facility maintenance activities are ongoing in support of Space Shuttle, Space Launch Initiative (SLI), DoD and commercial test projects. The RPTMB will continue to make test assignments that optimize utilization of existing test facilities across the agency and achieve further cost savings. Efforts will also continue to assess test facilities for possible closure and activate other test facilities currently being modified in preparation for planned testing in FY 2002 and beyond. Additional investments in new test technologies will continue to enhance our ability to monitor the status of hardware during testing and increase operational safety.

Investments will continue to be made in the development of improved scheduling tools, test technologies and modularization of test support hardware to reduce turnaround times, improve test management capabilities and improve operational efficiencies. Plans are also under consideration to establish a single Test Operations Contractor for the 4 NASA centers under RPTMB control. We will also continue to work with DoD through the NRPTA in consolidation of national test capabilities, test assignments, test facility utilization and modernization.

PROGRAM PLANS FOR FY 2003

During FY 2003, the RPTMB will continue critical facility upgrades to ensure existing test assets are truly "world-class. Test facility maintenance activities are ongoing in support of Space Shuttle, Space Launch Initiative (SLI), DoD and commercial test projects. Efforts will also continue to assess test facilities for possible closure and activate other test facilities currently being modified in preparation for planned testing in FY 2002 and beyond. Additional investments in new test technologies will continue to enhance our ability to monitor the status of hardware during testing and increase operational safety.

Investments will continue to be made in the development of improved tools, technologies and modularization of test support hardware to improve operational efficiencies. We will also continue to work with DoD through the NRPTA in consolidation of national test capabilities, test assignments, test facility utilization and modernization.

BASIS OF FY 2003 FUNDING REQUIREMENT

HEDS INSTITUTIONAL SUPPORT

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Institutional Support to HEDS Enterprise.........................	1,133.5	1,111.5	1,072.1
Research and Program Management	1,014.6	1,038.2	997.2
Personnel and Related Costs..................................	805.0	739.3	763.0
Travel	24.7	22.8	23.1
Research Operations Support (ROS)................................	184.9	276.1	211.1
Construction of Facilities	118.9	73.3	74.9
Environmental	26.8	21.8	26.1
Construction of Facilities......................................	92.1	51.5	48.8
Full-Time Equivalent (FTE) Workyears	**7,839**	**7,090**	**6,786**

Note - Includes budget augmentation for Security Allocation under ROS in FY 2002 ($76m)
Note - FY 2001 data in this section is for comparison purposes only. Reductions shown are primarily due to transfer of program content from HEDS to other enterprises. See *Mission Support* sections for more details.

DESCRIPTION/JUSTIFICATION

The two primary goals of this budget segment are to:

1.) Acquire and maintain a civil service workforce that reflects the cultural diversity of the Nation and, along with the infrastructure, is sized and skilled consistent with accomplishing NASA's research, development, and operational missions with innovation, excellence, and efficiency for the Human Exploration and Development of Space (HEDS) Enterprise.
2.) Ensure that the facilities critical to achieving the HEDS Enterprise are constructed and continue to function effectively, efficiently, and safely, and that NASA installations conform to requirements and initiatives for the protection of the environment and human health.

Research and Program Management (R&PM)

R&PM provides the salaries, other personnel and related costs, travel and the necessary support for all administrative functions and other basic services in support of research and development activities at NASA installations. The salaries, benefits, and supporting costs of this workforce comprise approximately 76% of the requested funding. Administrative and other support is approximately 21% [of the requests. The remaining 2% of the request are required to fund travel necessary to manage NASA and its programs.

Research Operations Support provides three major services: facilities services, technical services and management and operations. Facility services provide security, fire protection, and other custodial services. It also provides maintenance of roads and grounds and of all administrative buildings and facilities. Finally, it provides rental of administrative buildings and all utility costs of administrative buildings. Technical Services provides the Administrative Automatic Data Processing capability that supports Accounting, Payroll, Budgeting, Procurement, and Personnel as well as all the other Administrative functions. It also funds the Graphics and Photographic support to these functions. Finally, it funds the Installation-wide safety and public information programs. Management and Operations funds the telephone, mail, and logistics systems, the administrative equipment and supplies, and the transportation system including the general purpose motor pools and the program support aircraft. It also funds the basic medical and environmental health programs. Finally, it funds the System Management Office, printing and reproduction and all other support, such as small contract and purchases for the Center Directors staff and the Administrative functions.

The Systems Management Office (SMO) provides support and independent evaluations of projects and programs for compliance with the implementation of NPG 7120.5A, NASA Program and Project Management Processes and Requirements and, as appropriate, the Marshall Quality Manual. The SMO determines consistency across product lines for Center systems engineering functions related to space systems programs and projects, including requirements development and requirements flowdown, program verification, and cost projections. The SMO provides leadership, consultation services, and technical expertise on systems engineering processes.

Construction of Facilities (CofF)

This budget line item provides for discrete projects required for components of the basic infrastructure and institutional facilities. Almost all of these projects are for capital repair. NASA has conducted a thorough review of its facilities infrastructure finding that the deteriorating plant condition warrants an increased repair and renovation rate to avoid safety hazards to personnel, facilities, and mission; and that some dilapidated facilities need to be replaced. Investment in facility revitalization is needed to maintain a facility infrastructure that is safe and capable of supporting NASA's missions.

Detailed cost estimates for HSF R&PM are shown as part of the total agency R&PM budget (see R&PM narratives) to provide a complete picture of NASA's budget requirements for personnel and administrative support. The descriptions and cost estimates are shown as part of the Construction of Facilities program (see Construction of Facilities narratives) to provide a complete picture of NASA's budget requirement for facilities. Extensive detail as to how this funding is utilized by HSF is located under the Two-Appropriation/Mission Support portion of the budget.

ROLES AND MISSIONS

The detail provided here is for the support of HEDS Enterprise programs at the following institutions - Johnson Space Center, Kennedy Space Center, Marshall Space Flight Center, Stennis Space Center, Ames Research Center, Dryden Flight Research Center, Glenn Research Center, Langley Research Center, Jet Propulsion Laboratory, and Goddard Space Flight Center.

Johnson Space Center (JSC)

The Human Exploration and Development of Space Enterprise funds approximately 90% of JSC's Institution cost in FY 2003.

Institutional support funding at the Johnson Space Center (JSC) supports personnel carrying out the lead center management responsibility for the International Space Station program. In addition, specific JSC technical responsibilities include development of a set of facilities and systems to conduct the operations of the Space Station including on-orbit control of the Space Station. JSC also provides institutional personnel as well as engineering and testbed support to the Space Station program. This includes test capabilities, the provision of Government Furnished Equipment (GFE), and engineering analysis support for the work of the prime contractor, its major subcontractors, and NASA system engineering and integration efforts.

JSC also has lead center management responsibility for the Space Shuttle. In addition, JSC personnel will provide development, integration, and operations support for the Mission Control Center (MCC), the Shuttle Mission Simulator (SMS), and other ground facilities needed for Space Shuttle Operations. JSC workers will provide Space Shuttle operational flight program management including system integration, crew equipment modification and processing, crew training, flight mission planning and operations, and procurement of Orbiter hardware.

In the Payload and ELV support program, JSC personnel provide support to payload operations and support equipment.

JSC will also conduct concept studies and development on flight systems and options for human transportation. JSC provides support to the engineering and technical and technology program support.

Space Operations Management Office (SOMO) personnel at JSC manage the telecommunication, data processing, mission operation, and mission planning services needed to ensure that the goals of NASA's exploration, science, and research and development programs are met in an integrated and cost-effective manner. SOMO also provides the administration and management of the Consolidated Space Operations Contract (CSOC).

Kennedy Space Center (KSC)

The Human Exploration and Development of Space Enterprise funds approximately 97% of KSC's Institution cost in FY 2003.

The Kennedy Space Center (KSC) is a supporting center for the Space Station Program. KSC personnel have developed a set of facilities, systems, and capabilities to conduct the operations of the Space Station. KSC develops launch site operations capabilities for conducting pre-launch and post-landing ground operations including integrated testing, interface verification, servicing, launch activities, and experiment-to rack physical integration. The KSC workforce provides launch site logistics support, resupply and customer utilization. KSC serves as the primary agent for management and integration of ground processes for all U.S. launched International Space Station (ISS) elements from manufacture and assembly through verification and launch. KSC develops and maintains ISS flight systems expertise to support the ISS on-orbit mission and retains technical and operational experience within NASA and KSC for ground processing and verification of space flight hardware.

KSC workers will also provide Space Shuttle launch preparation, including orbiter processing, Ground Support Equipment (GSE) logistics; operation and maintenance of GSE; and launch and landing operations.

KSC is the Lead Center for the Payload Carriers and Support Program. KSC personnel provide technical expertise, facilities and capabilities to perform payload buildup, test and checkout, integration and servicing of multiple payloads. They also support development, operation, logistics and maintenance of Ground Support Equipment; transportation of payloads and supporting equipment to the Space Shuttle; and integration and installation of the payloads into the Space Shuttle. KSC workers develop, activate, operate and maintain the Payload Carrier facility system, GSE, and processes to enable efficient launch site processing of carriers and payloads.

KSC personnel will provide government insight/oversight of all launch vehicle and payload processing and checkout activities for all NASA contracted expendable launch vehicle and upper stage launch services both at KSC and the Vandenburg Air Force Base.

Marshall Space Flight Center (MSFC)

The Human Exploration and Development of Space Enterprise funds approximately 41% of MSFC's Institution cost in FY 2003. This is down from 61% in last year's Budget request, due to the transfer of the International Space Station research from the HEDS enterprise to the Biological and Physical Research Enterprise, along with an increase in funding from the Aerospace Technology Enterprise for pace Launch Initiative activities.

Marshall Space Flight Center (MSFC) will provide engineering support to the ISS program including engineering analysis in support of the International Space Station (ISS) system engineering and integration effort. The Center also has oversight responsibility for the development of the Nodes 1 & 2, and the Multi Purpose Logistics Module. MSFC personnel carry out design integration of cargo elements for flight on the MSFC provided unpressurized logistics carrier to support ISS mission-build and logistics supply flights. MSFC also has responsibility for developing payload utilization capabilities and planning and executing payload integration and operations activities. This includes the development and operation of the EXPRESS Rack payload carrier, ISS Payload Data Services System and the ISS Payload Planning System.

The Institutional Support in the Space Shuttle Projects Office (SSPO) at MSFC is responsible for executing the Space Shuttle Program role assigned to the Center. These responsibilities include activities associated with the Space Shuttle Main Engine (SSME), External Tank (ET), Solid Rocket Booster (SRB), and Reusable Solid Rocket Motor (RSRM). The SSPO is responsible for these propulsion hardware elements and associated systems, test and flight operations, and facilities.

MSFC manages and maintains the NASA Integrated Services Network (NISN) - NISN services provide communications hardware, software, and transmission medium that inter-connects NASA Headquarters, installations, universities, and major contractor locations for the transfer of data, voice, and video.

Stennis Space Center (SSC)

The Human Exploration and Development of Space Enterprise funds approximately 43% of SSC's Institution cost in FY 2003. This is down from 58% in last year's Budget request, as a result of correcting the allocation of indirect support among the HEDS, Earth Science and Aerospace Technology Enterprises.

The Stennis Space Center will provide, maintain and manage the facilities and the related capabilities required for the continued development and acceptance testing of the Space Shuttle Main Engines.

As the Lead Center for Propulsion Testing, SSC will operate, maintain, and manage a propulsion test capability that includes test facilities at JSC/WSTF, MSFC and GRC/Plum Brook and related systems for development, certification, and acceptance of rocket propulsion systems and components. SSC will also maintain and support the Center's technical core laboratory and operations to enable SSC to conduct advanced propulsion test technology research and development for government and commercial propulsion programs.

Ames Research Center (ARC)

The Human Exploration and Development of Space Enterprise funds approximately 3% of ARC's Institution cost in FY 2003. This is down from 8% last year due to transfer of the International Space Station research from the HEDS enterprise to the Biological and Physical Research Enterprise. Ames Research Center has the agency lead role in Gravitational Biology and Ecology programs. These synergistic programs examine the adaptation of life forms to reduced gravity.

Dryden Flight Research Center (DFRC)

The Human Exploration and Development of Space Enterprise funds approximately 5% of DFRC's Institution cost in FY 2003. This is down from 22% last year due to transfer of the management of the Western Aeronautical Test Range from the HEDS enterprise to Aerospace Technology Enterprise as a part of the decentralization of the Space Communications and Data Systems program. DFRC conducts technology development and flight test of the X-38 vehicle. They also provide operational and technical support for the conduct of Space Shuttle missions, including on-orbit tracking and communications and, as needed, landing support for the orbiter, crew, and science requirements.

Glenn Research Center (GRC)

The Human Exploration and Development of Space Enterprise funds approximately 12% of GRC's Institution cost in FY 2003. This is down from 23% last year due to increased funding from the Space Science Enterprise. GRC support to the space station program includes technical and management support in the areas of power and on-board propulsion components and system, engineering and analysis, technical expertise, and testing for components and systems. This includes use of facilities and testbeds and construction of flight hardware as required. GRC also develops and demonstrates communications and network technologies in relevant environments to enhance the performance of existing mission services or enable new services. These people identify and infuse new capabilities at higher frequencies (Ka-band and above) into the next generation of spacecraft and communications satellites, to enable seamless interoperability between NASA assets and commercial space and ground networks. The Center's personnel also ensure timely and high-quality availability of radio frequency spectrum to enable the realization of NASA goals.

Langley Research Center (LaRC)

The Human Exploration and Development of Space Enterprise funds approximately 3% of LaRC's Institution cost in FY 2003. LaRC supports the HEDS Enterprise through systems analyses of potential Space Station evolution as well as future human exploration missions in space.

Jet Propulsion Laboratory (JPL)

The Human Exploration and Development of Space Enterprise funds approximately 2% of JPL's Institution cost in FY 2003 in the areas of other than direct Research Operations Support and Construction of Facilities funding. This is down from 35% last year due to the transfer of management of the Deep Space Network from the HEDS Enterprise to the Space Science Enterprise.

Goddard Space Flight Center (GSFC)

The Human Exploration and Development of Space Enterprise funds approximately 7% of GSFC's Institution cost in FY 2003. This is down from 14% last year due to transfer of management of the Ground Networks from the HEDS Enterprise to the Earth Science Enterprise. GSFC manages flights of the Hitchhiker, a reusable carrier system that provides increased flight opportunities with reduced lead-time while maximizing Space Shuttle load factors and minimizing spaceflight costs. GSFC personnel also manage and coordinate the Agency's Get Away Special (GAS) program.

Research and technology activities at GSFC involve the investigation and development of advanced systems and techniques for spacecraft communications and tracking, command and control, and data acquisition and processing. The primary objectives are to apply technology and develop advanced capabilities to meet the tracking and data processing requirements of new missions and to improve the cost effectiveness and reliability of flight mission support.

GSFC personnel also manage a number of critical program elements in the Space Communications and Data Systems program including operation of the Tracking and Data Relay Satellite System (TDRSS) and development of the replenishment TDRSS spacecraft.

Headquarters (HQ)

The Human Exploration and Development of Space Enterprise funds approximately 28% of HQ's Institution cost in FY 2003. This is down from 35% last year due to reallocation of funding headquarters activities between the Enterprises. The Enterprise's Institutional Support figure includes an allocation for funding Headquarters activities based on the relative distribution of direct FTE's across the agency. A more complete description can be found in the Mission Support/Two Appropriation budget section.

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

The FY 2002 funding estimate for Research Operations Support includes $76.0M provided in the Emergency Supplemental to enhance NASA's security and counter-terrorism capabilities.

PROGRAM PLANS FOR FY 2003

The FY 2003 funding estimate for Research Operations Support includes $24.0M provided in the Emergency Supplemental to enhance NASA's security and counter-terrorism capabilities.

HUMAN SPACE FLIGHT

FISCAL YEAR 2003 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE FLIGHT **SPACE COMMUNICATIONS AND DATA SYSTEMS**

SUMMARY OF RESOURCES REQUIREMENTS

Web Address: http://www.jsc.nasa.gov/somo/

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET	Page Number
	(Millions of Dollars)			
Operations	361.2	318.8	82.1	HSF 5-4
Upgrades	73.8	25.4	1.4	HSF 5-14
Tracking and Data Relay Satellite System Replenishment Project	50.9	117.5	16.5	HSF 5-19
Technology Infusion	35.8	20.5	17.5	HSF 5-22
*[Budget Offsetting Reimbursements [non-add]]	[43.0]	[45.0]	[45.0]	
Total	521.7	482.2	117.5	
Distribution of Program Amount by Installation				
Johnson Space Center	247.6	26.9	21.0	
Kennedy Space Center	37.1	74.2	8.9	
Marshall Space Flight Center	9.5	72.8	57.1	
Dryden Space Flight Center	12.8	12.4	--	
Glenn Research Center	8.6	3.5	3.4	
Goddard Space Flight Center	79.9	111.0	14.3	
Jet Propulsion Laboratory	123.9	175.2	7.5	
Headquarters	2.3	6.2	5.3	
Total	521.7	482.2	117.5	

Note: The Space Communications and Data Systems Program was titled the Space Operations Program in FY 2001 and FY 2002 budgets.
* Budget offsetting reimbursements are that portion of total program reimbursable revenue that partially defray the fixed and variable costs of operating a NASA multi-mission facility as a service to a variety of NASA and non-NASA users.

SPACE COMMUNICATIONS AND DATA SYSTEMS LINKAGE TO STRATEGIC PLAN

Strategic Plan Goals Supported:
- Enable humans to live and work permanently in space
- Enable the commercial development of space

Strategic Plan Objectives Supported:
- Meet sustained space operations needs while reducing costs
- Develop new capabilities for Human Space Flight and commercial applications through partnerships with the private sector

The program supports NASA's Enterprises and external customers with Space Communications and Data Systems (SCDS) services that are responsive to customer needs. The program performs infrastructure upgrades and replenishment efforts necessary to maintain the service capability that satisfy the approved mission model. The program conducts technology and standards infusion efforts to provide more efficient and effective services. The program provides operational services through major SCDS factories including the Ground Networks (GN), Space Network (SN), Deep Space Network (DSN), Wide Area Network (WAN), and Western Aeronautical Test Range (WATR).

In line with the National Space Policy, the program is committed to seeking and encouraging commercialization of NASA communications services and to participate with NASA Enterprises in collaborative inter-agency, international, and commercial initiatives. NASA procures commercially available goods and services to the fullest extent feasible, and enables the use of existing and emerging commercial telecommunication services to meet NASA's SCDS needs. The Space Communications program has undertaken the following commercialization initiatives: (1) WAN data distribution services, (2) ground-based tracking and data services at Svalbard, Norway, (3) ground-based tracking and data services at Poker Flats, Alaska, and (4) commercial replacement ofMerritt Island Launch Area /Ponce de Leon (MILA/PDL).

A decentralized management process basis is being implemented that involves transferring management functions previously performed by the Space Operations Management Office (SOMO) at the Johnson Space Center to NASA Headquarters. The transition process begins in FY 2002 with the transfer of certain technology infusion and upgrades tasks, and project unique capabilities to the appropriate Enterprises. The Deep Space Network will be managed by the Office of Space Science, the Ground Networks will be managed by the Office of Earth Science, and the Western Aeronautical Test Range will be managed by the Office of Aerospace Technology beginning in FY 2003. Information about these networks can be found in the respective sections of each Enterprise responsible for that network. The Office of Space Flight will perform overall program integration, including management of the Consolidated Space Operations Contract (CSOC). With the decentralized approach, funding for space communication activities has been spread throughout the agency. Below is a chart summarizing the total budget for space communication activities in the agency.

ENTERPRISE BUDGET SUMMARY

$ in Millions	FY 2001	FY 2002	FY 2003
Space Communications Program (Code M)	**521.7**	**482.2**	**117.5**
TDRS Replenishment	50.9	117.5	16.5
Upgrades	73.8	25.4	1.4
Operations	361.2	318.8	82.1
Technology Infusion	35.8	20.5	17.5
Enterprise Mission Requirements	**156.2**	**232.9**	**527.7**
Space Flight (Code M)	104.8	132.8	197.9
Space Science (Code S)	10.3	57.2	234.2
Earth Science (Code Y)	40.7	42.2	82.9
Aerospace Technology (Code R)	0.3	0.7	12.7
TOTAL SPACE OPERATIONS	**677.8**	**715.1**	**645.2**

BASIS OF FY 2003 FUNDING REQUIREMENT

OPERATIONS

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Operations Integration	58.8	28.8	18.8
Ground Networks	33.6	39.6	1.0
Space Network	7.0	--	--
Deep Space Network	142.2	154.3	--
Wide Area Network	99.7	77.0	57.1
Western Aeronautical Test Range	12.5	12.0	--
Spectrum Management	4.5	2.5	0.6
Standards Management	0.3	0.7	0.7
Navigation & Communications Architecture	--	0.3	0.3
Program Management Support	2.6	3.6	3.6
Total	361.2	318.8	82.1

DESCRIPTION/JUSTIFICATION

The operations functions for Space Communications are defined as those activities that provide data services to customers to enable their utilization and exploration of space. The goal is to provide high-quality, reliable, cost-effective operations that support planning, system engineering, design, development, and analysis to a large number of NASA missions including planetary and interplanetary missions; human space flight missions; near-Earth and Earth-orbiting missions; sub-orbital and aeronautical test flights.

Data services operations are conducted in the facilities provided by NASA at multiple locations both in the United States and at overseas sites. Data Services provide command, tracking, and telemetry data services between the ground facilities and flight mission vehicles. This includes all the interconnecting telecommunications services to link tracking and data acquisition network facilities, mission control facilities, data capture and processing facilities, industry and university facilities, and the investigating scientists.

Data services are also provided to non-NASA customers on a reimbursable basis. Space Network ground terminal complex operations and maintenance at White Sands Complex (WSC) and Network Control Center (NCC) functions at Goddard Space Flight Center (GSFC) are funded with budget offset reimbursements.

The Space Network (SN) encompasses the WSC in New Mexico, the Guam Remote Ground Terminal, and the NCC at GSFC to operate the constellation of Tracking and Data Relay Satellites (TDRS). The SN is required to operate 24 hours per day, 7 days per week, providing data relay services to many flight missions. The Space Network extended service (on a reimbursable basis) to the expendable launch vehicle community, including agreements with US Air Force Titan, Lockheed Martin's commercial Atlas programs, and Boeing's Delta program

The Deep Space Network (DSN) includes the Goldstone Deep Space Communications Complex (GDSCC) in California, the Madrid Deep Space Communications Complex (MDSCC) in Spain, and the Canberra Deep Space Communications Complex (CDSCC) in Australia.

The Ground Networks (GN) is comprised of tracking stations in Poker Flats Research Range in Alaska, Merritt Island Launch Annex (MILA) in Svalbard, Norway, McMurdo Ground Station in the Antarctic, and Wallops Flight Facility. The GN provides launch support, polar orbiting Spacecraft support, and sounding rocket and atmospheric balloon mission support. The GN also supports critical Space Shuttle launches, emergency communications, and landing activities, as well as emergency communications and tracking support for the International Space Station. The GN provides for the implementation, maintenance, and operation of the tracking and communications facilities necessary to fulfill program goals for flight projects in the NASA mission set. Missions supported also include NASA inter-agency collaborative programs, and other national, international, and commercial enterprises on a reimbursable basis. Space Shuttle launches are supported through dedicated facilities of the MILA station and the Ponce de Leon inlet annex.

Dryden Flight Research Center (DFRC) Western Aeronautical Test Range (WATR) provides communications, tracking, data acquisition, and mission control for a wide variety of aerospace vehicles. The WATR meets widely diverse research project requirements with tracking, telemetry, and communication systems and control room complexes. Due to the nature of the aerospace research mission, it is essential to respond to new project requirements within days or weeks rather than months or years, and to do so safely, efficiently, and economically. To accomplish this, WATR facilities, systems, and processes are designed to support a wide range of requirements, to be easily reconfigured (less than one hour for control rooms), to be shared between multiple projects, and to readily interface with specialized equipment brought in by our customers. This approach provides the needed agility to be responsive to individual customers by increasing utilization rates

Mission control facilities operated and sustained under this program are Mission Operation Centers (MOC) for the Hubble Space Telescope (HST) program; the International Solar Terrestrial Physics (ISTP) Wind, Polar, and Solar Observatory for Heliospheric Observation (SOHO) missions; Rossi X-ray Timing Explorer (RXTE), Total Ozone Mapping Satellite- Earth Probe (TOMS-EP), Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX); Transport Region and Coronal Explorer (TRACE); Submillimeter Wave Astronomy Satellite (SWAS) mission, and the Multi- satellite Operations Control Center (MSOCC) which supports Upper Atmosphere Research Satellite (UARS) and Earth Radiation Budget Satellite (ERBS) missions. The Advanced Composition Explorer (ACE), Tropical Rainfall Measurement Mission (TRMM), Earth Observing (EO-1) and Land Satellite (Landsat- 7) are also operated out of GSFC MOCs.

The data processing function captures Spacecraft data received on the ground, verifies the quantity and quality of the data, and prepares data sets ready for scientific analysis. The data processing facilities perform the first order of processing of Spacecraft data (Level 0) prior to its distribution to science operations centers and to individual instrument managers and research teams

The Flight Dynamics Facility (FDF) provides a variety of services to its customers, including orbit determination and control, attitude determination and control, acquisition data generation, tracking network calibration, attitude and orbit maneuver design and planning, and other related services. The orbiting missions include ACE, ERBS, HST, the GOES series, RXTE, the TDRS series, TERRA, TOMS-EP, TOPEX, TRACE, TRMM, and UARS, as well as ISS.

The Wide Area Network (WAN) provides for the implementation, maintenance, and operation of the telecommunications services, control centers, switching systems, and other equipment necessary to provide an integrated approach to NASA communications requirements.

Spectrum management support is provided for all missions across the NASA strategic enterprises. Future spectrum and orbit requirements are identified and integrated into National and international regulatory activities to assure near-term and far-term Agency requirements are met.

Standards Management responsibilities include establishing NASA space data systems standards policy, providing strategic direction, and maintaining oversight of the NASA space data systems program.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goals Supported:
- Enable humans to live and work permanently in space
- Enable the commercial development of space

Strategic Plan Objectives Supported:
- Meet sustained space operations needs while reducing costs
- Develop new capabilities for Human Space Flight and commercial applications through partnerships with the private sector

Performance Plan Metrics Supported:
1H20, 1H21

Milestones	FY 2003 Budget	FY 2002 Budget	FY 2001 Budget	FY 2002-FY 2003 Change	Comment
Number of FY 2001 Space Shuttle launches supported by Space Network	7	7	9	–	
Number of hours of space network services planned for FY 2001	71000	61000	61000	10000	Change in calculation methodology to more accurately reflect actual support
Number of NASA Integrated Systems Network (NISN) physical locations connected in FY 2001	295	340	420	-45	Due to the NISN/Wide Area Networks active peering relationships, the WAN has eliminated many dedicated services to principal researchers at domestic locations.
Number of FY 2001 NASA Deep Space Network Missions supported	47	47	47		
Number of hours of Deep Space Network Service planned for FY 2001	80,000	81,000	81,000	-1,000	Number of hours of services is continually renegotiated throughout the year based on launch slips, unplanned maintenance and mission support requirements.
Number of NASA/Other ELV launches for Ground Networks planned for FY 2001	21	25	54	-4	Launch slip and delays/project cancellations
Number of NASA Earth-Orbiting Missions in FY 2001	37	37	32	-	
Number of Sounding Rocket deployments in FY 2001	12	12	25	-13	Launch slips/delays
Number of Balloon deployments (scientific) in FY 2001	26	26	26	--	
Number of hours in FY 2001 for Ground Networks orbital tracking	23,532	25,200	23,000	-1,668	Launch slips/delays

Milestones	FY 2003 Budget	FY 2002 Budget	FY 2001 Budget	FY 2002-FY 2003 Change	Comment
Number of hours of Western Aeronautical Test Range mission control center in FY 2001	4,546	1,875	1,875	2,671	Higher than planned mission control hours due to increased support for X-43
Number of hours of data services support for Western Aeronautical Test Range in FY 2001	27,399	27,000	27,000	399	Data services support was provided to 3 unscheduled Shuttle landings.
Number of NASA Spacecraft supported by GSFC mission control facilities for Mission and Control Data Services in FY 2001	22	22	25	-	
Number of mission control hours of service (in thousands) in FY 2001	48,992	58,000	62,000	-9,008	Launch slips/delays
Number of NASA/Other missions provided flight dynamic services in FY 2001	37	45	49	-8	Launch delays/project cancellations
Number of NASA/Other ELV launches supported by flight dynamic services in FY 2001	20	20	22	-	
Number of FY 2002 Space Shuttle launches supported by Space Network	7	7	7	--	
Number of hours of space network services planned for FY 2002	79,919	61,000	61,000	18,919	Change in calculation methodology to more accurately reflect actual support

Milestones	FY 2003 Budget	FY 2002 Budget	FY 2001 Budget	FY 2002-FY 2003 Change	Comment
Number of NASA Integrated Systems Network (NISN) physical locations connected in FY 2002	295	323	323	-28	Due to the NISN/Wide Area Networks active peering relationships, the WAN has eliminated many dedicated services to principal researchers at domestic locations.
Number of FY 2002 NASA Deep Space Network Missions supported	50	51	51	-1	Deep Space Network Support to reimbursable missions has been reduced.
Number of hours of Deep Space Network Service planned for FY 2002	85,000	84,000	84,000	1,000	Starting in FY 2002, delta differenced one-way ranging (Delta DOR) is a requirement for all DSN sites, causing a minimal increase in usage.
Number of NASA/Other ELV launches for Ground Networks planned for FY 2002	26	25	25	1	Launch delays/project cancellations
Number of NASA Earth-Orbiting Missions in FY 2002	44	37	37	7	Mission support extensions in addition to launches
Number of Sounding Rocket deployments in FY 2002	41	25	25	16	FY 2001 delayed launches shifted to FY 2002
Number of Balloon deployments (scientific) in FY 2002	23	26	26	-3	Weather and other factors reduced total deployment
Number of hours of service (Ground Networks orbital tracking) in FY 2002	25,200	25,200	25,200	--	
Number of hours of Western Aeronautical Test Range mission control center in FY 2002	6,980	1,875	1,875	5,105	Higher than planned mission control hours due to increased support for X-43.

Milestones	FY 2003 Budget	FY 2002 Budget	FY 2001 Budget	FY 2002-FY 2003 Change	Comment
Number of hours of data services support for Western Aeronautical Test Range in FY 2002	30,000	30,000	30,000	--	
Number of NASA Spacecraft supported by GSFC mission control facilities for Mission and Control Data Services in FY 2002	23	23	23	--	
Number of mission control hours of service (in thousands) in FY 2002	58,000	58,000	58,000	--	
Number of NASA/Other missions provided flight dynamic services in FY 2002	38	46	46	-8	Launch delays/project cancellations
Number of NASA/Other ELV launches supported by flight dynamic services in FY 2002	30	30	30		
Number of FY 2003 Space Shuttle launches supported by Space Network	4	4	4		
Number of hours of space network services planned for FY 2003	81,479	81,479	81,479		
Number of NASA Integrated Systems Network physical locations connected in FY 2003	285	285	285		

Lead Center:	**Other Centers:**
Johnson Space Center	Goddard Space Flight Center, Jet Propulsion Laboratory, Marshall Space Flight Center, Dryden Flight Research Center, Headquarters, Glenn Research Center, Kennedy Space Center
Networks: Deep Space Network Space Network Ground Networks Wide Area Network	
Major Contractors: Lockheed Martin Australian Space Office Ingenieria Y Servicios Aeroespaciales, S.A.	

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

The Space Network will continue to provide services to the Space Shuttle flights and their attached payloads as well as the construction phase of the International Space Station.

The number of missions serviced by the Deep Space Network facilities and the requirements of the individual missions will increase over the next several years. In anticipation of the increases, new antenna system capabilities are being developed and obsolete systems will be phased out or converted for alternate uses. FY 2001 was a busy period with numerous mission-critical events, including launches, seven Spacecraft emergencies, three Jovian moon encounters, and a spectacular asteroid landing. In FY 2001, major mission launches supported include Mars Odyssey in April, Microwave Anisotropy Probe (MAP) in June, and Genesis in August. Galileo encountered Ganymede in December 2000, Callisto in May 2001, and Io in August 2001. Finally, the Near-Earth Asteroid Rendezvous (NEAR) mission made a historic, first time ever landing on an asteroid, when it landed on the Earth Resource Observation System (asteroid EROS on February 12, 2001. The DSN navigation team supported the descent sequence design. FY 2002 also has many significant activities planned. Mars Odyssey begins its mapping of Mars in January. This will increase the tracking load on the DSN and require regular use of the DSN's new Multiple Spacecraft Per Aperture (MSPA) capabilities for the first time. Galileo's thirty-third encounter with Io is planned for late January. The DSN expects to support ten launches through the year, including TDRS in March, followed by HESSI, Pro-SEDS, Contour, SIRTF, MUSES-C, and Integral.

In the area of Ground Networks, operations of the tracking station at Svalbard, Norway, have been consolidated under a commercial provider, Space Data Services. Operations of the tracking station at Poker Flats, Alaska, are planned to be consolidated under a commercial provider in FY 2002.

The Western Aeronautical Test Range saw its agility put to the test in FY 2001 when its traditional customer base diversified. The new customer base includes a greater number of experimental vehicles, Unpiloted Aerial Vehicles (UAVs), and access-to-space vehicles that bring with them a greater amount of mission unique requirements. In addition to local DFRC customers, the WATR supports other NASA Centers, the U.S. Army, U.S. Air Force, U.S. Navy, Federal Aviation Administration, and the aerospace industry. Three unscheduled Edwards AFB Shuttle landings were supported in FY 2001. Significant FY 2001 and FY 2002 activities include the build-up of a Mission Control Center and data processing system to support unique X- 40A, and X-43 (Hyper- X) requirements. Initially, a work-around was developed to support classified data on the first flight of the X-43. However, additional modifications to the Mission Control Complex will be required for future X-43 missions. The extended test range, developed with our alliance partners, will be maintained for use on future X-43 missions. Mobile tracking systems will be used more frequently for remote deployments in support of a variety of UAVs.

The Microwave Anisotropy Probe (MAP), the second Medium-class Explorer (MIDEX) was launched during FY 2001 and mission control facilities are now operating and sustained under this program. The International Monitoring Platform (IMP-8) completed its mission in October 2001 after 27 years of service.

The Earth Observation System (EOS) Data and Operations System (EDOS) began supporting the EOS Terra (AM- 1) mission and is preparing for the second mission of the EOS series, Aqua (PM- 1) currently planned for March 2002. EDOS provides the science data processing capability and product generation and delivery for the EOS missions. In addition, the Terra mission is supported via the SN and transmits telemetry to the EDOS Ground System Interface Facility (GSIF) located at the WSC for storage and delivery to the EDOS Level Zero Processing Facility located at GSFC. Data processing is also provided for the ISTP missions (Geotail, WIND, Polar and SOHO), SMEX missions (SWAS, SAMPEX, TRACE and FAST), ACE, TOMS-EP, EO-1, and RXTE. A new system, Packet Processor (PACOR) Automation, will provide Level-0 processing for HST, TRMM, UARS, and ERBS and reduce operations costs while continuing to meet product delivery and data recovery requirements. Higher level data processing (Levels 1-3) is provided for the ISTP and UARS missions, with UARS support ending November 2002.

The Flight Dynamics Facility (FDF) provides a variety of services to its customers, including orbit determination and control, attitude determination and control, acquisition data generation, tracking network calibration, attitude and orbit maneuver design and planning, and other related services. The orbiting missions include ACE, ERBS, HST, the GOES series, RXTE, the TDRS series, TERRA, TOMS-EP, TOPEX, TRACE, TRMM, and UARS, as well as ISS. During FY 2002, the level of support from the Flight Dynamics Facility for current and future missions is expected to increase due to the aging onboard sensors and actuators, requiring additional analysis, different algorithms, and processing. Some notable missions to be launched in FY 2002 are EOS AQUA (PM-1), the High Energy Spectroscopic Imager (HESSI), the Galaxy Evolution Explorer (GALEX), and the Servicing Mission 3B for HST. In addition, in FY 2002, as the Network Control Center functions migrate from Building 13 of Goddard to the White Sands Complex, FDF will move from the current location in Building 28 to Building 13 with a back-up facility in Building 25, providing more reliable and robust capabilities to its customers.

The Wide Area Network (WAN) continues to expand its service offerings while reducing overall cost. During FY 2001, the WAN backbone capacity was expanded by 20 percent while reducing cost per kilobit by 17 percent. In FY 2002, the WAN will begin to upgrade the infrastructure utilized by its operational mission network. NASA will be adding services to support continued implementation of IFMP, Consolidated Supercomputing Management Office (CoSMO), ISS Phase II, National Oceanic and Atmospheric Administration (NOAA)-K, Earth Observation System, Advanced Composition Explorer (ACE), Advanced Earth Observing Satellite (ADEOS) and TRMM. Additional tasks planned for FY 2002 include further definition of the Mission Network Modernization project, including the design and implementation plan, and more interactive tools for network problem resolution and reporting to customers. Investigations planned for FY 2002 include video conferencing over Internet Protocol, while keeping an interface to current ISDN connected systems, collaborative data sharing tools to incorporate into video teleconferencing service, and future platform for network services.

The Spectrum Management program began preparations for the 2003 World Radiocommunications Conference (WRC- 2003). Study efforts were conducted and contributed to International Telecommunications Union study groups to prepare the technical bases for Agency proposals to WRC- 2003. These efforts include enhancement of frequency allocations for spaceborne radars, protection of vital tracking and data relay capabilities, and ensuring the protection of sensitive signals from deep space scientific research. The program leverages its activities through coordination with other civil space agencies throughout the World by participation in the Space Frequency Coordination Group (SFCG). The 2001 SFCG meeting was hosted by the French Space Agency, CNES, near their launch complex in French Guiana. The program is also helping to foster NASA's commercialization goals by working with the National regulatory agencies to solve the associated regulatory challenges. The program will continue to support NASA missions in obtaining national and international authority to operate in a protected and properly allocated manner.

PROGRAM PLANS FOR FY 2003

The SN is required to operate 24 hours per day, 7 days per week, providing data relay services to numerous flight missions. The SN will continue to provide for the implementation, maintenance, and operation of the communications systems and facilities necessary to ensure and sustain the high-quality performance to our NASA and non-NASA customers. The SN will continue to provide services to the Space Shuttle flights and their attached payloads as well as the construction phase of the International Space Station.

The WAN provides for the implementation, maintenance, and operation of the telecommunications services, control centers, switching systems, and other equipment necessary to provide an integrated approach to NASA communications requirements. Plans for FY 2003 include the initial installations of the Mission Network Modernization project for improved technology and performance in providing mission services to both manned and unmanned space programs; and the introduction of voice over Internet protocol into the mission infrastructure allowing a low cost solution to NASA's principle investigators participating in NASA's missions. NASA's peering agreements will continue to be improved to provide NASA greater connectivity to the university and research networks without expensive dedicated circuits to those locations.

Consistent with the new decentralized management process, the Deep Space Network will be managed by the Office of Space Science, the Ground Networks will be managed by the Office of Earth Science, and the Western Aeronautical Test Range will be managed by the Office of Aerospace Technology beginning in FY 2003. Information about these networks can be found in the respective sections of each Enterprise responsible for those networks.

BASIS OF FY 2003 FUNDING REQUIREMENT

UPGRADES

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Mission Services	33.9	--	--
Data Services	39.9	25.4	1.4
Total	73.8	25.4	1.4

DESCRIPTION/JUSTIFICATION

The goal of the Upgrades Project is to improve the communications and data capabilities available to NASA's Enterprises by implementing required upgrades to space communications systems and services. Reliable electronic communications and mission control systems are essential to the success of every NASA flight mission, from planetary Spacecraft to the Space Shuttle to aeronautical flight tests.

Upgrades are made to the Space Network, Deep Space Network, and Ground Networks. These areas establish, operate, and maintain NASA facilities to provide communications services to a variety of flight programs. These include deep space, Earth-orbital, research aircraft, and sub-orbital missions.

Upgrade tasks are being conducted on the Space Network, the Deep Space Network, and the Ground Networks to enable the conduct of on going and new missions by the NASA strategic Enterprises. The Goddard Space Flight Center (GSFC), the Jet Propulsion Laboratory (JPL), and their respective industry partners implement these upgrades.

A major upgrade effort is underway to reduce operations costs for the Space Network and Ground Networks through the implementation of the Data Services Management Center at the White Sands Complex (WSC) in New Mexico. This effort involves consolidating scheduling, management, and control of operations for the Space Network and Ground Networks, including relocating the Network Control Center (NCC) from GSFC to WSC. The NCC, the primary interface for all SN customer missions, provides scheduling for customer mission services. In addition, the NCC generates and transmits configuration control messages to the network's ground terminals and TDRS satellites and provides fault isolation services for the network. The Upgrades Project provides comprehensive mission planning, user communications systems analysis, mission analysis, network loading analysis, and other customer services and tests to ensure network readiness and technical compatibility for in-flight communications.

In the Deep Space Network (DSN) area, JPL is working with its industry contract partners to transform the DSN and associated mission operations system architecture into a service provision system known as the Deep Space Mission System (DSMS). The

DSMS will provide a customer-oriented, turn-key service system, which seamlessly integrates the facilities of the DSN, and the Advanced Multi-Mission Operations System (AMMOS). This system will enable more efficient provision of currently available services as well as the creation of entirely new services.

Beyond efficiency improvements to existing assets, NASA is exploring ways to enhance the amount of deep space communications capability that can be applied to servicing the growing exploration fleet. NASA efforts along these lines include international cooperation and technology upgrades to existing assets.

In the international cooperation arena, NASA, through JPL, is working with other space-faring nations to implement a standardized set of communications protocols that will allow Spacecraft interoperability with U.S. and foreign ground communications assets. NASA is also working to establish the agreements necessary to utilize such interoperability, such as the possible application of Italy's planned 64-meter Sardinia antenna to the support of some U.S. deep space missions.

JPL is working to improve capacity through data processing and antenna feed enhancements at current radio frequencies and through the application of higher radio, and even optical, frequencies. This will enable significant leaps in the data rates available for future missions. The first major new radio frequency improvements involve the addition of Ka-band reception capability on all of the Deep Space Network's 34-meter beam wave-guide antennas. NASA is also working to develop the corresponding Ka-band transmission hardware needed for the flight elements. In addition, the Office of Space Science's Mars Exploration Program implemented the building of an additional 34-meter beam wave-guide antenna in Spain to meet DSN mission loading requirements.

Efforts to reduce the cost of operations for low-Earth orbit Spacecraft will continue with the commercialization of ground based tracking systems. The goal of these efforts is to provide a low-cost ground tracking capability utilizing commercial ground tracking services in lieu of building additional government assets. This concept is being validated by the NASA/Consolidated Space Operations Contract polar tracking services contracts with the Honeywell DataLYNX and Space Data Services contractors in support of the Earth Observing System (EOS) Program.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goals Supported:
- Enable humans to live and work permanently in space
- Enable the commercial development of space

Strategic Plan Objectives Supported:
- Meet sustained space operations needs while reducing costs
- Develop new capabilities for Human Space Flight and commercial applications through partnerships with the private sector

Performance Plan Metrics Supported:
1H20, 1H21

Milestones	FY 2003 Budget	FY 2002 Budget	FY 2001 Budget	FY 2002-FY 2003 Change	Comment
Data Services Management Center (DSMC)	3rd Qtr FY 2002	3rd Qtr FY 2002	3rd Qtr FY 2002	--	The DSMC consolidates Ground Networks (GN) and Space Network (SN) scheduling and service accounting functions at the White Sands Complex (WSC) to reduce operations costs.
Ground Networks - McMurdo Ground Station Upgrades	4th Qtr FY 2002	2nd Qtr FY 2001	2nd Qtr FY 2001	6 Qtrs later	Upgrade the existing facility (joint with the USAF) to improve operability during inclement weather and support future cooperation with the USAF. Competing priorities for technical staff and constrained implementation season at McMurdo station resulted in schedule slip
Mission Services – PACOR Automation	2nd Qtr FY 2002	3rd Qtr FY 2001	3rd Qtr FY 2001	3 Qtrs later	Automate and upgrade existing data processing systems to reduce operations costs. Under estimated complexity and scope of software development effort resulted in schedule slip.
Ka-Band Ground Terminal Development	2nd Qtr FY 2002	4th Qtr FY 2001	4th Qtr FY 2001	2 Qtrs later	Implement a Ka-Band ground terminal to test and demonstrate high rate ground data acquisition at this higher frequency. The manufacturer has experienced technical difficulties while develpping the higher frequency RF components required for Ka-band.
Space Network Demand Access System	3rd Qtr FY 2002	1st Qtr FY 2002	1st Qtr FY 2002	2 Qtrs later	Implement an improved Space Network multiple access system to provide increased capacity to support new operational uses of the TDRSS. Under estimated complexity and scope of software development effort resulted in schedule slip.

Milestones	FY 2003 Budget	FY 2002 Budget	FY 2001 Budget	FY 2002-FY 2003 Change	Comment
Deep Space Network DSS-26 Antenna implementation	3rd Qtr FY 2003				Implement a 34M deep space antenna with X-Band and Ka-Band downlink capability.
Deep Space Network - Network Simplification Project	3rd Qtr FY 2003				Automate and upgrade existing tracking, telemetry, and command systems to increase reliability and reduce operations costs.

Lead Center:	**Other Centers:**
Johnson Space Center	Goddard Space Flight Center, Jet Propulsion Laboratory
Subsystem:	**Major Contractors:**
Data Services Upgrades	Lockheed Martin

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

The Ka-Band Ground Terminal Development activity continues in FY 2002. This effort seeks to demonstrate the commercial viability of providing high rate ground data acquisition in the Ka-Band area. This activity will include participation by members from various NASA centers and commercial vendors. The successful demonstration of this capability is scheduled for late FY 2002. Capabilities to be demonstrated are far beyond what is in operation today. Success will allow NASA and its commercial partners to take advantage of the new frequency allocations for space and earth science and to alleviate issues regarding radio frequency spectrum interference that exist today.

Work will continue in FY 2002 on various components of the Space Network Demand Access System (DAS). The Third Generation Beam Forming System development activity was completed to augment the TDRSS multiple-access capability and to permit customers to implement new operations concepts incorporating continuous return link communications. The DAS will expand existing Multiple Access (MA) return service capabilities by allowing customers to directly obtain services from the Space Network without scheduling through the NCC. The DAS will be installed at WSC and is expected to be operational and available for customer use in FY 2002.

JPL has also been working to decrease the Deep Space Network's complexity and improve equipment reliability; thereby enabling substantial DSN operations and maintenance cost savings. Efforts along these lines include improved network control, network simplification, upgrades to the 26-meter antenna subnet, and the replacement of aging electronics systems.

The Network Simplification Project (NSP) has continued on schedule. NSP consolidates or replaces all the telemetry and radiometric DSN equipment with new technology and commercial-off-the-shelf solutions that enable advanced capabilities and remote operations. The objectives include replacing failure-prone aging assemblies, reducing system interfaces, reducing manual switches, replacing old NASA-unique protocols with industry standards, and providing new deep space mission command services to eliminate labor-intensive controller functions. The final installations are planned for mid-2002 through 2003. The first-of-a-kind uplink and downlink replacement systems will be installed on the 34-meter beam wave-guide antenna at Goldstone for operational testing during FY 2002.

Implementation has begun on the telecommunications roadmap that was developed in FY 1998. The roadmap laid out a plan for using new technologies to increase the Deep Space Network's deep space communications capabilities to accommodate a growing exploration fleet while maximizing the utility of the existing DSN antennas. The first major goal of this implementation will be the addition of Ka-band reception capability on all of the Deep Space Network's 34-meter beam wave-guide antennas. An implementation plan was developed in FY 1999 that has successfully passed a preliminary definition and cost review, and has moved on to prototyping activities for certain key technologies. One of these technologies currently under test is a single microwave feed horn and associated cryogenic low-noise amplifiers that can receive both X-band (8 GHz) and Ka-band (32 GHz) simultaneously. The other significant effort undertaken as part of the telecommunications roadmap is the completion of the 34-meter antenna at Goldstone. The electronics for this antenna have been developed and are being installed to make this antenna operational in FY 2003.

NASA is planning for the future of the McMurdo Ground Station (MGS) in Antarctica. The drivers for this station are the need to provide for predictable performance of MGS in support of Launch and Early Orbit Operations, to provide for supplemental telemetry support, and to pursue a mutually beneficial relationship with the U. S. Air Force with regard to improved service and cost sharing. Concept definition, project plans, and approval to proceed were granted in FY 1999. Work will continue in FY 2002 to complete the implementation of a Joint Operations Center with the U. S. Air Force and subsystem upgrades in support of the Earth Observing Missions.

PROGRAM PLANS FOR FY 2003

The Network Simplification Project (NSP) will continue on schedule. The final installations are planned for completion by 2003. The electronics for the 34-meter antenna at Goldstone will be installed to make this antenna operational in FY 2003. Consistent with the new decentralized management process, we began the transition of Upgrades tasks to the appropriate Enterprises in FY 2002 and FY 2003. In FY 2004, the Enterprises will be fully responsible for funding all Upgrade requirements they believe are necessary to support their future needs.

BASIS OF FY 2003 FUNDING REQUIREMENT

TRACKING AND DATA RELAY SATELLITE REPLENISHMENT PROJECT

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Spacecraft Development	14.0	44.5	8.8
Launch Services	36.9	73.0	7.7
Total	50.9	117.5	16.5

DESCRIPTION/JUSTIFICATION

The Tracking and Data Relay Satellite (TDRS) Replenishment Project (TDRS H, I, J Spacecraft) is to provide three satellites to continue Space Network tracking, data, voice, and video services to NASA scientific satellites, the Space Shuttle, International Space Station, and to other NASA customers. These satellites are replacements to the current constellation of geosynchronous TDRS as they begin to exceed their lifetimes. The functional and technical performance requirements for these satellites will be virtually identical to those of the current Spacecraft except for improved multiple access and S-band single access performance, addition of Ka-band, and Spacecraft collocation. The three Spacecraft will be placed in orbit by expendable launch vehicles (ELV).

The Goddard Space Flight Center manages the development of the TDRS Replenishment Project, and the systems modification of the ground facilities and equipment as necessary to sustain network operations for current and future missions. The three TDRS Spacecraft, procured under a fixed-price contract, were awarded to the Hughes Space and Communications Company (now Boeing) in 1995. Lockheed Martin Corporation is the prime contractor for launch services for the TDRS Replenishment Spacecraft.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goals Supported:
- Enable humans to live and work permanently in space
- Enable the commercial development of space

Strategic Plan Objectives Supported:
- Meet sustained space operations needs while reducing costs
- Develop new capabilities for Human Space Flight and commercial applications through partnerships with the private sector

Performance Plan Metrics Supported:
1H20, 1H21

Milestones	FY 2003 Budget	FY 2002 Budget	Baseline	FY 2002-FY 2003 Change	Comment
Integrate and Test Complete H Spacecraft	November 1999	November 1999	January 1999	--	
Integrate and Test Complete I Spacecraft	August 1999	July 1999	June 1999	1 month	Impact of TDRS-I MA & Spacecraft integration rework
Integrate and Test Complete J Spacecraft	December 2001	December 2001	August 1999	--	
Launch H Spacecraft	6/00	6/00	7/99	0	TDRS-H launched 6/30/00
Available for Launch I Spacecraft	9/01	8/01	1/00	1	Impact of TDRS-I MA & Spacecraft integration rework
Available for Launch J Spacecraft	1/02	1/02	7/00	0	

Lead Center:	**Other Centers:**
Goddard Space Flight Center	Johnson Space Center, Kennedy Space Center, Jet Propulsion Laboratory, Glenn Research Center
Subsystems:	**Major Contractors:**
Spacecraft Payload Ground Modifications	Boeing Lockheed Martin

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

The TDRS-8 Spacecraft was launched successfully on June 30, 2000 with on-orbit checkout completed in September 2000. The Spacecraft is working well and meets all user service telecommunications performance requirements, except for a Multiple Access (MA) performance anomaly. As a result of an investigation, Boeing and NASA have executed a settlement agreement that results in a $35 million dollar credit to the Spacecraft contract. This is reflected in our revised FY 2002 operating plan as a credit of $8 million dollars and our FY 2003 budget request as a credit of $27 million dollars.

Changes to the TDRS-I and -J Spacecraft flight hardware and test program as a result of the MA investigation will be completed prior to the completion of environmental and final functional testing of the Spacecraft. Environmental testing for TDRS-I was completed in June 2001 and final functional testing occurred in November 2001. Launch is planned for March 2002. The environmental testing for TDRS-J was completed in November 2001 and final functional testing is scheduled for January 2002.

PROGRAM PLANS FOR FY 2003

The launch of TDRS-J is scheduled for October 2002.

TDRSS REPLENISHMENT LIFE CYCLE COST DATA

$ in Millions	Prior	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	BTC	Total
Initial Baseline	**714.4**	**70.0**	**97.8**	**54.5**						**936.7**
FY03 President's Budget	**618.2**	**50.9**	**117.5**	**16.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**803.1**
Development	486.8	14.0	44.5	8.8						554.1
Launch Services	131.4	36.9	73.0	7.7						249.0

BASIS OF FY 2003 FUNDING REQUIREMENT

TECHNOLOGY INFUSION

	FY 2001	FY 2002	FY 2003
	(Millions of Dollars)		
Advanced Communications.	12.0	13.9	13.6
Space Internet.	2.1	0.6	0.3
Virtual Space Presence	4.7	--	--
Autonomous Mission Operations	5.9	0.9	--
Advanced Guidance, Navigation, and Control	3.9	2.6	1.0
Standards.	4.8	2.5	2.6
Technology Program Support	2.4	--	--
Total	35.8	20.5	17.5

DESCRIPTION/JUSTIFICATION

The objective of the Space Communications Technology Infusion Project is to identify, develop, integrate, validate, and transfer/infuse advanced technologies that will increase the performance, provide new capabilities, and reduce the costs of providing data services to the Space Communications and Data Systems (SCDS) customers. The Technology project serves to reduce the cost of SCDS services, or provide the technology advancement to allow the introduction of new services to the overall Space Communications Architecture.

The SCDS strategy for achieving technology goals is to define five specific campaigns that address unique technology needs across the NASA Enterprises. In defining the activities in each of these campaigns, SCDS works closely with the relevant Enterprises to understand their needs and focus on those activities of greatest potential for enabling future missions and reducing the cost of communications and data services. The five campaigns are described below. In addition, funds are requested for Agency standards activities. This provides infusion of new protocols and information system standards to meet space communications and mission operations of NASA and international partners. This budget program support provides funds to cover field center institutional assessments.

Advanced Communication

The focus of this campaign is development of telecommunications technologies to increase data return and decrease costs for support of NASA's missions. The Advanced Communication Campaign is committed to the development of high performance communication technologies for use in future NASA Spacecraft and the ground and space assets that support them. The new communication technologies and more efficient implementation schemes will enable or augment future NASA missions with enhanced, lower cost communication services and allow the scientific community to perform more and better research by providing them with access to greater overall communication system bandwidth. The mission of the Advanced Communication Campaign is to identify, develop, and infuse high performance communications technologies necessary to enable or enhance mission data services and to achieve seamless interoperability among NASA, commercial satellite, and terrestrial communications systems.

This campaign has focused work areas supporting the unique low signal levels of Deep Space, high data rates for Near Earth, and low size, weight, power, and cost components for all missions. Activities related to the development and validation of a wide variety of radio frequencies, including Ka-band, for relief of spectrum congestion and optical devices (antennas, receivers, transmitters, modems, and codes) are part of this campaign.

Space Internet

Supporting the Integrated Operations Architecture (IOA) vision for transparent operations, the Space Internet Campaign seeks to provide users direct access to tools, payloads, and data. The mission of the Space Internet Campaign is to identify, develop, and infuse Internet and supporting communications infrastructure technologies necessary to achieve seamless interoperability between satellite and terrestrial networks. For Near Earth and near planetary missions, the Space Internet Campaign is committed to the extension of commercially available, terrestrial-based Internet technologies into future NASA Spacecraft to enhance the capabilities for remote access and control of space-based assets. Deep Space missions will require new communications protocols and new relay telecommunications. The long round-trip light times, intermittent link availability, and extremely low signal-to-noise ratio of deep space links demand carefully tailored protocols to achieve the kinds of high-level file transfer capabilities that we take for granted in today's terrestrial Internet. Within this campaign, we will develop new deep space protocols, test and validate them in protocol testbeds, and infuse them into new radios that provide high-level communication and navigation functionality in low-mass, power-efficient, highly interoperable systems. This campaign also includes activities related to development and validation of space qualified code, local area network (LAN), routing, and switching hardware and software.

Virtual Space Presence

As we gather more detailed science information in remote locations, and rely more heavily on robotic exploration and autonomous operations, we must shift how we plan, operate, and visualize these activities. These technologies provide improved science return through advanced tools for high fidelity 3-D visualization of planned and executed Spacecraft activities, and the ability to remotely plan activities and display the results, enable distributed team operations and broad outreach by providing secure access to science and mission information resources.

Autonomous Mission Operations

This campaign will enable the planning, design, development, and operation of missions with challenging observational or exploration scenarios. These include autonomous decision-making and control for complex navigation and guidance scenarios, collaborative robotic exploration of remote bodies or terrain, autonomous observation planning and optimization of information return, and hazard avoidance and autonomous maintenance of Spacecraft operational safety. Model-based system design and operation, goal-oriented planning, and related advanced testing techniques for autonomous systems are essential elements of these approaches. System automation to increase information handling and effective science return, automate system responsiveness to operational activities and Spacecraft driven service requests, and automated detection and response to unplanned events are elements of this campaign.

Advanced Guidance, Navigation and Control (GN&C)

Enabling the planning, design, development, and operation of missions with challenging navigation scenarios is the Advanced GN&C Campaign. Scenarios include autonomous navigation and guidance, autonomous formation flying and constellation operations, and operation in complex gravitational fields. Many of these mission scenarios require highly responsive guidance approaches with control loops closed on the Spacecraft rather than between Spacecraft and ground. Autonomous maneuver decision-making, planning, and execution techniques are being extended to enable distributed networks of individual vehicles to interact with one another and act collaboratively as a single functional unit. The activities in this campaign include the techniques and subsystems to enable the relative positions and orientations of vehicles to be determined; formation flying control architectures, strategies, and management approaches; inter-Spacecraft communication techniques for constellation coordination; and assessments of ground/flight operations concepts, trades, and accommodation requirements. Global positioning system (GPS) technologies that have been utilized for applications at the Earth are being evaluated and extended to support autonomous navigation for non-low earth orbit missions.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goals Supported:
- Enable humans to live and work permanently in space
- Enable the commercial development of space

Strategic Plan Objectives Supported:
- Meet sustained space operations needs while reducing costs
- Develop new capabilities for Human Space Flight and commercial applications through partnerships with the private sector.

Performance Plan Metrics Supported: 1H20, 1H21

Milestones	FY 2003 Budget	FY 2002 Budget	FY 2001 Budget	FY 2002-FY 2003 Change	Comment
Disseminate Advanced Communication Technology Satellite (ACTS) experiment results and complete data and record archiving	3rd Qtr FY 2002	4th Qtr FY 2001	4th Qtr FY 2001	3 Qtrs later	Overall experiment results will be catalogued and made available through the ACTS Web Page (http://acts.grc.nasa.gov) pending resolution of website public access concerns.
Develop SiGe-based power amplifier	4th Qtr FY 2002	4th Qtr FY 2002	4th Qtr FY 2002		Contingent on execution of a Space Act Agreement with Boeing, develop a Ku-band Silicon-Germanium-based power amplifier MMIC design for a phased-array antenna transit module.
Common Planning and Scheduling System (COMPASS) design review for distributed constellation planning	4th Qtr FY 2001	4th Qtr FY 2001	4th Qtr FY 2001		COMPASS capability extended to provide flight planning and scheduling in addition to science planning. COMPASS has been incorporated into the Advanced Visual Tools and Architecture Project Build 1 prototype. COMPASS is expected to reduce the cost of mission planning while enabling planning for distributed, independent and/or cooperative observatories (constellations). Project concluded in FY 2001.
Advanced Visual Tools and Architectures (AVATAR) project TAR Build 1 prototype release	2nd Qtr FY 2001	2nd Qtr FY 2001	2nd Qtr FY 2001		Zoomable Unit Interface, Data Carousel implemented, and Health Modeling design complete. Project concluded in FY 2001.
Demonstration of Deep Space Station Controller (DSSC) prototype	2nd Qtr FY 2002	4th Qtr FY 2001	4th Qtr FY 2001	2 Qtrs later	Includes model-based health monitoring and diagnosis. Slipped due to scheduling issues with the DSN.
Reconfigurable Radio Test Bed Demo	4th Qtr FY 2001	4th Qtr FY 2001	4th Qtr FY 2001		Radiometric navigation and telecommunications between multiple vehicles at Mars.

Milestones	FY 2003 Budget	FY 2002 Budget	FY 2001 Budget	FY 2002-FY 2003 Change	Comment
Optical Communications Technology Laboratory (OCTL) First Light	1st Qtr FY 2002	1st Qtr FY 2002	1st Qtr FY 2001	1 year later	OCTL development completed and delivery and installation of 1M-diameter telescope at Table Mountain. Performance Validation initiated. The slip for this milestone can be attributed to a delay in the actual placement of the contract, and difficulties in telescope development. No budget growth, no customer impact.
Ka-band TWTA Protoflight model delivery	4th Qtr FY 2002	3rd Qtr FY 2002	3rd Qtr FY 2002	1 Qtr later	24W EOL Traveling Wave Tube Amplifier with greater than 40% efficiency. A key technology in enabling Ka-band communications. Contract option to raise power to 35W picked up, based on success early success; option included later delivery of Protoflight model.
Communications and Navigation Demonstration on Shuttle (CANDOS)	3rd Qtr FY 2002		3rd Qtr FY 2002		A Shuttle-based demonstration of the first generation Low Power Transceiver (LPT)

Lead Center:	Other Centers:
Johnson Space Center	Goddard Space Flight Center, Jet Propulsion Laboratory, Marshall Space Flight Center, Kennedy Space Center, Glenn Research Center

Major Contractors:
Computer Sciences Corporation
Zin
Analex

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

A low power transceiver is being developed for near earth missions which will allow the unit to process multiple channels allowing simultaneous Tracking and Data Relay Satellite System (TDRSS) and Global Positioning System (GPS) signal reception. In FY 2001, the Field Programmable Gate Array (FPGA)-based transceiver completed ground-based demonstration of a 2^{nd} generation prototype capable of processing 16 channels. A Shuttle-based demonstration of the first generation LPT is scheduled for FY 2002.

The Advanced Visual Tools and Architectures (AVATAR) project applied visualization technology to Spacecraft engineering data analysis in order to increase operator performance in multi-mission, constellation, and lights-out environments.
Key technologies needed to enable utilization of Ka-band communications on future deep space missions will continue. A contract has been awarded for the development of a 27 Watt (24 Watt at end-of-life) space-qualified Ka-band Traveling Wave Tube Amplifier which is more than 40% efficient. Delivery is expected in the third quarter of FY 2002. A small profile rigid X/Ka-band antenna with high illumination efficiency is also under development. For the ground-receiving end, development of a Ka-band multi-cavity maser low noise amplifier will be demonstrated. Additionally, a combination deformable plate mirror and array feed compensation system will be developed and demonstrated to compensate for large DSN antenna distortions due to gravity and wind buffeting.

Development of the Optical Communications Telescope Laboratory (OCTL) will continue. The 1m-diameter telescope will be delivered and "first light" is planned for first quarter of FY 2002. The OCTL facility on Table Mountain in California will be used to demonstrate and validate optical communications techniques; components and systems level performance for application to NASA's future high capacity near-Earth and deep-space communications needs. The network of three Atmospheric Visibility Monitoring telescopes will continue to collect data, which will be used to assess statistics of optical signal propagation through the atmosphere. Models from these data will be used to evaluate optical link performance for future mission applications.

The Autonomous Formation Flyer (AFF) development has been infused into the New Millennium Program's Space Technology 3 program. A derivative of the AFF, a software reconfigurable Spacecraft transceiver processor prototype, is being developed to provide radiometric navigation and telecommunications between multiple vehicles at Mars. The design will be capable of reconfiguration from the ground through uploads of new software or Field Programmable Gate Array (FPGA) code.

Development of the Deep Space Station Controller (DSSC) prototype will continue and will lead to a demonstration of automated downlink operations in an actual DSN environment. The DSSC is developing an architecture and prototype for achieving station-centric automated control and employs AI-based methods for system health monitoring, diagnosis, and recovery. The monitoring and diagnosis portion of the prototype will employ the BEAM technology, which utilizes a combination of deterministic and stochastic models to monitor system health. Automation of recovery actions is achieved through the Closed-loop Execution and Recovery (CLEaR) technology, which employs continuous planning and execution capabilities. A prototype of the Deep Space Station Controller (DSSC) was demonstrated successfully in the fourth quarter of FY 2001.

The ACTS experiments program officially concluded with the ACTS Conference held in conjunction with the 6th International Ka-band Utilization Conference in May 2000. Instead of ceasing all operations and rendering the Spacecraft inert, NASA transferred ACTS to a university-based consortium. The Ohio Consortium for Advanced Communications Technology (OCACT) was formed in

FY 2001. NASA has been fully reimbursed for operations costs. In FY 2002, NASA plans to extend the operating license past FY 2001 (via IRAC with FCC approval) and provide minimal oversight of Spacecraft operations in exchange for experimental access to the payload to support the communications technology project. The OCACT will pursue an experimental license with the FCC for its use of the communications payload.

PROGRAM PLANS FOR FY 2003

The programmatic priorities for FY 2003 are to complete activities currently underway. Consideration will be given to high potential Technology Infusion tasks requiring no more than one year of funding to reach a significant milestone. Consistent with the new decentralized management process, we began the transition of Technology Infusion tasks to the appropriate Enterprises in FY 2002 and FY 2003. In FY 2004, the Enterprises will be fully responsible for identifying and funding all future Technology Infusion requirements that they believe are necessary to support their future needs.

SAFETY, MISSION ASSURANCE AND ENGINEERING (SMA&E)

FY 2003 ESTIMATES
BUDGET SUMMARY
SUMMARY OF RESOURCE REQUIREMENTS

OFFICE OF SAFETY & MISSION ASSURANCE
OFFICE OF THE CHIEF ENGINEER

SAFETY, MISSION ASSURANCE AND ENGINEERING

	FY 2001* OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
Safety and Mission Assurance	25.1	28.5	28.5
Engineering	17.5	19.1	19.1
Advanced Concepts**	4.8	--	--
Total	47.4	47.6	47.6
Distribution of Program Amount by Installation			
Johnson Space Center	7.2	7.2	8.7
Kennedy Space Center	0.4	0.7	0.7
Marshall Space Flight Center	3.2	3.1	3.6
Stennis Space Center	0.1	0.2	0.4
Ames Flight Research Center	1.2	0.6	1.0
Dryden Research Center	0.2	0.2	1.0
Langley Research Center	5.9	5.5	5.8
Glenn Research Center	2.5	2.5	2.1
Goddard Space Flight Center	15.6	12.2	12.6
Jet Propulsion Laboratory	7.3	7.7	7.3
Headquarters	3.9	7.7	4.4
Total	47.4	47.6	47.6
Direct Full Time Equivalent (FTE) Personnel* **	97	92	91

*****In FY 2001 and prior, these activities were included in the Mission Support appropriation.*
***Beginning in FY 2002, funding for Advanced Concepts is included within the Aerospace Technology Enterprise.*
****Includes personnel that support cross-Agency functional SMA&E activity and excludes personnel assigned to specific programs.*

BASIS OF FY 2003 FUNDING REQUIREMENT

SAFETY AND MISSION ASSURANCE

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Safety and Mission Assurance	25.1	28.5	28.5

DESCRIPTION/JUSTIFICATION

Safety, Mission Assurance and Engineering (SMA&E) is an investment to enable the safety and success of all NASA programs. The SMA&E budget supports the activities of the Office of Safety and Mission Assurance and the Office of the Chief Engineer. These Offices advise the Administrator, oversee NASA programs, develop Agency-wide policies and standards, and support technology requirements of NASA flight programs. Each area is discussed separately.

Safety and Mission Assurance (SMA) assures that sound and robust SMA strategies, processes, and tools are in place to enable safe and successful missions. It establishes strategies, policies, and standards, and assures that effective and efficient processes and tools are appropriately applied throughout the program life cycle. SMA analyzes, oversees, and independently assesses programs and flight and ground operations to assure that attention is placed on risk, missions are conducted safely, and there is a high probability of meeting Agency objectives. SMA funds research, development, pilot application, and evaluation of tools, techniques, and practices that advance NASA's capabilities in areas such as facility and operational safety, risk management, human reliability, software assurance, and risk analysis. Funding also develops SMA training courses.

SMA GOALS

- Early integration and life-cycle implementation of safety, reliability, maintainability, and quality assurance (SRM&QA) into NASA's programs and operations.
- Thorough and expeditious independent assessments (IA's) of program/project safety, reliability, maintainability, and quality.
- Innovation and rapid transfer of SRM&QA technologies, processes, and techniques to help program/project managers improve the likelihood of mission success while reducing overall costs.
- Development and application of risk management methodologies to provide relevant, practical, and timely contributions to NASA's management of risk.
- Deployment of an Agency-wide Safety and Mission Assurance (SMA) team that is highly motivated, trained, and properly equipped.
- Development of Assurance tools and methodologies for application on system development work performed by SMA, SMO, and Engineering organizations

SMA PROGRAM CONTENT

Safety and Mission Assurance funding contributes to advances in the following areas:

- Software Assurance
- Safety
- Risk Management
- Probabilistic Risk Assessment
- Mission Assurance Project Applications
- Failure Detection and Prevention
- Non-Destructive Evaluation
- HEDS Independent Assessment
- Assurance Assessments

ACCOMPLISHMENTS AND RESULTS IN THE PAST YEAR

The Office of Safety and Mission Assurance (OSMA) accomplishments over the past year included research, development, pilot application, and evaluation of SMA tools, techniques and practices in disciplines such as operational and facility safety, risk management, probabilistic risk assessment, software assurance, failure detection and prevention, and human reliability with the goal of enhancing NASA safety and mission success. OSMA also completed revisions to SMA policies & guidance, including safety and mission success and mishap reporting; and developed a policy and guidance for software independent verification and validation. OSMA provided support to and independent review of International Space Station (ISS), Space Shuttle (missions), and science programs (including expendable launch vehicle (ELV) payload launches) in FY 2001.

In FY 2001, NASA achieved a lost time injury rate of 0.31 occurrences of lost time injuries per 100 workers**.** This experience is well below the goal of 1.15 occurrences per 100 workers established by the President in "Federal Worker 2000". OSMA made significant progress to improve NASA's capability to conduct Probabilistic Risk Assessment (PRA) in support of its projects and developed PRA policy, methodology training, tools, and reference materials. The procurement and SMA communities joined forces to establish a Risk-Based Acquisition Management (R-BAM) process to consider risk early in the acquisition process.

Over the past year, OSMA made considerable progress in the development of the Process-Based Mission Assurance (PBMA) Knowledge Management System (KMS). PBMA-KMS is a web-based resource that enables NASA to share critical knowledge and best practices.

NASA continued the Agency Safety Initiative in FY 2001. The Centers advanced on the Agency's goal to have all Centers certified to Voluntary Protection Program standards by the end of FY 2002. Three of 10 Centers are now certified, and several other Centers are nearing their certification review.

PROGRAM PLANS FOR FY 2003

Independent review of the ISS will continue. SMA support and review will be provided to seven Shuttle and ten ELV and payload missions in FY 2002, and four Shuttle and nine ELV and payload missions in FY 2003. OSMA will continue to identify, develop, update, and evaluate SMA tools, techniques, and practices (including risk management, operational safety, probabilistic risk assessment, software assurance, failure detection and prevention, and human reliability) to enhance safety and mission success.

OSMA began to enhance the Agency's quality program for hardware and software in FY 2001 and is planning to establish and manage a quality program to integrate the experiences of each Center with that of the Defense Contract Management Agency. Better control of products produced by prime contractors and their vendors will enhance the level of success for NASA missions. In FY 2002 and beyond, OSMA expects further advances in software and human reliability and the development of a PRA database.

Full implementation of PBMA-KMS is expected in FY 2003 following roll out of PBMA-KMS to all Centers in FY 2002.

Safety and Mission Assurance will conduct policy and process evaluations as needed through FY 2002 and FY 2003. Any missions carrying nuclear materials will be reviewed for safety.

BASIS OF FY 2003 FUNDING REQUIREMENT

OFFICE OF THE CHIEF ENGINEER

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Engineering	17.5	19.1	19.1

DESCRIPTION/JUSTIFICATION

The Office of the Chief Engineer (OCE) serves as the steward of the cross-cutting Agency process to Provide Aerospace Products and Capabilities, which governs a very substantial portion of the total NASA budget. In that capacity, the office is directly involved with overseeing the application of the process to specific agency programs and with improving the efficiency and effectiveness of the Program and Project Management approach and the requisite supporting Engineering capability.

ENGINEERING GOALS

The specific goals of the Engineering program are as follows:

- Maintain and improve NASA's engineering capability through advances in processes, tools and skills
- Continuously improve NASA's Program/Project management process to ensure requirements are met within cost/schedule

ENGINEERING PROGRAM CONTENT/APPROACH

Specific elements of engineering and program management improvement are as follows:

- Systems Engineering to improve the processes, tools and capabilities for consistent integration of complex systems
- Software Engineering using structured processes to increase assurance and effectiveness in meeting mission needs
- Technical Standards to provide and improve technical guidance for engineering
- Electronic Parts and Packaging to support program needs for evaluation and low risk insertion of electronic technology.
- Independent Program Assessment and Cost Analysis of NASA Programs and Projects to support Program Management verification of flight program technical readiness, implementation, and cost performance

ACCOMPLISHMENTS AND RESULTS

In FY 2001, NASA began developing guidance for an Agency-wide systems engineering process. Implementation and training should begin in FY 2002. Priorities for improved analysis tools and methods will be identified to establish an advanced engineering environment enabling greater efficiency and effectiveness in systems engineering practice.

A draft NASA Software Procedures and Guideline (NPG 2820) was developed and software process improvement plans were established for all NASA Centers. Software process improvement will be initiated in FY 2002 including skill training and metrics to monitor improvement.

A new capability now provides NASA engineers centralized, web-based access to full-text technical standards and update information, supporting adoption of over 2,000 voluntary consensus standards, implementing PL 104-113. A major focus for FY 2002 is linking “lessons learned” to technical standards, integrating current experience with the technical guidance used for programs.

The NASA Electronic Parts and Packaging (NEPP) Program performs evaluations of the reliability and radiation tolerance of newly available and emerging microelectronic and photonic technologies to facilitate infusion of required technologies into NASA flight systems. FY 2001 evaluations included advanced commercial processors, and a variety of specialized devices. Guidelines on technology reliability and a Web Portal now provide access to NEPP information, including new methods for qualification of parts and packages.

In FY 2002, NEPP will emphasize increased dependence on commercial off-the-shelf (COTS) parts, technology insertion and electronic board level qualification. Leveraging of NASA dollars continues through partnerships and collaboration. New technology evaluations will include reliability at extreme temperatures, very long mission parts requirements, and very low power electronics.

Independent Program Assessments, managed and conducted by the Independent Program Assessment Office (IPAO), which is located at LaRC while serving as an agent of the Headquarters OCE, provide evaluations of program concept readiness during program formulation and ability to meet requirements once programs are approved. Independent Assessments (IA’s) are detailed reviews of proposed concepts; Non Advocate Reviews (NAR’s) confirm thoroughness and realism during formulation; Independent Implementation Reviews (IIR’s) evaluate progress against plans. The first two reviews include Independent Life Cycle Cost Analysis (ILCCA). During FY 2001, seven IA’s and 2 NAR’s were completed. In addition, 25 IIR’s were completed, including one for the Space Station Program, providing an improved basis for revised program plans. An Independent Review Team process has been instituted to combine existing review teams for efficiency, and places increased reliance on non-NASA reviewers to improve independence. In FY 2001, NASA began increasing cost estimating capabilities through university cooperation, external recruiting, training, and improvements to cost estimating models.

In FY 2002, the Independent Program Assessment Office will conduct 20 IIR's, 3 IA's and 5 NAR's. In addition, the IPAO will complete eight Independent Life-Cycle Cost Analyses for certification and submittal to Congress, in accordance with the FY 2000 Authorizations Act. The IPAO will also provide leadership for the improvement in cost estimating capability across NASA in the areas of personnel development, tool development, and process improvement.

PROGRAM PLANS FOR FY 2003

In FY 2003, implementation of improved systems engineering tools and methods will support some piloting of an advanced engineering environment. Capability assessment of engineering system maturity and project performance will be used to measure the benefit of systems engineering process improvements.

FY 2003 software emphasis will include formal assessment of software capability, infusion of software technology into programs and improvements to the software acquisition process. Software metrics will be collected from all major flight programs.

Field Center best practices will be consolidated into Agency-wide standards and, where possible into Voluntary Consensus Standards. Linking of "lessons learned" to standards will be expanded and expert systems evaluated for selecting technical standards and relevant lessons learned to enhance design capabilities.

NEPP areas of emphasis will include testing for complex parts/packages, qualification at higher levels of integration, and methods for rapid qualification of increasingly more complex parts. Programs will be aligned with industry roadmaps to increase use of COTS.

Assessment plans for FY 2003 include approximately 3 IA's and 2-3 NAR's and approximately 20-25 IIR's. Approximately 10-15 Independent Life Cycle Cost Analyses (ILCCA) will be performed, including those required by NASA's FY 2000-2002 Authorization Bill (P.L. 106-391); and cost estimating improvement capabilities, that began in FY 2001, will continue.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SCIENCE, AERONAUTICS AND TECHNOLOGY

FISCAL YEAR 2003 ESTIMATES
(IN MILLIONS OF REAL YEAR DOLLARS)

SUMMARY OF RESOURCE REQUIREMENTS

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
Space Science	2,606.6	2,867.1	3,414.3
Biological & Physical Research	362.2	820.0	842.3
Earth Science	1,762.2	1,625.7	1,628.4
Aerospace Technology	2,212.8	2,507.7	2,815.8
Academic Programs	132.7	227.3	143.7
Total	**7,076.5**	**8,047.8**	**8,844.5**
Distribution of Program Amount by Installation			
Johnson Space Center	210.5	275.5	292.7
Kennedy Space Center	232.9	260.7	257.4
Marshall Space Flight Center	599.5	978.3	1,319.9
Stennis Space Center	162.2	109.3	82.6
Ames Research Center	641.3	724.7	701.4
Dryden Flight Research Center	180.7	177.9	183.2
Glenn Research Center	515.9	590.6	684.8
Langley Research Center	645.4	721.5	708.4
Goddard Space Flight Center	2,283.7	2,447.5	2,491.4
Jet Propulsion Laboratory	1,243.2	1,183.0	1,401.2
Headquarters	361.2	578.8	721.5
Total	**7,076.5**	**8,047.8**	**8,844.5**

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SCIENCE, AERONAUTICS AND TECHNOLOGY

FISCAL YEAR 2003 ESTIMATES

STRATEGIC PLAN LINKAGE TO THIS BUDGET

The Science, Aeronautics and Technology (SAT) appropriation provides funding for the research and development activities of NASA. This includes funds to extend our knowledge of the Earth, its space environment, and the universe; and to invest in new aerospace transportation technologies that support the development and application of technologies critical to the economic, scientific, and technical competitiveness of the United States.

Beginning in FY 2002, the SAT account includes the direct funding of science and aeronautics research and technology *plus* other related costs (Research and Program Management and non-programmatic Construction of Facilities) that are allocated based on the number of full time equivalent personnel. There will no longer be a Mission Support account. In addition, beginning in FY 2002, funding for Space Operations Services is included in the Human Space Flight account. Also in FY 2002, Space Station Research Facilities were transferred to the Biological and Physical Research Enterprise under the Science, Aeronautics and Technology account.

In FY 2003, the SAT appropriation provides for the science, aeronautics and technology activities supporting the Agency. These activities include space science, biological and physical research, Earth science, aerospace technology, and academic programs. This appropriation also provides for salaries and related expenses (including travel); design, repair, rehabilitation, and modification of facilities and construction of new facilities; maintenance, and operation of facilities; and other operations activities supporting science, aeronautics, and technology programs. In FY 2003, Space Operations activities formerly budgeted under Human Space Flight were transferred to Science, Aeronautics and Technology. Specifically, the Deep Space Network was transferred to the Space Science Enterprise, the Ground Network to the Earth Science Enterprise, and the Western Aeronautical Test Range to the Aerospace Technology Enterprise.

For comparable year-to-year budget comparisons, please see page MY-2.

Space Science Enterprise

The Space Science Enterprise seeks to chart the evolution of the universe, from origins to destiny, and understand its galaxies, stars, planetary bodies, and life.

Strategic Objectives

Goal 1 – Science: Chart the evolution of the universe, from origins to destiny, and understand its galaxies, stars, planets, and life.

- Understand the structure of the universe, from its earliest beginnings to its ultimate fate.
- Explore the ultimate limits of gravity and energy in the universe.
- Learn how galaxies, stars, and planets form, interact, and evolve.
- Look for signs of life in other planetary systems.
- Understand the formation and evolution of the solar system and the Earth within it.
- Probe the evolution of life on Earth, and determine if life exists elsewhere in the solar system.
- Understand our changing Sun and its effects throughout the solar system.
- Chart our destiny in the solar system.

Goal 2 – Support Human Space Flight: Use robotic science missions as forerunners to human exploration beyond low-Earth orbit.

- Investigate the composition, evolution, and resources of Mars, the Moon, and small bodies.
- Develop the knowledge to improve reliability of space weather forecasting.

Goal 3 – Technology: Develop new technologies to enable innovative, less expensive flight missions.

- Acquire new technical approaches and capabilities.
- Validate new technologies in space.
- Apply and transfer technology.

Goal 4 – Education and Public Outreach: Share the excitement and knowledge generated by scientific discovery and improve science education.

- Share the excitement of space science discoveries with the public.
- Enhance the quality of science, mathematics, and technology education, particularly at the precollege level.
- Help create our 21st century scientific and technical workforce.

Biological and Physical Research Enterprise

The Biological and Physical Research Enterprise conducts basic and applied research to support human exploration of space and to take advantage of the space environment as a laboratory.

Goal 1 – Enable Exploration: Conduct research to enable safe and productive human habitation of space.

- Conduct research to ensure the health, safety, and performance of humans living and working in space.
- Conduct physical science research on planetary environments to ensure safe and effective missions of exploration.
- Conduct research on biological and physical processes to enable future missions of exploration.

Goal 2 – Science: Use the space environment as a laboratory to test the fundamental principles of physics, chemistry, and biology.

- Investigate chemical, biological, and physical processes in the space environment, in partnership with the scientific community.
- Develop strategies to maximize scientific research output on the International Space Station and other space research platforms.

Goal 3 – Outreach: Commerce: Enable and promote commercial research in space.

- Assure that NASA policies facilitate industry involvement in space research.
- Systematically provide basic research knowledge to industry.
- Provide technical support for companies to begin space research.
- Foster commercial research endeavors with the International Space Station and other assets.

Goal 4 – Use space research opportunities to improve academic achievement and the quality of life.

- Engage and involve the public in research in space.
- Advance the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets.

Earth Science Enterprise

The Earth Science Enterprise aims to understand the Earth and its response to natural- and human-induced changes in order to improve prediction of climate, weather, and natural hazards, and help us to be responsible stewards of our planet for future generations.

Goal 1 – Science: Observe, understand, and model the Earth system to learn how it is changing, and the consequences for life on Earth.

- Discern and describe how the Earth is changing.
- Identify and measure the primary causes of change in the Earth system.
- Determine how the Earth system responds to natural and human-induced changes.
- Identify the consequences of change in the Earth system for human civilization.
- Enable the prediction of future changes in the Earth system.

Goal 2 – Applications: Expand and accelerate the realization of economic and societal benefits from Earth science, information and technology.

- Demonstrate scientific and technical capabilities to enable the development of practical tools for public and private sector decisions-makers.
- Stimulate public interest in and understanding of Earth system science and encourage young scholars to consider careers in science and technology.

Goal 3 – Technology: Develop and adopt advanced technologies to enable mission success and serve national priorities.

- Develop advanced technologies to reduce the cost and expand the capabilities for scientific Earth observation.
- Develop advanced information technologies for processing, archiving, accessing, visualizing, and communicating Earth science data.
- Partner with other agencies to develop and implement better methods for using remotely sensed observations in Earth system monitoring and prediction.

Aerospace Technology Enterprise (AST)

The Aerospace Technology Enterprise works to maintain U.S. preeminence in aerospace research and technology. The Enterprise aims to radically improve air travel, making it safer, faster, and quieter as well as more affordable, accessible, and environmentally sound. The Enterprise is also working to develop more affordable, reliable, and safe access to space; improving the way in which air and space vehicles are designed and built; and ensure new aerospace technologies are available to benefit the public.

Goal 1 – Revolutionize Aviation Mobility: Enable a safe environmentally friendly expansion of aviation.

- Increase Safety – Make a safe air transportation system even safer.
- Reduce Emissions – Protect local air quality and our global climate.
- Reduce Noise – Reduce aircraft noise to benefit airport neighbors, the aviation industry, and travelers.
- Increase Capacity – Enable the movement of more air passengers with fewer delays.
- Increase Mobility – Enable people to travel faster and farther, anywhere, any time.

Goal 2 – Advanced Space Transportation: Create a safe, affordable highway through the air and into space.

- Mission Safety – Radically improve the safety and reliability of space launch systems.
- Mission Affordability – Create an affordable highway in space.
- Mission Reach – Extend our reach in space with faster travel times.

Goal 3 – Pioneer Technology Innovation: Enable a revolution in aerospace systems.

- Engineering Innovation – Enable rapid, high-confidence, and cost efficient design of revolutionary systems.
- Technology Innovation – Enable fundamentally new aerospace system capabilities and missions.

Goal 4 – Commercialize Technology: Extend the commercial application of NASA technology for economic benefit and improved quality of life.

- Commercialization – Facilitate the greatest practical utilization of NASA know-how and physical assets by U.S. Industry.

Academic Programs

NASA's direction for education is set forth in the NASA Strategic Plan through the Agency's Communicate Knowledge Crosscutting Process to support the Nation's education goals.

Goal – Ensure that NASA's customers receive information from the Agency's efforts in a timely and useful form.

- Educational Excellence: We involve the educational community in our endeavors to inspire America's students, create learning opportunities, and enlighten inquisitive minds.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROPOSED APPROPRIATION LANGUAGE

SCIENCE, AERONAUTICS AND TECHNOLOGY
(INCLUDING TRANSFER OF FUNDS)

For necessary expenses, not otherwise provided for, in the conduct and support of science, aeronautics and technology research and development activities, including research, development, operations, support and services; maintenance; construction of facilities including repair, rehabilitation, revitalization and modification of facilities, construction of new facilities and additions to existing facilities, facility planning and design, environmental compliance and restoration, and acquisition or condemnation of real property, as authorized by law; space flight, spacecraft control and communications activities including operations, production, and services; program management; personnel and related costs, including uniforms or allowances therefore, as authorized by 5 U.S.C. §§ 5901- 5902; travel expenses; purchase and hire of passenger motor vehicles; not to exceed **[**$20,000**]***$24,000* for official reception and representation expenses; and purchase, lease, charter, maintenance and operation of mission and administrative aircraft, **[**$7,857,100,000**]** *$8,918,500,000*, to remain available until September 30, **[**2003**]** *2004*, of which amounts as determined by the Administrator for salaries and benefits; training, travel and awards; facility and related costs; information technology services; science, engineering, fabricating and testing services; and other administrative services may be transferred to the Human Space Flight account in accordance with section 312(b) of the National Aeronautics and Space Act of 1958, as amended by Public Law 106-377**[**, except that no funds may be transferred to the program budget element for Space Station**]**. *(Departments of Veterans Affairs and Housing and Urban Development, and Independent Agencies Appropriations Act, 2002; additional authorizing legislation required.)*

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SCIENCE, AERONAUTICS AND TECHNOLOGY

FISCAL YEAR 2003 REIMBURSABLE ESTIMATES
(IN MILLIONS OF REAL YEAR DOLLARS)

	FY 2001 OPLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
Space Science	45.7	63.7	69.0
Biological & Physical Research	0.6	1.6	0.8
Earth Science	342.2	393.8	416.8
Space Operations*	62.4	--	--
Aerospace Technology	66.0	81.5	84.4
Academic Programs	0.2	0.6	0.2
Institutional Support**	--	56.5	60.6
Total	**517.1**	**597.7**	**631.8**

** In FY 2002, Space Operations is included in the Human Space Flight appropriation*
*** In FY 2001, Institutional Support for Science, Aeronautics and Technology was included in the Research and Program Management and Construction of Facilities budgets of the Mission Support appropriation*

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 2003 ESTIMATES

DISTRIBUTION OF SCIENCE, AERONAUTICS, AND TECHNOLOGY BY INSTALLATION
(Millions of Dollars)

Program		Total	Johnson Space Center	Kennedy Space Center	Marshall Space Flight Center	Stennis Space Center	Ames Research Center	Dryden Flight Research Center	Langley Research Center	Glenn Research Center	Goddard Space Flight Center	Jet Propulsion Lab	Headquarters
Space Science	2001	2,606.6	20.2	114.5	171.0	0.0	107.7	0.3	36.0	13.3	1,061.4	975.4	106.8
	2002	2,867.1	20.1	152.8	216.4	0.0	105.8	0.2	18.0	8.9	1,215.0	934.3	195.6
	2003	3,414.3	18.2	148.8	243.7	0.0	116.8	0.2	18.0	93.3	1,318.6	1,158.3	298.4
Biological and Physical Research	2001	362.2	123.6	8.2	70.7	0.0	60.8	0.0	0.1	52.3	5.8	15.9	24.8
	2002	820.0	202.0	19.0	259.1	0.0	104.2	0.0	3.4	111.5	5.8	34.7	80.3
	2003	842.3	225.0	18.8	246.7	0.0	116.4	0.0	3.5	103.3	3.0	43.3	82.3
Earth Science	2001	1,762.2	35.2	84.0	18.0	83.8	33.2	23.9	141.5	3.0	1,049.4	208.3	81.9
	2002	1,625.7	21.3	52.8	26.3	57.9	32.8	25.6	156.1	1.4	957.7	178.9	114.9
	2003	1,628.4	18.2	53.2	25.7	42.3	33.8	20.6	138.8	0.4	996.9	161.3	137.2
Aerospace Technology	2001	2,212.8	28.2	22.9	331.3	76.5	435.2	155.0	464.1	438.3	85.1	42.2	134.0
	2002	2,507.7	29.2	33.5	466.4	49.9	474.4	150.3	539.7	459.2	89.3	34.3	181.5
	2003	2,815.8	26.7	33.7	794.1	38.4	429.7	160.8	545.2	479.1	73.7	37.6	196.8
Academic Programs	2001	132.7	3.3	3.3	8.5	1.9	4.4	1.5	3.7	9.0	82.0	1.4	13.7
	2002	227.3	2.9	2.6	10.1	1.5	7.5	1.8	4.3	9.6	179.7	0.8	6.5
	2003	143.7	4.6	2.9	9.7	1.9	4.7	1.6	2.9	8.7	99.2	0.7	6.8
TOTAL SCIENCE, AERONAUTICS AND TECHNOLOGY	2000	7,076.5	210.5	232.9	599.5	162.2	641.3	180.7	645.4	515.9	2,283.7	1,243.2	361.2
	2001	8,047.8	275.5	260.7	978.3	109.3	724.7	177.9	721.5	590.6	2,447.5	1,183.0	578.8
	2002	8,844.5	292.7	257.4	1,319.9	82.6	701.4	183.2	708.4	684.8	2,491.4	1,401.2	721.5

*FY 2001 restructured to reflect new FY 2002 Two Appropriation Structure

**Full funding for Federal Retiree Cost are not included (see Special Issues)

Note: totals may not add due to rounding

SCIENCE, AERONAUTICS AND TECHNOLOGY
FY 2003 ESTIMATES
BUDGET SUMMARY

OFFICE OF SPACE SCIENCE
Web Address: http://spacescience.nasa.gov

SUMMARY OF RESOURCE REQUIREMENTS

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET	Page Number
		(Millions of Dollars)		
Development Programs:				
Space Infrared Telescope Facility (SIRTF)	118.3	113.0	47.4	SAT 1-7
Hubble Space Telescope (HST)	179.5	172.0	138.9	SAT 1-11
Gravity Probe-B (GP-B)	41.2	46.1	19.7	SAT 1-15
Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics (TIMED)	13.3	4.2		SAT 1-18
Stratospheric Observatory For Infrared Astronomy (SOFIA)	43.1	38.0	46.9	SAT 1-21
Solar Terrestrial Relations Observatory (STEREO)		52.9	74.3	SAT 1-24
Gamma-ray Large Area Space Telescope (GLAST)		20.7	69.2	SAT 1-27
New Frontiers			15.0	SAT 1-31
Payload and Instrument Development	39.6	47.5	38.0	SAT 1-32
Explorers	141.3	125.2	135.1	SAT 1-38
Discovery	213.0	214.6	207.7	SAT 1-45
Mars Exploration Program (MEP)	429.5	414.7	453.6	SAT 1-51
Mission Operations	122.8	174.8	385.2	SAT 1-60
Technology Program	353.2	440.2	703.9	SAT 1-68
Research Program	613.0	646.5	709.6	SAT 1-89
Investments	13.2			
Institutional Support	285.6	356.7	369.8	SAT 1-98
Total	**2,606.6**	**2,867.1**	**3,414.3**	

OFFICE OF SPACE SCIENCE

DISTRIBUTION OF PROGRAM AMOUNT BY INSTALLATION

	FY 2001	FY 2002	FY 2003
	(Millions of Dollars)		
Johnson Space Center	20.2	20.1	18.2
Kennedy Space Center	114.5	152.8	148.8
Marshall Space Flight Center	171.0	216.4	243.7
Ames Research Center	107.7	105.8	116.8
Langley Research Center	36.0	18.0	18.0
Glenn Research Center	13.3	8.9	93.3
Goddard Space Flight Center	1061.4	1215.0	1318.6
Jet Propulsion Laboratory	975.4	934.3	1158.3
Dryden Flight Research Center	0.3	0.2	0.2
Stennis Space Center	--	--	--
Headquarters	106.8	195.6	298.4
Total	**2,606.6**	**2,867.1**	**3,414.3**

SPACE SCIENCE STRATEGIC PLAN LINKAGE TO THIS BUDGET

Thousands of years ago, on a small rocky planet orbiting a modest star in an ordinary spiral galaxy, our remote ancestors looked up and wondered about their place between Earth and sky. On the threshold of the 21st century, we ask the same profound questions:

- How did the universe begin and evolve?
- How did we get here?
- Where are we going?
- Are we alone?

Today, after only the blink of an eye in cosmic time, we are beginning to answer these questions. Using tools of science that range from abstract mathematics and computer modeling to laboratories and observatories, humans are filling in the details of the amazing story of the universe. In the last 40 years, space probes and space observatories have played a central role in this fascinating process, and NASA's Space Science Enterprise will continue to address these four profound questions:

How did the universe begin and evolve? We seek to explain the earliest moments of the universe, how stars and galaxies formed, and how matter and energy are entwined on the grandest scales. We study astrophysical objects, such as neutron stars and black holes, with extreme conditions that demonstrate fundamental laws of physics at work. We study the behavior of matter, radiation, and magnetic fields under less severe conditions, in the giant laboratory of our Solar System. The understanding thus gained applies directly to the history and behavior of stars and galaxies.

How did we get here? We investigate how the chemical elements necessary for life have been built up and dispersed throughout the cosmos. We look for evidence about how the Sun has behaved over time and what affect this has had on Earth and everything on it. We send probes to other planets to learn about their similarities and differences as keys to how they formed and evolved, and study the comets and asteroids in our Solar System for clues to their effects on the evolving Earth. We carry out ground-based research on the environmental limits of life to learn how it might have arisen and evolved on early Earth.

Where are we going? Our ultimate place in the cosmos is wrapped up in the fate of the universe. Nearer to home, the variability of our Sun and vulnerability of Earth to possible impacts by small Solar System bodies are being investigated. We are comparing the climate histories of Earth and its sibling planets. Humanity has taken its first steps off our home world, and we will contribute to making it safe to travel throughout the Solar System and will ascertain what resources possible destinations could offer to human explorers.

Are we alone? Beyond astrophysics and cosmology, there lies the central human question: Are we on Earth an improbable accident of nature? Or is life, perhaps even intelligent life, scattered throughout the cosmos? We seek to explain how planets originated around our Sun and other stars— planets that might support life. We observe nearby stars for indirect evidence of other planets, and look to the future when advanced observatories in space might be able to directly image such relatively small objects across the vast interstellar void. Beginning with life found in astonishing places on Earth, we conjecture about what kinds of environments could bear and support life, and how common habitable planets might be. Is there now, or has there ever been, life in our own Solar System other than on Earth?

Answers to these deep questions will not be extracted from narrow inquiries, but will be built up by combining innumerable individual clues over the years to come. The broad outlines of much of the puzzle are discernible now, but a clear picture of the whole awaits years of varied research that will undoubtedly produce many surprises along the way. In order to structure the scientific research, Space Science has established the following goals, objectives, and research focus areas:

Enterprise Goals (from NASA Strategic Plan)		**Science Objectives** (From Space Science Enterprise Strategic Plan)	**Research Focus Areas** (From NASA Performance Plan)
Chart the evolution of the universe, from origins to destiny, and understand its galaxies, stars, planets, and life	□	Understand the structure of the universe, from its earliest beginnings to its ultimate fate	• Identify dark matter and learn how it shapes galaxies and systems of galaxies • Determine the size, shape, age, and energy content of the universe
	□	Explore the ultimate limits of gravity and energy in the universe	• Discover the sources of gamma ray bursts and high energy cosmic rays • Test the general theory of relativity near black holes and in the early universe, and search for new physical laws using the universe as a laboratory • Reveal the nature of cosmic jets and relativistic flows
	□	Learn how galaxies, stars, and planets form, interact, and evolve	• Observe the formation of galaxies and determine the role of gravity in this process • Establish how the evolution of a galaxy and the life cycle of stars influence the chemical composition of material available for making stars, planets, and living organisms • Observe the formation of planetary systems and characterize their properties • Use the exotic space environments within our Solar System as natural science laboratories and cross the outer boundary of the Solar System to explore the nearby environment of our galaxy
	□	Look for signs of life in other systems	• Discover planetary systems of other stars and their physical characteristics • Search for worlds that could or do harbor life
	□	Understand the formation and evolution of the Solar System and Earth	• Inventory and characterize the remnants of the original material from which the Solar System formed • Learn why the planets in our Solar System are so different from each other • Learn how the Solar System evolves

Enterprise Goals		Science Objectives	Research Focus Areas
	□	Probe the origin and evolution of life on Earth and determine if life exists elsewhere in our Solar System	• Investigate the origin and early evolution of life on Earth, and explore the limits of life in terrestrial environments that might provide analogues for conditions on other worlds • Determine the general principles governing the organization of matter into living systems and the conditions required for the emergence and maintenance of life • Chart the distribution of life-sustaining environments within our Solar System, and search for evidence of past and present life • Identify plausible signatures of life on other worlds
	□	Understand our changing Sun and its effects throughout the Solar System	• Understand the origins of long- and short-term solar variability • Understand the effects of solar variability on the solar atmosphere and heliosphere • Understand the space environment of Earth and other planets
	□	Chart our destiny in the Solar System	• Understand forces and processes, such as impacts, that affect habitability of Earth • Develop the capability to predict space weather • Find extraterrestrial resources and assess the suitability of Solar System locales for future human exploration

Each Space Science program and mission is linked to these Goals, Objectives, and Research Focus Areas, as specified in the section for each program that follows.

SIGNIFICANT NEW FEATURES IN THE FY 2003 BUDGET

Within the Solar System Exploration Focused Technology Program, a new Nuclear Electric Propulsion program will enable: 1) significant reductions in the cruise time for spacecraft to reach distant targets; 2) the use of smaller launch vehicles thereby reducing total mission costs; 3) entire new classes of planetary exploration missions that can carry out in-depth research at multiple planetary targets; 4) reduced operation costs by reducing the amount of time a spacecraft is in its operations phase; 5) reduction or elimination of launch windows required for gravity assists; and 6) less expensive and more frequent missions.

Also within the Solar System Exploration Focused Technology Program, a new Nuclear Power program offers the potential to dramatically increase the potential scientific return of many future missions, by increasing the operational lifetime and productivity of spacecraft and instruments; enabling multiple landers on a single mission; providing energy for high-power planetary survey instruments for remote sensing and deep atmosphere probes; and allowing high bandwidth communications. Within the Mars Exploration program, nuclear power has been incorporated as an element of the 2009 Mars Smart Lander/Mobile Laboratory mission, and will greatly extend the duration of surface operations, thereby significantly increasing scientific return.

A new program called New Frontiers is a revamping of the Outer Planets missions program. The program will provide frequent access to space for mid-sized planetary missions that will perform high-quality scientific investigations. New Frontiers will be structured and managed along the lines of the highly successful Discovery program. New Frontiers will pursue a clear set of goals and science priorities, and will select missions through a fully open and competitive process.

A large part (over $200 million) of the apparent increase from FY 2002 to the FY 2003 Budget request is not an increase at all, but is due to the transfer of funding and responsibility for two critical components of Space Science spacecraft operations (the Deep Space Network, and Mission Services for Space Science missions) from the Office of Space Flight. These elements are now part of Space Science's Mission Operations budget. See page MY-2 for a normalized comparison of NASA's FY 2001, FY 2002, and FY 2003 budgets.

BASIS OF FY 2003 FUNDING REQUIREMENT

Space InfraRed Telescope Facility (SIRTF)

Web Address: http://sirtf.caltech.edu

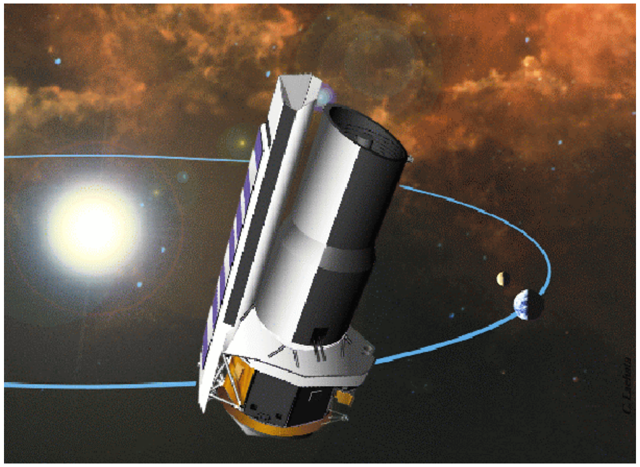
	FY 2001	FY 2002	FY 2003
SIRTF Development *	**118.3**	**113.0**	**47.4**

* SIRTF Total life cycle cost data is provided at the end of this section.

DESCRIPTION / JUSTIFICATION

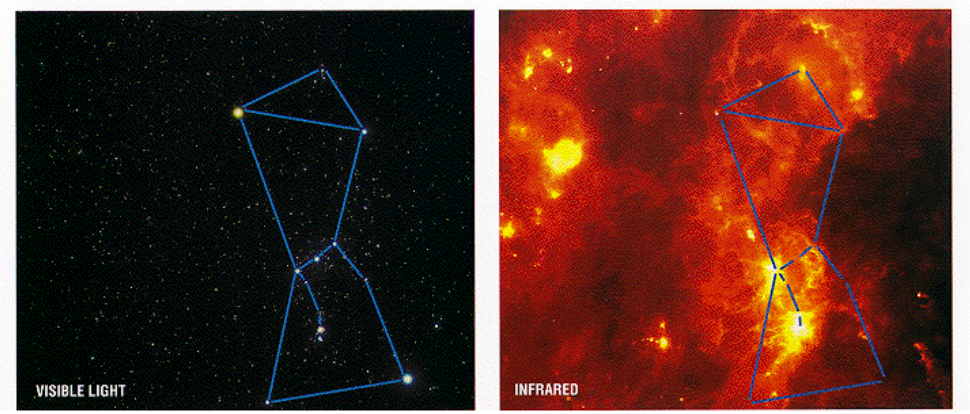
The Space Infrared Telescope Facility (SIRTF) will explore the nature of the cosmos through the unique windows available in the infrared portion of the electromagnetic spectrum. Exploiting these windows requires a cryogenically cooled telescope, limited in sensitivity only by the faint infrared glow of the interplanetary dust. These windows allow infrared observations to explore:

- The *cold* Universe by looking at heat radiation from objects which are too cool to radiate at optical and ultraviolet wavelengths;
- The *hidden* Universe by penetrating into dusty regions which are too opaque for exploration in the other spectral bands;
- The *distant* Universe by virtue of the cosmic expansion, which shifts the ultraviolet and visible radiation from distant sources into the infrared spectral region.



SIRTF is the fourth and final of NASA's Great Observatories, which include the Hubble Space Telescope, Compton Gamma Ray Observatory, and the Chandra X-Ray Observatory.

Views of the constellation Orion dramatically illustrate the difference between the familiar, visible light view and the richness of the Universe accessible in the infrared part of the spectrum



SIRTF ANSWERS PRIMARY SCIENTIFIC QUESTIONS

SCIENTIFIC QUESTION:	SIRTF APPROACH
How do galaxies form and evolve?	SIRTF's deep surveys will determine how the number and properties of galaxies changed during the earliest periods of the Universe.
What engine drives the most luminous objects in the Universe?	SIRTF will study the evolution with cosmic time of extremely luminous galaxies and quasar populations and probe their interior regions to study their energy sources.
Is the mass of the Galaxy hidden in sub-stellar objects and giant planets?	SIRTF will search for cold objects with mass less than 0.08 times that of the Sun, not massive enough to ignite nuclear reactions, which may contain a significant fraction of the mass of the Galaxy.
Have planetary systems formed around nearby stars?	SIRTF will determine the structure and composition of disks of material around nearby stars whose very presence implies that these stars may harbor planetary systems.
What lies beyond?	SIRTF's greater than 1000-fold gain in astronomical capability beyond that provided by previous infrared facilities gives this mission enormous potential for the discovery of new phenomena.

While these scientific objectives drive the mission design, SIRTF's powerful capabilities have the potential to address a wide range of other astronomical investigations. SIRTF should be able to make substantial progress in NASA's efforts to understand the formation of planetary systems; SIRTF's measurements of the density and opaqueness of the dust disks around nearby stars will help set the requirements for future missions designed to directly detect planets.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

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

Strategic Plan Objectives Supported: Understand the structure of the Universe, from its earliest beginnings to its ultimate fate; and learn how galaxies, stars, and planets form, interact and evolve.

Performance Plan Metrics Supported: When operational, SIRTF will support Annual Performance Goal (APG) #3S1, "Earn external review rating of "green," on average, on making progress in the following research focus areas:

- Identify dark matter and learn how it shapes galaxies and systems of galaxies.
- Determine the size, shape, age and energy content of the universe."

and APG #3S3, "Earn external review rating of "green," on average, on making progress in the following research focus areas:

- Establish how the evolution of a galaxy and the life cycle of stars influence the chemical composition of material available for making stars, planets, and living organisms.
- Observe the formation of planetary systems and characterize their properties.

Milestones	FY02 Budget Date	FY03 Budget Date	Change	Comment
Launch	7/02	NET 12/02	+5 mos	Flight software readiness delays; 12/02 launch readiness date used for development of budget estimates; launch date and budget are under review

Lead Center: JPL	**Other Centers:** GSFC/ARC/KSC	**Interdependencies:** No other partners
Subsystem	**Builder**	
Spacecraft:	Lockheed Martin: Sunnyvale, CA	
Cryogenic Telescope Ass'y:	Ball; Boulder, CO	
Instruments	**Builder**	**Principal Investigator**
IRS	Cornell	Houck
MIPS	U. Arizona	Rieke
IRAC	Smithsonian Astronomical Observatory	Fazio
Launch Vehicle:	**Tracking/Communications:**	**Data:**
Boeing Delta 7920H	Deep Space Network	Infrared Processing Analysis Center (IPAC), Cal Tech

PROGRAM STATUS / NOTIFICATIONS / PLANS THROUGH 2002

As a result of software development delays and anomalies during integration and test, the launch date has slipped from last year's plan. The budget estimates support a December 2002 launch, but the date may slip a few months further. All instruments have now been integrated into the CryoTelescope Assembly. The Telescope Acceptance Review was completed in January 2001; the Telescope meets or exceeds all Level 1 science requirements. The telescope has also been integrated into the Cryogenic Telescope Assembly, which has been successfully performance tested and is expected to be shipped to Lockheed for integration in early CY 2002. Observatory-level testing will continue through the balance of FY 2002.

PROGRAM PLANS FOR FY 2003

Shipment of the completed SIRTF observatory to KSC is expected in early FY 2003, followed by launch and a 60-day in-orbit checkout period before transition to science operations.

SIRTF LIFE CYCLE COST DATA ($ in millions)

	Prior	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	BTC	TOTAL
FY 2003 President's Budget	393.2	118.3	113.0	79.1	68.5	70.0	70.0	73.8	155.1	1,141.0
Pre-Development Studies	79.9									79.9
Development	281.4	106.4	91.3	47.4						526.5
Launch Services	31.9	11.9	21.7							65.5
Operations				3.2	7.3	6.3	5.3	6.5	9.1	37.7
Data Analysis				28.5	61.2	63.7	64.7	67.3	146.0	431.4
[Estimated Civil Servant FTE]		24	12							

BASIS OF FY 2003 FUNDING REQUIREMENT

Hubble Space Telescope (HST) Development

Web Address: http://hubble.gsfc.nasa.gov

	FY 2001	FY 2002	FY 2003
HST Development *	**179.5**	**172.0**	**138.9**

* HST Total life cycle cost data is provided at the end of this section.

DESCRIPTION / JUSTIFICATION

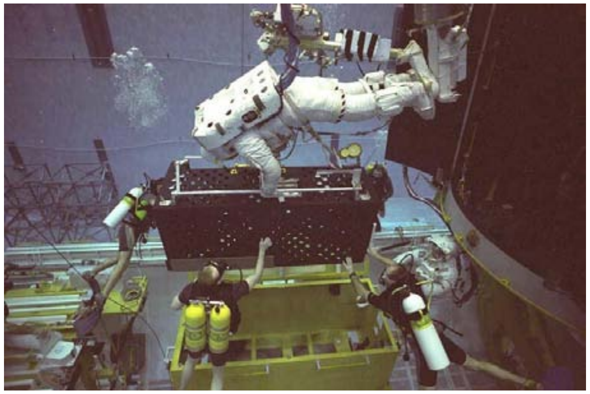
Not since Galileo turned his telescope towards the Heavens in 1610 has any event so changed our understanding of the Universe as the deployment of the Hubble Space Telescope.

Hubble orbits 600 Kilometers above Earth, working around the clock to unlock the secrets of the Universe. It uses excellent pointing precision, powerful optics, and state-of-the-art instruments to provide stunning views of the Universe that cannot be made using ground-based telescopes or other satellites. Hubble was originally designed in the 1970s and launched in 1990. Thanks to on-orbit service calls by the Space Shuttle astronauts, Hubble continues to be a state-of-the-art space telescope.

Hubble is the first scientific mission of any kind that is specifically designed for routine servicing by spacewalking astronauts. It has a modular design, which allows the astronauts to take it apart, replace worn out equipment and upgrade instruments. These periodic service calls make sure that Hubble produces first-class science using cutting-edge technology.

The HST Development budget supports these periodic Servicing Missions, as well as modification and upkeep of ground operations systems. Operations and data analysis costs are not included here. Servicing missions are currently planned for early 2002 (SM3B) and 2004 (SM4), after which NASA plans to operate HST until 2010 without further servicing missions, to enable development of a follow-on telescope to Hubble, the Next Generation Space Telescope.

Astronauts training for Servicing Mission 3B; activities during Servicing Mission 2



HST ANSWERS PRIMARY SCIENTIFIC QUESTIONS

SCIENTIFIC QUESTION:	HST APPROACH
How many galaxies and clusters formed in the early Universe?	Install the Advanced Camera for Surveys (ACS) during SM3B to study the nature and distribution of galaxies in the early Universe
What can we learn by studying wavelengths of light (e.g., near infrared) that do not penetrate Earth's atmosphere?	Install the NICMOS Cryocooler during SM-3B to enable several years of near-infrared astronomical investigations
How did large-scale structure originate in the early Universe?	Install the Cosmic Origins Spectrograph (COS) during SM4 to observe high-energy activities (such as those found in new hot stars and Quasi Stellar Objects) at near- and mid-ultraviolet wavelengths.
How have galaxies evolved?	Install the Wide Field Camera 3 (WFC3) during SM4, replacing the WF-PC2 (which will be 10 years old). WFC3 will use the latest CCD technology and will maintain good imaging capabilities throughout the life of Hubble's mission.

HST will address the scientific questions above, and many others. HST has repeatedly stretched our knowledge of the Universe in ways that had not been anticipated. With the scientific capabilities to be provided by the next generation of instruments, HST will remain on the forefront of astronomical research.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

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

Strategic Plan Objectives Supported: Understand the structure of the Universe, from its earliest beginnings to its ultimate fate; and understand the formation and evolution of the Solar System and Earth within it.

Performance Plan Metrics Supported: Annual Performance Goal (APG) #3S9, "Earn external review rating of "green," on making progress in the following area: Design, develop, and launch projects to support future research in pursuit of Strategic Plan science objectives."

Note: HST operations support Annual Performance Goal (APG) #3S1, "Earn external review rating of "green," on average, on making progress in the following research focus areas:

- Identify dark matter and learn how it shapes galaxies and systems of galaxies.
- Determine the size, shape, age and energy content of the universe."

and APG #3S3, "Earn external review rating of "green," on average, on making progress in the following research focus areas:

- Establish how the evolution of a galaxy and the life cycle of stars influence the chemical composition of material available for making stars, planets, and living organisms.
- Observe the formation of planetary systems and characterize their properties."

Milestones	FY 2002 Budget Date	FY 2003 Budget Date	Change	Comment
SM-3B	5/02	2/02	-3 mos	Subject to Space Shuttle availability
COS System Test	FY02	FY02		

Lead Center: GSFC | **Other Centers:** JPL | **Interdependencies:** Shuttle

Instruments	Builder	Pr. Investigator
Advanced Camera for Surveys	Ball, JHU, STScI, GSFC	Holland Ford, Johns Hopkins University
Cosmic Origins Spectrograph	Ball	University of Colorado
Wide Field Camera 3	GSFC, JPL, Ball, STScI	facility-class instrument

Tracking/Communications: Tracking and Data Relay Satellites (TDRS)

Data: Space Telescope Science Institute

PROGRAM STATUS / NOTIFICATIONS / PLANS THROUGH 2002

Final arrangements are being made for Servicing Mission 3B launch in early 2002. Meanwhile, development of the Cosmic Origins Spectrograph (COS) and Wide-Field Camera-3 (WFC3) continues in anticipation of Servicing Mission 4 in 2004.

PROGRAM PLANS FOR FY 2003

COS and WFC3 will undergo integration and testing prior to shipment to KSC, while astronaut training will begin and detailed plans will be made for each day of activity during SM4.

HST TOTAL COST DATA ($ in millions; excludes Shuttle costs)

	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07
FY 2003 President's Budget	256.4	257.7	228.2	164.6	125.6	130.6	134.9
Development	179.5	172.0	138.9	73.3	30.8	31.6	33.1
Operations	1.5	5.0	5.1	5.3	5.5	5.6	5.9
Data Analysis	75.4	80.7	84.2	86.0	89.3	93.4	95.9
[Estimated Civil Servant FTE]	172	174	170	121	83	86	86

BASIS OF FY 2003 FUNDING REQUIREMENT

Gravity Probe B (GP-B)

Web Address: http://einstein.stanford.edu

	FY 2001	FY 2002	FY 2003
GP-B Development *	**41.2**	**46.1**	**19.7**

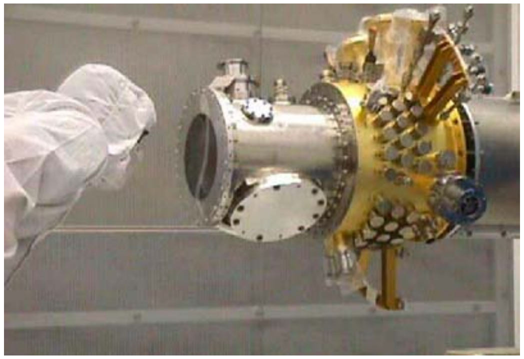
* GP-B Total life cycle cost data is provided at the end of this section.

DESCRIPTION / JUSTIFICATION

The purpose of Gravity Probe B is to verify Einstein's theory of general relativity. This is the most accepted theory of gravitation and of the large-scale structure of the Universe. General relativity is a cornerstone of our understanding of the physical world, and consequently of our interpretation of observed phenomena. However, it has only been tested through astronomical observation and Earth-based experiments. An experiment is needed to explore and test more precisely the predictions of the theory in two areas: (1) a measurement of the "dragging of space" by rotating matter; and (2) a measurement of space-time curvature known as the "geodetic effect". The dragging of space has never been measured, and the geodetic effect needs to be measured more precisely. Whether the experiment confirms or contradicts Einstein's theory, its results will be of the highest scientific importance. The measurements of both the frame dragging and geodetic effects will allow Einstein's Theory to be either rejected or given greater credence. The effect of invalidating Einstein's theory would be profound, and would call for major revisions of our concepts of physics and cosmology.

In addition, GP-B is contributing to the development of cutting-edge space technologies that are also applicable to future space science missions and transportation systems.

Inspecting the GP-B telescope; the dewar will cool the instrument to just above absolute zero



LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

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

Strategic Plan Objectives Supported: Explore the ultimate limits of gravity and energy in the Universe.

Performance Plan Metrics Supported: Annual Performance Goal (APG) #3S9, "Earn external review rating of "green," on making progress in the following area: Design, develop, and launch projects to support future research in pursuit of Strategic Plan science objectives."
When operational, GP-B will support APG #3S2, "Earn external review rating of "green," on average, on making progress in the following area:

- Test the general theory of relativity near black holes and in the early universe, and search for new physical laws using the Universe as a laboratory."

Milestones	FY 2002 Budget Date	FY 2003 Budget Date	Change	Comment
Spacecraft assembly & test	8/01	4/01	-4 mos	Spacecraft ready to mate with the payload.
Payload flight verification	9/01	8/01	-1 mos	Finish testing of the payload. Completed early
Final integration and test	8/02	8/02		Final testing of the integrated flight vehicle
Launch	10/02	10/02		

Lead Center: MSFC	**Other Centers:** KSC	**Interdependencies:** none
Subsystem	**Builder**	**Principal Investigator**
Spacecraft and Telescope:	Lockheed	
Dewar	Ball	
Payload	Stanford University	Francis Everett
Launch Vehicle:	**Tracking/Communications:**	**Data:**
Delta 2	Stanford	Stanford

PROGRAM STATUS / NOTIFICATIONS / PLANS THROUGH 2002

Recent schedule progress has been very good, with most program milestones being completed on, or slightly ahead of, schedule. Still, schedule and budget reserves are minimal. The program is pressing to maintain the launch date, but a small slip (with some additional cost) is possible.

PROGRAM PLANS FOR FY 2003

Launch in October 2002. Operations will continue into FY 2004.

GP-B LIFE CYCLE COST DATA ($ in millions)

	Prior	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	BTC	TOTAL
FY 2003 President's Budget	523.6	41.2	46.1	28.9	9.5	1.9				651.2
Development	475.8	39.6	44.8	13.8						574.0
Launch Services	47.8	1.6	1.3	5.9						56.6
Operations				2.0	1.0					3.0
Data Analysis				7.2	8.5	1.9				17.6
[Estimated Civil Servant FTE]		20	30	16	1	1				

BASIS OF FY 2003 FUNDING REQUIREMENT

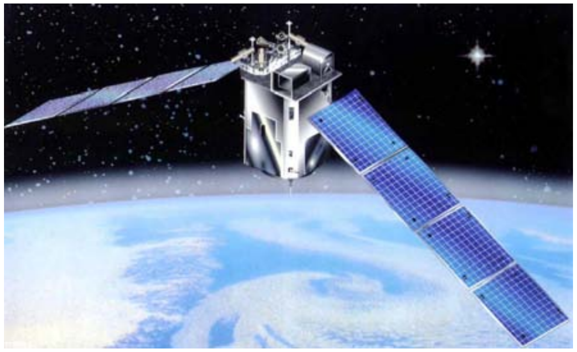
Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics (TIMED)

Web Address: http://www.timed.jhuapl.edu

	FY 2001	FY 2002	FY 2003
TIMED Development *	**13.3**	**4.2**	**--**

* TIMED total life cycle cost data is provided at the end of this section.

DESCRIPTION / JUSTIFICATION



TIMED is the first mission the Solar Terrestrial Probes (STP) Program as detailed in the Space Science Strategic Plan. The TIMED mission will investigate the influences of the Sun and humans on the Mesosphere and Lower Thermosphere/Ionosphere (MLTI) regions of the Earth's atmosphere (60-180 km altitude), a gateway between Earth's environment and space. This region is where energetic solar radiation is absorbed, energy input from the aurorae (Northern and Southern Lights) is maximized, intense electric currents flow, and atmospheric waves and tides occur.

TIMED will provide a core subset of measurements defining the basic states (density, pressure, temperature, winds) of the MLTI region and its thermal balance for the first time. These measurements will be important for developing an understanding of the basic processes involved in the energy distribution of this region, and the impact of natural and man-made variations.

An understanding of the atmospheric variability of this region is vital so that the impact of these changes on satellite tracking, spacecraft lifetimes, degradation of spacecraft materials, and re-entry of piloted vehicles can be predicted. The mesosphere may also show evidence of man-made effects that could herald global-scale environmental changes.

TIMED ANSWERS PRIMARY SCIENTIFIC QUESTIONS

SCIENTIFIC QUESTION:	TIMED APPROACH
How do the earth and planets respond to the variability of the sun?	To understand the MLTI region's basic pressure, temperature and winds that result from the transfer of energy into and out of this region.

While these scientific objectives drive the mission design, TIMED has the potential to address a wide range of other atmospheric investigations. TIMED should be able to achieve many of the initial goals of the Sun-Earth Connection program; TIMED measurements of the MLTI region will provide future Sun-Earth Connection missions with a baseline for future investigations of global change.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

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

Strategic Plan Objectives Supported: Understand our changing Sun and its effects throughout the Solar System.

Performance Plan Metrics Supported: Annual Performance Goal (APG) #3S7, "Earn external review rating of "green," on average, on making progress in the following research focus area:

- Understand the space environment of Earth and other planets."

Milestones	FY 2002 Budget Date	FY 2003 Budget Date	Change	Comment
Launch	8/01	12/01	+4 mos	Launch slip due to technical problems encountered by the co-manifested Jason 1 spacecraft; successful launch.

Lead Center: GSFC	**Other Centers:** LARC	**Interdependencies:** none.
Subsystem	**Builder**	
Spacecraft	Johns Hopkins University Applied Physics Laboratory (APL), Maryland	
Instruments	**Builder**	**Principle Investigator**
Solar EUV Experiment (SEE)	University Of Colorado	Woods
Sounding of the Atmosphere Board & Emission Radiometer (SABER)	Hampton University	Russell
Global Ultraviolet Imager (GUVI)	Aerospace/APL	Christensen
TIMED Doppler Interferometer (TIDI)	National Center for Atmospheric Research	Killeen
Launch Vehicle:	**Tracking/Communications:**	**Data:**
Delta II 7920-10	APL Satellite Control Facility	APL

PROGRAM PLANS FOR FY 2002

TIMED launched successfully on December 7, 2001.

TIMED LIFE CYCLE COST DATA ($ in millions)

	Prior	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	TOTAL
FY 2003 President's Budget	176.0	14.9	16.4	10.0	7.0	6.6	2.5		233.4
Development	144.8	13.3	4.2						162.3
Launch Services	30.7								30.7
Operations		0.1	3.5	3.1					6.7
Data Analysis	0.5	1.5	8.7	6.9	7.0	6.6	2.5		33.7
[Estimated Civil Servant FTE]		6	2	3	3	3	3		

BASIS OF FY 2003 FUNDING REQUIREMENT

Stratospheric Observatory for Infrared Astronomy (SOFIA)

Web Address: http://sofia.arc.nasa.gov

	FY 2001	FY 2002	FY 2003
SOFIA Development *	**43.1**	**38.0**	**46.9**

* SOFIA out-year cost data is provided at the end of this section.

DESCRIPTION / JUSTIFICATION

Astronomical research with instrumented jet aircraft has been an integral part of the NASA Physics and Astronomy program since 1965. For relatively low cost, NASA airborne systems have been able to provide to the science community very quick, global response to astronomical "targets of opportunity." SOFIA consists of a 2.5 m telescope, provided by the German Aerospace Center (DLR), integrated into a modified Boeing 747 aircraft.

The primary objective of the SOFIA program is to make fundamental scientific discoveries and contribute to our understanding of the universe through gathering and rigorous analysis and distribution of unique infrared astrophysical data. This objective will be accomplished by extending the range of astrophysical observations significantly beyond that of previous infrared airborne observatories, through increases in sensitivity and resolution.

While accomplishing its scientific mission, the SOFIA program will actively support our nation's goals to reform science, mathematics, and technology education, particularly at the K-12 level, and the general elevation of scientific and technological literacy throughout the country. In addition, the SOFIA program will identify, develop, and infuse promising new technologies.


The SOFIA aircraft; the primary telescope mirror

SOFIA will gather unique infrared astronomical data by flying above much of the moisture in the Earth's atmosphere, which absorbs many critical wavelengths. It will also be able to respond quickly to short-lived astronomical events, and offers a great deal of flexibility to the scientific community through the availability of several scientific instruments.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

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

Strategic Plan Objectives Supported: Understand the structure of the Universe, from its earliest beginnings to its ultimate fate; learn how galaxies, stars, and planets form, interact and evolve; and understand the formation and evolution of the Solar System and Earth within it.

Performance Plan Metrics Supported: Annual Performance Goal (APG) #3S9, "Earn external review rating of "green," on making progress in the following area: Design, develop, and launch projects to support future research in pursuit of Strategic Plan science objectives."
When operational, SOFIA will support APG #3S1, "Earn external review rating of "green," on average, on making progress in the following research focus area:
- Identify dark matter and learn how it shapes galaxies and systems of galaxies
- Establish how the evolution of a galaxy and the life cycle of stars influence the chemical composition of material available for making stars, planets, and living organisms.
- Observe the formation of planetary systems and characterize their properties
- Inventory and characterize the remnants of the original material from which the Solar System formed."

Milestones	FY 2002 Budget Date	FY 2003 Budget Date	Change	Comment
Complete bulkhead installation	FY 02	3Q/FY02		
Complete 747 structural mods	Under review	1Q/FY03		
Install cavity door on mockup	Under review	n/a	Deleted	Door will be installed directly on plane
First science flight	TBD	2005		

Lead Center: Ames **Other Centers:** GSFC (science instruments) **Interdependencies:** Germany

Prime contractor: United Space Research Associates (USRA)

Subsystem	Builder
Aircraft: mods	Raytheon, Waco TX (USRA subcontract)
Aircraft operations	United Airlines (USRA subcontract)
Telescope	Germany

PROGRAM STATUS / NOTIFICATIONS / PLANS THROUGH 2002

Aircraft modifications are proceeding well and will continue through FY 2002. In addition, delivery of the telescope from Germany is expected in FY 2002.

PROGRAM PLANS FOR FY 2003

During FY 2003, the aircraft door structural modifications will be completed, and the telescope will be installed. Development of science instruments will continue.

SOFIA COST DATA ($ in millions)

	Prior	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	BTC	TOTAL
FY 2003 President's Budget	190.3	43.1	38.0	46.9	41.3	38.8	42.8	44.3		
Development	190.3	43.1	38.0	46.9	41.3					359.6
Operations						23.2	26.3	27.4	Cont.	
Data Analysis						15.6	16.5	16.9	Cont.	
[Estimated Civil Servant FTE]		68	58	45	43	41	41	41		

BASIS OF FY 2003 FUNDING REQUIREMENT

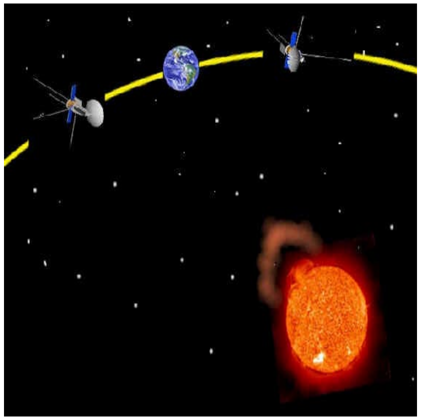
Solar Terrestrial Relations Observatory (STEREO)

Web Address: http://stp.gsfc.nasa.gov/missions/stereo/stereo.htm

	FY 2001	FY 2002	FY 2003
STEREO Development *	[21.9]	52.9	74.3

* STEREO Total life cycle cost data is provided at the end of this section.

DESCRIPTION / JUSTIFICATION

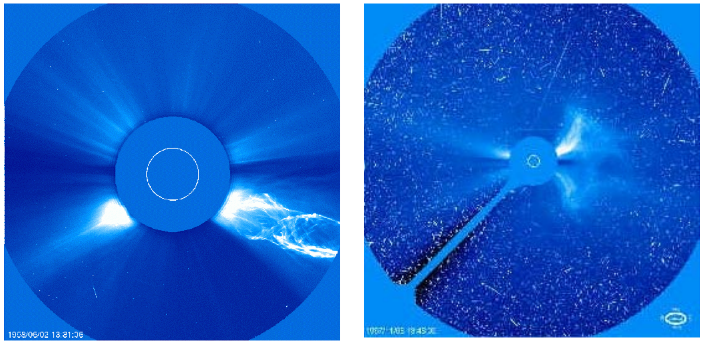


STEREO is the third mission planned in the Solar Terrestrial Probes (STP) program, as detailed in the Space Science Strategic Plan. STEREO's primary goal is to advance the understanding of the three-dimensional structure of the Sun's corona (outer "atmosphere"), the origin of huge eruptions of solar material known as coronal mass ejections (CMEs), their evolution in interplanetary space, and the interaction between CMEs and the earth's environment. STEREO will for the first time unveil the Sun in three dimensions. This will be achieved by:

- Sending two identically instrumented spacecrafts into solar orbits, with one flying ahead of the Earth and one behind.
- Measuring physical characteristics of CMEs with remote sensing and in-situ instruments.

STEREO ANSWERS PRIMARY SCIENTIFIC QUESTIONS

SCIENTIFIC QUESTION:	STEREO APPROACH
How and why does the Sun vary?	Make three-dimensional observations of CMEs from their origins out into the heliosphere for improved understanding of the physics involved, and for improved reliability of space weather forecasts and warnings.



These two images from the SOHO spacecraft show (left) helical structure in a CME that was not directed at Earth, and (right) a CME that was directed at Earth, creating a "blizzard" of solar protons. By observing the Sun from two different angles, STEREO will improve our understanding of Coronal Mass Ejections.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

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

Strategic Plan Objectives Supported: Understand our changing Sun and its effects throughout the Solar System.

Performance Plan Metrics Supported: Annual Performance Goal (APG) #3S9, "Earn external review rating of "green," on making progress in the following area: Design, develop, and launch projects to support future research in pursuit of Strategic Plan science objectives."
When operational, STEREO will support APG #3S7, "Earn external review rating of "green," on average, on making progress in the following research focus areas:

- Understand the origins of long- and short-term solar variability.
- Understand the space environment of Earth and other planets.

and APG #3S8, "Earn external review rating of "green," on average, on making progress in the following research focus area:

- Develop the capability to predict space weather.

Milestones	**FY 2002 Budget Date**	**FY 2003 Budget Date**	**Change**	**Comment**
Start Phase C/D	FY 02	03/02		
Launch	12/04	12/05	+12 mos	cost/schedule reassessment and risk reduction

Lead Center: GSFC	**Other Centers:** KSC	**Interdependencies:**
Subsystem	**Builder**	Germany (DLR), United Kingdom (PPARC), France (CNES), Hungarian Space Office, University of Bern (Switzerland), European Space Agency
Spacecraft	JHU Applied Physics Laboratory	
Instruments	**Builder**	**Pr. Investigator**
SECCHI	Naval Research Laboratory	Howard
IMPACTS	University of California @ Berkeley	Luhmann
PLASTIC	University of New Hampshire	Galvin
S/WAVES	CNRS Observatory of Paris	Bougeret
Launch Vehicle:	**Tracking/Communications:**	**Data:**
Delta II 2925-10L	Deep Space Network	APL

PROGRAM STATUS / NOTIFICATIONS / PLANS THROUGH 2002

STEREO expects to complete preliminary design reviews and independent assessments, before its planned March 2002 Confirmation Review. If approved to proceed, STEREO will begin the initial phase of implementation or Phase C. At that point detailed design of spacecraft and instrument systems and procurement of long lead parts will continue through the year.

PROGRAM PLANS FOR FY 2003

Design work will lead up to the Mission Critical Design Review. Flight component builds will continue through the remainder of the fiscal year.

STEREO LIFE CYCLE COST DATA ($ in millions)

	Prior	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	BTC	TOTAL
FY 2003 President's Budget	15.0	21.9	52.9	74.3	90.0	61.2	36.5	23.1	17.3	392.2
Pre-Development	15.0	21.9	21.0							57.9
Development			31.9	64.4	62.5	34.4	16.5			209.7
Launch Services				9.9	27.5	26.8	4.2			68.4
Operations							7.4	9.4	4.7	21.5
Data Analysis							8.4	13.7	12.6	34.7
[Estimated Civil Servant FTE]		15	16	16	14	14	10	3		

BASIS OF FY 2003 FUNDING REQUIREMENT

Gamma-ray Large Area Space Telescope (GLAST)

Web Address: http://glast.gsfc.nasa.gov

	FY 2001	FY 2002	FY 2003
GLAST Development *	**[7.7]**	**20.7**	**69.2**

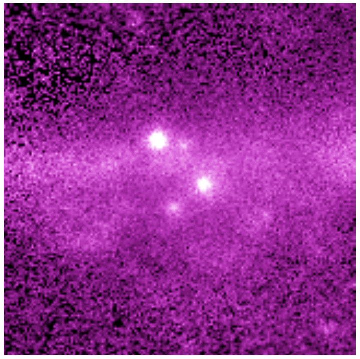
* GLAST Total life cycle cost data is provided at the end of this section.

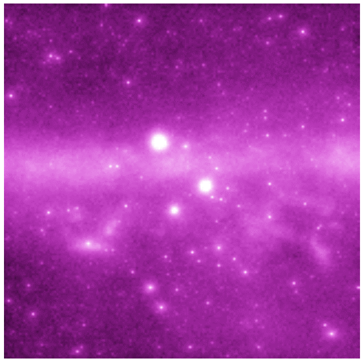
DESCRIPTION / JUSTIFICATION

The Universe is home to numerous exotic and beautiful phenomena, some of which can generate almost inconceivable amounts of energy. Supermassive black holes, merging neutron stars, and streams of hot gas moving close to the speed of light are but a few of the marvels that generate gamma-ray radiation, the most energetic form of radiation, billions of times more energetic than the type of light visible to our eyes. What is happening to produce this much energy? What happens to the surrounding environment near these phenomena? Can understanding how the physical laws of the Universe operate in the extreme heat and pressure of these environments lead to new insights into how the Universe is structured and behaves?

The Gamma-ray Large Area Space Telescope (GLAST) will open this high-energy world to exploration and help us to answer these questions. With GLAST, astronomers will at long last have a superior tool to study how black holes, notorious for pulling matter in, can accelerate jets of gas outward at fantastic speeds. Physicists will be able to study subatomic particles at energies far greater than those seen in ground-based particle accelerators. And cosmologists will gain valuable information about the birth and early evolution of the Universe.

Views of the Galactic Anticenter comparing actual observations from NASA's Compton Gamma-Ray Observatory (CGRO, 1991-2000) with a GLAST simulation. GLAST's higher resolution and sensitivity will reveal many more stars and galaxies, in much greater detail, and will help answer numerous scientific riddles.





GLAST ANSWERS PRIMARY SCIENTIFIC QUESTIONS

SCIENTIFIC QUESTION:	GLAST APPROACH
What is happening at the centers of active galaxies?	GLAST will increase the number of known Active Galactic Nuclei (AGN) galaxies from about 70 to thousands, and will scan the sky every three hours for AGN flares.
What are the known gamma-ray sources that are still unidentified?	GLAST will enable identification of the more than 60% of CGRO sources that are still unidentified at other wavelengths, by greatly improving knowledge of each object's location.
Do our theories of particle physics need revision?	The large area and low instrument noise of GLAST will allow searches for exotic particle decay in the early Universe, and other evidence for elementary particles that have been postulated but not yet been detected.
When did most of the stars in the Universe form?	GLAST studies of the gamma-ray background radiation will relate directly to the star formation history of the Universe.
What causes gamma ray bursts?	GLAST will continue the recent revolution of gamma-ray burst understanding by measuring spectra and tracking afterglows. GLAST will make definitive measurements of the high-energy behavior of bursts that will not be superseded by any planned mission.
How do pulsars work?	GLAST will increase the number of known gamma-ray pulsars from seven to perhaps 250 or more, and will determine how such pulsars generate gamma rays and accelerate particles.
Where do cosmic rays come from?	GLAST will study supernova remnants and nearby galaxies to test theories of how cosmic rays (subatomic particles traveling near the speed of light) are produced.
How does the sun produce gamma rays?	GLAST will have unique high-energy capability for the study of solar flares, and will be the only mission observing high-energy photons from flares during the next solar maximum.

While these scientific objectives drive the mission design, GLAST's powerful capabilities have the potential to address a wide range of other astronomical investigations.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

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

Strategic Plan Objectives Supported: Understand the structure of the Universe, from its earliest beginnings to its ultimate fate; and explore the ultimate limits of gravity and energy in the Universe.

Performance Plan Metrics Supported: Annual Performance Goal (APG) #3S9, "Earn external review rating of "green," on making progress in the following area: Design, develop, and launch projects to support future research in pursuit of Strategic Plan science objectives."

When operational, GLAST will support APG #3S1, "Earn external review rating of "green," on average, on making progress in the following research focus area:

- Identify dark matter and learn how it shapes galaxies and systems of galaxies."

and APG #3S2, "Earn external review rating of "green," on average, on making progress in the following research focus areas:

- Discover the sources of gamma ray bursts and high-energy cosmic rays.
- Reveal the nature of cosmic jets and relativistic flows."

Milestones	FY 2002 Budget Date	FY 2003 Budget Date	Change	Comment
LAT PDR	FY 02	January 2002		Preliminary Design Review of the Large Area Telescope completed.
CDR	N/A	3Q/FY03		
Launch	N/A	FY 06		

Lead Center: GSFC	**Other Centers:** MSFC	**Interdependencies:** DOE, France, Germany, Japan, Italy, Sweden
Instruments Large Area Telescope GLAST Burst Monitor	**Builder** Stanford Linear Accelerator Center MSFC	**Pr. Investigator** Stanford University Dr. Charles Meegan, MSFC
Launch Vehicle: Medium class	**Tracking/Communications:** Italy	**Data:** High Energy Astrophysics Science Archive Research Center (HEASARC)

PROGRAM STATUS / NOTIFICATIONS / PLANS THROUGH 2002

GLAST is scheduled for Phase C/D Confirmation in FY 2002. If approved to proceed, the implementation phase will begin at that point. Spacecraft contractor selection is scheduled for the third quarter of FY 2002. Detailed instrument design work will lead to Instrument Critical Design Reviews in late FY 2002 and early FY 2003.

PROGRAM PLANS FOR FY 2003

Detailed spacecraft design work will continue, leading to spacecraft Critical Design Review in late FY 2003.

GLAST LIFE CYCLE COST DATA ($ in millions)

	Prior	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	BTC	TOTAL
FY 2003 President's Budget	4.9	7.7	20.7	69.2	106.7	75.0	43.4	20.2	161.8	509.6
Pre-Development	4.9	7.7	8.2							20.8
Development			12.5	69.2	74.6	47.3	23.4			227.0
Launch Services					32.1	27.7	10.9			70.7
Operations							2.5	4.7	33.2	40.4
Data Analysis							6.6	15.5	128.6	150.7
[Estimated Civil Service FTE]	10	30	42	42	37	37	28	9		

BASIS OF FY 2003 FUNDING REQUIREMENT

New Frontiers Program

	FY 2001	FY 2002	FY 2003
New Frontiers Program	--	--	15.0

DESCRIPTION / JUSTIFICATION

New Frontiers is a revamping of the Outer Planets missions program. New Frontiers will pursue a clear set of goals and science priorities with an emphasis on understanding the origins of life and the potential for life elsewhere in the Solar System, and will select missions through a fully open and competitive process. It is envisioned that New Frontiers will be structured and managed along the lines of the highly successful Discovery program. The program will provide frequent access to space for mid-sized planetary missions that will perform high-quality scientific investigations. New Frontiers responds to the need for multiple missions of varying costs for solar systems and will seek to balance science return in this decade with investments that will enable more frequent missions with shortened development and trip times and more science return per dollar.

There will be close coupling between this new program and new technologies developed in the Nuclear Power, Nuclear Propulsion and In-Space Propulsion programs. Missions will be selected through open, peer-reviewed competitions subject to rigorous cost/schedule/risk reviews. The cost of building, launching, and operating a New Frontiers mission must not exceed $650 million in FY 2003 dollars and the mission must launch within 48 months from start of development.

The first Announcement of Opportunity is planned for release in spring 2002 with the science priorities responsive to the results of the Solar System Exploration Decadal Survey. Like the Discovery program, New Frontiers will also allow for selection of Missions of Opportunity. Missions of Opportunity involve participation in a non-NASA mission, typically sponsored by non-U.S. governments, other U.S. government agencies, or private sector organizations. This participation could include providing a complete science instrument, hardware components of a science instrument, or expertise in critical areas of the mission.

BASIS OF FY 2003 FUNDING REQUIREMENT

Payload and Instrument Development

	FY 2001	FY 2002	FY 2003
International Gamma Ray Astrophysics Laboratory (INTEGRAL)	1.4	1.3	0.5
Rosetta	7.7	1.3	0.9
Solar-B	22.1	25.4	16.2
Herschel		14.6	15.4
Planck	7.9	4.8	4.9
Other Payload and Instrument Development	0.5	0.1	0.1
Total	**39.6**	**47.5**	**38.0**

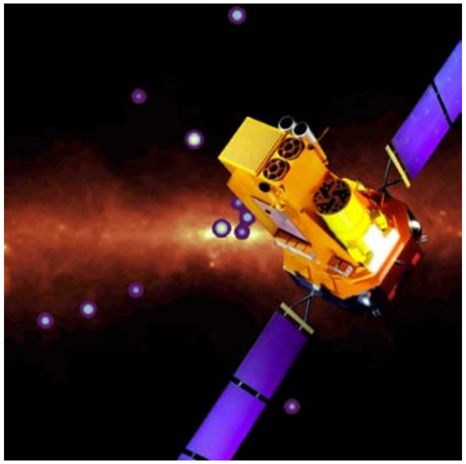
DESCRIPTION / JUSTIFICATION

Payload and Instrument Development supports the development of hardware to be used on international satellites or on Shuttle missions. International collaborative programs offer opportunities to leverage U.S. investments, and thus to obtain scientific data at a relatively low cost. Shuttle missions utilize the unique capabilities of the Shuttle to perform scientific experiments that do not require the extended operations provided by free-flying spacecraft.

The five international payloads currently under development (INTEGRAL, Rosetta, Solar-B, Herschel, and Planck) are described on the following pages. Other Payload and Instrument Development funding supports project management of the Spartan free-flying platform at GSFC (terminated in FY 2001) and project management activities at the Jet Propulsion Laboratory.

International Gamma Ray Astrophysics Laboratory (INTEGRAL) *http://sci.esa.int/home/integral/index.cfm*

INTEGRAL is a European Space Agency mission, with Russian and U.S. involvement. U.S. participation consists of co-investigators providing hardware and software components to the spectrometer and imager instruments; a co-investigator for the data center; a mission scientist; and a provision for ground tracking and data collection.



Objectives:

- Perform detailed spectroscopic and imaging studies of objects initially explored by the Compton Gamma Ray Observatory.
- Investigate processes taking place under extreme conditions of density, temperature, and magnetic field.

Funding:

FY 2001	FY 2002	FY 2003
1.4	1.3	0.5

Key Milestones:	FY 2002 Budget Date	FY 2003 Budget Date	Comment
Launch	n/a	10/02	Date set by ESA

Rosetta ***http://sci.esa.int/home/rosetta/index.cfm***

Rosetta is a European Space Agency comet mission that will be launched in January 2003. After a long cruise phase, the satellite will rendezvous with comet Wirtanen in 2011 and orbit it, while taking scientific measurements. A Surface Science Package will land on the comet surface to take in-situ measurements. The U.S. is developing three remote sensing instruments and a subsystem for a fourth instrument.

Objectives:

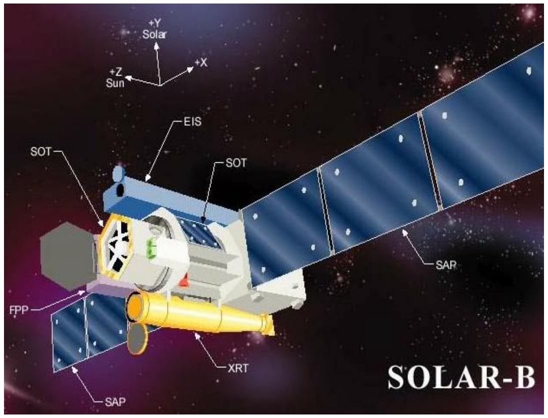
- Study the origin of comets
- Study the relationship between cometary and interstellar material
- Improve our knowledge of the origins of the Solar System

Funding:

FY 2001	FY 2002	FY 2003
7.7	1.3	0.9

Key Milestones:	FY 2002 Budget Date	FY 2003 Budget Date	Comment
U.S. Flight Unit Deliveries	3rd Qtr FY 01	3rd Qtr FY 01	Completed
Launch	January 2003	January 2003	Set by ESA

Solar-B ***http://stp.gsfc.nasa.gov/missions/solar-b/solar-b.htm***



Solar-B is a Japanese Institute of Space and Astronautical Science (ISAS) mission, with significant U.S. involvement, and follows the highly successful Japan/US/UK Yohkoh (Solar-A) collaboration. The mission consists of a coordinated set of optical, EUV and X-ray instruments. NASA will provide the Focal Plane Package for the optical telescope and components of the X-ray telescope and the Extreme Ultraviolet Imaging Spectrometer (EIS).

Objectives:
- Investigate the interaction between the Sun's magnetic field and its corona
- Understand the sources of solar variability

Funding:

FY 2001	FY 2002	FY 2003
22.1	25.4	16.2

Key Milestones:	**FY 2002 Budget Date**	**FY 2003 Budget Date**	**Comment**
EIS Pre-Environmental Review	FY 02	1/02	EIS instrument ready for environmental testing
Instrument Delivery	n/a	FY 04	3 instruments – date refers to last instrument delivery
Launch	n/a	FY 05	Launch readiness date is established by ISAS

Herschel ***http://sci.esa.int/home/first/index.cfm***

ESA's Herschel Space Observatory (formerly called Far Infrared and Submillimetre Telescope or FIRST) is an infrared telescope that will observe at wavelengths never covered before. Herschel is the fourth Cornerstone Mission (CS4) in the European Space Agency's "Horizon 2000" science plan. It will open up a virtually unexplored part of the spectrum that cannot be observed well from the ground. NASA is providing components for two of the three instruments that will be flown on Herschel: the Heterodyne Instrument for Far Infrared (HIFI) and the Spectral and Photometric Imaging Receiver (SPIRE).

Objectives:

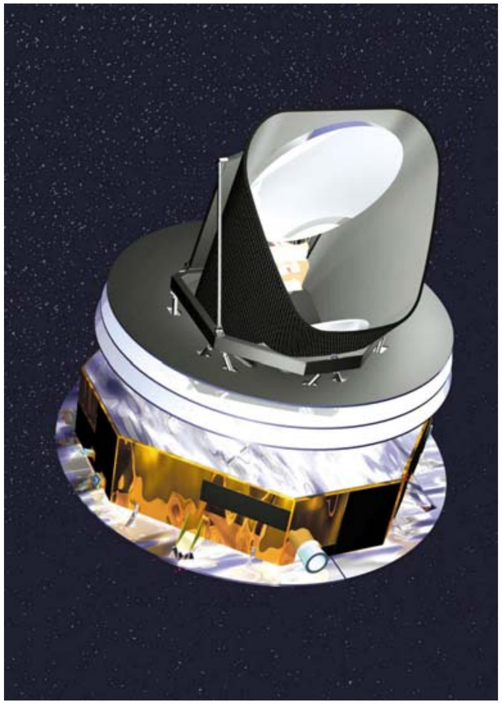
- Understand galaxy formation and evolution in the early universe, and the nature of active galaxy power sources
- Understand star forming regions and interstellar medium physics in the Milky Way and other galaxies
- Understand the molecular chemistry of cometary, planetary and satellite atmospheres in our solar system

Funding:

FY 2001	FY 2002	FY 2003
	14.6	15.4

Key Milestones:	FY 2002 Budget Date	FY 2003 Budget Date	Comment
Frequency mixer demonstrated	FY 01	June 2001	Completed on time
SPIRE qual. model detectors	FY 02		
Launch	n/a	2007	Launch date set by ESA

Planck ***http://sci.esa.int/home/planck/index.cfm***



Planck is the third Medium-Sized Mission (M3) of the European Space Agency's Horizon 2000 Scientific Programme. It is designed to image minor variations in the Cosmic Background Radiation over the whole sky, with unprecedented sensitivity and angular resolution. In support of the Planck mission, NASA is providing two redundant cryocoolers for the spacecraft and components for the High Frequency Instrument (HFI), one of the two instruments that will be flown on Planck.

Objectives:

- Will the Universe continue its expansion forever?
- What is the age of the Universe?
- What is the total amount of matter in the Universe and what is this matter made of?

Funding:

FY 2001	FY 2002	FY 2003
7.9	4.8	4.9

Key Milestones:	FY 2002 Budget <u>Date</u>	FY 2003 Budget <u>Date</u>	<u>Comment</u>
Cooler Test	FY 01	September 2000	completed
Cooler performance report	4th Qtr FY01	September 2001	completed
HFI Flight detectors complete	FY 02	1Q/FY03	
Launch	n/a	2007	Launch date set by ESA

BASIS OF FY 2003 FUNDING REQUIREMENT

Explorers Program

Web Address: http://explorers.gsfc.nasa.gov/missions.html

	FY 2001	FY 2002	FY 2003
Microwave Anisotropy Probe (MAP) *	17.7		
Swift Gamma Ray Burst *	50.1	57.0	33.5
Full-Sky Astrometric Mapping Explorer (FAME) *	20.0		
Small Explorers (SMEX)	37.0	38.5	3.7
Explorer Planning (All Others)	16.5	29.7	97.9
Total	**141.3**	**125.2**	**135.1**

* Total life cycle cost data is provided at the end of each section.

DESCRIPTION / JUSTIFICATION

The mission of the Explorers Program is to provide frequent flight opportunities for world-class astrophysics and space physics investigations utilizing innovative, streamlined and efficient management approaches to spacecraft development and operations. The program also seeks to enhance public awareness of, and appreciation for, space science and to incorporate educational and public outreach activities as integral parts of space science investigations.

Explorer missions are categorized by size, starting with the largest, the Medium-class (MIDEX) missions launched by Delta Expendable Launch Vehicles (ELVs), and the Small-class (SMEX) missions launched on Pegasus-class. Also included in both the MIDEX and SMEX mission classes are Missions of Opportunity (MO). MOs have a total NASA cost of under $35 million. These missions are conducted on a no-exchange-of-funds basis with the organization sponsoring the mission.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

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

Strategic Plan Objectives Supported: Understand the structure of the Universe, from its earliest beginnings to its ultimate fate; explore the ultimate limits of gravity and energy in the Universe; and learn how galaxies, stars, and planets form, interact and evolve.

Performance Plan Metrics Supported: Annual Performance Goal (APG) #3S9, "Earn external review rating of "green," on making progress in the following area: Design, develop, and launch projects to support future research in pursuit of Strategic Plan science objectives."

Microwave Anisotropy Probe (MAP) ***http://map.gsfc.nasa.gov/***

Objective: The Cosmic Microwave Background Explorer (COBE) was the first spacecraft to map the cosmic background radiation, providing strong confirmation of the Big Bang. The Microwave Anisotropy Probe (MAP) will make a map of the temperature fluctuations of the cosmic microwave background radiation with much higher resolution, sensitivity, and accuracy than COBE. The new information contained in these finer fluctuations will shed light on several key questions in cosmology, including the geometry of the universe, the amount of dark matter in the universe, and the origin of structures of galaxies in the early universe.

Salient Features:
Lead Center and Spacecraft: GSFC
Principal Investigator: Charles Bennett, GSFC
Launch vehicle: Delta 2
L2 Orbit, 3 years prime mission life

MAP Life Cycle Cost Data ($ in millions)

	Prior	FY01	FY02	FY03	FY04	FY05	FY06	FY07	BTC	Total
FY 2003 President's Budget	126.5	22.1	3.7	4.7	1.6					158.6
Development	82.9	11.3								94.2
Launch Vehicle	43.6	6.4								50.0
Mission Operations		1.5	1.8	1.4						4.7
Data Analysis		2.9	1.9	3.3	1.6					9.7

Key Milestones:	FY 2002 Budget Date	FY 2003 Budget Date	Comment
Launch	3rd Qtr FY01	June 30, 2001	Launched successfully

Swift Gamma-Ray Burst ***http://swift.gsfc.nasa.gov/***

Objective: Swift will determine redshifts for most of the bursts that it detects (allowing us to know how far away they are and how absolutely bright they are), and will also provide detailed multi-wavelength light curves for the duration of the afterglow (allowing us to probe the physical environment in which the event took place). Studying ~ 500 bursts in its two-year nominal mission, Swift has the capability to determine the origin of the still-mysterious gamma-ray bursts, and to use them to probe the conditions that existed in the early Universe. Swift is the first mission to focus on studying the afterglow from gamma ray bursts.

- Lead Center: GSFC
- Spacecraft: Spectrum Astro
- Science Instruments:
  Burst Alert Telescope (BAT) - GSFC
  X-ray Telescope (XRT) - Penn State
  UltraViolet/Optical Telescope (UVOT) - Penn State
- Launch vehicle: Delta 2
- Low-Earth Orbit; 3 year prime mission

Swift Life Cycle Cost Data ($ in millions)

	Prior	FY01	FY02	FY03	FY04	FY05	FY06	FY07	BTC	Total
FY 2003 President's Budget	22.2	50.1	57.0	33.5	3.9	3.0	2.6			172.3
Development	22.2	36.5	37.2	17.0						112.9
Launch Vehicle		13.6	19.8	16.5						49.9
Mission Operations					2.6	1.9	1.6			6.1
Data Analysis					1.3	1.1	1.0			3.4

Key Milestones:	FY 2002 Budget Date	FY 2003 Budget Date	Comment
Spacecraft subsystems complete	FY 02	9/02	
Start S/C Level I&T	n/a	9/02	Milestone not established in the FY 2002 budget
Launch	n/a	9/03	Milestone not established in the FY 2002 budget

Full Sky Astrometric Mapping Explorer (FAME) ***http://www.usno.navy.mil/FAME/***

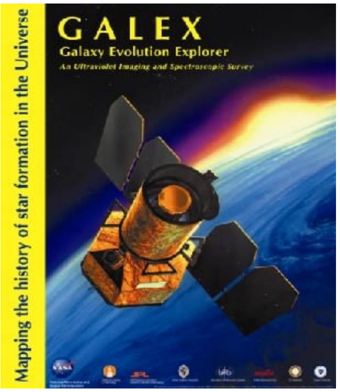
Objective: FAME was planned as an astrometric satellite designed to determine with unprecedented accuracy the positions, distances, and motions of 40 million stars within our galactic neighborhood. It was a collaborative effort between the U.S. Naval Observatory (USNO) and several other institutions. FAME was designed to measure stellar positions to less than 50 microarcseconds. The mission was not approved to proceed to development in early FY 2002, due to unacceptable cost growth identified at the Confirmation Review.

FAME Cost Data ($ in millions)

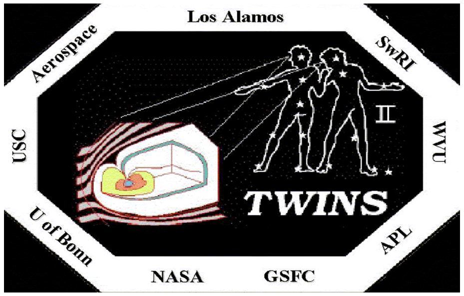
	Prior	FY01	FY02	FY03	FY04	FY05	FY06	FY07
Pre-development	5.2	20.0						

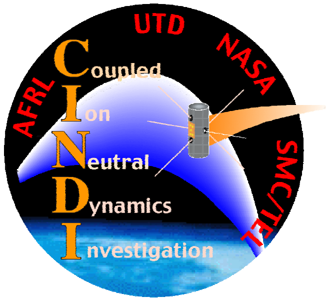
Small Explorers Program (SMEX) *http://explorers.gsfc.nasa.gov/missions.html*

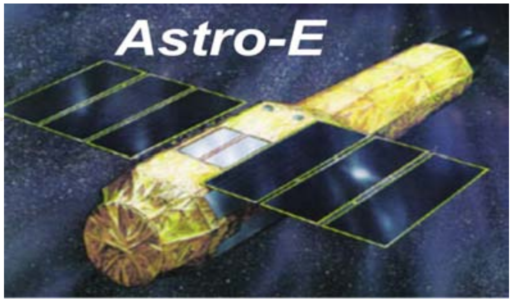
The Small Explorer (SMEX) program provides frequent flight opportunities for highly focused and relatively inexpensive missions. SMEX investigations are characterized by a total cost to NASA for definition, development, launch service, and mission operations and data analysis not to exceed $85 million (in Fiscal Year 2002 dollars). It is NASA's goal to launch one Small Explorer mission per year and one Mission of Opportunity per year.



Missions of Opportunity (MO) are space science investigations, costing no more than $35 million in FY 2002 dollars that are flown as part of a non-NASA space mission. MO are conducted on a no-exchange-of-funds basis with the organization sponsoring the mission. OSS intends to solicit proposals for MO with all future Explorer Announcements of Opportunities.







MISSIONS	LAUNCH DATE	OBJECTIVES
HESSI (High Energy Solar Spectroscopic Imager)	January 2002	explore the physics of particle acceleration and explosive energy release in solar flares
GALEX (The Galaxy Evolution Explorer)	May 2002	map the history and probe the causes of star formation and its evolution.
CINDI (MO) (Coupled Ion Neutral Dynamics Investigation)	Late 2003	provide measurements of the neutral atmosphere wind velocity and the charged particle drifts in the equatorial upper atmosphere at altitudes from 400 to 700 km.
TWINS A/B (MO) (Two Wide-angle Imaging Neutral-atom Spectrometers)	2003, 2005	stereoscopically image the magnetosphere
ASTRO-E2 (MO)	2005	Japanese x-ray astronomy mission to study high-energy phenomena

Explorer Planning ***http://explorers.gsfc.nasa.gov/missions.html***

Explorer Planning supports development of the Cosmic Hot Interstellar Plasma Spectrometer (CHIPS) mission. CHIPS is the last University-class Explorer (UNEX) mission, and will use an extreme ultraviolet spectrograph to study the "Local Bubble," a tenuous cloud of hot gas surrounding our solar system that extends about 300 light-years from the Sun. The University of California at Berkeley is developing CHIPS for a planned launch in August 2002; SpaceDev is building the CHIPS spacecraft.

Explorer planning also covers Explorer program management costs, the costs for soliciting and evaluating new missions, and the formulation and implementation costs for those new missions. In FY01, the Explorer program conducted funded concept studies for six potential SMEX missions and two potential MO missions. One of the MO missions was selected for flight (Astro-E2) in July 2001. An Announcement of Opportunity (AO) for the next two MIDEX missions was released in July 2001. In FY02, approximately four MIDEX projects, and possibly one or more MO projects, will be selected for funded concept studies (estimated date April 2002). Also, two of the six SMEX missions will be selected for flight and a decision will be made on the MO mission (estimated date July 2002). In FY03, development will begin on the two selected SMEX missions (estimated start October 2002), two of the MIDEX missions will be selected for flight and development will begin on them (estimated date January 2003), and an AO will be released for two future SMEX missions.

BASIS OF FY 2003 FUNDING REQUIREMENT

Discovery Program

Web Address: http://discovery.nasa.gov/

	FY 2001	FY 2002	FY 2003
Genesis Development *	22.0		
CONTOUR Development*	62.2	22.3	
MESSENGER Development *	51.8	94.3	68.0
Deep Impact Development *	72.7	85.2	59.1
Future Missions	4.3	12.8	80.6
Total	**213.0**	**214.6**	**207.7**

***** Total life cycle cost data is provided at the end of each section.

DESCRIPTION / JUSTIFICATION

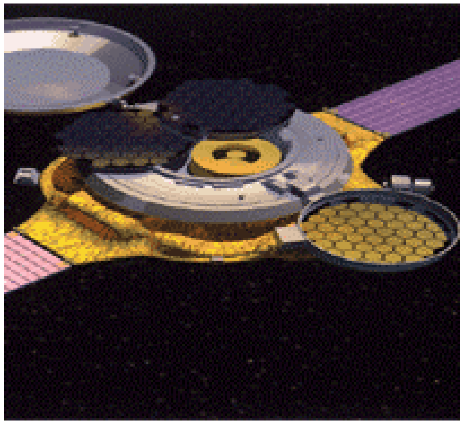
The Discovery program provides frequent access to space for small planetary missions that perform high-quality scientific investigations. The program responds to the need for low-cost planetary missions with short development schedules. Emphasis is placed on increased management of the missions by principal investigators. Missions are selected through open, peer-reviewed competitions, to ensure science community involvement while enhancing the return on investment. The Discovery program also aids in the national goal to transfer technology to the private sector. The cost of building, launching, and operating a Discovery mission must not exceed $300 million in FY 2001 dollars, and the mission must launch within three years from start of development.

Genesis ***http://genesismission.jpl.nasa.gov/***

Objective: "To capture a piece of the Sun and return it to Earth" -- To provide a sample of the solar wind, helping answer fundamental questions about the exact composition of the Sun and the chemical diversity present at the birth of our solar system

Salient Features:

- Principal Investigator: Don Burnett, California Institute of Technology
- Lead Center: JPL
- Spacecraft: Lockheed Martin; Launch vehicle: Delta 2
- Orbit about the Sun-Earth L1 point
- Science Instruments: Collector Arrays and Concentrator
- 2 Enabling Instruments: Electron Monitor and Ion Monitor
- Launched August 8, 2001; Sample Return to Earth: September 2004
- Minimum Sample Collection Time Required: 22 Months



Science:

- Measure Elemental & Isotopic Abundance's of Solar Wind Ions
- Provide a Reservoir of Solar Matter for Future Analysis

Genesis Life Cycle Cost Data:

	Prior	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	BTC	Total
	189.7	29.6	10.2	10.0	9.3	3.0	1.9	1.1	0.2	255.0
Pre-development	11.5									11.5
Development	130.7	20.8								151.5
Launch Services	47.5	1.2								48.7
Operations		3.4	6.2	7.2	6.2	0.4				23.4
Data Analysis		4.2	4.0	2.8	3.1	2.6	1.9	1.1	0.2	19.9
[Est. Civil Servant FTE]		2	1	1	1	1	1	1		

Key Milestones:	**FY 2002 Budget Date**	**FY 2003 Budget Date**	**Comment**
Launch	7/01	8/01	Launched August 8, 2001; sample return September 2004

Comet Nucleus Tour (CONTOUR) ***http://www.contour2002.org/***

Objective: To dramatically improve our knowledge of comet nuclei and to assess their diversity

Salient Features:
- Will encounter and study at least two comets, using Earth-gravity assist maneuvers
- Science Instruments: a wide-angle imager (CFI), a high-resolution imager and spectral mapper (CRISP), a dust analyzer (CIDA) and a neutral gas/ion mass spectrometer (NGIMS)
- Principal Investigator: Joe Veverka, Cornell University
- Lead Center and Spacecraft: APL
- Launch date: July 2002 on a Delta 2 vehicle
- Comet Encke encounter – November 12, 2003
- Comet Schwassmann-Wachmann-3 encounter – June 19, 2006

Science:
- To measure the diversity of comets' nuclei
- To study from close range the dynamic processes that shape a comet's nucleus
- To assess the differences between Kuiper Belt and Oort Cloud comets

CONTOUR Life Cycle Cost Data:

	Prior	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	BTC	Total
	61.3	62.2	22.3	3.9	3.5	1.8	3.4			158.4
Pre-development	9.2									9.2
Development	35.2	41.6	10.8							87.6
Launch services	16.9	20.6	11.5							49.0
Operations				2.4	2.0	0.4	1.6			6.4
Data Analysis				1.5	1.5	1.4	1.8			6.2
[Est. Civil Servant FTE]		10	9	6	6	3	3			

Key Milestones:	FY 2002 Budget Date	FY 2003 Budget Date	Comment
Complete environmental testing	FY 02	4/02	
Launch	7/02	7/02	On schedule

MESSENGER (MErcury Surface, Space ENvironment, Geochemistry, and Ranging) ***http://messenger.jhuapl.edu/***

Objective: To investigate key scientific questions regarding Mercury's characteristics and environment in order to better understand the evolution of terrestrial planets

Salient Features:
- Principal Investigator: Sean Solomon, Carnegie Institute of Washington
- Lead Center and Spacecraft: APL
- Seven miniaturized science instruments
- Launch date: March 2004, Delta 2 vehicle
- Five year voyage includes two flybys of Venus and two flybys of Mercury
- Enter Mercury orbit in April 2009 and orbit for one Earth year

Science: Answer the questions
- Why is Mercury so dense?
- What is the geologic history of Mercury?
- What is the structure of Mercury's core?
- What is the nature of Mercury's magnetic field?
- What are the unusual materials at Mercury's poles?
- What volatiles are important at Mercury?

MESSENGER Life Cycle Cost Data:

	Prior	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	BTC	Total
	11.3	51.8	94.3	68.0	39.1	7.1	7.5	8.7	42.2	330.0
Pre-Development	11.1	20.3								31.4
Development		25.9	72.8	46.0	19.1					163.8
Launch Services	0.2	5.6	21.5	22.0	15.6					64.9
Operations					2.9	4.1	4.2	4.2	19.5	34.9
Data Analysis					1.5	3.0	3.3	4.5	22.7	35.0

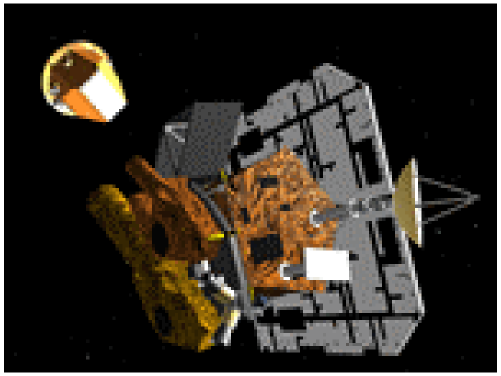
Key Milestones:	FY 2002 Budget Date	FY 2003 Budget Date	Comment
Critical Design Review	FY 02	3/02	
Launch	3/04	3/04	On schedule

Deep Impact ***http://deepimpact.jpl.nasa.gov***

Objective: To study the pristine interior of a comet by excavating a crater approximately 25 m deep and 100 m in diameter

Salient Features:

- Two part spacecraft: a larger "flyby" spacecraft carrying a smaller "impactor" spacecraft
- Principal Investigator: Michael A'Hearn, University of Maryland
- Lead Center: JPL; Spacecraft: Ball Aerospace
- Launch: January 2004, Delta 2 vehicle; Impact: July 2005
- Impactor will crash into the surface of a comet nucleus at 22,000 miles per hour
- Camera on the impactor will capture and relay images of the comet nucleus just before it collides with the comet
- Flyby spacecraft will observe and record the impact
- Professional and amateur astronomers expected to observe the impact from Earth



Science Objectives:

- Dramatically improve the knowledge of key properties of cometary nuclei
- Measure the composition of the interior of the comet
- Improve our understanding of the evolution of cometary nuclei

Deep Impact Life Cycle Cost Data:

	Prior	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	BTC	Total
	24.2	72.7	85.2	59.1	21.0	11.1	2.0			275.3
ATD	24.1	15.5								39.6
Development		49.9	62.7	36.3	7.7					156.6
Launch Services	0.1	7.3	22.5	22.8	4.9					57.6
Operations					6.8	8.2	0.3			15.3
Data Analysis					1.6	2.9	1.7			6.2

Key Milestones:	FY 2002 Budget Date	FY 2003 Budget Date	Comment
PDR	2/01	2/01	Held week of 2/26/01
CDR	1/02	1/02	On schedule
Launch	1/04	1/04	On schedule

Future Missions

Future Mission funding covers program management costs, costs for soliciting and evaluating new missions as well as costs for selected Missions of Opportunity. Missions of Opportunity involve participation in a non-NASA mission, typically sponsored by non-U.S. governments, other U.S. government agencies, or private sector organizations. This participation could include providing a complete science instrument, hardware components of a science instrument, or expertise in critical areas of the mission.

Selection of the next two Discovery missions was announced in December 2001. The selected missions are Dawn, which will orbit the two largest asteroids in our solar system, and Kepler, a space telescope that will search for Earth-like planets around nearby stars. Additional information about Dawn is available at http://www-ssc.igpp.ucla.edu/dawn/ , and Kepler is at http://www.kepler.arc.nasa.gov/

Analyzer of Space Plasmas and Energetic Atoms (ASPERA-3) is the first Discovery Mission of Opportunity approved for implementation in October 1999. ASPERA-3 will provide parts of a scientific instrument to study the interaction between the solar wind and the atmosphere of Mars. It will fly aboard the European Space Agency's Mars Express spacecraft in 2003. http://discovery.nasa.gov/aspera.html

The second Discovery Mission of Opportunity is a French led-Mars mission, NetLander, approved for implementation in January 2001. The Discovery NetLander project will contribute key components of the payload to allow the delineation of the interior structure of Mars and characterize the behavior of its atmosphere. It will fly aboard the CNES PREMIER orbiter in 2007. http://www-projet.cst.cnes.fr:8060/NETLANDER/index.html

BASIS OF FY 2003 FUNDING REQUIREMENT

Mars Exploration Program (MEP)

Web Address: *http://mars.jpl.nasa.gov/overview/index.html*

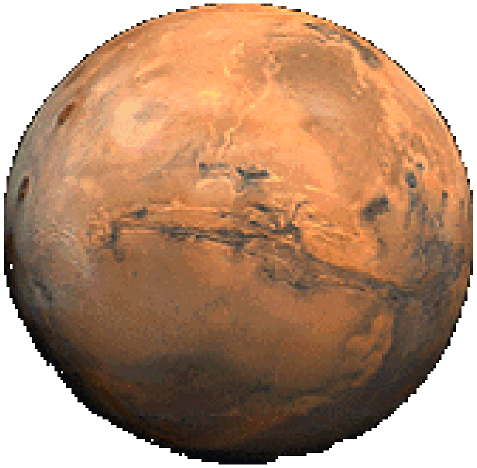
	FY 2001	FY 2002	FY 2003
2001 Mars Odyssey *	38.3		
2003 Mars Exploration Rovers (MER) *	296.0	245.2	113.9
Mars Express	6.8	3.8	3.4
2005 Mars Reconnaissance Orbiter (MRO) *	12.0	57.9	143.5
Future Mars **	76.5	88.4	176.3
JPL Flight Project Management Facility		19.4	16.5
TOTAL	**429.6**	**414.7**	**453.6**

* Total life cycle cost data is provided at the end of this section.
** Includes 2007 Mars Scout (fully competed mission); 2009 Mars Smart Lander/Mobile Laboratory; Mars International Missions; 34M Beam-Wave-Guide Antenna; Mars Technology; Planetary Protection; and Mars Program Management. See p. SAT 1-53

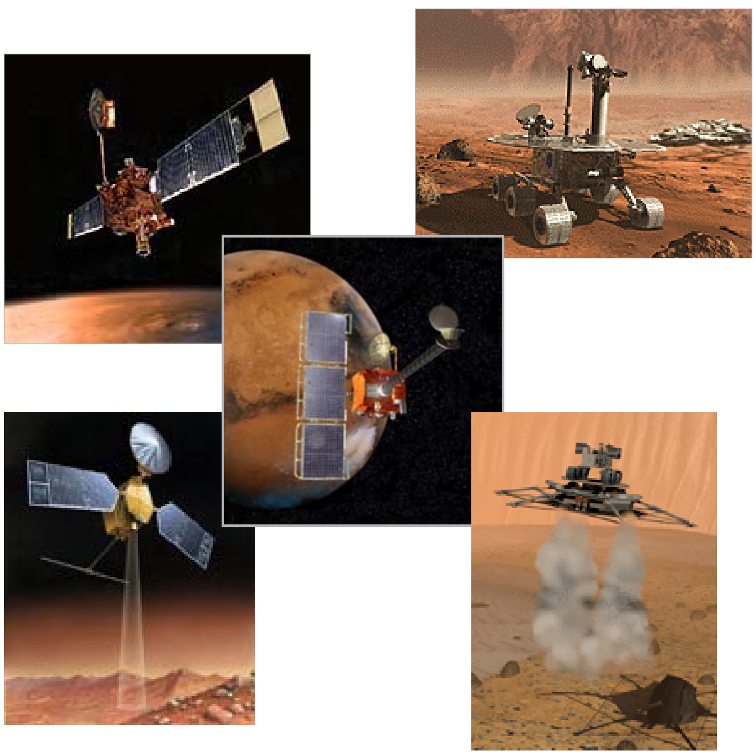
DESCRIPTION / JUSTIFICATION

The Mars Exploration Program (MEP) is an aggressive, sustained series of missions to Mars, to understand the planet's past and present conditions and their potential to support life. Taking advantage of launch opportunities available approximately every 26 months, the MEP science strategy is to "follow the water" in understanding the climatological, geological, and potentially biological history of Mars. In addition, these missions provide the scientific and technological basis for the next decade of Mars exploration.

Mars Exploration Program



A science-driven effort to characterize and understand Mars as a dynamic system, including its present and past environment, climate cycles, geology, and biological potential. A key question is whether life ever arose on Mars.



***Strategy:* "*Follow the Water*"**

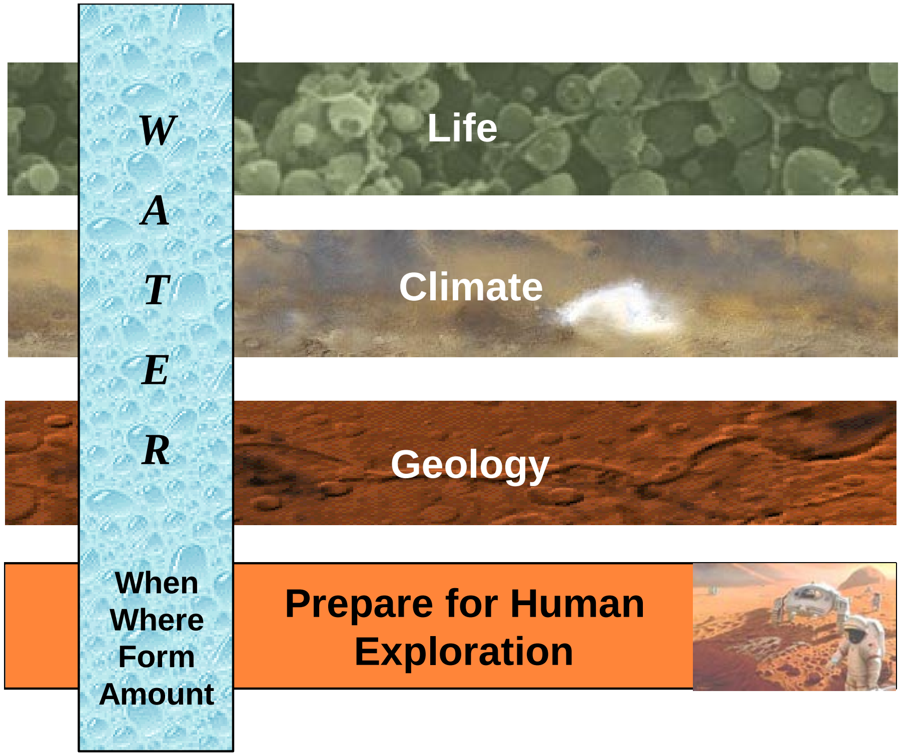
Search for sites on Mars with evidence of past or present water activity and with materials favorable for preserving either bio-signatures or life-hospitable environments

***Approach:* "*Seek - In Situ - Sample*"**

Orbiting and surface-based missions are interlinked to target the best sites for detailed analytic measurements and eventual sample return

Mars Science Strategy: "Follow the Water"

- When was it present on the surface?
- How much and for how long?
- Where did it go, and what are the telltale features it left behind?
- Did it persist long enough for life to have developed?



Understand the potential for life elsewhere in the Universe

Characterize the present and past climate and climate processes

Understand the geological processes affecting Mars' interior, crust, and surface

Develop knowledge and technology necessary for future human and robotic exploration

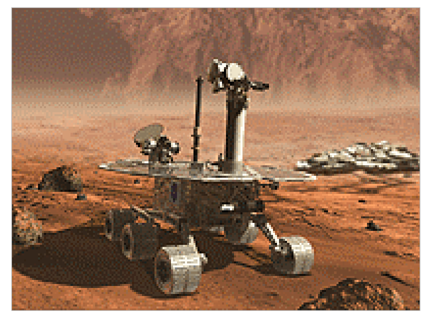
To achieve the goals as outlined above, these series of near-term Mars Exploration missions are required:

MEP Missions	Science Objectives
Mars Global Surveyor (MGS)	Mars Global Surveyor is currently orbiting Mars and mapping the planet at infrared and visible wavelengths and observing selected areas at high resolution.
2001 Mars Odyssey	2001 Mars Odyssey's objective is to determine the elemental and chemical composition of the Martian surface, map the mineralogy and morphology of the surface, and measure the radiation environment around Mars. The 2001 Mars Odyssey launched successfully April 2001, arrived at Mars in October 2001, and will start returning scientific data in February 2002.
2003 Mars Exploration Rovers (MER)	The goal of both rovers will be to learn about the history of ancient water and its role in the geology and climate of Mars. Each rover will be a robotic field geologist, equipped to read the geological record at its landing site and to learn what the conditions were like when the rocks and soils there were formed. The twin rovers will also have the mobility to travel up to 1000 meters across the Martian landscape, measuring the chemical character of the soils, rocks, and even the previously inaccessible interiors of rocks where unaltered materials may lurk.
Mars Express	Mars Express is a European Space Agency mission carrying US-provided instruments that will explore the atmosphere and surface of Mars from polar orbit. The mission's main objective is to search for sub-surface water from orbit and deliver a small lander to the Martian surface in 2003.
2005 Mars Reconnaissance Orbiter (MRO)	The goal of the orbiter is to understand the history of water on Mars by observing the planet's atmosphere, surface, and subsurface in unprecedented detail. This mission will identify the best sites for a new generation of landed vehicles to explore, by virtue of its ability to find local evidence of the chemical and geological "fingerprints" of water and other critical processes. MRO will explore from orbit several hundred locations on the surface of Mars, observing details that were previously only visible to landers. MRO will focus on the locations identified as most promising by MGS and Odyssey, searching for the most compelling environmental indicators that a particular area was once suitable for supporting life (e.g., warm and wet conditions).

MEP Missions	Science Objectives
Future Mars Exploration	• 2007 Mars Scout mission will be a fully competed science mission, led by a Principal Investigator (PI), to complement the MEP core program missions • U.S. contributions to 2007 International Mars missions will include programmatic and technical development support for the NASA-Agenzia Spaziale Italiana (ASI) telecommunications orbiter, and science and engineering instrumentation for the Centre National d'Etudes Spatiales (CNES) Orbiter and NetLanders. • 2009 Mars Smart Lander/Mobile Laboratory is a long-duration roving science laboratory that will conduct the next major step of in-situ science measurements and validate design and operations for future Mars landers and rovers. This mission will incorporate a nuclear power system to greatly extend the duration of surface operations, thereby significantly increasing scientific return. • Mars Technology will lay the groundwork and provide new capabilities for Mars missions beyond 2005. The technology investment in this area will include precision atmospheric entry and landing techniques, hazard avoidance systems, new in-situ sensors, optical navigation, surface power, and other ascent and mobility systems. • Construction of a Deep Space Network (DSN) 34-meter Beam-Wave-Guide (BWG) Antenna in Spain will meet DSN mission loading requirements, largely driven by MEP in FY03/04. • Construction of a Flight Projects Facility at JPL. (Refer to CofF / Mission Support section)

2003 Mars Exploration Rovers (MER)

Milestones	FY03 Date	FY02 Date	Change	Comment
Mission Selection	4Q/FY00	4Q/FY00		Completed on schedule
Mission PDR	1Q/FY01	1Q/FY01		Completed on schedule
Mission CDR	4Q/FY01	4Q/FY01		Completed on schedule
Start S/C level I&T	2Q/FY02	2Q/FY02		
Launch - 1st Lander	5/03	5/03		
Launch - 2nd. Lander	6/03	6/03		



Lead Center: JPL	**Other Centers: GRC (airbag);** LARC (Entry, descent, and landing simulation); KSC	**Interdependencies:** Gutenberg U. /Germany
Subsystem	**Builder**	
Spacecraft:	JPL	
Instruments	**Builder**	**Pr. Investigator: Steve Squyres**
Rover 1 & 2	JPL	
Mossbauer Spectrometer	Gutenberg U/Germ.	
Alpha Proton X-ray Spectrometer (APXS)	MPI/Germany	
Microscopic Imager (MI)	JPL	
Panoramic Camera (Pancam)	JPL	
Mini Thermal Emission Spectrometer (Mini-TES)	Arizona State U.	
Launch Vehicle:	**Tracking/Communication**	**Data:**
Boeing Delta 7920H & 7920	Deep Space Network	Planetary Data System (PDS)

2003 Mars Exploration Rovers (MER) – Lifecycle cost

	Prior	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	BTC	Total
	18.9	296.0	245.2	122.1	41.1	17.0				740.3
Development	18.9	263.7	199.5	81.4						563.5
Launch Support		32.3	45.7	32.5						110.5
Operations				5.9	25.7	4.4				36.0
Data Analysis				2.3	15.4	12.6				30.3
[Est. Civil Servant FTE]		4	20	19	13	13				

2005 Mars Reconnaissance Orbiter (MRO)

Milestones	FY03 Date	FY02 Date	Change	Comment
S/C Selection	10/01			
Instruments selection	11/01			
PDR	4Q/02			
CDR	3Q/03			
Start I&T	3Q/05			
Launch	4Q/05			

Lead Center: JPL	**Other Centers:**	**Interdependencies:** Agenzia Spaziale Italiana (ASI)
Subsystem	**Builder**	
Spacecraft:	Lockheed Martin	
Instruments	**Builder**	**Pr. Investigator**
Mars Climate Sounder	JPL	D. McCleese
Mars Color Imager	Malin Space Science Systems	M. Malin
High-Resolution Imager (HIRISE)	Ball Aerospace & Technologies	Alfred S. McEwen (U. Arizona, Tucson); Science investigator
Imaging Spectrometer (CRISM)	JHU Applied Physics Lab	Scott L. Murchie; Science Investigator
Context Imager (Facility Instrument)	Malin Space Science Systems	
Shallow Radar (SHARAD) (Facility Instrument)	Italian Space Agency	
Launch Vehicle:	**Tracking/Communications:**	**Data:**
TBD -decision to be made in 5/02	Deep Space Network	Planetary Data System (PDS)

2005 Mars Reconnaissance Orbiter (MRO) – lifecycle cost

	Prior	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07	BTC	Total
		12.0	57.9	143.5	173.4	103.1	32.0	36.7	66.2	624.8
Pre-Development		12.0	48.0							60.0
Development			9.9	122.5	137.3	64.7				334.4
Launch Support				21.0	36.1	33.1				90.2
Operations						3.9	21.2	19.8	46.4	91.3
Data Analysis						1.4	10.8	16.9	19.8	48.9

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Chart the evolution of the universe from origins to destiny, and understanding its galaxies, stars, planets and life; and use robotic science missions as forerunners to human exploration beyond low-Earth orbit.

Strategic Plan Objectives Supported: Probe the origin and evolution of life on Earth and determine if life exists elsewhere in our Solar System; and investigate the composition, evolution, and resources of Mars, the Moon, and small bodies.

Performance Plan Metrics Supported: Annual Performance Goal (APG) #3S9, "Earn external review rating of "green," on making progress in the following area: Design, develop, and launch projects to support future research in pursuit of Strategic Plan science objectives."
Current and future operating missions support APG #3S6: "Earn external review rating of "green," on average, on making progress in the following research focus areas:

- Chart the distribution of life-sustaining environments within our Solar System, and search for evidence of past and present life.
- Identify plausible signatures of life on other worlds.

PROGRAM PLANS FOR FY 2002

- 2001 Mars Odyssey took its first thermal infrared temperature image of Mars on 10/31/01; the image was an indication that the imaging system is working properly. The main science-mapping mission is expected to begin in early February 2002, and will continue throughout FY 2002.
- 2003 Mars Exploration Rover: 1st and 2nd flight systems will start Assembly, Test, and Launch Operations and environmental testing in Feb. 2002.
    - Mars Express: the US provided instruments (Radar Sounder (MARSIS) Antenna and Transmitter and RF subsystems) will be completed and delivered to ESA by the end of 2nd qtr. FY 2002.
    - 2005 Mars Reconnaissance Orbiter (MRO), NASA selected Lockheed Martin Astronautics as the spacecraft provider in October 2001, and selected all the instruments and science investigations in November 2001. A preliminary Design Review (PDR) and a Non-Advocate Review (NAR) is scheduled in the 4th qtr. of FY 2002, which will initiate a start of Phase C/D for the project also during the 4th qtr. FY 2002.
- JPL Flight Project Management Facility: refer to Mission Support – Construction of Facilities section.
- Future Mars
    1. An Announcement of Opportunity for the 2007 Mars Scout will be released in the 3rd QTR of FY 2002, allowing the mission to enter into formulation phase.
    2. U.S. contributions to both 2007 International Mars missions (CNES Orbiter and ASI Telecom) will enter into formulation phase.
    3. Mars Technology - NASA will continue to actively develop new instrument technology that could unlock the mysteries of the Martian climate and geological history through FY 2002. NASA will also continue to develop Mars-focused technologies (i.e. precision landing/aerocapture/hazard avoidance, new in-situ sensor, power and fuel production) that would enable a launch of a Smart Lander/Mobile Laboratory mission in 2009.

4. The construction and outfitting for the Deep Space Network (DSN) 34-meter Beam-Wave-Guide (BWG) Antenna in Spain to meet DSN mission loading requirements in FY 2003/04 will be ongoing throughout FY 2002.

PROGRAM PLANS FOR FY 2003

- 2001 Mars Odyssey will continue its primary science mapping throughout FY 2003.
- 2003 Mars Exploration Rovers (MER) will complete the final assembly, integration and test by the end of the 1st QTR of FY 2003. MERs will be shipped to the Kennedy Space Center (KSC) for final assembly in preparation for launches in May and June 2003. The rovers are scheduled to land on the surface of Mars in January 2004.
- Mars Express is scheduled for launch in June 2003, followed by Mars Orbit Insertion (MOI) in December 2003.
- 2005 Mars Reconnaissance Orbiter (MRO) will proceed with the full-scale implementation phase in FY 2003. A mission Critical Design Review (CDR) is expected in the 4th QTR of FY 2003.
- JPL Flight Project Management Facility: refer to Mission Support – Construction of Facilities section.
- Future Mars

1. A Step 1 selection (concept study) for the competitively selected 2007 Mars Scout mission will occur in the 1st QTR of FY 2003, followed by a Step 2 selection (flight development) in 4th QTR of FY 2003.
2. 2007 CNES Orbiter will be entering into a preliminary design of a cooperative science and technology validation by CNES and NASA, delivering NetLander science stations and other experiments.
3. 2007 ASI Telecom Orbiter (G. Marconi) will start Phase A, and will initiate and complete trade studies for different spacecraft designs and orbits in FY2003. At the end of FY 2003, 2007 ASI Telecom Orbiter will complete a Systems Requirements Review (SRR).
4. For fiscal year 2003 the Mars technology program will attend to focused technology critical to the success of the 2009 Smart Lander Mission (focused), and multimission technologies. Focused technologies include: entry, descent, and landing; surface power; and in-situ sample preparation, handling and analysis. The base or multi-mission technologies include: science instruments and systems; regional mobility and subsurface access; telecom and navigation; transportation and orbit insertion; advanced entry, descent, and landing; and information systems integration.
5. The construction for the Deep Space Network (DSN) 34 meter Beam Wave Guide (BWG) Antenna in Spain will be completed by the 3rd QTR of FY03. Outfitting, electronics installations, testing and integration will continue throughout FY03. This antenna will be fully operational by 1st QTR of FY04.

BASIS OF FY 2003 FUNDING REQUIREMENT

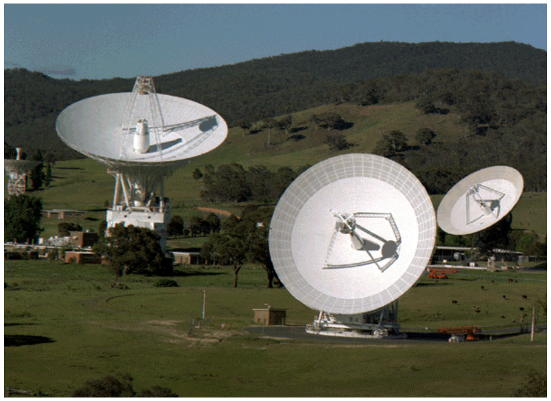
Space Science Mission Operations

Web Address: http://spacescience.nasa.gov/missions/index.htm

	FY 2001	FY 2002	FY 2003
Astronomy and Physics Operations	12.0	14.9	20.4
Sun-Earth Connections Operations	6.9	37.0	43.5
Mars Operations	18.0	24.8	26.0
Solar System Operations	85.9	98.1	295.3
Space Science Mission Operations *	**122.8**	**174.8**	**385.2**

* Includes transfer of the Deep Space Network and Mission Services from the Office of Space Flight in FY 2002/2003

MISSION OPERATIONS PROGRAM GOALS

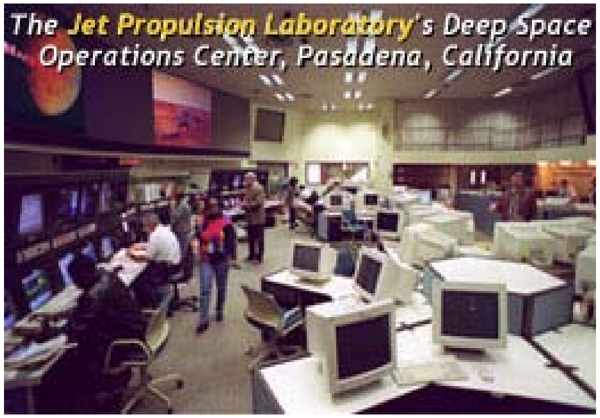


- Maximize the scientific return from NASA's investment in spacecraft and other data collection sources by efficiently operating the data-collecting hardware that produces scientific discoveries, and maintaining the operational effectiveness of that hardware.
  - Funding supports spacecraft operations during the performance of the core missions plus extended operations of selected spacecraft.
- Work to dramatically reduce costs while preserving, to the greatest extent possible, science output.
  - Accept prudent risk, explore new conceptual approaches, streamline management and make other changes to enhance efficiency and effectiveness.
  - Utilize the savings, and seek additional cost reductions, in order to sustain operations of ongoing missions as long as is merited by the science return.

The science community both inside and outside of NASA regularly reviews the mission operations program to ensure that only the missions with the highest science return are funded.

DESCRIPTION / JUSTIFICATION

As of the end of December 2001, there are 25 operational Space Science missions (26 spacecraft), in addition to participation in seven foreign missions (ten spacecraft).



At the end of FY 2003, we expect to have as many as 28 operational Space Science missions (30 spacecraft), in addition to participation in eight foreign missions (eleven spacecraft).

While the cost of operating our missions has continued to decline, the budget for Space Science Mission Operations grows significantly from FY 2002 to FY 2003. This is due to the transfer of responsibilities from the Office of Space Flight (Space Operations) for the Deep Space Network and for Mission Services, which are described below. See page MY-2 for a normalized comparison of NASA's FY 2001, FY 2002, and FY 2003 budgets.

Beginning in FY 2003, the budget for the Deep Space Network (DSN) is included in Space Science, consistent with "full cost" budgeting and management. The transfer of management responsibility for the DSN to the Office of Space Science has already begun. JPL is working with its industry contract partners to transform the DSN and associated mission operations system architecture into a service provision system known as the Deep Space Mission System (DSMS). The DSMS will provide a customer-oriented, turnkey service that seamlessly integrates the facilities of the DSN and the Advanced Multi-Mission Operations System (AMMOS). This system will enable more efficient provision of currently available services as well as the creation of entirely new services.

The overall purpose of the DSMS program is to enable Space Science missions by providing:

- Cost-effective and reliable telecommunications services
- Cost-effective and reliable mission-operations tools, services and engineering support
- Extensions of telecommunications and mission-operations capabilities
- New technologies for telecommunications and mission operations

The DSN includes the Goldstone Deep Space Communications Complex (GDSCC) in California, the Madrid Deep Space Communications Complex (DSCC) in Spain, and the Canberra Deep Space Communications Complex (CDSCC) in Australia. The DSN plans to provide approximately 84,000 hours of tracking support to over 50 missions during FY 2002 and FY 2003. These include NASA, NASA cooperative and reimbursable spacecraft launches. Special tracking coverage is provided in support of spacecraft emergencies and anomalies. The number of missions serviced by the DSN facilities and the requirements of the individual missions will increase dramatically over the next several years. In anticipation of the increases, new antenna systems have been developed and obsolete systems will be phased out or converted for alternate uses. More information about the Deep Space Network is available at http://deepspace.jpl.nasa.gov/dsn/

The Planetary Flight Support (PFS) program provides ground system hardware, software, and mission support for all deep-space missions. Planetary Flight Support has recently focused on the design and development of multi-mission ground operation systems for deep space and high-Earth-orbiting spacecraft, including generic multi-mission ground system upgrades such as the Advanced Multi-Mission Operations System (AMMOS). This new capability is designed to significantly improve our ability to monitor spacecraft systems, resulting in reduced workforce levels and increased operations efficiencies for Cassini and future planetary missions. New missions in the Discovery, Mars Surveyor, and New Frontiers programs will work closely with the Planetary Flight Support Office to design ground systems developed at minimum cost, in reduced time, with greater capabilities, and able to operate at reduced overall mission operations costs.

In addition to the transfer of the DSN, starting in FY 2002 the Space Science budget includes funding for Mission Services for Space Science missions, previously funded in Space Operations.

CURRENT / PROJECTED MISSIONS IN OPERATION:

The following is a comprehensive list of all Space Science spacecraft that are, or are expected to be, operational at any time between January 2002 and September 2003. Those missions whose end is specified to be "Beyond 2003" will be subjected to future review by the science community. This is to ensure that only the missions with the highest science return are funded.

MISSION	LAUNCH DATE	MISSION END	Mission Objectives
Advanced Composition Explorer (ACE)	**8/25/97**	**Beyond 2003**	The spacecraft is the primary provider of real-time space weather measurements of the solar wind; also the spacecraft provides data on the composition of the solar wind and energetic particle events from the Sun.
Cassini	**10/15/97**	**~2008**	Conduct detailed exploration of the Saturnian system including: 1) the study of Saturn's atmosphere, rings and magnetosphere; 2) remote and in-situ study of Saturn's largest moon, Titan; 3) the study of Saturn's other icy moons; and 4) a Jupiter fly-by to expand our knowledge of the Jovian System. During the trip from Jupiter to Saturn, Cassini will conduct unique radio-science measurements designed to detect ripples of gravitational field produced by catastrophic events in the galaxy. Cassini will arrive at Saturn in 2004.

MISSION	LAUNCH DATE	MISSION END	Mission Objectives
Chandra X-ray Observatory (CXO)	**7/23/99**	**~2009**	Obtain high-resolution x-ray images and spectra in the 0.1-to-10-KeV wavelength range; investigate the existence of stellar black holes; study the contribution of hot gas to the mass of the universe; investigate the existence of dark matter in galaxies; study clusters and superclusters of galaxies; investigate the age and ultimate fate of the universe; study mechanisms by which particles are accelerated to high energies; confirm the validity of basic physical theory in neutron stars; investigate details of stellar evolution and supernovae.
Cluster	**8/9/00**	**Beyond 2003**	Cluster is a European Space Agency program with major NASA involvement. The four Cluster spacecraft carry out three-dimensional measurements in the Earth's magnetosphere.
Comet Nucleus Tour (CONTOUR)	**July 2002**	**Beyond 2003**	Dramatically improve knowledge of key characteristics of comet nuclei, and assess their diversity, by making close approaches to at least two comets.
Cosmic Hot Interstellar Plasma Spectrometer (CHIPS)	**August 2002**	**2003**	Use an extreme ultraviolet spectrograph to study the "Local Bubble," a tenuous cloud of hot gas surrounding our Solar System that extends about 300 light-years from the Sun.
Fast Auroral SnapshoT (FAST)	**8/21/96**	**2003**	Explore the regions of the lower magnetosphere that generate the fast currents of charged particles that create the auroras.
Far Ultraviolet Spectroscopic Explorer (FUSE)	**6/24/99**	**Beyond 2003**	Measure abundances of deuterium produced by the Big Bang, the Milky Way, and distant galaxies; determine the origin and temperature of galactic gaseous clouds and observe interaction between the solar wind and planetary atmospheres.
Galaxy Evolution Explorer (GALEX)	**May 2002**	**Beyond 2003**	Use an ultraviolet telescope to explore the origin and evolution of galaxies and the origins of stars and heavy elements. Detect millions of galaxies out to a distance of billions of light years and conduct an all-sky ultraviolet survey.

MISSION	LAUNCH DATE	MISSION END	Mission Objectives
Galileo	**10/18/89**	**2003**	Execute a series of close flybys of Jupiter and its moons, studying surface properties, gravity fields and magnetic fields, and characterizing the magnetospheric environment of Jupiter and the circulation of its Great Red Spot.
Genesis	**8/8/01**	**2004**	Collect samples of the charged particles in the solar wind and return them to Earth laboratories for detailed analysis.
Geotail	**7/24/92**	**Beyond 2003**	Geotail is a Japanese program with major NASA involvement. The primary objective is to study the dynamics of the Earth's magnetotail over a wide range of distance.
Gravity Probe B	**October 2002**	**Beyond 2003**	Use extremely precise gyroscopes to test Einstein’s theory of General Relativity.
High Energy Solar Spectroscopic Imager (HESSI)	**January 2002**	**Beyond 2003**	Study the physics of particle acceleration and energy release in solar flares.
Highly Advanced Laboratory for Communications and Astronomy (HALCA)	**2/12/97**	**2002**	HALCA is a Japanese program with major NASA involvement. HALCA allows imaging of astronomical radio sources with significantly improved resolution over ground-only observations.
High Energy Transient Experiment (HETE 2)	**10/9/00**	**Beyond 2003**	Carry out a multiwavelength study of gamma ray bursts (GRBs) with UV, X-ray, and gamma ray instruments. A unique feature of the mission is its capability to localize bursts with several arcsecond accuracy in near real-time aboard the spacecraft.
Hubble Space Telescope (HST)	**4/24/90**	**2010**	HST is an operational program that continues to generate major scientific discoveries. HST's instruments provide scientific data in the ultraviolet, visible, and near infrared regions of the electromagnetic spectrum.
Imager for Magnetopause-to-Aurora Global Exploration (IMAGE)	**2/15/00**	**Beyond 2003**	Study the global response of the Earth's magnetosphere to changes in the solar wind.
International Gamma-Ray Astrophysics Laboratory (INTEGRAL)	**October 2002**	**Beyond 2003**	INTEGRAL is a European Space Agency program with major NASA involvement, dedicated to fine spectroscopy and fine imaging of celestial gamma ray sources, with concurrent source monitoring in the X-ray and optical energy ranges.

MISSION	LAUNCH DATE	MISSION END	Mission Objectives
Microwave Anisotropy Probe (MAP)	**6/30/01**	**Beyond 2003**	Probe conditions in the early universe by measuring the properties of the cosmic microwave background radiation over the full sky.
Mars Global Surveyor, (MGS)	**11/7/96**	**Beyond 2003**	Global mapping of the Martian atmosphere, surface, magnetic field. Also provide relay capability for the 2003 Mars Exploration Rovers.
2001 Mars Odyssey	**4/7/01**	**Beyond 2003**	Determine the elemental and chemical composition of the Martian surface.
2003 Mars Exploration Rovers (MER)	**May / July 2003**	**Beyond 2003**	Learn about ancient water and climate on Mars; read the geological record at its landing site and learn what the conditions were like when the rocks and soils were formed.
Mars Express	**June 2003**	**Beyond 2003**	Mars Express is a European Space Agency / Italian program with major NASA involvement, which will explore the atmosphere and surface of Mars from polar orbit.
Nozomi	**7/3/98**	**Beyond 2003**	Nozomi is a Japanese program with major NASA involvement, and will study the structure and dynamics of the atmosphere and ionosphere of Mars, including any interactions with the solar wind.
Polar	**2/24/96**	**Beyond 2003**	Measure the properties of the Earth's magnetosphere in the equatorial regions
Rosetta	**January 2003**	**Beyond 2003**	Rosetta is a European Space Agency program with major NASA involvement, which will rendezvous with a comet.
Rossi X-ray Timing Explorer (RXTE)	**12/30/95**	**Beyond 2003**	Study time variability in the emission of X-ray sources. This time behavior is a source of important information about processes and structures in white-dwarf stars, X-ray binaries, neutron stars, pulsars and black holes.
Student Nitric Oxide Explorer (SNOE)	**2/26/98**	**Beyond 2003**	Investigate the effects of energy from the sun and magnetosphere on the density of nitric oxide in the Earth's upper atmosphere.

MISSION	LAUNCH DATE	MISSION END	Mission Objectives
Stardust	**2/7/99**	**2006**	Rendezvous with Comet Wild-2, in January 2004, and return samples of comet dust to Earth.
Space InfraRed Telescope Facility (SIRTF)	**No earlier than December 2002**	**Beyond 2003**	Explore: - The cold Universe by looking at heat radiation from objects which are too cool to radiate at optical and ultraviolet wavelengths; - The hidden Universe by penetrating into dusty regions which are too opaque for exploration in the other spectral bands; - The distant Universe by virtue of the cosmic expansion, which shifts the ultraviolet and visible radiation from distant sources into the infrared spectral region.
Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX)	**7/3/92**	**2003**	Study a wide range of solar, heliospheric, and magnetospheric scientific questions using observations of energetic particles observed from a nearly polar, low Earth orbit.
Solar and Heliospheric Observatory (SOHO)	**12/2/95**	**Beyond 2003**	SOHO is an ESA/NASA program to observe the Sun without interruption, to learn more about the solar interior, the heating of the solar corona, and the acceleration of the solar wind and solar energetic particles.
Submillimeter Wave Astronomy Satellite (SWAS)	**12/5/98**	**2002**	Study the chemical composition, energy balance and structure of interstellar clouds and the processes that lead to the formation of stars and planets.
Swift Gamma Ray Burst Explorer	**September 2003**	**Beyond 2003**	Study the position, brightness, and physical properties of gamma ray bursts.
Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics (TIMED)	**12/7/01**	**Beyond 2003**	Determine the temperature, density, and wind structure in the mesosphere/lower thermosphere/ionosphere region, including seasonal and latitudinal variations; determine the relative importance of various sources and sinks of energy for the thermal structure of the MLTI.
Transition Region and Coronal Explorer (TRACE)	**4/2/98**	**Beyond 2003**	Make definitive analyses of the heating and dynamics of all regions of the solar atmosphere simultaneously; coordinate TRACE observations with SOHO data; and provide new insights on coronal heating and other solar phenomena.

MISSION	LAUNCH DATE	MISSION END	Mission Objectives
Ulysses	**10/6/90**	**Beyond 2003**	Explore interplanetary solar material at high solar latitudes.
Voyager	**8/20/77, 9/5/77**	**Beyond 2003**	The two Voyager spacecraft are exploring the properties and dynamics of the outer heliosphere beyond Pluto.
Wind	**11/1/94**	**Beyond 2003**	Provide complete plasma, energetic particle, and magnetic field input for magnetospheric and ionospheric studies and determine the magnetospheric output to interplanetary space in the up-stream region. Investigate basic plasma processes occurring in the near-Earth solar wind.
X-Ray Multi-Mirror (XMM)	**12/10/99**	**Beyond 2003**	XMM is an X-ray astrophysics observatory developed by the European Space Agency, with U.S. participation. XMM enables sensitive X-ray spectroscopic observations of a wide variety of cosmic sources.
Yohkoh	**8/30/91**	**2003**	Find explanations for solar X-ray and gamma-ray emissions

BASIS OF FY 2003 FUNDING REQUIREMENT

TECHNOLOGY PROGRAM

	FY 2001	FY 2002	FY 2003
Focused Programs	294.9	369.0	636.1
Astronomical Search for Origins	111.1	195.5	278.8
Solar System Exploration	112.4	102.9	218.0
Sun-Earth Connections	46.3	56.9	117.8
Structure & Evolution of the Universe	25.1	13.7	21.5
New Millennium Program	21.6	60.2	62.8
Technology Planning	36.6	11.0	5.0
Total	**353.2**	**440.2**	**703.9**

TECHNOLOGY CROSSWALK from FY 2002 to FY 2003

Technology Program (FY 2002 Budget Structure)	Technology Program (FY 2003 Budget Structure)	Comments
Focused Programs	Focused Programs	No change
Astronomical Search for Origins	Astronomical Search for Origins	No change
Solar System Exploration	Solar System Exploration	No change
Sun-Earth Connections	Sun-Earth Connections	No change
Structure and Evolution of the Universe	Structure and Evolution of the Universe	No change
New Millennium Program	New Millennium Program	No change
Core Program	Technology Planning	Name/content change
Explorer Planning	Explorer Planning	Deleted at end of FY 2001
High Performance Computing	High Performance Computing	Deleted at end of FY 2001
Gossamer Technology	Gossamer Technology	Deleted at end of FY 2002
Space Solar Power	Space Solar Power	No funding budgeted after FY 2002
Next Decade Planning	Next Decade Planning	No change
Planetary Fight Support		Moved to Mission Operations
Information Systems		Moved to Data Analysis

DESCRIPTION / JUSTIFICATION

TECHNOLOGY PROGRAM GOAL

Develop new technologies to enable innovative and less expensive research and flight missions.

TECHNOLOGY PROGRAM OBJECTIVES

(1) Acquire new technical approaches and capabilities
(2) Validate new technologies in space
(3) Apply and transfer technology

TECHNOLOGY PROGRAM CONTENT

FOCUSED PROGRAMS

Focused Programs are dedicated to high-priority technologies needed for specific science missions. Space Science programs use an aggressive technology development approach that requires all major technological hurdles to be cleared prior to a science mission's development phase. Technology activities can encompass developments from basic research all the way to infusion into science missions. Focused Programs also includes mission studies -- the first phase of the flight program development process. Scientists work collaboratively with technologists and mission designers to develop the most effective alignment of technology development programs with future missions. This collaboration enables intelligent technology investment decisions through detailed analysis of the trade-offs between design considerations and cost. In order to ensure that the decisions resulting from mission studies are realistic and can be implemented, the studies employ new techniques for integrated design and rapid prototyping.

The FY 2003 budget includes four categories of activities under focused programs, corresponding to the four scientific themes of the Space Science Enterprise:

- Astronomical Search for Origins (http://origins.jpl.nasa.gov/)
- Solar System Exploration (formerly known as Advanced Deep Space Systems Development) (http://solarsystem.nasa.gov/)
- Sun-Earth Connections (http://sec.gsfc.nasa.gov/)
- Structure and Evolution of the Universe (http://universe.gsfc.nasa.gov/)

The major missions and technologies under development within these Themes are described on the following pages.

Keck Interferometer ***http://huey.jpl.nasa.gov/keck/***
Astronomical Search for Origins Focused Technology project

Objectives:
- Detect and study planetary systems around other stars
    - Detect dust clouds around other stars
    - Detect the signature of planets as small as Uranus orbiting stars as distant as about 75 light-years away
    - Detect and characterize the atmospheres of hot, Jupiter mass planets
    - Make images of proto-stellar disks and stellar debris disks

Funding:

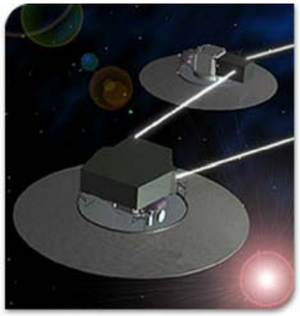
FY 2001	FY 2002	FY 2003
10.5	6.2	9.3

Critical New Technologies Demonstrated:
- Routine operation of a large-aperture optical interferometer on the ground

Key Milestones:	FY 2002 BUDGET DATE	FY 2003 BUDGET DATE	COMMENT
Fringe Detection	FY 01	February 2001	First combination of light from separate sources
Combine 2 telescopes	FY 01	May 2001	First combination of light from 2 main telescopes
Install first outrigger	TBD	4Q/FY 2003	Assumes permits received by May 2002

StarLight　　　***http://starlight.jpl.nasa.gov***
Astronomical Search for Origins Focused Technology mission

StarLight concept



Objectives:

- Demonstrate precision formation flying of two spacecraft
- Demonstrate separated spacecraft optical interferometry
  - Technologies required for Terrestrial Planet Finder and/or other future space observatories

Funding:

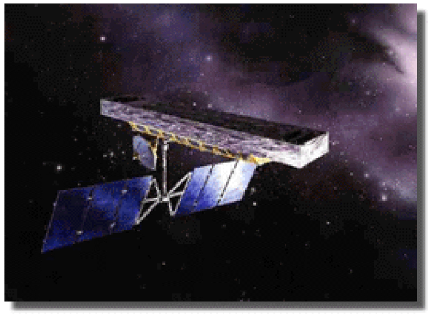
FY 2001	FY 2002	FY 2003
14.5	28.7	67.3

Key Formulation Milestones:	FY 2002 BUDGET DATE	FY 2003 BUDGET DATE	COMMENT
System Architecture Review	FY 01	2Q/FY02	
Preliminary Design Review	FY 02	2Q/FY03	
Implementation Start	TBD	3Q/FY03	
Critical Design Review	FY 03	FY 04	Delays in technology readiness

Space Interferometry Mission (SIM) ***http://sim.jpl.nasa.gov***

Astronomical Search for Origins Focused Technology mission

SIM concept



Objectives:

- Search 200 nearby stars for planets that are as small as three times the mass of the Earth
- Survey ~2000 stars to find planetary systems like our own, to place our solar system in context
- Study the birth of planetary systems around young stars
- Demonstrate the high-precision interferometry tools that will be needed by future space telescopes, including (potentially) Terrestrial Planet Finder

Funding:

FY 2001	FY 2002	FY 2003
29.7	34.9	39.5

Critical New Technologies Required:

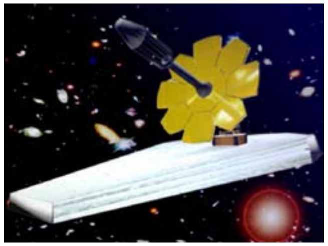
- Precision Metrology
- Vibration Isolation And Structural Quieting Systems
- Optical Delay Lines

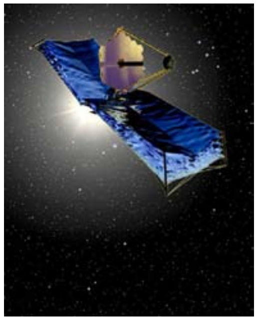
Key Formulation Milestones:	FY 2002 BUDGET DATE	FY 2003 BUDGET DATE	COMMENT
Metrology Testbed Demonstration	FY 02	4Q/FY02	
Systems Requirements Review	TBD	FY 04	Schedule was under review last year
Non-Advocate Review	TBD	FY 05	Schedule was under review last year

Next Generation Space Telescope (NGST) ***http://ngst.gsfc.nasa.gov***

Astronomical Search for Origins Focused Technology mission

NGST concepts





Objectives:

- investigate the early Universe by observing the first stars and galaxies
- understand the formation and subsequent evolution of galaxies
- uncover the "fossil record" of star formation for our Galaxy and dozens of neighboring galaxies
- use infrared light to see deeper inside star-forming dust clouds and measure their structures, enabling further understanding of star and planet formation
- Demonstrate the large aperture development, deployment, and management techniques that will be needed by future space telescopes, including (potentially) Terrestrial Planet Finder

Funding:

FY 2001	FY 2002	FY 2003
45.1	92.1	126.2

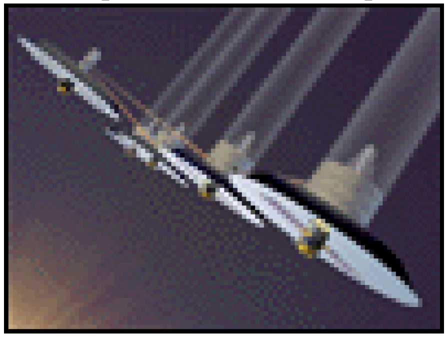
Critical New Technologies Required:

- Cryogenic lightweight deployables
- Active lightweight optics
- Low-noise, near-infrared and mid-infrared detectors
- Image-based wavefront sensing algorithms and techniques

Key Formulation Milestones:	FY 2002 BUDGET DATE	FY 2003 BUDGET DATE	COMMENT
Spacecraft contractor selection	n/a	3Q/FY02	
System Definition Review	n/a	1Q/FY03	
Implementation Start	FY 04	FY 04	

Terrestrial Planet Finder (TPF) ***http://tpf.jpl.nasa.gov***
Astronomical Search for Origins Focused Technology mission

One possible TPF concept



Objectives:
- Directly detect Earth-like planets around other stars
- Detect chemical signatures indicating whether a planet could support life as we know it

Funding:

FY 2001	FY 2002	FY 2003
5.5	17.8	19.7

Critical New Technologies Required:
Depends upon selected mission architecture, but may include:
- Precision formation flying
- Separated spacecraft optical interferometry
- Passive cooling of telescope and detectors
- Active optics
- High contrast imaging

Key Formulation Milestones:	FY 2002 BUDGET DATE	FY 2003 BUDGET DATE	COMMENT
Test nulling breadboard	FY 01	February 2001	
Architecture Plan	FY 02	2Q / FY 02	
Implementation Start	FY 08	TBD	Dependent on technology progress

New Horizons Pluto-Kuiper Belt Mission **http://pluto.jhuapl.edu**
Solar System Exploration Focused Technology mission

Objectives:
- Characterize the global geology and morphology of Pluto and Charon
- Map surface composition of Pluto and Charon
- Characterize the neutral atmosphere of Pluto and its escape rate

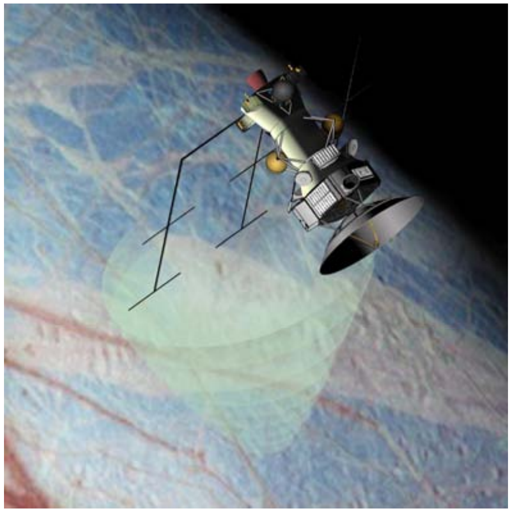
Funding:

FY 2001	FY 2002	FY 2003
	30.0	

Critical New Technologies Required:
- None

Status:
- Congressional direction in the Fiscal 2002 appropriation provided funding and program direction to initiate PKB spacecraft and science instrument development and launch vehicle procurement
- No funding for FY 2003 or subsequent years is included in this budget request; the application of all available funding from the Solar System Exploration Focused Technology Program in FY 2003 to this mission would be insufficient to meet mission requirements
- "New Horizons: Shedding Light on Frontier Worlds" selected on November 29, 2001 to proceed with Phase B (preliminary design studies)
- Scientific value is highly dependent on an ambitious schedule (NEPA and launch vehicle qualification) for a 2006 launch that achieves flyby of Pluto NLT 2020

Europa Orbiter/X-2000 ***http://www.jpl.nasa.gov/europaorbiter***
Solar System Exploration Focused Technology mission



Due to high cost growth and schedule delays, the Europa Orbiter mission is cancelled. Because other Space Science missions rely on X-2000 deliveries, funding to complete the X-2000 avionics package is continued. The X2000 hardware is the next generation of high performance, radiation hardened, space flight avionics. The technologies are targeted for deep space missions, but are applicable to other NASA, commercial or DOD missions.

Objective:
- Develop high performance, low power, low mass core electronics, which can be used in a plug and play mode
- Provide a steady progression of advanced, reusable, common software technology within a flexible, but complete architecture framework that enables rapid spacecraft development/deployment

Salient Features:
- Radiation Hardened Avionics
- Next Generation Autonomy
- Long Life (14 years)/High Reliability Electronics
- Potential Mission Customers: Deep Impact, ST5 (Nanosat Constellation Trailblazer), Mars 05 and 07, SIM, DoD

Status:
- Focus in FY 2002 is directed towards X-2000 avionics development
- X-2000 Avionics effort re-planned for more realistic schedules accounting
- Adjusted schedules based on experience with other recently completed X2000 tasks
- Accounts for limited personnel availability in key skills
- Greater rigor of incremental technical reviews
- Distributed schedule margins through each development, rather than at end
- Greater conservatism in planning developments requiring unproven capabilities

Funding:

FY 2001	**FY 2002**	**FY 2003**
87.3	30.8	30.0

Nuclear Power Program
Solar System Exploration Focused Technology

The Nuclear Power Program is one of three new nuclear technology elements included in this budget. The other two elements are the Nuclear Electric Propulsion Program (discussed on the following page), and the incorporation of a nuclear power system on the Mars 2009 Smart Lander/Mobile Laboratory mission (discussed under the Mars Exploration Program).

Objective:

- Dramatically increase the potential scientific return of missions by:
  - Increasing the operational lifetime and productivity of spacecraft and instruments
  - Enabling multiple landers on a single mission
  - Providing energy for high-power planetary survey instruments for remote sensing and deep atmosphere probes
  - Allowing high bandwidth communications
- Planetary exploration missions are otherwise reliant on solar energy power generation and battery power storage systems
- Nuclear power offers an increase in overall science productivity by one to two orders of magnitude over solar power

Funding:

FY 2001	FY 2002	FY 2003
		79.0

Salient Features:

- Management oversight responsibility for the Nuclear Power Program will be assigned to the Glenn Research Center
- Funding supports parallel path competition during first two years between two alternate technologies: radioisotope thermoelectric generators (RTGs) and Stirling power generators
- Purchase of nuclear fuel will be handled through the Department of Energy
- Program also provides for technology developments for advanced instruments and for an advanced radioisotope power system

Nuclear Electric Propulsion Program

Solar System Exploration Focused Technology

The Nuclear Electric Propulsion Program is one of three new nuclear technology elements included in this budget. The other two elements are the Nuclear Power Program (discussed on the previous page), and the incorporation of a nuclear power system on the Mars 2009 Smart Lander/Mobile Laboratory mission (discussed under the Mars Exploration Program). A nuclear electric propulsion engine would use a nuclear power source to generate electricity and propel ionized gas out of a rocket nozzle. This is potentially a much more efficient way to accelerate spacecraft than using chemical rockets, creating much more thrust per pound of fuel.

Objectives:

- Significantly reduces the cruise time for spacecraft to reach distant targets
- Allows the use of smaller launch vehicles thereby reducing total mission costs
- Enables entire new class of planetary exploration missions with multiple targets
- Saves operation costs by reducing the amount of time a spacecraft is in its operations phase
- Reduces or eliminates launch windows required for gravity assists

Funding:

FY 2001	FY 2002	FY 2003
		46.5

Salient Features:

- Management oversight responsibility for the Nuclear Electric Propulsion Program will be assigned to the Marshall Space Flight Center, with significant participation from the Glenn Research Center
- This is a technology development program; it does not include the cost of potential flight units
- Resolution of key subsystem design issues in 2003: e.g., 9,000 sec ion engine proof-of-concept, 50 kg/kW reactor power subsystem design, Brayton preliminary design
- Technology assessments at Systems Readiness Review (2003) and Preliminary Design Review (2005) provide key decision points
- Transitions to flight demonstration programs in about 2005 only after clear milestones have been achieved
- Operation of reactor, power conversion and thruster engineering design units (EDU) by 2005 to provide reference for flight system design

In-Space Propulsion

Solar System Exploration Focused Technology (in FY 2001 and prior years, funding for In-Space Propulsion was carried in the Aerospace Technology Enterprise)

Objectives:

- Reduce or eliminate need for gravity assists; launch any year
- Shorter trip times
- Ability to reach new science vantage points and modify orbits during observational phase
- Minimize launch vehicle requirements to reduce cost
- Increase payload delivery capability – more mass for science, greater margins
- Includes funding for Propulsion Research Laboratory Construction ($22.0M) in FY 2002, consistent with the Congressional earmark in the FY 2002 appropriation

Funding:

FY 2001	FY 2002	FY 2003
	41.6	62.5

Critical New Technologies Required:

High Priority

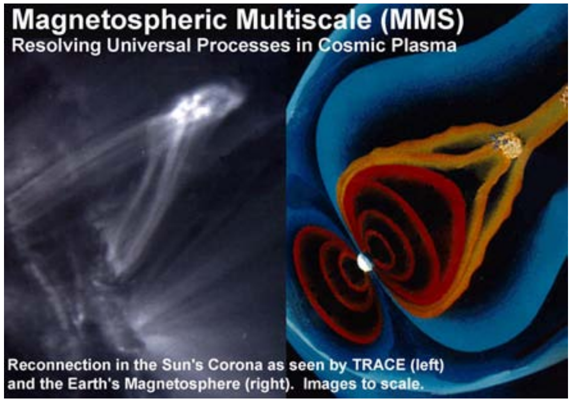
- Next Generation Ion Engine
- Aerocapture
- Advanced funding for Nuclear Electric Propulsion (NEP) in FY 2002
- Solar Sails

Medium Priority

- High Power Electric Thrusters
- Solar Electric Propulsion Hall Thrusters
- Advanced Chemical

Magnetospheric Multiscale (MMS) **http://stp.gsfc.nasa.gov/missions/mms/mms.html**

Sun-Earth Connections (SEC) Focused Technology mission



Objectives:

- MMS will determine the small-scale basic plasma processes that transport, accelerate and energize plasmas in thin boundary and current layers -- and which control the structure and dynamics of the Earth's magnetosphere.
- MMS will for the first time measure the 3D structure and dynamics of the key magnetospheric boundary regions, from the subsolar magnetopause to the distant tail.
- MMS will pave the way for future Constellation-type missions.

Funding:

FY 2001	FY 2002	FY 2003
.5	2.3	9.0

Critical New Technologies Required:

- Make advances in spacecraft systems miniaturization and small satellite manufacturing techniques.
- Advances in instrument miniaturization, data systems, spacecraft attitude control, inter-spacecraft communication, spacecraft autonomous operation, and ground operations.

Key Formulation Milestones:	FY 2002 BUDGET DATE	FY 2003 BUDGET DATE	COMMENT
Release Draft AO of MMS ISST	03/02	03/02	(Instrument Suite Science Team)
ISST Proposals Due	08/02	08/02	
Initiate Phase A Study	11/02	11/02	

Solar Dynamics Observatory (SDO) ***http://lws.gsfc.nasa.gov/sdo.htm***
Sun-Earth Connections (Living With a Star) Focused Technology mission

Objective:

- Observe the Sun's dynamics to further our understanding of the nature and source of the Sun's variations, from the stellar core to the turbulent solar atmosphere.

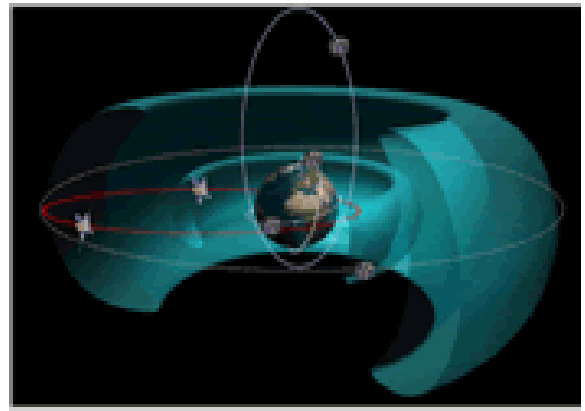
Funding:

FY 2001	FY 2002	FY 2003
1.7	8.6	26.6

Key Technologies: Large format, fast read-out CCDs and enhancing technologies at the subsystem or component level.

Key Milestones:	FY 2002 BUDGET DATE	FY 2003 BUDGET DATE	COMMENT
Release Announcement of Opportunity (AO)	FY 2002	Jan. 2002	
AO Awards	--	1st Qtr. FY 2003	
Preliminary Design Review (PDR)	--	FY 2004	
Confirmation Review (CR)	--	FY 2004	

Geospace Missions ***http://lws.gsfc.nasa.gov/geospace.htm***
Sun-Earth Connections (Living With a Star) Focused Technology mission



Geospace satellites studying the Earth's ionosphere and magnetosphere

Objective:

- Increase scientific understanding of how the Earth's ionosphere and magnetosphere respond to changes due to solar variability

Funding:

FY 2001	FY 2002	FY 2003
	13.3	48.5

Key Technologies: Miniaturization of Geospace Instruments

Key Milestones:	FY 2002 BUDGET DATE	FY 2003 BUDGET DATE	COMMENT
Release Instrument Announcement of Opportunity (AO)	--	4th Qtr. FY 2002	
AO Awards	--	2nd Qtr. FY 2003	

Constellation-X ***http://constellation.gsfc.nasa.gov***

Structure and Evolution of the Universe Focused Technology mission

Constellation-X concept

Constellation-X is a team of powerful X-ray telescopes that will orbit close to each other in space. These telescopes will work in unison to simultaneously observe the same distant objects, combining their data and becoming 100 times more powerful than any single X-ray telescope that has come before it.

Objectives:

- Probe the nature of black holes, ranging from those in the Milky Way galaxy that are 10-100 times as massive as the Sun, to those in the cores of distant quasars that are more than 1 million times as massive as the Sun.
- Measure chemical abundances in the universe over cosmic time, to record the history of the Universe and help build models of how the Universe may evolve in the future.
- Provide new clues to the nature of the mysterious "dark matter", which is the dominant form of mater in the Universe.

Funding:

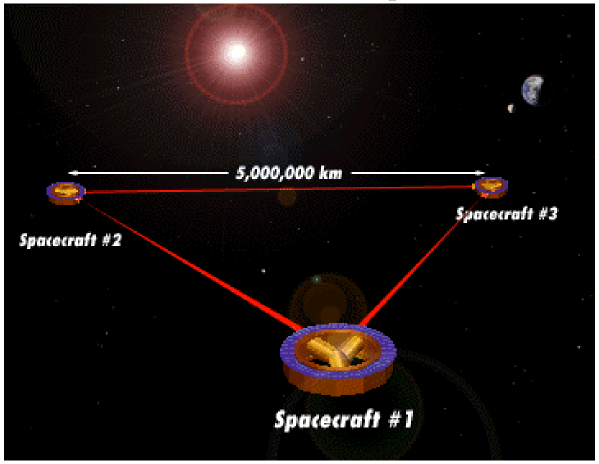
FY 2001	FY 2002	FY 2003
2.0	6.4	12.8

Key Formulation Milestones:	FY 2002 BUDGET DATE	FY 2003 BUDGET DATE	COMMENT
Complete Formulation Authorization Document	n/a	4Q / FY 03	No milestones identified in FY 2002 Budget

Laser Interferometer Space Antenna (LISA) **http://lisa.jpl.nasa.gov/**

Structure and Evolution of the Universe Focused Technology mission

LISA concept



The Laser Interferometer Space Antenna (LISA) consists of three spacecraft flying 5 million kilometers (km) apart in the shape of an equilateral triangle, as shown in the image at right. LISA will observe gravitational waves, which are one of the fundamental building blocks of our theoretical picture of the universe. Although there is strong indirect evidence for the existence of gravitational waves, they have not yet been directly detected.

Objectives:

- Observe gravitational waves from sources involving massive black holes
- Observe gravitational waves from thousands of double-star systems, and be able to determine the number and distribution of such systems in our Milky Way galaxy.
- Search for a possible cosmic background of gravitational waves, a remnant from the Big Bang.

Funding:

FY 2001	FY 2002	FY 2003
.2	6.2	7.3

Key Formulation Milestones:	FY 2002 BUDGET DATE	FY 2003 BUDGET DATE	COMMENT
Formulation Approval Document signed	n/a	2Q / FY 2003	Approval to begin Phase A study

Other Focused Technology Program Elements

In addition to the strategic missions listed above, the Focused Technology Program provides for activities in each theme that support future missions. These activities include the evaluation of mission concepts and early technology development. The goal of this work is to retire technology risk as early as possible during the lifecycle of a mission. In addition, this funding provides for the initial development of future missions after they have been evaluated and selected. The total budget for other Focused Technology Program elements is shown below, followed by a list of activities in each theme.

Funding:

FY 2001	FY 2002	FY 2003
97.9	50.1	51.9

Key Activities:

Astronomical Search for Origins

- Phase B planning funding for Herschel and GLAST in FY 2001 (see Development sections for complete lifecycle costs)
- Large Binocular Telescope Interferometer
- Interferometry Science Center
- Navigator Program Office
- Future Origins mission studies

Solar System Exploration

- Center for Integrated Space Microsystems
- Pluto-Kuiper Express (FY 2001 only; replaced by New Horizons mission in FY 2002 as shown above)
- Future Solar System Exploration missions

Sun-Earth Connections

- Phase B planning funding for STEREO in FY 2001 (see Development section for complete lifecycle costs)
- Solar Probe
- Future Solar-Terrestrial Probes (e.g., Geospace Electrodynamic Connections and Magnetospheric Constellation)
- Future Living With A Star (LWS) missions (e.g., Solar Sentinel Missions) and other LWS elements:
    - Space Environment Testbeds
    - Theory and Modeling

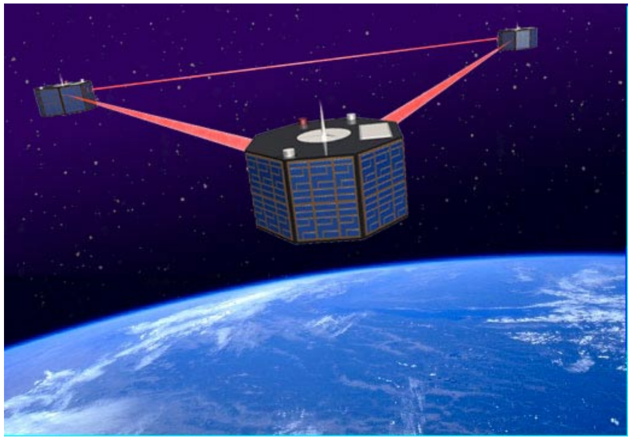
Structure and Evolution of the Universe

- Future Structure and Evolution of the Universe missions

NEW MILLENNIUM PROGRAM

The **New Millennium Program** provides a path to flight-validate key emerging technologies to enable more capable and more frequent science missions. Through the New Millennium Program, high-value technologies are made available for use in the Space Science program without imposing undue cost and risk on individual science missions. This program was restructured to increase its levels of openness and competitiveness, to reduce the size and cost of the missions, and to ensure focus on technology demonstration, versus science data gathering. The program includes validation of both complete systems and subsystems. NASA plans to enable two small ($40-50 million each) and one medium ($100-150 million) system validations every four years, along with two-to-three subsystem validations per year, including carrier and secondary launch. Partnerships with industry, universities, and other government agencies are pursued, where feasible, to maximize both the return on investment in technology development and rapid infusion.

Space Technology 5 (ST5) Concept



Milestones	FY02 Date	FY03 Date	Change	Comment
ST-5 CDR	FY02	4/02		Complete Critical Design Review
ST-6 Project Selections	FY01	--		Completed FY01
ST-7 Project Selections	FY01	--		Completed FY01
ST-8 Project Selections	--	9/02		
ST-6 Project Approval	FY01	--		Completed FY01
ST-7 Project Approval	--	2/02		
ST-8 Project Approval	--	FY03		
ST-6 Confirmation Review	FY02	6/02		
ST-7 Confirmation Review	--	FY03		
ST-8 Confirmation Review	--	FY04		
ST-6 CDR	FY02	9/02		
ST-7 CDR	--	FY03		
ST-8 CDR	--	FY04		
New Millennium Carrier-1 (NMC-1) Confirmation Review	FY02	FY03	+1 FY	ST-6 selections do not require NMC host; NMC delayed to accommodate ST-8 schedule.

NEW MILLENNIUM PROGRAM STATUS / NOTIFICATIONS / PLANS THROUGH 2002

The Space Technology-5 (ST-5) constellation of three small satellites, also called the Nanosat Constellation Trailblazer project, was confirmed for Implementation in November 2001. Results of the ST-5 project will be used to design future missions requiring constellations of lightweight, highly miniaturized spacecraft. Critical Design Review (CDR) for ST-5 is planned for completion in FY 2002.

Three Space Technology-6 (ST-6) subsystem technologies were selected for Formulation Refinement (Phase B) in October 2001. Selected technologies include a low power avionics sensor suite featuring a miniature active pixel sensor star camera and Micro Electro Mechanical System (MEMS) gyro, which provides precision attitude determination for long duration space science missions in a very low mass, very low power package. The low mass, low power characteristics of this technology free up critical spacecraft resources that can then be used for scientific payloads. Another technology, Autonomous Rendezvous, provides a demonstration of capabilities that significantly enhance in-space rendezvous operations, which are critical for space science sample return and small body landing missions. Finally, an Autonomous Sciencecraft technology demonstration uses on-board science analysis algorithms to dramatically increase science data return. Using intelligent downlink selection and data-driven science targeting, this technology will enable radically different mission operations approaches for both earth and space science missions. Confirmation reviews for the ST-6 technology experiments are scheduled for completion in FY 2002.

A Technology Announcement for the Space Technology-7 (ST-7) mission was issued to competitively solicit technology providers to join Phase A study teams for the identified system concepts: Solar Sail, Aerocapture/Aeroentry, Disturbance Reduction System, and Spacecraft Autonomy. Study reports for each concept will be evaluated and a single concept will be down-selected for Formulation Refinement (Phase B) during FY 2002.

Space Technology-8 (ST-8) represents NMP's second subsystem technology validation opportunity. ST-8 technology providers will be competitively selected during FY 2002. Phase B activities for New Millennium Carrier-1 (NMC-1) will also be initiated in order that ST-8 technology experiments each have an equal opportunity for being hosted on a carrier spacecraft. The New Millennium Carrier Project seeks to develop low cost access-to-space approaches to accommodate subsystem-level technologies (e.g., ST-6, ST-8) for flight validation. Approaches include providing a means of accommodating the flight validations via existing host spacecraft, or utilizing a small, dedicated free-flying platform to host multiple subsystem technology experiments.

NEW MILLENNIUM PROGRAM PLANS FOR FY 2003

During FY2003, the New Millennium Program plans to confirm the selected ST-7 system concept for Implementation (Phase C), receive approval to proceed to Formulation Refinement (Phase B) for the competitively selected ST-8 subsystem technology experiments, and approve NMC-1 for Implementation (Phase C) in support of ST-8. Project selections (Phase A) for Space Technology-9 (ST-9) are also planned for FY2003.

TECHNOLOGY PLANNING

As shown in the budget crosswalk at the beginning of the technology section, the Technology Planning (formerly called Core Technology) contains only one element after the end of FY 2002. This element: Next Decade Planning, supports intra-agency planning to develop and refine a robust set of potential civil space programs that could be undertaken in the next decade. This planning effort is generating roadmaps that will aid in selecting technologies aimed at enabling these future programs.

Two additional elements of the former Core Technology Program will continue after FY 2002, but have been transferred to other program elements. Planetary Flight Support (PFS) provides services such as ground system hardware, software, and mission support for all deep space missions. It also supports the development of generic multi-mission ground system upgrades such as the Advanced Multi-mission Operations System (AMMOS). Although PFS has technology development elements, it has direct and immediate benefits to the operations program, and we are transferring it to Mission Operations.

Another element of the former Core Technology Program, Information Systems, is moving into Data Analysis, where it will be called Science Data and Computing Technology. Following a detailed review of this program element, and the elimination of one of its three components after FY 2002, it has been determined that this effort is in direct support of mission data analysis, and consequently it has been moved to the Data Analysis program.

BASIS OF FY 2003 FUNDING REQUIREMENT

RESEARCH PROGRAM

	FY 2001	FY 2002	FY 2003
Research and Analysis	242.5	255.5	272.9
Data Analysis	328.9	347.3	387.2
Suborbital	41.6	41.6	44.3
Balloon Program	15.3	14.0	14.0
Sounding Rockets	26.3	27.6	30.3
Program Construction of Facilities		2.2	5.2
Total	**613.0**	**646.6**	**709.6**

DESCRIPTION / JUSTIFICATION

Scientific research is the foundation of the Space Science Enterprise. Underpinning the space science flight programs, the Research Program develops the theoretical tools and laboratory data needed to analyze flight data, makes possible new and better instruments to fly on future missions, and analyzes the data returned so that we can answer specific questions posed and fit them into the overall picture. Without a vigorous Research Program it would not be possible to conduct a scientifically meaningful flight program. Examples of the contributions of the Research Program abound across the whole frontier of space science.

RESEARCH & ANALYSIS

GOALS

- Enhance the value of current space missions by carrying out supporting ground-based observations and laboratory experiments;
- Conduct the basic research necessary to understand observed phenomena and develop theories to explain observed phenomena and predict new phenomena, thereby yielding scientific questions to motivate subsequent missions;
- Continue the synthesis, analysis, interpretation and evaluation of data from laboratories, airborne observatories, balloons, rocket experiments and spacecraft data archives;
- Develop and promote scientific and technological expertise in the U.S. scientific community.

CONTENT

The Research and Analysis Program provides grants to non-NASA research institutions throughout the Nation, and funds scientists at NASA Field Centers.

- The Enterprise NASA Research Announcement (NRA) for Research Opportunities in Space Science (ROSS) solicits proposals for basic investigations to seek to understand natural space phenomena across the full range of space science programs.
- Approximately **1,500 grants are awarded each year** after a rigorous peer-review process.
- Participation in this program is **open to all categories of U.S. and non-U.S. organizations** including educational institutions, industry, nonprofit institutions, NASA Centers, and other Government agencies.
- Only about **one out of four proposals is accepted for funding**, making this research program among the most competitive in government.
- The Program also develops new types of detectors and other scientific instruments, many of which are tested and flown aboard sounding rockets or balloons.

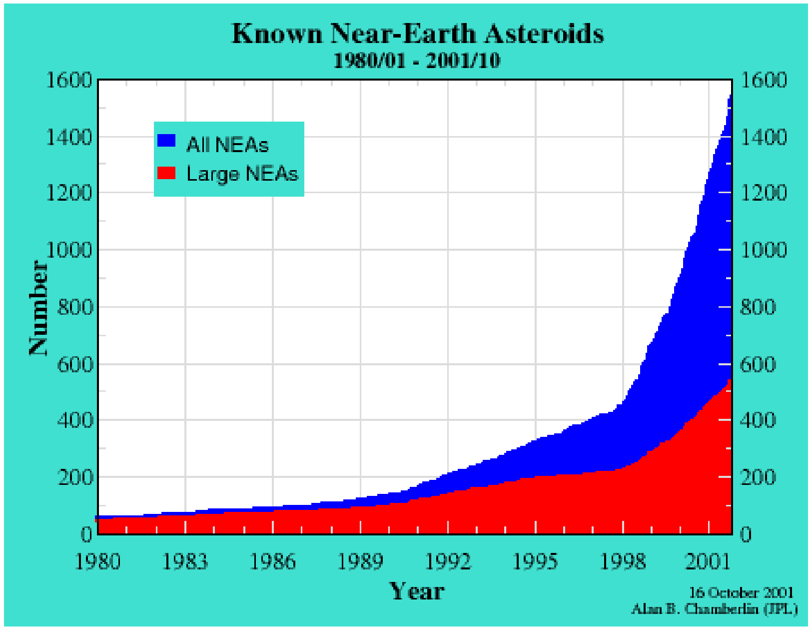
The Program also supports publication and dissemination of the results of new missions, both inspiring and enabling cutting-edge research into the fundamental questions that form the core of the mission of the Space Science Enterprise.

- Currently, with the exception of a proprietary period of up to one year for some missions, 100% of the data from current and past Space Science missions is openly available to the public via the internet; i**n the future, these proprietary periods will be phased out completely.**
- Minority and disadvantaged institutions are particularly encouraged to apply.
- Recommendations for funding are based on the independent evaluation of each proposal's science and technical merits, and its relevance to the Space Science Enterprise objectives as described in the NRA.

MILESTONES	FY 2002 BUDGET DATE	FY 2003 BUDGET DATE	CHANGE	COMMENT
Issue FY 2001 NASA Research Announcement (NRA)	2nd Qtr, FY 01	1/26/01		
Issue FY 2002 NASA Research Announcement (NRA)	2nd Qtr, FY 02	1/02		
Issue FY 2003 NASA Research Announcement (NRA)	N/A	2nd Qtr, FY 03		

MAJOR RESEARCH & ANALYSIS RESULTS IN THE PAST YEAR

Our R&A program continued to produce exciting scientific results in 2001. The Near-Earth Object (NEO) Program Office at JPL continues to focus on the goal of locating at least 90 percent of the asteroids and comets that approach the Earth and are larger than about 2/3-mile (about 1 kilometer) in diameter, by the end of the next decade. These are objects that are difficult to detect because of their relatively small size, but are large enough to cause global effects if one were to hit the Earth. Detection, tracking, and characterization of such objects are all critical. As additional telescopes and improved detectors have been added to the search, the detection rate has continued to increase. Current estimates (based on a statistical analysis of the objects located to date) are that approximately half of the NEO's have been located. More information about NEO's is available at http://neo.jpl.nasa.gov



Detailed scientific analysis of high-resolution images obtained by the BOOMERANG (Balloon Observations of Millimetric Extragalactic Radiation and Geophysics) balloon mission provided the most precise measurements to date of several of the key characteristics cosmologists use to describe the Universe. These images were the first to bring the cosmic microwave background (the radiation remaining from the "big bang" that created the Universe) into sharp focus. More information about BOOMERANG is available at http://www.physics.ucsb.edu/~boomerang/

Many discoveries in 2001 related to the rapidly growing field of extrasolar planet (planets outside our Solar System) detection. Astronomers announced the discovery of over 20 new extrasolar planets in 2001, bringing the total number of extrasolar planet detections to about eighty. The latest discoveries uncovered more evidence of what the astronomers are calling a new class of planets, with circular orbits similar to the orbits of planets in our solar system. At least two of the recently detected planets have approximately circular orbits. The majority of the extrasolar planets found to date are in elongated, or "eccentric," orbits, which are thought to be less conducive to life. More information about exoplanets is available at http://exoplanets.org/

In recognition of the interrelationship between the origin and evolution of life and the origin and evolution of planets, a new program within the framework of Astrobiology was initiated in 1997. A multi-disciplinary Astrobiology Institute was established with members from geographically distributed research institutions, linked through advanced telecommunications. In 2001, the discovery of fossilized remnants of a microbial mat provided evidence that life existed on land as early as 2.6 to 2.7 billion years ago. The findings suggest that an oxygen atmosphere and a protective ozone layer were in place around Earth by that time. Other research provided evidence that Earth's most severe mass extinction -- an event 250 million years ago that wiped out 90 percent of the life on Earth -- was triggered by a collision with a comet or asteroid. More information about Astrobiology is available at http://nai.arc.nasa.gov/

DATA ANALYSIS PROGRAM

GOALS

- Maximize the scientific return from our space missions, within available funding.
- Contribute to public education and understanding of science through media attention and our own education and outreach activities.

CONTENT

Provide funding support to scientific teams using data from our spacecraft.

- Depending on the mission, scientists supported may include Principal Investigators who have built hardware and been guaranteed participation, Guest Observers who have successfully competed for observing time, and researchers using archived data from current or past missions.

Fund a number of critical "Science Center" functions that are necessary to the operation of the spacecraft but do not involve the actual commanding of the spacecraft.

- The planning and scheduling of spacecraft observations, the distribution of data to investigators, and data archiving services are all supported under Data Analysis.

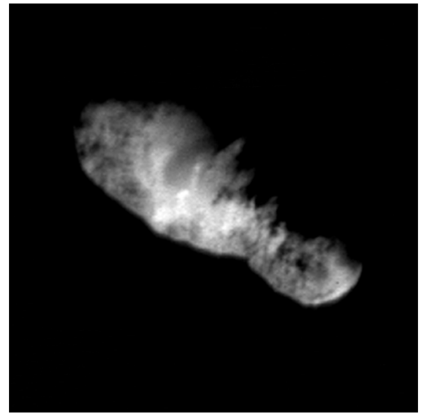
MAJOR DATA ANALYSIS RESULTS IN THE PAST YEAR

NASA's Space Science spacecraft continue to generate a stream of scientific discoveries. Many of these findings are of broad interest to the general public, as demonstrated by widespread media coverage. Recent highlights include results from the Hubble Space Telescope, the Chandra X-ray Observatory, the Near Earth Asteroid Rendezvous (NEAR), Mars Global Surveyor, Galileo, the Rossi X-Ray Timing Explorer (RXTE), and the Solar and Heliospheric Observatory (SOHO). However, many other Space Science spacecraft have been "in the news" and extremely scientifically productive as well. Listed below are just a few of the top science stories of the past year from NASA Space Science missions.

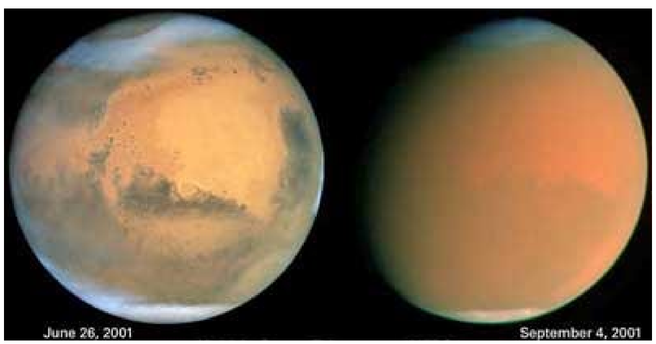
The Hubble Space Telescope discovered a supernova blast that occurred very early in the life of the Universe, bolstering the case for the existence of a mysterious form of “dark energy” pervading the Universe. The concept of dark energy, which pushes galaxies away from each other at an ever-increasing speed, was first proposed, and then discarded, by Albert Einstein early in the last century. The Hubble discovery also reinforces the startling idea that the universe only recently began speeding up. This and other HST findings are available at http://hubble.stsci.edu

The Chandra X-ray Observatory enhanced the understanding of black holes on many fronts. Chandra took the deepest X-ray images ever and found the early Universe teeming with black holes, probed the theoretical edge of a black hole known as the event horizon, and captured the first X-ray flare every seen from the supermassive black hole at the center of our own Milky Way galaxy. This and other CXO findings are available at http://chandra.harvard.edu .

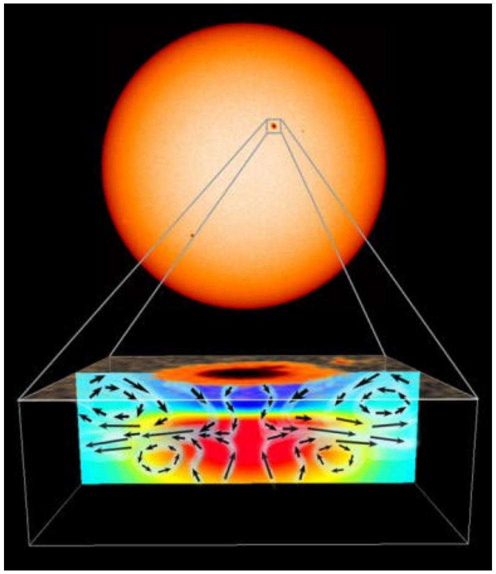
In a risky flyby, the Deep Space 1 (DS1, http://nmp.jpl.nasa.gov/ds1) spacecraft successfully navigated past comet Borrelly, giving researchers the best look ever inside the glowing core of icy dust and gas. DS1 passed just 2,200 kilometers (1,400 miles) from the rocky, icy nucleus of the 10 kilometer-long (more than 6 mile-long) comet. The NEAR (Near Earth Asteroid Rendezvous, http://near.jhuapl.edu) Shoemaker spacecraft achieved the first soft landing on an asteroid. The landing was the culmination of a year-long orbital mission at the asteroid Eros during which the mission returned enormous quantities of scientific data and images.



Many discoveries in 2001 related to the rapidly growing field of extrasolar planets (planets outside our Solar System). Observations from the Submillimeter Wave Astronomy Satellite (SWAS, http://sao-www.harvard.edu/swas/) provided the first evidence that extrasolar planetary systems contain water, a molecule that is an essential ingredient for known forms of life. Also in this field, astronomers using the Hubble Space Telescope have made the first detection and chemical analysis of the atmosphere of a planet outside our Solar System.



A pair of spacecraft, the Mars Global Surveyor and the Hubble Space Telescope, provided astronomers with a ringside seat to the biggest global dust storm seen on Mars in several decades. The Martian dust storm, larger by far than any seen on Earth, raised a cloud of dust that engulfed the entire planet for several months. The sun-warmed dust raised the atmospheric temperatures by 80 degrees F while the shaded surface chilled precipitously. Also in 2001, the Mars Odyssey 2001 spacecraft successfully achieved orbit around Mars following a six month, 286 million mile journey. The spacecraft will be placed in its final science mapping orbit in February 2002; it will characterize composition of the Martian surface at unprecedented levels of detail. More information is at http://mars.jpl.nasa.gov/



Anatomy of a sunspot - below the surface

In the field of Sun-Earth Connections, where we seek to develop a scientific understanding of the physical interactions in the Sun-Earth system, there were several important scientific accomplishments in 2001. The Solar and Heliospheric Observatory (SOHO, http://sohowww.nascom.nasa.gov/) observed the largest sunspot in ten years, with a surface area as big as the surface area of thirteen Earths. This area proved to be a prolific source of stormy solar activity, hurling clouds of electrified gas (know as Coronal Mass Ejections, or CME's) towards Earth. Other studies conducted by the SOHO spacecraft have provided the first clear picture of what lies beneath sunspots, peering inside the Sun to see swirling flows of electrified gas that create a self-reinforcing cycle which holds a sunspot together.

SUBORBITAL PROGRAM

GOALS

- Provide frequent, low-cost flight opportunities for space science researchers to fly payloads to conduct research of the Earth's ionosphere and magnetosphere, space plasma physics, astronomy, and high-energy astrophysics.

- Serve as a technology testbed for instruments that may ultimately fly on orbital spacecraft, thus reducing cost and technical risks associated with the development of future space science missions.

- Provide the primary opportunity for training graduate students and young scientists in hands-on space flight research techniques.

CONTENT

The suborbital program provides the science community with a variety of options for the acquisition of in-situ or remote sensing data, using aircraft, balloons and sounding rockets to provide access to the upper limits of the Earth's atmosphere. Activities are conducted on both a national and international cooperative basis.

Balloons **http://www.wff.nasa.gov/~code820/**

The Balloon Program is a level-of-effort flight program that:

- Provides a cost-effective way to test flight instrumentation in the space radiation environment, and to make observations at altitudes above most of the water vapor in the atmosphere.

- Provides the only means of flying some primary scientific experiments, due to their size, weight or cost.

- Iis particularly useful for infrared, gamma ray, and cosmic ray astronomy.

The Balloon Program develops new technologies to improve payload size and flight duration:

- The program has successfully developed balloons capable of lifting payloads greater than 5000 pounds.

- Balloons are now also capable of conducting a limited number of missions lasting 9 to 24 days, and successful long-duration flights are being conducted in or near both Polar Regions.

- Analytical tools have been developed to predict balloon performance and flight conditions.

- These tools are being employed to analyze new balloon materials in order to develop an ultra-long-duration balloon (ULDB) flight capability (approximately 100 days), based on super-pressure balloons.

- An integrated management team has been established to develop and test the balloon vehicle and balloon-craft support system.

The GSFC Wallops Flight Facility (WFF) manages the Balloon contract. The National Scientific Balloon Facility (NSBF), a government-owned, contractor-operated facility in Palestine, Texas, conducts flight operations.

Sounding Rockets **http://rscience.gsfc.nasa.gov/**

The Sounding Rockets Program performs low-altitude measurements (between balloon and spacecraft altitude) for which rockets are uniquely suited, including the measurement of the vertical variation of many atmospheric parameters.

The Sounding Rockets Program supports special areas of study, such as:

- The nature, characteristics and composition of the magnetosphere and near space;

- The effects of incoming energetic particles and solar radiation on the magnetosphere, including aurora production and energy coupling into the atmosphere;

- The nature, characteristics and spectra of radiation of the Sun, stars and other celestial objects.

The Sounding Rockets Program allows several science disciplines to flight-test instruments and experiments being developed for future space missions, and also provides a means for calibrating flight instruments and obtaining vertical atmospheric profiles to complement data obtained from orbiting spacecraft.

Launch operations are conducted from facilities at WFF, Virginia; White Sands, New Mexico; and Poker Flat, Alaska, as well as occasional foreign locations. A performance-based contract, managed by the GSFC/WFF, was awarded February 1999 to allow the government to transition away from operational control.

MAJOR SUBORBITAL RESULTS IN THE PAST YEAR

In FY 2001, 11 balloons were flown for the core (short duration flights) program, of which 10 were successful flights, with one balloon failure. Two successful long duration flights were conducted from Antarctica, and two Ultra-Long Duration test flights were conducted from Australia, one of which succeeded and the other failed. During FY 2002, we expect about 18 flights, including one Long Duration flight from Alaska.

In FY 2001, 12 sounding rocket missions were flown, of which all were successful flights. The sounding rocket program plans to launch 41 missions in FY 2002, anticipating that at least half will be ready and have no complications.

PROGRAM PLANS FOR FY 2003

In FY 2003 the Balloon Program expects to launch about 18 missions, including Long-Duration flight from Antarctica. The Sounding Rocket program plans to launch 20 missions.

BASIS OF FY 2003 FUNDING REQUIREMENT

SPACE SCIENCE INSTITUTIONAL SUPPORT

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Institutional Support to Space Science Enterprise	[285.6]	356.7	369.8
Research and Program Management	[258.8]	329.0	342.3
Personnel and Related Costs	[204.0]	248.1	265.4
Travel	[6.3]	7.3	7.4
Research Operations Support	[46.9]	73.6	69.5
Construction of Facilities	[26.8]	27.7	27.5
Direct Full-Time Equivalent (FTE) Workyears	**[1,389]**	**[1,591]**	**1,572**

Note - FY 2001 and FY 2002 data in this section are for comparison purposes only. See *Mission Support* sections for more details.

PROGRAM GOALS

The two primary goals of this budget segment are to:

1. Acquire and maintain a civil service workforce that reflects the cultural diversity of the Nation, and is both sized and skilled consistently with accomplishing NASA's research, development, and operational missions with innovation, excellence, and efficiency for the Space Science Enterprise.
2. Ensure that the facilities critical to achieving the goals of the Space Science Enterprise are constructed and continue to function effectively, efficiently, and safely, and that NASA installations conform to requirements and initiatives for the protection of the environment and human health.

RESEARCH AND PROGRAM MANAGEMENT (R&PM): This program provides the salaries, other personnel and related costs, travel, and the necessary support for all administrative functions and other basic services in support of research and development activities at NASA installations. The FY 2002 funding estimate for ROS includes $7.4M provided in the Emergency Supplemental to enhance NASA's security and counter-terrorism capabilities. The FY 2003 funding estimate is $4.5M. The salaries, benefits, and supporting costs of this workforce are covered in the Personnel budget, which comprises approximately 75% of the requested R&PM funding. Research and Operations Support, which covers administrative and other support, is approximately 20% of the request. The remaining 5% of the request is required to fund the travel necessary to manage NASA and its programs.

CONSTRUCTION OF FACILITIES (CoF): This budget line item provides funding for discrete projects required by components of NASA's basic infrastructure and institutional facilities; almost all CoF funding is used for capital repair. NASA facilities are critical for the support of research conducted by the Space Science Enterprise. NASA has conducted a thorough review of its facilities infrastructure, and determined that, 1) the deteriorating plant condition warrants increased repair and renovation efforts in order to avoid safety hazards to personnel, facilities, and mission, and 2) some dilapidated facilities need to be replaced. Increased investment in facility revitalization is required to maintain an infrastructure that is safe and capable of supporting NASA's missions.

ROLES AND MISSIONS

The Space Science budget contains funding for civil servants at Goddard Space Flight Center, Ames Research Center, Langley Research Center, Marshall Space Flight Center, Johnson Space Center, and Headquarters. Jet Propulsion Laboratory is a Federally Funded Research and Development Center; therefore, the Lab's employees are not civil servants, and their personnel and related costs are included in direct program costs.

Goddard Space Flight Center (GSFC)

The Office of Space Science provides approximately 52% of GSFC’s institutional funding. GSFC is the Lead Center for two of the four science themes in the Space Science Enterprise: Sun-Earth Connections and Structure & Evolution of the Universe. The objectives of Sun-Earth Connections are to seek a scientific understanding of the why Sun varies and to determine how solar variability affects life and society. Structure & Evolution of the Universe is comprised of three fundamental scientific quests: explaining the structure of the universe and forecasting our cosmic destiny, exploring cycles of matter and energy in the evolving universe, and examining the ultimate limits of gravity and energy in the universe. In support of these objectives, GSFC manages many currently operating missions, such as the Hubble Space Telescope, the Microwave Anisotropy Probe, and the Thermosphere-Ionosphere-Mesosphere-Energetics and Dynamics mission. GSFC also manages a large number of missions in development, including all missions in the Explorers program, missions in the Living With a Star program, as well as several major strategic missions, such as the Next Generation Space Telescope. GSFC also conducts world-class space science research in such areas as astrophysics, solar physics, high energy astronomy (x-ray and gamma ray), optical astronomy, microwave/infrared astronomy, and radio astronomy. Other activities include managing the NASA’s sounding rocket program and scientific balloon research program.

GSFC is a Performing Center for two of the four science themes in the Space Science Enterprise: the Astronomical Search for Origins and Solar System Exploration. In addition to managing two key missions in the Origins theme (the Hubble Space Telescope and the Next Generation Space Telescope), GSFC develops science instruments and technologies targeted at improving instruments, on-board spacecraft systems, and subsystems. GSFC has also conducted scientific research in support of the Origins program, planetary exploration, and investigations into other bodies in the Solar System.

Ames Research Center (ARC)

The Office of Space Science provides approximately 16% of ARC's institutional funding. ARC has the Agency lead role in Astrobiology (the study of life in the universe), which focuses on the origin, adaptation, and destiny of life in the universe. Research includes advanced laboratory and computation facilities for astrochemistry; planetary atmosphere modeling, including relationships to the atmosphere of the Earth; the formation of stars and planetary systems; and an infrared technology program to investigate the nature and evolution of astronomical systems. Development continues of the Stratospheric Observatory for Infrared Astronomy (SOFIA) for research to be conducted by various NASA/university teams. Research and development in advanced information technologies are directed toward significantly increasing the efficiency of SOFIA as it becomes operational. ARC provides critical testing capabilities for aerobraking and aerocapture techniques used in several Space Science missions, including the Mars Exploration Program.

Langley Research Center (LaRC)

The Office of Space Science provides approximately 4% of LaRC's institutional funding. Conduct a technology development program for advanced ultra-lightweight and adaptive materials, structural systems technologies, and analytical tools for significantly reducing the end-to-end cost and increasing the performance of space science instruments and systems. Continue studies and selected technology development for future planetary atmospheric flight vehicles including aeroshells, airplanes, gliders, etc. Develop active and passive sensor technologies and concepts for application in planetary atmospheric studies. Selectively develop laser, LIDAR, and passive sensor technologies and perform research for planetary studies in areas, which are related to our Earth Science role. Continues to provide analysis of spacecraft aerodynamics, aerothermodynamics, and flight dynamics for spacecraft entering planetary atmospheres (including Earth) in support of both spacecraft design and flight operations. Support the solicitation and selection process of the Office of Space Science's (OSS) Discovery, Explorer, and Solar Terrestrial Probes Programs; conduct reviews of candidate and selected missions and independent assessments of on-going space science missions to help ensure that OSS criteria for high quality science return within cost and schedule constrains are met. LaRC is also responsible for the design and development of atmospheric entry vehicle technologies for ongoing robotic exploration programs.

Marshall Space Flight Center (MSFC)

The Office of Space Science provides approximately 7% of MSFC's institutional funding. MSFC manages the Solar B and the GLAST Burst Monitor, and conducts fundamental research in six disciplines—cosmic-ray physics, gamma-ray astronomy, x-ray astronomy, solar physics, space plasma physics and astrobiology. MSFC manages the operation of the MSFC developed Chandra X-ray Observatory through the Operations Control Center and the Chandra X-ray Center at the Smithsonian Astrophysical Observatory in Cambridge, MA.

Johnson Space Center (JSC)

The Office of Space Science provides approximately 2% of JSC's institutional funding. JSC is responsible for leadership in the field of astromaterials and operates NASA's astromaterial curatorial facility for extraterrestrial sample materials. The Center supports the Agency's Space Science goals through research, information dissemination, and interaction with the scientific community. This research includes planetary science, astrobiology, space debris, and sample material handling. The primary focus is on the composition, structures, and evolutionary histories of astromaterials to further our understanding of the solar system and aid in the planning for future missions.

Glenn Research Center (GRC)

The Office of Space Science provides approximately 3% of GRC's institutional funding. GRC provides enabling technologies in the areas of power systems, on-board propulsion systems, air breathing propulsion, rocket components and integrated vehicle monitoring systems. GRC is the lead center for the Nuclear Power Program, and will perform a significant role in the propulsion programs managed by the Marshall Space Flight Center (In-Space Propulsion and the Nuclear Propulsion Program).

Headquarters (HQ)

The Office of Space Science provides approximately 11% of HQ's institutional funding. The Enterprise's Institutional Support figure includes an allocation for funding Headquarters activities based on the relative distribution of direct FTE's across the agency. A more complete description can be found in the Mission Support/two Appropriation budget section

FY 2003 ESTIMATES
BUDGET SUMMARY

BIOLOGICAL AND PHYSICAL RESEARCH (BPR) ENTERPRISE and
OFFICE OF THE CHIEF HEALTH AND MEDICAL OFFICER (OCHMO)
SUMMARY OF RESOURCE REQUIREMENTS
Web Address: http://SpaceResearch.nasa.gov

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET	Page Number
	(Millions of Dollars)			
Biological and Physical Research and Technology	**312.9**	**277.9**	**321.8**	SAT 2-10
Bioastronautics Research (BR)*	101.0	95.6	113.0	SAT 2-10
Advanced Human Support Technology (AHST)	30.8	26.3	(32.2)	
Biomedical Research and Countermeasures (BR&C)	69.2	69.3	(80.8)	
[Construction of Facilities – included in BR&C number]	[11.6]	[9.8]	[2.8]	
Minority University Research and Education Program (MUREP)	1.0			
Fundamental Space Biology (FSB)	40.6	35.3	56.0	SAT 2-14
Physical Sciences Research (PSR)	130.4	120.0	134.1	SAT 2-17
Space Product Development (SPD)*	29.2	17.0	14.8	SAT 2-20
Space Product Development (SPD)	13.7	16.8	(14.6)	
Mission Integration (MI)	15.5	0.2	(0.2)	
Health Research**	11.7	10.0	3.9	SAT 2-23
ISS Research Capability (ISSRC) (non-add FY 2001 number included for comparison purposes)	**[457.4]**	**371.3**	**347.2**	SAT 2-6
Institutional Support	**49.3**	**170.9**	**173.3**	SAT 2-26
TOTAL (numbers may not add due to rounding)	**362.2**	**820.0**	**842.3**	
Direct FTEs	**332**	**1,030**	**1,025**	

* In the FY 2003 structure, Bioastronautics Research and Space Product Development will each be a single line; lower-level AHST, BR&C, SPD, and MI breaks are shown for comparison purposes only.

** In FY 2001, the content of Health Research was divided among BPR ($3.2M), HEDS ($5.2M), and the Office of the Chief Health and Medical Officer (OCHMO) ($3.3M). In the FY 2002 column, the BPR portion ($1.2M) has been transferred into BR&C, and no longer shows up in Health Research. In the FY 2003 column, the HEDS portion ($5.9M) has been transferred to HEDS, and the remaining $3.9M funds OCHMO. None of the Health Research content areas have been eliminated.

BIOLOGICAL AND PHYSICAL RESEARCH ENTERPRISE
AND OFFICE OF THE CHIEF HEALTH AND MEDICAL OFFICER

DISTRIBUTION OF PROGRAM AMOUNT BY INSTALLATION

	FY 2001	FY 2002	FY 2003
	(Millions of Dollars)		
Johnson Space Center	123.6	202.0	225.0
Kennedy Space Center	8.2	19.0	18.8
Marshall Space Flight Center	70.7	259.1	246.7
Ames Research Center	60.8	104.2	116.4
Langley Research Center	0.1	3.4	3.5
Glenn Research Center	52.3	111.5	103.3
Goddard Space Flight Center	5.8	5.8	3.0
Jet Propulsion Laboratory	15.9	34.7	43.3
Dryden Flight Research Center	--	--	--
Stennis Space Center	--	--	--
Headquarters	24.8	80.3	82.3
Total (numbers may not add due to rounding)	**362.2**	**820.0**	**842.3**

STRATEGIC PLAN LINKAGE TO THIS BUDGET

As humans make the first steps off of the Earth and into space, we enter a new realm of opportunity to explore profound questions, new and old, about the laws of nature. At the same time, we enter an environment unique in our evolutionary history that poses serious physiological and psychological challenges. BPR addresses the challenges of space flight through basic and applied research on the ground and in space, and seeks to exploit the rich opportunities of space flight for fundamental research in the biological and physical sciences, as well as in commercial development. BPR seeks to understand the basic questions underlying human space flight while conducting research to enable efficient and effective systems for protecting and sustaining humans in space; and to understand nature’s forces in space.

In FY 2001, the Biological and Physical Research (BPR) Enterprise was created as NASA’s fifth strategic enterprise. BPR closed its first fiscal year with a significant record of accomplishment. It expanded its interagency research collaboration, establishing a new memorandum of understanding with the United States Department of Agriculture, conducting a joint research solicitation with the National Cancer Institute, and continuing work under 18 other agreements with the National Institutes of Health. A BPR investigator received the Nobel Prize in physics for ground-based research that he plans to extend and expand on the International Space Station (ISS). Outfitting ISS for research began with the delivery of the Human Research Facility in March 2001. Two research equipment racks were delivered to the ISS in mid-April, and an additional two at the beginning of Expedition 3 in August.

BPR initiated a program of research on the ISS to take advantage of available resources during the construction phase. The ISS Expedition 1 and 2 teams were able to exceed expectations for meeting research objectives of the planed experiments, with only one unsuccessful experiment due to technical reasons.

In FY 2002, BPR will continue to increase knowledge and demonstrate key technology capabilities for humans in space, address critical questions in crew health and safety, and physical sciences and commercial research payloads will be flown on both the Space Shuttle and aboard ISS. A highlight of FY 2002 is the planned flight of STS-107 in July. The Space Station research program is on-track to deliver another five equipment racks on-orbit by the end of 2002. Also in FY 2002, BPR will initiate a procurement activity leading to release of the final Request for Proposal (RFP) for a contract to manage ISS utilization by a Non-Governmental Organization (NGO). Working with the scientific community, its advisory committees, and the Administration, BPR will complete the development of research priorities across its portfolio of research endeavors to provide a basis for critical resource allocation decisions. In the area of public outreach and education, BPR plans to develop electronic and printed educational materials that focus on biological and physical research targeting K-12 and university students.

In FY 2003, BPR will implement its research priorities and develop ISS flight facilities to achieve a prioritized and productive research program. BPR will also work with Space Research Museum Network members to explore opportunities for the development of projects, special events, or workshops focused on the life sciences and biology-related research themes to attract and engage public audiences. In addition, BPR will make available to wide audiences an online database of Commercial Space Center activities, including publications listings, patents, and other information useful to the general public.

Enterprise Strategic Plan Goals:

<u>Goal 1: Conduct research to enable safe and productive human habitation of space.</u>
BPR conducts fundamental and applied research in the biological and physical sciences to reduce the health risks of space travel. We conduct research on technology for efficient, self-sustaining life-support systems to provide safe, hospitable environments for space exploration, and develop advanced technologies for healthcare delivery. Advances in healthcare first developed for the space flight environment are applied on Earth to enhance healthcare.

<u>Goal 2: Use the space environment as a laboratory to test the fundamental principles of physics, chemistry, and biology.</u>
The space environment offers a unique laboratory in which to study biological and physical processes. Researchers take advantage of this environment 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. Materials scientists study the role of gravity in important industrial processes. Physicists take advantage of microgravity to study exotic forms of matter that are better handled in space. Biological researchers investigate the role of gravity in life processes and how the space environment experience affects living organisms. The knowledge derived from BPR's diverse research will inform and expand scientific understanding, support economic and technological progress, and help to enable the human exploration of space.

<u>Goal 3: Enable and promote commercial research in space.</u>
BPR provides knowledge, policies, and technical support to facilitate industry investment in space research. BPR will continue to enable commercial researchers to take advantage of space flight opportunities for proprietary research. The commercial sector will

grow to become the premier mechanism for applying space knowledge to benefit the American people, and commercial applications of space knowledge will generate new products, new jobs, and new spin-off companies.

Goal 4: Use space research opportunities to improve academic achievement and the quality of life.

BPR seeks to use its research activities to encourage educational excellence and to improve scientific literacy from primary school through the university level and beyond. We deliver value to the American people by facilitating access to the experience and excitement of space research. BPR strives to involve society as a whole in the transformations that will be brought about by research in space.

Enterprise Goals	Science Objectives	Research Focus Areas	Enabling Program/Mission
1. Conduct research to enable safe and productive human habitation of space.	• Conduct research to ensure the health, safety, and performance of humans living and working in space.	• Biomedical Research and Countermeasures • Advanced Human Support Technology	ISS, STS-107, Ground-Based Research
	• Conduct physical science research on planetary environments to ensure safe and effective missions of exploration.	• Physical Sciences Research	Future
	• Conduct research on biological and physical processes to enable future missions of exploration.	• Fundamental Space Biology • Physical Sciences Research	ISS, STS-107, Ground-Based Research
2. Use the space environment as a laboratory to test the fundamental principles of physics, chemistry, and biology.	• Investigate chemical, biological and physical processes in the space environment, in partnership with the scientific community.	• Fundamental Space Biology • Physical Sciences Research	ISS, STS-107, Ground-Based Research
	• Develop strategies to maximize scientific research output on the International Space Station and other space research platforms.	• All Divisions of Biological and Physical Research	ISS, STS-107, Ground-Based Research
3. Enable and promote commercial research in space.	• Assure that NASA policies facilitate industry involvement in space research. • Systematically provide basic research knowledge to industry. • Provide technical support for companies to begin space research. • Foster commercial research endeavors with the International Space Station and other assets.	• Space Product Development	ISS, STS-107, Ground-Based Research
4. Use space research opportunities to improve academic achievement and quality of life.	• Engage and involve the public in research in space. • Advance the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets.	• All Divisions of Biological and Physical Research	ISS, STS-107, Ground-Based Research

BASIS OF FY 2003 FUNDING REQUIREMENT

INTERNATIONAL SPACE STATION RESEARCH CAPABILITY PROGRAM

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
ISS Research Capability Program Development*	**[457.4]****	**371.3**	**347.2**
(lower-level breaks for information only)			
Bioastronautics Research	[40.2]	[30.2]	[33.9]
Earth Observation Systems	[4.0]	[3.4]	[3.4]
Fundamental Space Biology	[75.7]	[58.0]	[42.1]
Physical Sciences Research	[145.7]	[114.3]	[113.0]
Space Product Development	[19.7]	[15.5]	[15.8]
Engineering Technology (FY 2001 only)	[3.0]		
Multi-User Systems and Support (FY 2002 and out)		[149.9]	[138.9]
Flight Multi-User Hardware and Support (FY 2001 only)	[52.0]		
Payload Integration and Operations (FY 2001 only)	[117.0]		

* (numbers may not add due to rounding)
** (included in HEDS in FY 2001; shown for comparison purposes only)

DESCRIPTION/JUSTIFICATION

At the beginning of FY 2002, the Research portion of the International Space Station Program was transferred from the Human Space Flight Appropriation into the BPR account in the Science, Aeronautics, and Technology appropriation. The International Space Station Research Capability (ISSRC) Program encompasses the research-discipline-based facility development and utilization projects and multi-user systems support for the science, as well as technological and commercial payloads planned to utilize the International Space Station (ISS) as a research platform. The ISSRC includes the development of research facilities, experiment-unique equipment, multi-user payload hardware, and the ground facilities, software, and tools to implement the utilization tasks. Utilization support services are provided to both U.S. and International Partners, and include services for payload planning and engineering support, crew and user team training, sub-rack- and sub-pallet-level payload integration, ground processing, and on-orbit payload operations for all research related hardware and software on-board the ISS. All Principal Investigator grants are funded through separate NASA Science Enterprise programs and are not included in the ISSRC.

The ISSRC provides the foundation to enable the NASA Science Enterprises to utilize the ISS as an interactive laboratory and observatory in space to advance scientific, exploration, engineering, and commercial activities. As a microgravity laboratory, the ISS is being used to advance fundamental scientific knowledge, foster new scientific discoveries for the benefit of the U. S., and develop beneficial applications derived from long-term, space-based research. The ISS is the world's premier facility for studying the role of gravity on biological, physical, and chemical systems. The program is delivering the capability to perform unique, long-duration, space-based research in molecular, cellular, comparative, and developmental biology, human physiology, biotechnology, fluid physics, combustion science, materials science, and fundamental physics. The experience and knowledge gained from long-duration human presence on the ISS is helping us learn how to more safely and effectively live and work in space. ISS also provides a unique platform for making observations of the Earth's surface and atmosphere, the sun, and other astronomical objects, as well as the space environment and its effects on new spacecraft technologies.

Scientific Question and Program Approach

BPR has identified four major overarching goals which will be pursued through ISS Research: (1) conduct research to enable the safe and productive human habitation of space; (2) use the space environment as a laboratory to test the fundamental principles of physics, chemistry, and biology; (3) enable and promote commercial research in space; and (4) use space research opportunities to improve academic achievement and the quality of life.

BPR will also prioritize its ISS research activities using input from an external committee, the Office of Science and Technology Policy, and BPR's standing advisory committees. Such priorities, to be identified by August 2002, will enable BPR to make the most effective use of the research resources available, particularly those of the ISS. Content and dates identified below may change based on this prioritization process.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Develop strategies to maximize scientific research output on the ISS and other space research platforms.
Strategic Plan Objectives Supported: Use the space environment as a laboratory to test the fundamental principles of physics, chemistry, and biology.
Performance Plan Metrics Supported: Goal 3B8: In close coordination with the research community, allocate flight resources and develop facilities to achieve a balanced and productive research program. In FY 2001, BPR received a "Green" for meeting Goal 1H5: Continue initial research on the International Space Station by conducting 6 to 10 investigations.

Milestones	Plan in FY 2003 Budget	Plan in FY 2002 Budget	Plan in FY 2001 Budget	FY 2002 - FY 2003 Change	Comment
UF-2 Launch	3rd Qtr., FY02	2nd Qtr., FY02	4/99	1 Qtr.	Space Shuttle Program Manifest
ULF1 Launch	1st Qtr., FY03	4th Qtr., FY02	6/02	1 Qtr.	Space Shuttle Program Manifest
Human Research Facility-2	1st Qtr., FY03	4th Qtr., FY02		1 Qtr.	[to be delivered to orbit on ULF1 Mission]

Lead Center: JSC	**Performing Centers: ARC, GSFC, JPL, JSC, KSC, LaRC, & MSFC**	**Interdependencies:** International Partners, ISS Vehicle Program
Subsystem	**Builder**	**Status**
Human Research Facilities (HRF) 1 & 2	Boeing, MSFC/JSC	HRF-1 on orbit
EXPRESS Racks (ER) 1-8	Boeing, MSFC	ER1, 2, 4, and 5 on orbit; ER3 launch on UF-2 5/02
Window Observational Research Facility (WORF)	Boeing, MSFC	
Habitat Holding Racks (HHR) 1 & 2	Boeing, MSFC/ARC	
Materials Sciences Research Facility (MSRF) 1	NASA/ESA	
Fluids Integrated Rack (FIR)	GRC	
Combustion Integrated Rack (CIR)	GRC	
Life Science Glovebox (LSG)	NASDA	
Microgravity Science Glovebox (MSG)	ESA	MSG launch on UF-2 5/02
Minus Eighty-Degree Life Sciences Freezer for the ISS (MELFI)	ESA	
Cryogenic Freezer	ESA	
Low Temperature Microgravity Physics Facility (LTMPF)	Ball Aerospace, JPL	
Instruments	**Builder**	**Pr. Investigator**
Multiple	Multiple	Multiple
Launch Vehicle	**Tracking/Comm**	**Data**
Multiple Launches, Shuttle	ISS KU Band	Multiple Data Transmissions

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

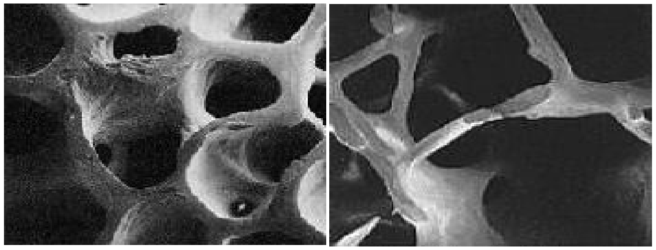
Delivery of the U.S. Laboratory in February 2001 set the stage to begin ISS Research in earnest, and the astronauts have completed 47 experiments aboard the Station. During FY 2001, initial Lab outfitting was accomplished with deployment of five racks (the Human Research Facility-1 and four EXPRESS Racks). Two additional racks are planned for on-orbit deployment in the third quarter of FY 2002: the Microgravity Sciences Glovebox and one EXPRESS Rack. The first three long-term Expeditions have been completed and Expedition 4 is currently aboard the ISS. The Expedition 1 (October 2000 to February 2001) crew focused on research outfitting, but conducted some early Earth observations, education experiments, biological crystal growth experiments, technology development, and human research data collection. The Expedition 2 (February 2001 to August 2001) crew began a more robust program of scientific research, consisting of experiments primarily focused on biomedical research in the areas of the radiation environment, bone loss and changes in reflexes. Other experiments included plant germination and growth, Earth observations, macromolecular crystal growth, and physics experiments using colloids to model the crystallization process. Research on Expedition 3 (August 2001-December 2001) included investigation of the mechanism of space flight-induced orthostatic intolerance, which has symptoms such as lightheadedness, palpitations, tremulousness, and poor concentration; a study of pulmonary function in space as affected by extravehicular activities; a study of the risk factors associated with kidney stone formation during and after space flight; and the use of new techniques for studying structural biology in space. BPR's Physics of Colloids in Space experiment is already yielding unique new data on never-before-seen colloidal crystallization patterns. Additional experiment runs will be carried out in order to confirm the exciting earlier results on the unexpected power law for crystal growth. The ultimate application of this research may be in the fabrication of photonic devices for optical communications and electronics. Expeditions 4, 5, and 6 will fly during FY 2002 and experiments will continue in the areas of biomedical research, biotechnology, microgravity research, materials science, agriculture, and Earth observations. NASA continues to prepare for on-orbit research through the preparation and testing of five additional research racks, ongoing payload crew training, and operation of the ground support infrastructure (including the Payload Operations Center).

Fiscal Year 2002 will be a transition year during which the program will be re-baselined and a new management plan for program oversight will be developed for implementation in FY 2003.

PROGRAM PLANS FOR FY 2003

In the second quarter of FY 2003, Lab outfitting will continue with the planned delivery of three racks: the Window Observational Research Facility, Human Research Facility-2, and one EXPRESS Rack. By the end of FY 2003, a total complement of 10 research racks will be on-orbit and operating in the U.S. Laboratory. In FY 2003, Expedition 6 continues, followed by Expeditions 7 and 8. Middeck locker level experiments are planned to continue in the areas of biomedical research, biotechnology, microgravity research, materials science, agriculture, and Earth observations. The S3 U.S. Truss Segment is planned for launch in the fourth quarter of FY 2003; this segment provides the attach site for the external payloads planned for initial deployment no earlier than 2004.

BASIS OF FY 2003 FUNDING REQUIREMENT



Normal (left) and osteoporotic (right) human bone. BPR-funded research on rats shows that low-level vibration prevents decreased bone formation in a simulated microgravity environment; vibration therapy holds promise as a countermeasure for the bone loss that occurs during long-duration space flight.

BIOASTRONAUTICS RESEARCH PROGRAM

	FY 2001	FY 2002	FY 2003
Research Program ($ in Millions)	101.0	95.6	113.0

DESCRIPTION/JUSTIFICATION

The Bioastronautics Research (BR) Program has two main objectives that support space flight crew health, safety and performance. The first is to understand physiological and psychological adaptation to space flight and return to Earth in order to develop countermeasures and technologies that will mitigate risks to the crew. The second is to develop technologies that will improve spacecraft habitability, environmental controls, planetary habitability, and space systems. The primary goal of this research is to improve the health and safety of space travelers; however, this research also has the potential to make significant contributions to medical care on Earth. For example, space flight can provide models for exploring osteoporosis and other diseases of muscle and bone. The parallels between aging and space travel are currently under study by researchers at NASA and the National Institute on Aging. BPR research on life support technologies is intended to reduce the cost of space travel. This technology may also find application in process control systems for industry, and may even help to provide clean environments in homes, vehicles, and offices.

PROGRAM AREA

BR performs research and develops technology for next-generation systems that will enable humans to live and work safely and effectively in space. Special emphasis is placed on those technologies that will have a dramatic impact on the reduction of required mass, power, volume, and crew time, and on those that will increase safety and reliability. The program funds technologies that address both the near- and long-term needs of space travel, and places a high priority on making NASA technologies available to the private sector for Earth applications. It also performs the scientific research that develops the knowledge base and technologies required to preserve health, morale, performance, and safety in astronaut crews. Program research results are directed to providing a better understanding of physiological, psychological, and behavioral adaptations to space flight that will enable improvements in: predictions of astronaut health and safety risks; diagnostics of health status; management of medical and behavioral problems; establishment of human physiological norms for space flight; protection of humans from the negative physiological and behavioral effects of space flight; and tools available for rehabilitation of crewmembers after space flight.

GOALS

(1) to demonstrate and validate full self-sufficiency in air, water, and food recycling technology for use in space vehicles;
(2) to demonstrate and validate integrated, fully autonomous environmental monitoring and control systems;
(3) to validate human factors engineering technology and protocols to ensure maintenance of high ground and flight crew skills

during long-duration missions;
(4) to reduce the risk to crew health from space radiation;
(5) to reduce the risk of acute and chronic crew health, psychological and behavioral problems;
(6) to increase crew productivity in flight, and to ensure complete post-flight rehabilitation of the crew for a full, healthy life on Earth; and
(7) to transfer biomedical knowledge and technology gained through research on the ground and in space to the Earth-based medical community.

CONTENT

The Bioastronautics Research Program uses ground-based and flight research grants, contracts, cooperative agreements and interagency agreements supporting Shuttle and Space Station experiments to develop flight studies for Shuttle mid-deck missions and Space Station in the areas of countermeasure development, and medical research. It also funds Research and Technology Development (R&TD) activities through the same opportunities.

Milestones	Plan in the FY 2003 Budget	Plan in the FY 2002 Budget	Plan in the FY 2001 Budget	FY 2002 - FY 2003 Change	Comment/Status
Release 2 NRAs	2/02 10/02	2/02 N/A	2/02 N/A	None N/A	AHST NRA released February 2002; BR&C NRA released October 2001
Award Grants From NRA 01-OBPR-03	4/02				
Research Experiments On STS-107	7/02	1st Quarter, FY 2002	5/00	7-9-month slip	Launch delays due to manifest changes
Establish and Pursue Science Priorities	8/02 Final Report				Revalidation of scientific research content and prioritization
Establish New NASA Specialized Center of Research and Training (NSCORT)	10/02	1/02	1/02	10 Month Slip	Budget constraints forced deferral to FY 2003

MAJOR PROGRAM AREA RESULTS IN THE PAST YEAR

The world's smallest high-performance mass spectrometer (the quadrupole mass spectrometer array), contained within the Trace Gas Analyzer, was delivered to the International Space Station in February. The device, which can detect ammonia, hydrazine, oxygen, and nitrogen and water leaks, is expected to play a critical role in detecting leaks outside the orbiting facility. The Immobilized Microbe Microgravity Water Processing System (IMMWPS) was successfully demonstrated in ground tests, and a simulation of the experiment’s installation aboard the Shuttle mid-deck was performed. In another ground-based study, midodrine was found to maintain blood pressure in humans exposed to 16-days of head-down-tilt bed-rest. This drug will be tested on ISS and Shuttle astronauts following their return from space, becoming the first experiment in NASA's Countermeasure Evaluation and

Validation Project. An investigation funded by the BR program showed that intermittent vibration (10 minutes per day) prevented the bone loss in rats that normally occurs when the weight of the body is supported so that the limbs no longer carry weight. Clinical trials are underway to study this intervention on humans here on Earth, and a proposal for using the intervention on astronauts has been reviewed and received a passing score. This countermeasure would be tested by the astronauts on the ISS after successful validation in clinical trials. A set of polyethylene slabs was flown on the Space Station to provide local shielding for one astronaut's sleeping quarters, based on calculations developed by NASA researchers that predict superior shielding properties for this material against space radiation. A reduction of approximately 30% in radiation levels relative to unshielded areas was found, as predicted. Polyethylene shielding has been installed to replace the heavier aluminum shielding used previously. Construction of the Booster Applications Facility at the Brookhaven National Laboratory continues on schedule and on budget. This facility will be used to simulate the space radiation environment for radiobiology research after it is commissioned in the third quarter of FY 2003.

PROGRAM AREA PLANS FOR FY 2002

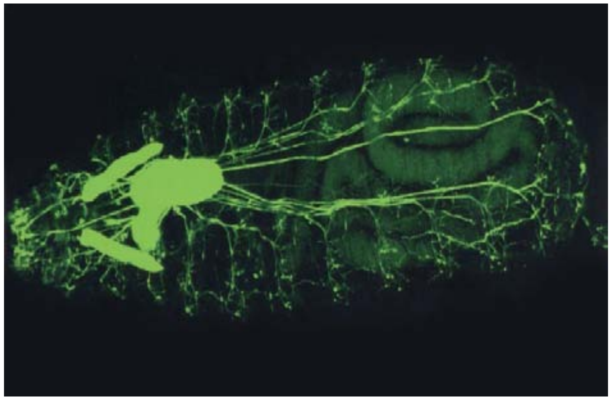
BR will fund developmental work in the area of advanced pumps to develop Sabatier reactor technology for ISS. A fully developed Sabatier reactor has the potential to save the cost of transporting 2,000 lbs. of water annually to the Station by recycling carbon dioxide produced by the crew into water and methane. BR will continue to conduct research to enhance the health and safety of the astronauts working and living on the ISS by investigating potential health and medical risks to crew and by developing "countermeasures" to reduce risk and illness, prevent health problems completely, or establish the most beneficial rehabilitation programs for returning astronauts. The focused flight and ground research announcements released in FY 2001 will lead to an intensive research effort for the ISS in the following areas during FY 2002: (1) bone and muscle loss in space, and (2) crew performance (e.g. psychological and social issues, human factors, physiological changes). During FY 2002, BR will select investigations judged to be meritorious through a competitive peer-review process for the program and the National Space Biomedical Research Institute (NSBRI, a consortium of research institutions which conducts biomedical research on space flight issues); with funding beginning in early FY 2003. In FY 2002, 25 Bioastronautics Research experiments will be performed on 3 ISS increments (4, 5, and 6). The process of setting clear priorities for ISS research will continue, and the research emphasis and mix may be changed, considering the recommendations of the IMCE task force (the "Young Committee") working with the scientific community, advisory committees, and the Office of Science and Technology Policy. The STS-107 research mission will launch in the fourth quarter of FY 2002 with a code U payload theme of "health, safety and countermeasures."

PROGRAM AREA PLANS FOR FY 2003

The Bioastronautics Research Program (along with the PSR and FSB programs) will accelerate BPR's efforts to develop knowledge, tools, and techniques to address the space radiation health problem. This "Space Radiation" initiative was prompted by the desire for an increased understanding of the effects of the radiation environment in low Earth orbit and beyond, where the radiation environment is much more hazardous, and by the establishment of more restrictive guidelines for astronaut exposure levels. The ground-based research initiative will generate knowledge, assess health risks to astronauts, and develop radiation shielding design tools, strategies, and countermeasures that can be employed aboard ISS and future space missions.

BR plans to develop advanced monitoring and control technologies to the point where they could be effectively tested and used in integrated test beds; develop air and water treatment technologies that will help reduce the equivalent system mass of the currently baselined ISS ECLSS (Environmental Control and Life Support Systems) technologies; solicit and fund low- and mid- range Technology Readiness Level (TRL) activities that will result in next-generation life support systems for the ISS and other low Earth orbit and long duration space missions; and develop tools that will result in better use and optimization of crew time on the ISS to increase science productivity. Such tools may include improved human-machine interfaces, crew restraints, and digital anthropometric data that could be implemented by 2003. BR will continue to conduct research to enhance the health and safety of the astronauts working and living on the ISS by investigating potential health and medical risks to crew and by developing "countermeasures" to reduce risk and illness, prevent health problems completely, or establish the most beneficial rehabilitation programs for returning astronauts. BR will fund investigations judged to be meritorious through a competitive peer-review process for the program and the NSBRI. During FY 2003, 17 Bioastronautics Research experiments will be performed on 3 ISS increments. Research priorities, developed during FY 2002, will be implemented in allocating resources for development and utilization of ISS research capabilities. An STS-107 science results workshop will be held during FY 2003. The program will also initiate the newly validated and prioritized research program content and continue ground-based and flight research in the validated and prioritized research areas.

BASIS OF FY 2003 FUNDING REQUIREMENT



Fluorescently stained nerve cells in a fruit fly used for studying how microgravity affects normal nervous system development.

FUNDAMENTAL SPACE BIOLOGY PROGRAM

	FY 2001	FY 2002	FY 2003
	(Millions of Dollars)		
Research Program	**40.6**	**35.3**	**56.0**

DESCRIPTION/ JUSTIFICATION

The Fundamental Space Biology (FSB) Program uses the environment of space to enhance our understanding of biology by providing a continuum of research that investigates the role of gravity and other space flight factors at all levels of biological processes. These include cell and molecular biology, developmental biology, organismal and comparative biology, gravitational ecology, and evolutionary biology. The understanding, development, and implementation of this research will provide the underpinnings necessary to support long-term human space flight.

PROGRAM AREA

GOALS

(1) Effectively use microgravity and the other characteristics of the space environment to enhance our understanding of fundamental biological processes;
(2) Develop the foundation of fundamental biological knowledge required to enable a long-duration human presence in space;
(3) Develop the biological understanding to support other biologically related NASA activities; and
(4) Apply this knowledge and technology to improve our nation's competitiveness, education, and the quality of life on Earth.

CONTENT

Ground-based and flight research grants, contracts, and interagency agreements are solicited and reviewed via a competitive peer review process supporting Shuttle and Space Station experiments to develop flight studies for Shuttle mid-deck missions and Space Station. These areas of focus are:

- Molecular Structures & Physical Interactions
- Cell & Molecular Biology
- Developmental Biology
- Neural Science
- Organismal and Comparative Biology
- Evolutionary Biology

- Gravitational Ecology

Milestones	Plan in the FY 2003 Budget	Plan in the FY 2002 Budget	Plan in the FY 2001 Budget	FY 2002 - FY 2003 Change	Comment/Status
Award Grants From NRA 01-OBPR-03	2/02	2/02	2/02	No change	
Release ground-based research NRA	10/02	10/02	10/02	No change	
Establish and Pursue Science Priorities	8/02 Final Report				Revalidation of scientific research content and prioritization
Research Experiments On STS-107	7/02	1st Quarter, FY 2002	5/00	7-9-month slip	Launch delays due to manifest changes

MAJOR PROGRAM AREA RESULTS IN THE PAST YEAR

During FY 2001, the transition of Fundamental Biology in the former Life Sciences Division to the Fundamental Space Biology (FSB) Division was completed. Strategic planning for the new division was carried out in conjunction with the Lead Center Program Office. During FY 2001, FSB funded 30 new ground research investigations, for a funding rate of approximately 20% of all applicants, and released a call for proposals (NRA) for ground-based research proposals to be funded in FY 2002. FSB also solicited flight research as part of the International Space Life Sciences Working Group (ISLSWG) flight solicitation. Collaborative efforts with the Astrobiology Program were carried out, including the funding of research at the National Astrobiology Institute. Increased integration and coordination of FSB with other components within BPR, including biomedical and biotechnology research, was implemented.

PROGRAM AREA PLANS FOR FY 2002

During FY 2002, FSB will increase fundamental knowledge in the biological sciences and address critical questions in crew health and safety by conducting flight investigations on the STS-107 Space Shuttle mission and ISS. These include investigations of the effects of gravity on plant growth and physiology, the effect of the space environment on bacterial virulence and gene expression, the effects of microgravity on avian development in space, on arterial functioning and vestibular adaptation, and the effects of gravity on plant photosynthesis and respiration. Six new Fundamental Space Biology flight investigations were selected for definition through the International Space Life Sciences Strategic Working Group peer review process. New ground-based research proposals, solicited through a call for proposals (NRA) released in FY 2001, will be funded.

During FY 2002, FSB will initiate planning for possible participation in a free-flyer research mission in FY 2004 using a Russian Bion research satellite in collaboration with the European, Canadian, and Japanese space agencies. Increased collaboration with other federal agencies will be pursued through participation in multi-agency activities.

PROGRAM AREA PLANS FOR FY 2003

The Fundamental Space Biology Program (along with the BR and PSR programs) will accelerate BPR's efforts to develop knowledge, tools, and techniques to address the space radiation health problem. This "Space Radiation" initiative was prompted by the desire for an increased understanding of the effects of the radiation environment in low Earth orbit and beyond, where the radiation environment is much more hazardous, and by the establishment of more restrictive guidelines for astronaut exposure levels. The ground-based research initiative will generate knowledge, assess health risks to astronauts, and develop radiation shielding design tools, strategies, and countermeasures that can be employed aboard ISS and future space missions.

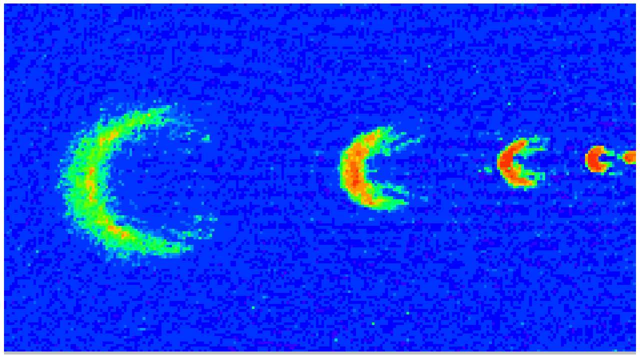
The FSB Program will initiate a new "Generations" project to study the adaptation of organisms to the space environment over several generations and the capacity of terrestrial life to evolve in space. The project will employ ground-based research and both the ISS and autonomous "free-flyer" platforms in different orbits, including High Earth Orbit beyond the Van Allen radiation belts that shield lower orbits from hazardous solar and galactic cosmic radiation. This will enable researchers to study the effects of the space flight environment on biological systems and processes, adding to fundamental knowledge, and may enable the development of countermeasures and life support technologies for future space missions.

The FSB program will also release a call for proposals (a NASA Research Announcement) for ground-based research. Support of currently funded flight investigations will continue and appropriate flight opportunities will be identified and pursued. ISS facilities development will continue. Assessing the use of free-flyers as space research flight platforms to augment the capabilities of the ISS will be conducted, including project planning for the proposed Russian Bion research mission, which will mature towards a projected launch in the latter half of FY 2004. The Program will also initiate the newly validated and prioritized research program content and continue ground-based and flight research in the validated and prioritized research areas.

BASIS OF FY 2003 FUNDING REQUIREMENT

PHYSICAL SCIENCES RESEARCH PROGRAM

	FY 2001	FY 2002	FY 2003
	(Millions of Dollars)		
Research Program	130.4	120.0	134.1



Wolfgang Ketterle's Nobel-Prize-winning first atom laser producing pulses of coherent matter.

DESCRIPTION/ JUSTIFICATION

The Physical Sciences Research (PSR) Program will combine unique experimental facilities with long-duration access to low-Earth orbit and beyond to enable new scientific discoveries and the development of technologies for the benefit of space exploration and Earth-based applications. The program is sponsoring peer-reviewed, interdisciplinary ground-based and flight research focusing on scientific issues and technological development that cannot be effectively addressed on Earth. The scope of the program includes the most recent and exciting areas of atomic and biomolecular physics and chemistry, groundbreaking research in biotechnology, and significant new developments in materials science, fluid physics, and combustion research. A unique component of the program is the cross-disciplinary research in the microgravity environment of space to increase understanding of those physical and chemical phenomena affecting biological systems that are masked by the effects of gravity on Earth.

PROGRAM AREA

GOALS

(1) to carry out groundbreaking, peer-reviewed, and multidisciplinary basic research enabled by the space environment to address NASA's goal of advancing and communicating knowledge;

(2) to develop a rigorous scientific capability bridging physical science and biology to address the Nation's human and robotic space exploration goals;

(3) to establish the International Space Station facilities as unique on-orbit science laboratories addressing targeted scientific and technological issues of high significance; and

(4) to enhance the knowledge base for Earth-bound technological and industrial applications.

CONTENT

The program employs ground-based and flight research grants, contracts, and interagency agreements solicited and reviewed via a competitive peer review process to support the development of flight studies and experiments for the Shuttle and Space Station. The areas of focus are: atomic and molecular physics; fluids physics and engineering; combustion research; biomolecular physics and chemistry; tissue engineering and cellular biotechnology; and structural biology.

Milestones	Plan in the FY 2003 Budget	Plan in the FY 2002 Budget	Plan in the FY 2001 Budget	FY 2002 - FY 2003 Change	Comment/Status
STS-107 Flight Investigations • Combustion Module 2 (CM-2) • Mechanics of Granular Materials (MGM-3) • Biotechnology Demonstration System (BDS-5) • Critical Viscosity of Xenon (CVX)	7/02	1st Quarter, FY 2002	5/00	7-9-month slip	Payloads are ready. Previous launch delays have been due to Shuttle manifesting changes.
• Physical Sciences NRA	Funding start				First integrated annual NRA
• Establish and Pursue Science Priorities	8/02 Final Report				Revalidation of scientific research content and prioritization

MAJOR PROGRAM AREA RESULTS IN THE PAST YEAR

PSR-funded researchers have been involved in the experimental control of light motion: the stopping, holding, and releasing of light has been demonstrated using lasers developed by a BPR investigator ("Physical Review" Letters, January 29, 2001, Vol. 86, Issue 5). Wolfgang Ketterle, a Fundamental Physics investigator, won the 2001 Nobel Prize in Physics for Bose-Einstein Condensation research. A study in materials science prompted the development of a new approach for suspending fine particles in fluids, which may have applications for the electronics, paint, cosmetics and pharmaceutical industries ("Proceedings of the National Academy of Sciences," July 2001).
By spinning ultra-cold sodium gas in a laboratory, BPR-funded scientists at the Massachusetts Institute of Technology (MIT) created a gas cloud riddled with tiny whirlpools like those that cause "starquakes." Thus, they created a physical model of processes taking place inside distant stars. A research group at MIT grew heart tissue with "significantly improved" structural and electrophysiological properties, using NASA bioreactor technology ("Journal of Physiology-Heart and Circulatory Physiology," Jan. 2001). StelSys (a joint venture of FVI and In Vitro Technologies) signed an agreement with NASA to explore the commercial applications of bioreactor technology research, specifically in areas related to biological systems. As part of its efforts to develop an artificial liver system for patients suffering from liver damage, StelSys will conduct a space flight experiment using liver tissue in May 2002.

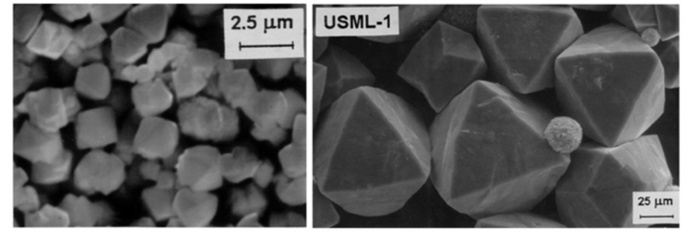
PROGRAM AREA PLANS FOR FY 2002

PSR will carry out manifested investigations in combustion research, fluid physics, and biotechnology on the STS-107 mission. The program will continue the development and fabrication of the Fluids Integrated Rack (FIR), the Combustion Integrated Rack (CIR), and the Materials Science Research Rack-1 (MSRR-1) for delivery and launch in 2004 and 2005. PSR will continue the development of the Biotechnology Facility (BTF) experiment inserts and the Low Temperature Microgravity Physics Facility (LTMPF) for delivery and launch in 2006. It will also initiate on-orbit research activities in the Microgravity Science Glovebox to be launched in the third quarter of FY 2002. The first flight of the liver tissues by the commercial venture in NASA research facility scheduled for May 2002. Also, PSR will release the first annual integrated call for proposals (NRA) in Physical Sciences and carry out the peer review and selection of proposals. The program will: continue the planned on-orbit ISS research in EXPRESS racks during Expeditions 4, 5, and 6; carry out a total program research validation and prioritization process; and peer review and select a Bioscience and Engineering Institute.

PROGRAM AREA PLANS FOR FY 2003

The Physical Sciences Research Program (along with the BR and FSB programs) will accelerate BPR's efforts to develop knowledge, tools, and techniques to address the space radiation health problem. This "Space Radiation" initiative was prompted by the desire for an increased understanding of the effects of the radiation environment in low Earth orbit and beyond, where the radiation environment is much more hazardous, and by the establishment of more restrictive guidelines for astronaut exposure levels. The ground-based research initiative will generate knowledge, assess health risks to astronauts, and develop radiation shielding design tools, strategies, and countermeasures that can be employed aboard ISS and future space missions.

PSR plans to analyze STS-107 flight experiment results. It will continue fabrication of ISS research racks and experiment inserts for the CIR, FIR, and MSRR-1. PSR plans to carry out manifested ISS research investigations in EXPRESS Racks and the Microgravity Science Glovebox in order to process the already selected flight investigations in the queue. The program will also initiate the newly validated and prioritized research program content and continue ground-based and flight research in the validated and prioritized research areas.



Zeolite crystals on Earth (left) and in space (right); space crystals are larger, have fewer defects, and are more ordered in structure. Improved crystals benefit refining, chemical processes, and other applications.

BASIS OF FY 2003 FUNDING REQUIREMENT

SPACE PRODUCT DEVELOPMENT PROGRAM

	FY 2001	FY 2002	FY 2003
	(Millions of Dollars)		
Research Program	29.2	17.0	14.8

DESCRIPTION/JUSTIFICATION

The Space Product Development (SPD) Program is implemented primarily through Commercial Space Centers (CSC). Each CSC is a non-profit consortium of commercial and academic entities, and some also include government agency participation. The CSCs follow business leads and commitments to pursue product-oriented research in three major disciplines: materials research and development, biotechnology, and agriculture. NASA's role in this partnership is to provide leadership and direction for the integrated program and to provide the flight opportunities that are essential to the success of these efforts.

PROGRAM AREA

GOALS

(1) facilitate the use of space for the development of commercial products and services (including appropriate supporting ground-based activities);
(2) couple NASA and private sector technology development to the advantage of both; and
(3) promote the benefits of space-based research to industry, facilitate industry's access to space, provide space research expertise and flight hardware, and advocate the development of policies to encourage the commercial use of space.

CONTENT

SPD supports the operation of the NASA Commercial Space Centers (CSC), along with the development of commercial flight research hardware for Space Shuttle and the International Space Station (ISS). SPD provides ground-based and parabolic aircraft flight opportunities for initial commercial research efforts.

The CSCs initiate industry involvement in two ways: (1) by identifying and investigating industry-led research areas of commercial promise; and (2) by assessing markets for these potential research opportunities. The businesses support the research effort with cash and in-kind resources, such as technical expertise, research materials, personnel, ground facilities, and research hardware.

Milestones	Plan in the FY 2003 Budget	Plan in the FY 2002 Budget	Plan in the FY 2001 Budget	FY 2002 - FY 2003 Change	Comment/Status
Annual Report Published	2/04	2/03	2/02	NA	Report on annual basis by February
Performance Review of CSCs initiated	3/02	3/02		No change	Continual reviews beginning in FY 2002 according to the following: Five CSCs reviewed in 2002, five in 2003, and five in 2004
Fly 6 Commercial Payloads on STS-107	7/02	1st Quarter, FY 2002	5/00	7-9-month slip	Launch delays due to manifest changes
Consolidate Management of CSC Program	11/01				Four CSCs transferred from the Aerospace Technology Enterprise November 2001

MAJOR PROGRAM AREA RESULTS IN THE PAST YEAR

A private company, Space Hardware Optimization Technology, Inc. (SHOT) of Greenville, Indiana, signed an agreement March 19 with NASA that allows the company to conduct flight experiments for commercial customers on the agency's Space Shuttle missions. It is now one of only four non-university-based companies in the Nation with such an agreement with NASA. One of NASA's objectives is to promote an increase in the use of space for commercial products and services. SHOT's independent marketing of space for industrial research helps NASA and SPD meet that objective.

The ProVision Technologies (PVT) CSC began work with the Federal Bureau of Investigation (FBI) Academy. A Memorandum of Understanding (MOU) between the FBI and NASA was signed and placed on the cooperative agreement as of September 30, 2001. This research activity will involve the construction of a hyperspectral imaging system with visible and near-infrared capabilities, training on the system for the FBI Academy, as well as some exploratory image acquisition and processing. The application will be in forensic examination of passports, documents, fingerprints, currency, and other evidentiary items, comparing dyes and inks.

PROGRAM AREA PLANS FOR FY 2002

At the beginning of FY 2002, BPR consolidated the management of the Commercial Space Centers (CSCs) within the structure of the SPD office. Management of both the Commercial Space Center for Engineering (CSCE) and ProVision Technologies (PVT) CSCs were transferred into the SPD office at Marshall Space Flight Center (MSFC). In addition, preparations were completed for transfer of the four “infrastructure” CSCs into SPD as they were released by NASA’s Aerospace Technology Enterprise and picked up by BPR.

Specific research efforts continuing into FY 2002 include Advanced Astroculture (deployed on ISS 6A and again on UF-1), which explores “seed-to-seed” generational research in microgravity. Future flight activity will also examine microgravity genetic engineering on plants with the goal of improved plant growth research in the Advanced Astroculture unit, which was developed by the Wisconsin Center for Space Automation and Robotics. This agriculture research expands our knowledge of closed environment system technology performance in a microgravity environment over long duration, and provides an important laboratory for improved crop development in a multi-billion dollar market.

The Commercial Generic Bioprocessing Apparatus (CGBA) will build on prior research conducted aboard Shuttle missions (STS-77 and STS-95) that achieved substantial levels of improvement in the rate of bacterial production compared to ground based samples (200% increase on STS-77, 75% increase on STS-95 in a different antibiotic arena). There will be additional research conducted on the International Space Station (ISS 8A) to replicate this increased production rate. These results may enable Bristol-Myers Squibb, the commercial partner to BioServe Space Technologies, to greatly increase its antibiotic production capability through newly developed fermentation methods. A 1% increase in process efficiency could result in the savings of millions of dollars in annual production costs for the company.

In sum, FY 2002 will see several commercial research payloads that had positive results aboard Space Shuttle missions flown on Station to build on these results with the commercial partners. There will also be new payloads designed for the ISS, such as the Zeolite Crystal Growth Furnace, that will make use of the extended duration capability of the ISS.

PROGRAM AREA PLANS FOR FY 2003

SPD will continue to perform CSC and ISS research, such as Zeolite Crystal Growth (ZCG) sample processing, genetic engineering research through the Advanced Astroculture Unit, and biomedical protein crystal growth research. New materials processing capabilities, such as the VULCAN combustion unit and the Space-DRUMS unit for high temperature material processing research, will be deployed. The ISS will continue the essential transition of research from the limited duration Shuttle sortie era to the long-duration experimentation made possible by the permanent presence of an orbiting laboratory. This ongoing access to microgravity research and the establishment of permanent facilities for commercial research efforts (ZCG, VULCAN, Space-DRUMS, etc.) represents NASA's commitment to its mandate under the Space Act to support the commercial use of space. It is envisioned that the ongoing research presence of such a capability will greatly strengthen the commercial partnerships with the Commercial Space Centers and advance the biomedical, agriculture, and materials processing product development efforts.

Lastly, development will continue on next-generation hardware to carry into the Station era the research efforts begun under the Shuttle program, such as Space Automated Bioproduct Lab (SABL, follow-on to the CGBA hardware) and the Commercial Plant Biotechnology Facility as complementary commercial research hardware to Advanced Astroculture.

The Program will also initiate the newly validated and prioritized research program content and continue ground-based and flight research in the validated and prioritized research areas.

BASIS OF FY 2003 FUNDING REQUIREMENT

OFFICE OF THE CHIEF HEALTH AND MEDICAL OFFICER

	FY 2001	FY 2002	FY 2003
	(Millions of Dollars)		
Agency Health and Medical Program	3.3	3.9	3.9

DESCRIPTION/JUSTIFICATION

The Office of the Chief Health and Medical Officer (OCHMO) was established in May 2000 to assist the Administrator in ensuring the health and safety of NASA employees in space and on the ground. The OCHMO is responsible for health policy formulation and oversight for all health and medical activities in the Agency, including oversight of healthcare delivery and professional competency, the establishment of standards of practice, and the assurance of consistent, quality occupational health services and medical care.

PROGRAM AREA

The Chief Health and Medical Officer (CHMO) is the principal advisor to the Administrator and other senior officials on all health and medical issues affecting NASA employees. The CHMO provides oversight of health care delivery and professional competency, ensuring quality and consistency of service Agency-wide. The CHMO also provides oversight of the process ensuring the safe and ethical execution of research involving human and animal subjects, and serves as the Agency medical waiver authority for atmospheric and space flight crews. The CHMO oversees the final review and evaluation of health research products and supporting clinical evidence prior to delivery to the operational community for further development and implementation.

The OCHMO's Agency Occupational Health and Agency Space Medicine programs cover the office's responsibilities for: 1) Agency health and medical policy; 2) oversight of overall medical quality assurance; 3) oversight of medical protection of research subjects and patients; 4) chairing the Agency Medical Policy Board and Health Council; 5) oversight of Agency occupational health programs; 6) oversight of professional development of NASA healthcare providers (including professional education and credentials verification); and 7) development and oversight of NASA medical and health-related research requirements review process and deliverables.

GOALS

(1) Enhance and continue to improve astronaut physical training, preflight conditioning, and post-flight rehabilitation as a critical part of the permanent human presence on the International Space Station;
(2) Acquire knowledge about the risks to human health during space flight beyond Earth's orbit and make all reasonable efforts to effectively mitigate those risks;
(3) Increase health threat awareness and readiness to defend against bioterrorism; and
(4) Implement physician credentialing as part of medical quality assurance.

CONTENT

In order to ensure the availability of appropriately trained aerospace medicine physicians, the OCHMO supports the only civilian pipelines for aerospace physicians through the Wright State Residency Program in Dayton, Ohio and the University of Texas, Medical Branch in Galveston. Through the Occupational Health Program (OHP), the OCHMO will continue to support occupational health initiatives, environmental and occupational medicine efforts, health threat awareness training, and occupational health education and training for employees across the Agency.

Milestones	Plan in the FY 2003 Budget	Plan in the FY 2002 Budget	Plan in the FY 2001 Budget	FY 2002 - FY 2003 Change	Comment/Status
Medicine of Extreme Environments IPA	January 2002	January 2001	January 2001	1 year slip	Difficulties associated with bringing on a foreign national to University of Texas – Medical Branch delayed arrival of IPA
Physician Credentialing Program	March 2002	Sept. 2001	Sept. 2001	6 Month slip	Software training and hardware acquisition delays forced deferral to FY 2003
First round of Center occupational health assessment visits	October 2001	October 2001	October 2001	None	Completed
Web-based stress management training modules		June 2001	June 2001	None	Completed

MAJOR PROGRAM AREA RESULTS IN THE PAST YEAR

With the successful completion of the first two ISS increments, Space Medicine shifted attention to worldwide long-duration operations, countermeasures to the environment of space, on-orbit medical certification and intervention, and comprehensive rehabilitation services post-flight. A behavioral health program was implemented to support ISS crewmembers and their families. This support included cross-cultural training, and cognitive and fatigue self-assessment to enable maximum performance and safety of crewmembers. The OCHMO commissioned a group of experts to evaluate and recommend for or against the efficacy of screening astronauts for congenital patent framen ovale (PFO, a physiologic condition that is potentially significant for astronauts performing EVAs). As a result, one of the first major policy decisions impacting the astronaut corps was to recommend against broad-based PFO screening because the risk of the screening procedure outweighs the benefit provided by the screening. The Occupational Health Program (OHP) restructured its award-winning Website with increased training modules, hot links, and medical alerts. Web metrics on an employee stress management module with embedded stress questionnaire documented the largest number of access hits in a single quarter, indicating widespread use by employees. A major medical first responders course received increased attention after the terrorist attacks of September 11 and the anthrax bioterrorism that followed. The OHP immediately stepped up dissemination of its not-yet-released general employee health threat awareness training. The OCHMO began unprecedented open discussion fora with employees at HQ, which were taped and broadcast repeatedly at the Centers.

PROGRAM AREA PLANS FOR FY 2002

In November 2001, the Institute of Medicine released its report on future space crew health, "Safe Passage". The report noted that there remains insufficient knowledge about the risks to human health in space flight and urges NASA to develop a comprehensive health care system, using an occupational health module, that captures all relevant clinical and epidemiological data, and to develop a focused health care strategy to define and ameliorate risks. With a newly hired external expert (hired through an Interagency Personnel Agreement, or IPA) for Medicine of Extreme Environments, NASA will concentrate on evolving health and medical care from remote, extreme environments on Earth to the environment of low Earth orbit and beyond. Physician credentialing is expected to be an integrated part of NASA's medical quality assurance system before the close of the calendar year. The Occupational Health Program will sponsor its second-ever joint Health and Safety conference and its fourth Occupational Health Conference since the principal Center was established. Finally, the threat of bioterrorism attacks will be met with increased security in the form of increased awareness, and enhanced detection and protection capabilities.

PROGRAM AREA PLANS FOR FY 2003

The OCHMO plans to further develop astronaut psychosocial support through its behavioral health programs, and will continue to refine its physical training, preflight conditioning, and post-flight rehabilitation efforts. Occupational Health training efforts will continue in both stress management and threat awareness training. Medical quality assurance efforts will ensure ongoing updates and refinement of the Centers' assessment instrument, and continue with credentialing efforts for NASA physicians.

BASIS OF FY 2003 FUNDING REQUIREMENT

BIOLOGICAL AND PHYSICAL RESEARCH INSTITUTIONAL SUPPORT

	FY 2001	FY 2002	FY 2003
	(Millions of Dollars)		
Institutional Support to the Biological and Physical Research Enterprise			
Research and Program Management (R&PM)..	42.6	156.3	154.4
Personnel and Related Costs..	32.4	124.8	126.6
Travel..	1.3	3.2	3.2
Research Operations Support...	8.9	28.3	24.6
Construction of Facilities..	6.8	14.7	19.0
Full-Time Equivalent (FTE) Workyears	**427**	**1,242**	**1,273**

Note: FY 2001 data in this section are for comparison purposes only and do not include ISS Research.

PROGRAM GOALS

The two primary goals of this budget segment are to:

1. Acquire and maintain a civil service workforce that reflects the cultural diversity of the Nation, and is both sized and skilled consistently with accomplishing NASA's research, development, and operational missions with innovation, excellence, and efficiency for the Biological and Physical Research Enterprise.
2. Ensure that the facilities critical to achieving the goals of the Biological and Physical Research Enterprise are constructed and continue to function effectively, efficiently, and safely, and that NASA installations conform to requirements and initiatives for the protection of the environment and human health.

RESEARCH AND PROGRAM MANAGEMENT (R&PM): This program provides the salaries, other personnel and related costs, travel, and the necessary support for all administrative functions and other basic services in support of research and development activities at NASA installations. The salaries, benefits, and supporting costs of this workforce are covered in the Personnel budget, which comprises approximately 82% of the requested R&PM funding. Research and Operations Support (ROS), which covers administrative and other support, is approximately 16% of the request. The ROS budget funds system management offices (SMOs) at all field Centers. The SMOs work with all Center programs to improve system engineering and cost estimating processes. The FY 2002 funding estimate for ROS includes $4.5M provided in the Emergency Supplemental to enhance NASA's security and counter-terrorism capabilities; the FY 2003 funding plan is $1.2M. The remaining 2% of the R&PM request is required to fund the travel necessary to manage NASA and its programs.

CONSTRUCTION OF FACILITIES (CoF): This budget line item provides funding for discrete projects required by components of NASA's basic infrastructure and institutional facilities; almost all CoF funding is used for capital repair. NASA facilities are critical for the support of research conducted by the Biological and Physical Research Enterprise. NASA has conducted a thorough review of its facilities infrastructure, and determined that, 1) the deteriorating plant condition warrants increased repair and renovation efforts in order to avoid safety hazards to personnel, facilities, and mission, and 2) some dilapidated facilities need to be replaced. Increased investment in facility revitalization is required to maintain an infrastructure that is safe and capable of supporting NASA's missions.

ROLES AND MISSIONS

The detail provided below is for the support of the Biological and Physical Research Enterprise institutions: Johnson Space Center (JSC), Kennedy Space Center (KSC), Marshall Space Flight Center (MSFC), Ames Research Center (ARC), Langley Research Center (LaRC), Glenn Research Center (GRC), Goddard Space Flight Center (GSFC), Jet Propulsion Laboratory (JPL), and NASA Headquarters.

JOHNSON SPACE CENTER (JSC)

The Biological and Physical Research Enterprise funds approximately 6.6% of JSC’s institutional budget. JSC is the Lead Center for developing and implementing International Space Station Research Capability (ISSRC), which encompasses the research-discipline-based facility development and utilization, multi-user systems support for the science, and technological and commercial payloads using ISS as a research platform. The ISSRC includes the development of research facilities, experiment-unique equipment, multi-user payload hardware, and the ground facilities, software, and tools to implement the utilization tasks. Utilization support services are provided to both U.S. and International Partners, and include services for payload planning and engineering support, crew and user team training, sub-rack- and sub-pallet-level payload integration, ground processing, and on-orbit payload operations for all research related hardware and software on-board the ISS. JSC coordinates all Performing Center activities for ISSRC.

JSC is the Lead Center for implementing Advanced Human Support Technology and Biomedical Research & Countermeasures work, as well as providing the mission implementation function for Headquarters research mission activities. JSC coordinates all Performing Center activities, manages Advanced Life Support facilities, and conducts all system-level integration and testing for these facilities. JSC also manages the significant ground-based grant activities and all flight experiment activities focused on human research. Countermeasures-focused research is managed by a cooperative agreement between JSC and Baylor College of Medicine. This agreement governs the National Space Biomedical Research Institute (NSBRI), a 12-university consortium managed by Baylor College of Medicine and JSC, in developing countermeasures. JSC manages clinical medical and psychological support for the astronauts as well as telemedicine efforts in support of medical operations activities for the Human Space Flight (HSF) Program.

Finally, JSC is also a Performing Center for Fundamental Space Biology, Physical Sciences Research, Space Product Development, Mission Integration, and the Agency Space Medicine Program.

KENNEDY SPACE CENTER (KSC)

The Biological and Physical Research Enterprise funds approximately 1.1% of KSC's institutional budget. Kennedy Space Center manages extramural research and conducts specific research tasks directed at using plants in advanced life support systems. KSC also provides pre- and post-flight support for Biomedical Research & Countermeasures and Fundamental Space Biology flight experiments. KSC is a Performing Center for Advanced Human Support Technology, Biomedical Research & Countermeasures, Fundamental Space Biology, ISS Research Capability, and the Agency Occupational Health Program.

MARSHALL SPACE FLIGHT CENTER (MSFC)

The Biological and Physical Research Enterprise funds approximately 17.5% of MSFC's institutional budget. Marshall Space Flight Center is the location of the ISS Payload Operations and Integration Center (POIC), and is the Lead Center for Physical Sciences Research's Fundamental Microgravity Research, and Biotechnology and Earth-Based Applications. The Microgravity Research Program Office (MRPO) at Marshall also manages Space Product Development. Marshall is also a Performing Center for Advanced Human Support Technology, Biomedical Research & Countermeasures, Fundamental Space Biology, and ISS Research Capability.

AMES RESEARCH CENTER (ARC)

The Biological and Physical Research Enterprise funds approximately 9.9% of ARC's institutional budget. Ames Research Center is the Lead Center for implementing Fundamental Space Biology, and plans are to designate ARC as the Lead Center for Physical Sciences Research's Biomolecular Physics and Chemistry efforts in FY 2002. Ames supports biomedical research investigations, and plays the primary life sciences role in the development of biomedical flight experiments requiring non-human subjects. ARC manages extramural research and conducts specific research tasks directed at analytical models and physicochemical processes for advanced life support systems. Ames is also a Performing Center for Advanced Human Support Technology, Biomedical Research & Countermeasures, and ISS Research Capability.

LANGLEY RESEARCH CENTER (LaRC)

The Biological and Physical Research Enterprise does not fund LaRC's institutional budget due to the limited amount of BPR work performed at the Center. LaRC is a Performing Center for Physical Sciences Research and ISS Research Capability.

GLENN RESEARCH CENTER (GRC)

The Biological and Physical Research Enterprise funds approximately 12.4% of GRC's institutional budget. GRC is a Performing Center for Physical Sciences Research and ISS Research Capability.

GODDARD SPACE FLIGHT CENTER (GSFC)

The Biological and Physical Research Enterprise does not fund GSFC's institutional budget; the grant-related work for GSFC is done at NASA Headquarters. GSFC is a Performing Center for Advanced Human Support Technology, Physical Sciences Research, and Space Product Development.

JET PROPULSION LABORATORY (JPL)

The Biological and Physical Research Enterprise funds approximately 2.7% of JPL's institutional budget. JPL is the lead for Advanced Environmental Monitoring and Control activities, bringing its personnel and industry contacts to the development of sensors and monitoring and control capability. JPL is a Performing Center for Advanced Human Support Technology, Biomedical Research & Countermeasures, Physical Sciences Research, Mission Integration, and ISS Research Capability.

NASA HEADQUARTERS

The Biological and Physical Research Enterprise funds approximately 3.1% of NASA Headquarters' institutional budget. NASA Headquarters is the Lead Center for planning and directing Mission Integration. The Enterprise's Institutional Support figure includes an allocation for funding Headquarters activities based on the relative distribution of direct FTEs across the Agency. The Headquarters-based Office of the Chief Health and Medical Officer manages the Agency Occupational Health and Agency Space Medicine programs.

SCIENCE, AERONAUTICS, AND TECHNOLOGY
FY 2003 ESTIMATES
BUDGET SUMMARY

OFFICE OF EARTH SCIENCE

Web Address: http://earth.nasa.gov/

SUMMARY OF RESOURCE REQUIREMENTS

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET	PAGE NUMBER
		(Millions of Dollars)		
Major Development	**852.2**	**752.6**	**556.4**	SAT 3-2
Earth Observing System	431.5	385.4	410.9	SAT 3-14
Earth Observing System Data Information System	279.1	293.0	74.3	SAT 3-67
Earth Explorers	141.6	74.2	71.2	SAT 3-74
Research and Technology	**564.2**	**537.1**	**506.3**	SAT 3-89
Earth Science Program Science..	350.2	340.5	353.9	SAT 3-91
Applications, Education and Outreach	114.1	94.8	61.7	SAT 3-100
Technology Infusion	99.9	101.8	87.3	SAT 3-109
Construction of Facilities	--	--	3.4	SAT 3-118
Mission Operations	**57.8**	**47.6**	**247.8**	SAT 3-119
Investments	**10.3**	**--**	**--**	SAT 3-123
Minority University Research & Education Program	8.8	--	--	
Education	1.5	--	--	
Institutional Support	**277.7**	**288.4**	**317.9**	SAT 3-125
Total...	**1,762.2**	**1,625.7**	**1,628.4**	
Total Direct Civil Servant Full-Time Equivalent (FTE) Work Years	**1,913**	**1,747**	**1,848**	

OFFICE OF EARTH SCIENCE

DISTRIBUTION OF PROGRAM AMOUNT BY INSTALLATION

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
Johnson Space Center......................................	35.2	21.3	18.2
Kennedy Space Center......................................	84.0	52.8	53.2
Marshall Space Flight Center	18.0	26.3	25.7
Ames Research Center	33.2	32.8	33.8
Langley Research Center	141.5	156.1	138.8
Glenn Research Center	3.0	1.4	0.4
Goddard Space Flight Center	1,049.4	957.7	996.9
Jet Propulsion Laboratory	208.3	178.9	161.3
Dryden Flight Research Center	23.9	25.6	20.6
Stennis Space Center	83.8	57.9	42.3
Headquarters	81.9	114.9	137.2
Total	**1,762.2**	**1,625.7**	**1,628.4**

EARTH SCIENCE STRATEGIC PLAN LINKAGE TO THIS BUDGET

The mission of NASA's Earth Science Enterprise (ESE) is to develop a scientific understanding of the Earth system and its response to natural and human-induced changes to enable improved prediction of climate, weather, and natural hazards for present and future generations. NASA brings to this endeavor the vantage point of space, allowing global views of Earth system change. NASA is a provider of objective scientific information, via observation, research, modeling, and applications demonstration, for use by decision-makers in both the public and private sectors. NASA has been studying the Earth from space from its beginnings as an Agency. These efforts have led to our current activity of deploying the first series of Earth Observing System (EOS) satellites that will concurrently observe the major interactions of the land, oceans, atmosphere, ice, and life that comprise the Earth system. In short, the purpose of the ESE is to provide scientific answers to the fundamental question:

How is the Earth changing, and what are the consequences for life on Earth?

A fundamental discovery made during the 20th century, enabled in large part by NASA's global view from space, is the existence of a multiplicity of linkages between diverse natural phenomena and interactions between the individual components of the Earth system. As a result, NASA has worked with other agencies to develop a new, interdisciplinary field of "Earth System Science", with the aim of investigating the complex behavior of the total Earth environment in which the global atmosphere, the oceans, the solid Earth, the ice-covered regions of the Earth, and the biosphere all function as a single interactive system. Earth System Science is an area of research with immense benefits to the nation, yielding new knowledge and tools for weather forecasting, agriculture, water resource management, urban and land use planning, and other areas of economic and environmental importance. In concert with other agencies and the global research community, ESE is providing the scientific foundation needed for the complex policy choices that lie ahead on the road to sustainable development.

ESE has established three broad goals through which to carry out its mission. 1) Science: Observe, understand, and model the Earth system to learn how it is changing, and the consequences for life on Earth; 2) Applications: Expand and accelerate the realization of economic and societal benefits from Earth science, information and technology; 3) Technology: Develop and adopt advanced technologies to enable mission success and serve national priorities. These goals are articulated in the ESE Strategic Plan.

NASA and its partners have already made considerable progress in understanding the Earth system. With satellites launched over the past decade, ESE has charted global ocean circulation including the waxing and waning of El Niño, mapped land cover change over the entire globe, illuminated the 3-D structure of hurricanes, and explored the chemistry of the upper atmosphere, as well as the causes of ozone depletion. With deployment of the EOS now underway, ESE is opening a new era in Earth observation from space in which the major interactions of the Earth system are studied simultaneously to provide a global view on climate change. With this knowledge, NASA and its partners will develop prediction capabilities to quantify the effects of natural and human-induced changes on the global environment. Operational agencies such as National Oceanic and Atmospheric Administration (NOAA) and United States Geological Survey (USGS), who are partners in this effort, can use these capabilities to improve weather and climate forecasting, natural resource management, and other services on which the Nation relies.

STRATEGY FOR ACHIEVING GOALS

SCIENCE

We know that natural and human-induced changes are acting on the Earth system. Natural forces include variation in the Sun's energy output and volcanic eruptions, which spew dust into the atmosphere and scatter incoming sunlight. Human forces include deforestation, carbon emission from burning of fossil fuels, methane and soil dust production from agriculture, and ozone depletion by various industrial chemicals. Internal climate factors such as atmospheric water vapor and clouds also introduce feedbacks that serve to either dampen or enhance the strength of climate forcing. We also know the climate system exhibits considerable variability in time and space, i.e., both short and long term changes and regionally specific impacts. For example, we have observed that over the past twenty years, the growing season has lengthened in much of the northern latitudes while Arctic sea ice extent has experienced a net decrease. Behind these net changes are considerable variations by region. Recent research has shown that dust aerosols in the atmosphere tend to slow the rate of evaporation and precipitation, while rising temperatures are expected to accelerate them. Distinguishing trends in the midst of substantial variability and countervailing forces, and distinguishing natural from human-induced changes, pose some of the challenges undertaken by ESE.

NASA has used the concept of Earth System Science in developing its program. Researchers have constructed computer models to simulate the Earth system, and to explore the possible outcomes of potential changes they introduce in the models. This way of looking at the Earth as a system is a powerful means of understanding changes we see around us. This has three implications for Earth Science. First, we need to ***characterize*** (that is, identify and measure) the forces acting on the Earth system and its responses. Second, we need to ***understand*** the source of internal variability: the complex interplay among components that comprise the system. Finally, by combining observations, research and modeling, we create a capability to ***predict*** Earth system change to help our partners produce better forecasts of change.

Earth system changes are global phenomena. Yet the system comprises many micro-scale processes, and the most significant manifestations are regional. Thus, studying such changes requires a global view at regionally discerning resolutions. This is where NASA comes in, bringing the unique capability to study planet Earth from the vantage point of space. To *characterize* the forces acting on the Earth system and its responses, *understand* the source of internal variability and *predict* Earth system change, NASA must observe the Earth, conduct research and analysis of the data, model the data and synthesize the information into new knowledge. Where we are on this knowledge "life cycle" determines the strategy for our investment decisions.

The ESE is pursuing a targeted research program, focused on a set of specific science questions that can be addressed effectively with NASA's capabilities. ESE formulates comprehensive research strategies that can lead to definitive scientific answers and potentially to effective applications by other entities.

The key Earth Science research topics sponsored by NASA follow from this view of the Earth as a system. Thus they are grouped into categories of variability in the Earth System, forces acting on the Earth system, responses of the system to change, consequences of change, and prediction of future changes. Complicating this seemingly linear construct is a set of feedbacks; responses to change often become forces of additional change themselves. This conceptual approach applies in essence to all research areas of NASA's ESE and is particularly relevant to the problem of climate change, a major Earth Science-related challenge facing our nation and the rest of the world. The ESE has articulated an overarching question and a set of strategic science questions reflecting this Earth system approach, which its observational programs, research and analysis, modeling, and advanced technology activities are directed at answering.

How is the Earth system changing, and what are the consequences for life on Earth?

- *How is the global Earth system changing? (Variability)*
- *What are the primary causes of change in the Earth system? (Forcing)*
- *How does the Earth system respond to natural and human-induced changes? (Response)*
- *What are the consequences of changes in the Earth system for human civilization? (Consequences)*
- *How can we predict future changes in the Earth system? (Prediction)*

ESE's Research Strategy for 2000-2010 describes NASA's approach to answering these questions. The intellectual capital behind ESE missions, and the key to generating new knowledge from them, is vested in an active program of research and analysis. Over 1,500 scientific research tasks from nearly every state within the U.S. are funded by the ESE research and analysis program. Scientists from seventeen other nations, funded by their own countries and collaborating with U.S. researchers, are also part of the ESE program. These researchers develop Earth system models from Earth science data, conduct laboratory and field experiments, run aircraft campaigns, develop new instruments, and thus expand the frontier of our understanding of our planet. ESE-funded scientists are recognized as world leaders in their fields, as exemplified by the award of the 1995 Nobel Prize in chemistry to two scientists who first recognized that chlorofluorocarbons provided a threat to upper atmospheric ozone. The research and analysis program is also the basis for generation of application pilot programs that enable universities, commercial firms, as well as state and local governments to turn scientific understanding into economically valuable products and services.

APPLICATIONS

NASA expects that expanded scientific knowledge of Earth processes and the utilization of advanced space-based and airborne observing techniques or facilities developed by NASA lead to practical applications beneficial to all citizens. Examples of these applications include: quantitative weather and hydrologic forecasts over an extended range of one to two weeks; prediction of seasonal or longer-range climate variations; the prediction of impacts of environmental changes on fisheries, agriculture, and water resources; global air quality forecasts and natural hazards risk assessments. NASA ESE has a role in demonstrating the potential applications.

ESE continues to build a viable applications program that bridges focused research and analysis and mission science investments towards demonstration of new remote sensing data products for industry, as well as regional and local decision makers. The emphasis is on helping weather forecasters, natural resource managers, disaster preparedness managers, and other decision and policy makers at the Federal, State and local levels to incorporate Earth science information in to their own decision support systems. The baseline Applications program provides the essential tools and funds key demonstration projects.

A series of regional workshops have been held around the Nation. These workshops enable a wide variety of State and local government users to share the challenges they face and explore the use of satellite remote sensing tools to address their challenges. One result is the establishment of regular, open, competitively selected opportunities for these organizations to propose partnerships with NASA, academia and industry. These partnerships will demonstrate new applications of Earth science data to specific problems. Successful demonstrations are expected to lead to new commercial as well as state and local government transactions, while ESE moves on to the next new demonstration activity.

TECHNOLOGY

In addition to ensuring a robust science program, this budget contains a focused Technology Program that supports development of key technologies to enable our future science missions. The baseline Technology Program includes the New Millennium Program (NMP), Instrument Incubator and advanced information systems and computing elements. The Technology Program also includes a focused Advanced Technology Initiative Program that identifies and invests in critical instrument, spacecraft and information system technologies.

The ESE will lead the way in the development of highly capable, remote and *in situ* instruments as well as the information system technologies needed to support its science and applications objectives. Together they will enable affordable investigation and broad understanding of the global Earth system. The ESE emphasizes the development of information system architectures. These architectures will increase the number of users of ESE information from thousands to millions, with the goal of providing easy access to global information for science, education, and applications. Finally, ESE will work in partnership with industry and operational organizations to develop the capabilities and infrastructure to facilitate the transition of sustained measurements and information dissemination to commercial enterprises.

ESE's technology strategy seeks to leverage the entire range of technology development programs offering benefits in cost, performance and timeliness of future Earth science process and monitoring campaigns. ESE's strategy is to establish strong links to other government programs in order to maximize mutual benefit and to use open competitions for ESE-sponsored technology programs to attract the best ideas and capabilities from the broad technology community, including industry and academia.

Technology investments will be made in the following areas:

- Advanced instrument and measurement technologies for new and/or lower cost scientific investigations;
- Cutting-edge technologies, processes, techniques, and engineering capabilities that reduce development, operations costs, and mission risk that support rapid implementation of productive, economical, and timely missions;
- Advanced end-to-end mission information system technologies that will have an impact on the data flow from origination at the instrument detector through data archiving. These technologies will collect and disseminate information about the Earth system and enable the productive use of ESE science and technology in the public and private sectors.

MISSION IMPLEMENTATION

The pursuit of Earth System Science would be impractical without the continuous, global observations provided by satellite-borne instruments. NASA's Earth science research program comprises an integrated slate of spacecraft and suborbital measurement capabilities; data and information management systems to acquire, process, archive and distribute global data sets; and research and analysis projects to convert data into new knowledge of the Earth system. Numerous users in academia, industry, as well as Federal, State, and local governments use this knowledge to produce products and services essential to achieving sustainable development. The ESE top priority continues to be the commitments to launch the first series of EOS and selected Earth Explorer missions that are nearing completion. In addition, ESE is committed to evolving functioning data and information systems to support the processing, archival, and distribution of data products for these missions. These satellites will propel the ESE into a new era of data collection, research, and analysis for which both the national and international Earth science community has been preparing over the last decade.

PARTNERSHIPS ARE ESSENTIAL TO SUCCESS IN EARTH SCIENCE

The challenge of Earth System Science, sustainable development, and mitigating risk to people, property and the environment from natural disasters, requires collaborative efforts among a broad range of national and international partners. NASA's Earth science research program constitutes its contribution to the U.S. Global Change Research Program (USGCRP), an interagency effort to understand the processes and patterns of global change. The USGCRP coordinates research among ten U.S. government agencies. NASA is the major partner in the USGCRP, providing the bulk of the USGCRP space-based observational needs. NASA will also participate in the Climate Change Research Initiative (CCRI) announced by the President in June 2001. The CCRI will focus on answering key gaps in knowledge, will adopt performance metrics for accountability, and will deliver products useful to policymakers in a short timeframe (2-5 years). NASA has extensive collaboration with the NOAA on weather and climate-related programs. The ESE is the responsible managing agent in NASA for the development of the NOAA operational environmental satellites. NOAA, NASA, and the Department of Defense (DoD) are working together to achieve the convergence of civilian and military weather satellite systems and extend selectively some observations required by climate research to the future operational systems. NASA collaborates with the USGS on a range of land surface, solid Earth and hydrology research projects. NASA and USGS continue to collaborate on the Landsat-7 program. In addition, NASA participates in the international programs of World Climate Research, the International Geosphere/Biosphere, and the World Meteorological Organization.

International cooperation is an essential element in the Earth science program. Earth science addresses global issues and requires international involvement in its implementation and application. Acquiring and analyzing the information necessary to address the science questions is a bigger task than a single nation can undertake. Furthermore, the acceptance and use of the scientific knowledge in policy and resource management decisions around the world require the engagement of the international scientific community. Global data and global participation are needed to devise a global response to environmental change. In addition, integrating our complementary science programs can result in fiscal benefits to the NASA program. For this reason, NASA has sought and nurtured international partnerships spanning science, data and information systems, and flight missions. Most of the ESE satellite missions have international participation, ranging from simple data sharing agreements to joint missions involving provision of instruments, spacecraft, and launch services. In the past three years over 60 international agreements have been concluded and more than 40 more are pending. In some capacity, Earth science programs involve international partners from over 35 nations, including Argentina, Armenia, Australia, Belgium, Brazil, Canada, Chile, China, Denmark, Egypt, France, Germany, India, Israel, Italy, Japan, Mongolia, Russia, South Africa, Ukraine, and others.

In order to structure the scientific research, the ESE has established goals, objectives, research focus areas and programs. The ESE is currently developing roadmaps for how to achieve its science objectives. Until the roadmaps are completed, the phrase "increase understanding" is being used as a placeholder in the research focus areas.

Enterprise Goals	Science Objectives	Research Focus Areas	Enabling Program/Mission
Observe, understand, and model the Earth system to learn how it is changing, and the consequence for life on Earth.	Discern and describe how the global Earth system is changing.	Increase understanding of global precipitation, evaporation and how the cycling of water through the Earth system is changing.	TRMM, Aqua, NPP
		Increase understanding of global ocean circulation and how it varies on interannual, decadal, and longer time scales by meeting 2 of 2 performance indicators.	Aqua, SeaWinds, Ocean Topography, TOPEX, Jason-1, Grace, ground networks
		Increase understanding of global ecosystems change.	SeaWifs, Terra, Aqua, NPP
		Increase understanding of stratospheric ozone changes, as the abundance of ozone-destroying chemicals decreases and new substitutes increases.	Aura, TOMS and SAGE
		Increase understanding of change occurring in the mass of the Earth's ice cover.	ICESat, aircraft campaigns, Quikscat, DMSP
		Increase understanding of the motions of the Earth, the Earth's interior, and what information can be inferred about the Earth's internal processes.	VLBI/SLR networks, Magnetometer/Global Positioning System (GPS) constellation, Grace, SCIGN
	Identify and measure the primary causes of change (forcings) in the Earth system.	Increase understanding of trends in atmospheric constituents and solar radiation and the role they play in driving global climate.	Terra, TOMS, SAGE, AGAGE, ACRIMSat, SORCE, UARS, NPP, CALIPSO

Enterprise Goals	Science Objectives	Research Focus Areas	Enabling Program/Mission
		Increase understanding about the changes in global land cover and land use and their causes	Terra, Landsat, LDCM, NPP
		Increase understanding of the Earth's surface and how it is transformed and how such information can be used to predict future changes.	SRTM, EO-1, Landsat, Terra, SAR observations and ground based networks, space GPS receivers
	Determine how the Earth system responds to natural and human-induced changes	Increase understanding of the effects of clouds and surface hydrologic processes on climate change	CloudSat, CALIPSO, Aqua, Terra, Seawinds, ACRIMSat, NPP
		Increase understanding of how ecosystems respond to and affect global environmental change and affect the global carbon cycle	Aqua, Terra, NPP
		Increase understanding of how climate variations induce changes in the global ocean circulation	SeaWinds, TOPEX, Quickscat, Jason-1
		Increase understanding of stratospheric trace constituents and how they respond to change in climate and atmospheric composition	SOLVE, Aura, TOMS, SAGE
		Increase understanding of global sea level and how it is affected by climate change	RADARSAT, ERS 1 and 2
		Increase understanding of the effects of regional pollution on the global atmosphere, and the affects of global chemical and climate changes on regional air quality.	TRACE-P, TOMS, SAGE, Aura, Terra
	Identify the consequences of change in the Earth system for human civilization.	Increase understanding of variations in local weather, precipitation and water resources and how they relate to global climate variation.	TRMM, Seawinds, GPM, Jason-1, Ocean Topography

Enterprise Goals	Science Objectives	Research Focus Areas	Enabling Program/Mission
		Increase understanding of the consequence of land cover and land use change for the sustainability of ecosystems and economic productivity.	LDCM, Landsat-7, Terra, NPP
		Increase understanding of the consequences of climate and sea level changes and increased human activities on coastal regions.	Landsat-7, LDCM, Terra, SeaWifs
	Enable the prediction of future changes in the Earth system.	Increase understanding of the extent that weather forecast duration and reliability can be improved by new space-based observations, data assimilation and modeling.	Seawinds, TRMM, Ocean Topography, Operational satellites
		Increase understanding of the extent that transient climate variations can be understood and predicted	Seawinds, Topex/Poseidon, Aqua, NPP, Jason-1
		Increase understanding of the extent that long-term climate trends can be assessed or predicted.	Improved modeling
		Increase understanding of the extent that future atmospheric chemical impacts on ozone and climate can be predicted.	Improved modeling
		Increase understanding of the extent that future concentrations of carbon dioxide and methane and their impacts on climate can be predicted.	Improved modeling
Expand and accelerate the realization of economic and societal benefits from Earth science, information & technology.	Demonstrate scientific and technical capabilities to enable the development of practical tools for public and private sector decision-makers.	Provide regional decision-makers with scientific and applications products and tools.	RESAC, Federal Partnership (USDA, NOAA, FEMA, EPA), Commercial Partnership Programs

Enterprise Goals	**Science Objectives**	**Research Focus Areas**	**Enabling Program/Mission**
	Stimulate public interest in and understanding of Earth System Science and encourage young scholars to consider careers in science and technology.	Share the excitement of NASA's scientific discoveries and the practical benefits of Earth science to the public in promoting understanding of science and technology in service to the society.	Education/Outreach, New Investigator Program, graduate fellowships, undergraduate curriculum development, professional partnerships, press reports, GLOBE
Develop and adopt advanced technologies to enable mission success and serve national priorities.	Develop advanced technologies to reduce the cost and expand the capability for scientific Earth observation.	Successfully develop and infuse technologies that will enable future science measurements, and/or improve performance and reduce the cost of existing measurements. Increase the readiness of technologies under development, retiring risks and advancing them to a maturity level where they can be infused into new missions with shorter development cycles	IIP, tech transfers, commercialization, NMP, ATI, EO-3, GIFTS
		Develop baseline suite of multidisciplinary models and computational tools leading to scalable global climate simulations.	Computational Technologies Program
	Partner with other domestic and international agencies to develop and implement better methods for using remotely sensed observations in Earth system monitoring and prediction.	Collaborate with other domestic and international agencies in developing and implementing better methods for using remotely sensed observations to support national and international assessments of climate changes and their practical consequences.	Federal Partnership, CEOS, IGOS-P, International Partnership
	Develop advanced information technologies for processing, archiving, accessing, visualizing, and communicating Earth science data.	Develop hardware/software tools to demonstrate high-end computational modeling to further our understanding and ability to predict the dynamic interaction of physical, chemical and biological processes affecting the earth	Computing/Modeling, Computational Technologies Program

Enterprise Goals	**Science Objectives**	**Research Focus Areas**	**Enabling Program/Mission**
Enterprise-Wide Activities that enable achievement of Earth Science strategic goals.	Successfully develop one (1) spacecraft and have ready for launch. Operate instruments on orbiting spacecraft to enable Earth Science research and applications goals and objectives.	Successfully develop and have ready for launch at least one spacecraft. At least 90% of the total on-orbit instrument complement will be operational during their design life.	Satellite Launch
	Successfully disseminate Earth Science data to enable our science research and applications goals and objectives.	Make available ESE acquired data and information on Earth's atmosphere, land and/or oceans to users.	EOSDIS Program
		Increase by 20-30% the total volume of data acquired by and available from NASA for its research programs compared to FY 2002.	
		Maintain satisfactory support for the number of distinct NASA ESE data and information center customers compared to FY 2002.	Airborne Field Campaigns
		Enable production of and distribute scientifically valid data sets from the Aqua mission.	
		Maintain or improve the overall level of ESE data center customer satisfaction as measured by User Working Group surveys.	
	Safely operate airborne platforms to gather remote and *in situ* earth science data for process and calibration/ validation studies.	Support and execute seasonally dependent coordinated research field campaigns within two-weeks of target departure with the aid of airborne and sub-orbital platforms.	

ENABLING PROGRAM/MISSION ACRONYM LIST

ACRIMSat – Active Cavity Radiometer Irradiance Monitor Satellite
AGAGE – Advanced Global Atmospheric Gases Experiment
DMSP – Defense Meteorological Satellite Program
EO-1 – Earth Observing 1
ERS – European Remote-Sensing Satellite
EPA – Environmental Protection Agency
FEMA – Federal Emergency Management Agency
GPS – Global Precipitation Mission
GPS – Global Positioning System
Grace – Gravity Recovery and Climate Experiment
ICESat – Ice, Cloud and Land Elevation Satellite
Landsat – Land Remote-Sensing Satellite
LDCM – Landsat Data Continuity Mission
NOAA – National Oceanic and Atmospheric Administration
NPP – National Polar-Orbiting Operational Environmental Satellite System (NPOESS) Preparatory Program
Quikscat – Quick Scatterometer
RESAC – Regional Science Applications Center
SAGE – Stratospheric Aerosol and Gas Experiment
SAR – Synthetic Aperture Radar
SCIGN – California Integrated GPS Network
SeaWifs – Sea-viewing Wide Field-of-View Sensor
SOLVE – SAGE Ozone Loss and Validation Experiment
SORCE – Solar Radiation and Climate Experiment
SRTM – Shuttle Radar Topography Mission
TOMS – Total Ozone Mapping Mission
TOPEX – Ocean Topography Experiment
TRMM – Tropical Rainfall Measurement Mission
UARS – Upper Atmosphere Research Satellite
USDA – U.S. Department of Agriculture
VLBI/SLR – Very Long Baseline Interferometer/Shuttle Landing Radar

BASIS OF FY 2003 FUNDING REQUIREMENT

EOS PROGRAM

Web Address: http://gaia.hq.nasa.gov/ese_missions/

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
		(Millions of Dollars)	
Terra	3.3	2.4	--
Aqua (formerly PM-1)	68.5	45.1	4.7
Aura (formerly Chemistry)	99.5	70.4	85.3
Special Spacecraft	113.4	71.0	21.0
EOS Follow-on	55.0	109.6	238.5
Algorithm Development	89.3	83.4	59.7
QuikSCAT	1.1	1.8	--
Landsat-7	1.4	1.7	1.7
Total	431.5	385.4	410.9

* EOS Total life cycle cost data is provided at the end of this section.

DESCRIPTION/JUSTIFICATION

The EOS Program provides a broad range of systematic and survey type observations and measurements to improve our understanding of the Earth system. This improved understanding, combined with improvements in predictive Earth system models, will provide the government and the public with the basis for formulating scientifically well founded environmental and resource management policies.

The EOS Program consists of the following key elements:

(1) Multiple flights to collect measurement sets that contribute to answering the science questions using instruments such as spectrometers, sounders, and radiometers.

(2) Data systems and network facilities to command and control spacecraft and instruments; to process data; and to archive, distribute and manage NASA's Earth science data.

(3) Algorithm development activities to produce the algorithms and software needed to generate the standard data products. These data products will support the Earth System Science research needed to accomplish the ultimate objectives of the Enterprise.

The measurements to be made by these and other future Earth science missions as well as current on-orbit missions provide data products that are used extensively in the Earth science program. These activities are providing an ever-increasing scientific understanding of the global environment and the effects of natural and human sources of change.

EOS PROGRAM ENABLES ANSWERS TO PRIMARY SCIENTIFIC QUESTIONS

The overall goal of the Earth Observing System (EOS) Program is to advance the understanding of the entire Earth system on a global scale by improving our knowledge of the components of the system, the interactions between them, and how the Earth system is changing. The EOS data will be used to study the atmosphere, oceans, cryosphere, biosphere, land surface, and solid Earth; particularly as their interrelationships are manifested in the flow of energy and in the cycling of water and other chemicals through the Earth system.

The objectives of the EOS Program are to develop, launch, and operate remote sensing missions that will provide long-term observations in the area of climate as well as terrestrial and marine ecosystems. The EOS Program will use these observations to provide the supporting information systems necessary to develop a comprehensive understanding of how the Earth functions as a unified system and solve practical problems of interest to society.

The key research topics studied by NASA's ESE fall largely into five categories: variability, forcings, responses, consequences, and prediction. This conceptual approach applies in essence to all research areas of NASA's Earth science program, although it is particularly relevant to the problem of climate change, a major Earth science-related issue facing the countries of the world. The scientific strategy to address this immensely complex problem can be laid out in five steps or fundamental questions, each raising a wide range of cross-disciplinary science problems:

- How is the global Earth system changing? (Variability)
- What are the primary forcings of the Earth system? (Forcing)
- How does the Earth system respond to natural and human-induced changes? (Response)
- What are the consequences of change in the Earth system for human civilization? (Consequence)
- How well can we predict the changes to the Earth system that will take place in the future? (Prediction)

LINKAGES

Strategic Plan Goal Supported: Observe, understand, and model the Earth system to learn how it is changing, and the consequences for life on Earth.

Strategic Plan Objectives Supported: Discern and describe how the global Earth system is changing; Identify and measure primary causes of change in the Earth system; Determine how the Earth system responds to natural and human-induced changes; Identify the consequences of change in the Earth system for human civilization; Enable the prediction of Earth system changes that will take place in the future.

Performance Plan Metrics Supported: Annual Performance Goals as shown in Annual Performance Plan:1A1-1A6, 1B1-1B2, 1C1-1C6, 1D1**-1D3, 1E1-1E5.**

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

The top priority continues to be the existing near-term commitments with the safe and effective implementation of the EOS first series, including the launches of Aqua, Sorce and Icesat in FY 2002.

Also in FY 2002, ESE plans to continue development of NPP and begin/continue formulation activities for a Landsat Data Continuity Mission (LDCM), global precipitation, the observation of global ocean topography and ocean surface winds to succeed TRMM, Jason-1, and SeaWinds on ADEOS II, respectively.

PROGRAM PLANS FOR 2003

In parallel with deploying EOS, NASA ESE is looking ahead to determine the important Earth science questions in the next decade that require NASA's unique capabilities and leadership to be answered. Drawing on existing reports of the National Academy of Sciences and the state of progress in current scientific endeavors, ESE has developed a *Research Strategy for this decade* that articulates a hierarchy of one overarching question, five broad subordinate questions, and twenty-three detailed questions that can and should be tackled over this decade. ESE is in the process of developing roadmaps for each of the detailed questions. Some of those roadmaps may indicate the need for definition of candidate missions.

The opportunity to hand off a required measurement to an operational agency is one of the criteria that were used to identify missions funded in the FY 2003 budget request. Therefore, a high priority in this timeframe is the National Polar-Orbiting Operational Environmental Satellite System (NPOESS) Preparatory Program (NPP). NPP will serve to provide continuity with the Terra and Aqua missions as well as a demonstration of instruments for the converged weather satellite program. NASA and the Integrated Program Office (IPO) jointly fund the NPP mission. The IPO consists of representatives from the three agencies participating in NPOESS – NASA, the NOAA, and the Air Force. The follow-on to JASON also falls into this category. Another priority is the Landsat Data Continuity Mission (LDCM) to succeed Landsat-7 as required by the Land remote Sensing Policy Act of

1992 to maintain the continuity of Landsat-type data beyond Landsat-7 into the New Millennium. As with Landsat-7, this mission is being planned in partnership with USGS and the private sector. NASA and USGS plan to implement LDCM as a commercial data purchase and have released a request for proposal from industry for Landsat-type data to meet data continuity requirements. In FY 2003, there will be a pause in the development of other proposed satellites, pending a review of the USGCRP, and its relationship to the new CCRI.

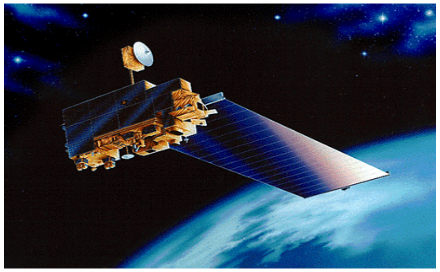
BASIS OF FY 2003 FUNDING REQUIREMENT

TERRA

Web Address: http://terra.nasa.gov/

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
TERRA Development ($ in Millions) *	3.3	2.4	--

* TERRA Total life cycle cost data is provided at the end of this section.



DESCRIPTION/JUSTIFICATION

Terra was launched on December 18, 1999 and its aperture doors were opened on February 24, 2000 beginning its science operations. Terra is providing key measurements that are significantly contributing to our understanding of the total Earth system. The instrument complement is obtaining information about the physical and radiative properties of clouds, air-land and air-sea exchanges of energy, carbon, and water as well as measurements of trace gases, and volcanology. Terra Level-1 data products from MODIS and CERES were released 4 months after launch with spacecraft checkout completed by April 2000. Terra collects 200 gigabytes (200,000 megabytes) of data per day over the entire globe. Among the first operational uses of Terra was imagery from the MODIS instrument in support of the U.S. Forest Service to combat the western U.S. forest fires this past summer. The images from MODIS assisted fire fighters in identifying the active locations of the fire(s) itself instead of through smoke-filled images, and allowed them to control the rapidly spreading fires. MODIS imagery was also used by the Geography Department at Dartmouth College in New Hampshire to assist in flood hazard reduction programs. MODIS data also supports geographic information that Dartmouth converts and distributes to disaster relief agencies through the World Wide Web. In FY 2001 Terra Level-2 and above products were released as the first round of product validation efforts completed by instrument science teams. In FY 2001, the Terra spacecraft collected over 99.5 percent of the mission data. All five instruments are operating successfully.

TERRA ANSWERS PRIMARY SCIENTIFIC QUESTIONS

SCIENTIFIC QUESTION:	TERRA APPROACH
How are global ecosystems changing? *What trends in atmospheric constituents and solar radiation are driving global climate?* *What changes are occurring in global land cover and land use, and what are their causes?* *What are the effects of clouds and surface hydrologic processes on Earth's climate?* *How do ecosystems respond to and affect global environmental change and the carbon cycle?* *What are the consequences of land cover and land use change for the sustainability of ecosystems and economic productivity?* *What are the consequences of climate and sea level changes and increased human activities on coastal regions?*	The following instruments are in operation aboard the TERRA spacecraft: The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) obtains high-resolution images of the Earth in 14 different wavelengths of the electromagnetic spectrum, ranging from visible to thermal infrared light. Scientists use ASTER data to create detailed maps of land surface temperature, emissivity, reflectance, and elevation. The Multi-Angle Imaging Spectro-Radiometer (MISR) views the Earth with cameras pointed at nine different angles. In addition to improving our understanding of the fate of sunlight in the Earth's environment, MISR data can distinguish different types of clouds, aerosol particles, and surfaces. The Moderate-resolution Imaging Spectroradiometer (MODIS) sees every point on our world every 1-2 days in 36 discrete spectral bands. Consequently, MODIS greatly improves upon the heritage of the NOAA Advanced Very High Resolution Radiometer (AVHRR) and tracks a wider array of the earth's vital signs than any other Terra sensor. For instance, the sensor measures the percent of the planet's surface that is covered by clouds almost every day. This wide spatial coverage enables MODIS, together with MISR and CERES, to determine the impact of clouds and aerosols on the Earth's energy budget. The Measurement of Pollution in the Troposphere (MOPITT) is an instrument designed to enhance our knowledge of the lower atmosphere and to particularly observe how it interacts with the land and ocean biospheres. There are two identical CERES instruments aboard Terra that measure the Earth's total radiation budget and provide cloud property estimates that enable scientists to assess clouds' roles in radiative fluxes from the surface to the top of the atmosphere.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Observe, understand, and model the Earth system to learn how it is changing, and the consequences for life on Earth.

Strategic Plan Objectives Supported: Discern and describe how the global Earth system is changing; Identify and measure primary causes of change in the Earth system; Determine how the Earth system responds to natural and human-induced changes; Identify the consequences of change in the Earth system for human civilization; Enable the prediction of Earth system changes that will take place in the future.

Performance Plan Metrics Supported: See Annual Performance Goals 1A3, 1B1, 1B2, 1C1, 1C2, 1D2, 1D3 as described in above science question section.

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-FY03 Change	Comment
Spacecraft Complete	3/99	3/99	3/98		
Del Flight	8/97	8/97	2/97		
Start Observatory I&T	3/96	3/96	3/97		
Del Observatory	3/99	3/99	3/98		
Launch	12/99	12/99	6/98		Successfully launched 12/18/99

Lead Center: GSFC

Other Centers: JPL and LARC (instrument development), KSC (Launch vehicle)

Subsystem	**Builder**
Spacecraft	Lockheed-Martin, Valley Forge, PA

Instruments	**Builder**
Moderate Resolution Imaging Spectro Radiometer (MODIS)	Raytheon (SBRS)
Multi-Angle Imaging Spectro-Radiometer (MISR)	JPL
Clouds and the Earth's Radiant Energy System (CERES)	LARC/TRW
Measurements of Pollution in the Troposphere (MOPPITT)	Canadian Space Agency
Adv Spaceborne Therm Emis & Reflect Radiometer (ASTER)	Japan/JAROS

Launch Vehicle: Atlas IIAS

Tracking/Communications: TDRS/Ground Network

Data Handling: EOSDIS

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

Spacecraft operations are nominal.

PROGRAM PLANS FOR FY 2003

Continue nominal operations budgeted under Earth Science Operations.

TERRA LIFE CYCLE COST DATA

$ in Millions	Prior	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	BTC	Total
Initial Baseline (lifecycle)	1,142.4									1,142.4
FY03 President's Budget	1,387.5	3.3	2.4							1,393.2
Development	1,220.8	3.3	2.4							1,226.5
Launch Vehicle	166.7									166.7
FTEs (number)		(1)								

BASIS OF FY 2003 FUNDING REQUIREMENT

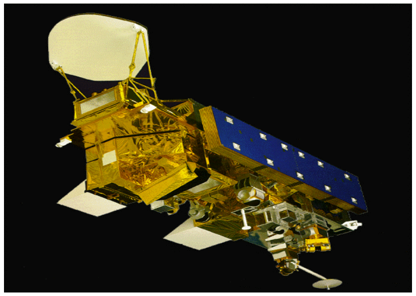
EOS PROGRAM - PROJECTS IN IMPLEMENTATION

AQUA

Web Address: http://eos-pm.gsfc.nasa.gov/

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
AQUA Development ($ in Millions) *	**68.5**	**45.1**	**4.7**

* AQUA Total life cycle cost data is provided at the end of this section.



DESCRIPTION/JUSTIFICATION

The Aqua spacecraft payload will consist of a suite of passive microwave radiometers, infrared radiometers, high spectral resolution infrared sounding and infrared imaging instruments that will be used to help improve numerical weather prediction and understanding of the Earth's climate. Specifically these instruments will provide measurements of:

1. Atmospheric temperature and humidity profiles, clouds, aerosols, and radiative balance
2. Measurements of the extent of terrestrial snow and ice
3. Sea-surface temperature and ocean productivity.

AQUA ANSWERS PRIMARY SCIENTIFIC QUESTIONS

SCIENTIFIC QUESTION:	AQUA APPROACH
How are global precipitation, evaporation, and the cycling of water changing? How is the global ocean circulation varying on inter-annual, decadal, and longer time scales? How are global ecosystems changing? What are the effects of clouds and surface hydrologic processes on Earth's climate? How do ecosystems respond to and affect global environmental change and the carbon cycle?	The instruments carried on Aqua will have the following technical characteristics: • Advanced Infrared Sounder (AIRS) - A grating array spectrometer infrared sounder that will measure tropospheric and stratospheric temperature, day-and-night sides, globally, every 2 days; • Advanced Microwave Scanning Radiometer (AMSR-E) provided by Japan- A scanning passive microwave radiometer which will provide all-weather, day/night, global observations of a variety of surface and atmospheric variables (precipitation, water vapor, temperature, snow and ice, soil moisture); • Advanced Microwave Sounding Unit (AMSU-A) - A microwave sounding radiometer that provides atmospheric temperature measurements, plus a cloud-filtering capability for tropospheric observations (intricately coupled with AIRS); • Clouds and the Earth's Radiant Energy System (CERES) - Two broadband scanning radiometers providing radiant flux at the top of the atmosphere; • Humidity Sounder for Brazil (HSB) provided by Brazil - A four-channel microwave sounding radiometer providing (with AIRS and AMSU) humidity profiles under overcast conditions. • Moderate Resolution Imaging Spectroradiometer (MODIS) - An imaging spectroradiometer designed to measure biological and physical processes on a global basis every 1 to 2 days; providing land and ocean temperatures, ocean color, Earth's vegetation and land surface cover, and cloud cover and properties.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Observe, understand, and model the Earth system to learn how it is changing and the consequences for life on Earth.

Strategic Plan Objectives Supported: Discern and describe how the global Earth system is changing; Determine how the Earth system responds to natural and human induced changes.

Performance Plan Metrics Supported: See Annual Performance Goals 1A1, 1A2, 1A3, 1C1, 1C2 as described in scientific question section above.

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-FY03 Change	Comment
Preliminary Design Review	April 1997	April 1997	April 1997		
Critical Design Review	June 1998	June 1998	April 1998		
Spacecraft Complete	October 2000	October 2000	October 2000		
Deliver Flight Instruments	January 2000	January 2000	September 1999		Due to Spacecraft problems, instrument delivery delayed
Start Observatory Integration &Test	June 1999	June 1999	June 1999		
Launch	NET March 2002	NET June 2001	December 2000		Launch delay due to technical issues related to spacecraft (array electronics/solid state recorder) delayed observatory I&T

Lead Center: GSFC	**Other Centers:** JPL, LaRC, KSC	**Interdependencies:** Japan, Brazil, EOS Aura Mission (Common spacecraft 2nd build after Aqua)
Subsystem	**Builder**	
Spacecraft	TRW, Redondo Beach, CA	
Instruments	**Builder**	
Moderate Resolution Imaging Spectro Radiometer (MODIS)	Raytheon (SBRS)	
Atmospheric Infrared Sounder (AIRS)	JPL/LMIRIS	
Cloud & the Earth's Radiant Energy System (CERES)	LaRC/TRW	
Advanced Microwave Sounding Unit (AMSU-A)	Aerojet	
Advanced Microwave Scanning Radiometer (AMSR-E)	NASDA/MELCO	
Humidity Sounder Brazil (HSB)	Brazil INPE/MMS	
Launch Vehicle: Delta II 7920	**Tracking/Communications:** TDRSS/Ground Network	**Data Handling:** EOS Data Information System

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

In FY2001, observatory integration and test continued, culminating in a successful thermal vacuum test ending in early October 2001. Currently the spacecraft and instrument combination is going through its final series of tests prior to shipment to the Western Test Range (Vandenburg Air Force Base) for launch. Launch is planned for no earlier than (NET) March 2002.

PROGRAM PLANS FOR FY 2003

After a 120 day on orbit checkout, the spacecraft will be turned over to operations. The balance of FY 2002 and FY 2003 is expected to be normal operations with the return of science data.

AQUA LIFE CYCLE COST DATA

$ in Millions	Prior	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	BTC	Total
Initial Baseline (lifecycle	926.3	20.4								946.7
(Does not include Launch Vehicle)										
FY03 President's Budge	829.3	68.5	45.1	4.7	4.6	0.1	0.1			952.4
Development	773.7	65.3	45.1	4.7	4.6	0.1	0.1			893.6
Launch Vehi	55.6	3.2								58.8
FTEs (number)		(39)	(6)							

BASIS OF FY 2003 FUNDING REQUIREMENT

EOS PROGRAM - PROJECTS IN IMPLEMENTATION

AURA

Web Address: http://eos-chem.gsfc.nasa.gov/

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
AURA Development ($ in Millions) *	**99.5**	**70.4**	**85.3**

* AURA Total life cycle cost data is provided at the end of this section.

DESCRIPTION/JUSTIFICATION

The Aura mission will study the chemistry and dynamics of the Earth's atmosphere with emphasis on the troposphere and lower stratosphere (altitudes up to 20 km). The mission will measure ozone, aerosols, and several key atmospheric constituents that play an important role in atmospheric chemistry, air quality, and climate. This mission will help in understanding the chemical and pollutant transport phenomena that are essential ingredients in evaluating the environmental policies and international agreements on chlorofluorocarbon (CFC) phase out.

The Aura project will launch four instruments on the EOS Common Spacecraft into a 705km, 98.2-degree inclination, polar sun-synchronous orbit. The spacecraft will have an equatorial crossing time (ascending node) of 1:45pm.

AURA ANSWERS PRIMARY SCIENTIFIC QUESTIONS

SCIENTIFIC QUESTION:	AURA APPROACH
How is stratospheric ozone changing, as the abundance of ozone-destroying chemicals decrease and new substitutes increase?	The instruments carried on AURA will have the following technical characteristics: • High Resolution Dynamic Limb Sounder (HIRDLS) jointly built by NASA and the United Kingdom- is an infrared limb-scanning radiometer designed to sound the

How do stratospheric trace constituents respond to change in climate and atmospheric composition? What are the effects of regional pollution on the global atmosphere, and the effects of global chemical and climate changes on regional air quality?	upper troposphere, stratosphere and mesosphere. • Microwave Limb Sounder (MLS) - ranging from 118 GHz to 2.5THz frequency, is designed to measure the stratospheric temperature and numerous chemical species. • Tropospheric Emission Spectrometer (TES)- a high-resolution infrared imaging Fourier transform spectrometer that observes in the limb and nadir. • Ozone Monitoring Instrument (OMI) provided by the Netherlands Space Agency and the Finnish Meteorological Institute - is an ultraviolet and visible grating spectrometer providing global mapping of ozone and other trace gases.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Observe, understand, and model the Earth system to learn how it is changing and the consequences for life on Earth.

Strategic Plan Objectives Supported: Discern and describe how the global Earth system is changing; Determine how the Earth system responds to natural and human induced changes.

Performance Plan Metrics Supported: See Annual Performance Goals 1A4, 1C4, 1C6 as described in scientific question section above.

Key Milestones:	**FY 2003 DATE**	**FY 2002 DATE**	**BASELINE DATE**	**CHANGE (FY02-FY03)**	**COMMENT**
Preliminary Design Review	October 1999	October 1999	March 1998		
Critical Design Review	August 2000	August 2000	August 2000		
Spacecraft Integration &Test	August 2001	August 2001	June 2001		
Instrument Delivery	October 2002	May 2002	June 2001	+ 5 Months	Inst. Problems causing later delivery, reduced slack
Launch	NET Jan 2004	July 2003	December 2002	+ 6 Months	Launch delay due to instrument problems/delays; shared resources (staffing & GFE) with Aqua and longer test times for Aura based on Aqua experience.

Lead Center: GSFC	**Other Centers:** JPL (Instrument development), KSC (Launch vehicle**)**	**Interdependencies:** United Kingdom, Netherlands, EOS Aqua mission (1st build of EOS common spacecraft)
Subsystem	**Builder**	
Spacecraft:	TRW, Redondo Beach, CA	
Instruments	**Builder**	
Microwave Limb Sounder (MLS)	JPL	
Tropospheric Emission Spectrometer (TES)	JPL	
High Resolution Dynamics Limb Sounder (HIRDLS)	LMSS/Oxford/RAL, United Kingdom	
Ozone Measuring Instrument (OMI)	TNO/TPD, Fokker/VTT, Netherlands	
Launch Vehicle: Delta II 7920	**Tracking/Communications**: TDRSS/Ground Network	**Data Handling:** EOS Data Information System

PROJECT STATUS/NOTIFICATIONS/PLANS THROUGH FY 2002

During FY 2001, the remaining technology developments required for the EOS Aura Instruments were demonstrated. Nearly all of the flight subsystem hardware was completed and delivered to system-level Integration and Test (I&T). Progress on the spacecraft bus was also very successful. The Aura and Aqua missions share a common spacecraft contractor. As a result of Aqua technical issues, the Aqua delays have impacted the integration schedule of Aura. Hardware technical problems that were discovered during I&T of the Aqua spacecraft are being addressed for Aura as well. In FY 2002, integration of the spacecraft bus will be completed, as will integration, test, and calibration of all of the instruments.

PROJECT PLANS FOR FY 2003

Integration of the instruments onto the observatory will occur in late FY 2002 based on lessons learned from Aqua spacecraft. This will result in extended test durations. Observatory level testing will be conducted in FY 2003, with the launch of Aura planned for January 2004. Funding requirements for the launch readiness delay from July 2003 to January 2004 are being assessed. A major factor in this assessment is the successful completion of Aqua development and its launch, which is currently, scheduled NET March 2002.

AURA LIFE CYCLE COST DATA

$ in Millions	Prior	FY 2001	FY 2002	FY 2003	FY 2004	Y 2005	FY 2006	FY 2007	Total
Initial Baseline (lifecycle)	561.8	145.8							707.6
(Does not include Launch Vehicle)									
FY03 President's Budget	451.7	99.5	70.4	85.3	0.1				707.0
Development	451.6	85.6	42.0	70.0	0.1				649.3
Launch Vehicle	0.1	13.9	28.4	15.3					57.7
FTEs (number)		(40)	(45)	(40)	(8)				

Note: Funding requirments for the launch readiness delay from July 2003 to January 2004 are being assessed (starting in FY 2003).

BASIS OF FY 2003 FUNDING REQUIREMENT

PROJECT DATA-SPECIAL

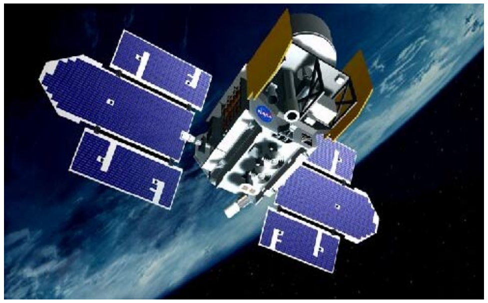
The Special spacecraft are designed to study atmospheric aerosols, ocean circulation, ice-sheet mass balance, cloud physics, atmospheric radiation properties, and solar irradiance

SPECIAL: ICESat

Web Address: http://icesat.gsfc.nasa.gov/

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
		(Millions of Dollars)	
ICESat Development ($ in Millions) *	53.3	21.6	--

* ICESat Total life cycle cost data is provided at the end of this section.



DESCRIPTION/JUSTIFICATION

The Ice, Clouds and land Elevation Satellite (ICESat) Project provides a subset of the EOS measurements, primarily land ice and sea ice products, for which an orbit is required that maximizes polar coverage over the ice sheets.

ICESat ANSWERS PRIMARY SCIENTIFIC QUESTIONS

SCIENTIFIC QUESTION:	ICESat APPROACH
What changes are occurring in the mass of the Earth's ice cover?	The primary objective of the ICESat mission is to measure ice sheet height and volume change for long-term climate variability studies, providing a 3-year data set of ice sheet topography. This will be achieved via a laser altimetry instrument, Geoscience Laser Altimeter System (GLAS), an Nd:YAG laser with 1064 and 532 nm output. The instrument will be launched into a 600 km, 94° inclination orbit.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Observe, understand, and model the Earth system to learn how it is changing and the consequences for life on Earth.

Strategic Plan Objectives Supported: Discern and describe how the global Earth system is changing.

Performance Plan Metrics Supported: See Annual Performance Goal 1A5 as described in scientific question section above.

Key Milestones:	FY 2003 DATE	FY 2002 DATE	BASELINE DATE	CHANGE (FY02-	COMMENT
Instrument Preliminary Design Review	June 1998	June 1998	June 1998		
Instrument Critical Design Review	March 1999	March 1999	March 1999		
Spacecraft Complete	June 2001	October 2000	October 2001	+8 months	Delayed interface definition and risk reduction
Instrument Delivery	TBD	February 2001	October 2001	TBD	Optical stability and rework
Algorithm (V2)	April 2001	April 2001	January 2002		
Observatory Integration &Test	TBD	June 2001	May 2002	TBD	Delayed instrument delivery
Launch	NET March 2002	December 2001	January 2002	+3	Delayed instrument delivery

Lead Center: GSFC

Other Centers: KSC (Launch vehicle), JPL GPS Receiver

Interdependencies: EOS SORCE Project/University of Colorado at Boulder, Laboratory for Atmospheric and Space Physics (LASP). LASP is performing mission ops for both ICESAT and SORCE.

Subsystem	Builder
Spacecraft	Ball Aerospace
Global Positioning System (GPS) Receiver	JPL

Instruments	Builder
Geoscience Laser Altimeter System (GLAS)	GSFC/In-house

Launch Vehicle: Delta 7320

Tracking/Communications: Ground Network

Data Handling: EOS Data Information System/LASP

PROJECT STATUS/NOTIFICATIONS/PLANS THROUGH FY 2002

The spacecraft was fully qualified in the summer of 2001. The Mission Operations Center and Instrument Support Facility were also completed. The GLAS instrument experienced a laser failure and instrument technical problems continue to erode the schedule. The spacecraft bus is flight qualified and awaiting GLAS delivery. The schedule is being re-evaluated under new management. Planned activities for FY 2002 include delivery of the GLAS instrument, integration and test with the spacecraft. Funding requirements for a launch readiness delay beyond March 2002 are being assessed.

PROJECT PLANS FOR FY 2003

Generation of data products will begin in late FY 2003 and continue for 3 years.

ICESat LIFE CYCLE COST DATA

$ in Millions	Prior	FY 2001	Y 2002	Y 2003	Y 2004	Y 2005	Y 2006	Y 2007	BTC	Total
Initial Baseline (lifecycle)	**127.5**	**37.6**								**165.1**
FY03 President's Budget	**139.6**	**53.3**	**21.6**							**214.5**
Development	**123.0**	**29.2**	**14.7**							166.9
Launch Vehicle	**16.6**	**24.1**	**6.9**							47.6
FTEs (number)		(51)	(15)							

BASIS OF FY 2003 FUNDING REQUIREMENT

SPECIAL: SeaWinds

Web Address: http://gaia.hq.nasa.gov/ese_missions

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
SeaWinds Development ($ in Millions) *	**4.1**	**4.5**	**2.2**

* SeaWinds Total life cycle cost data is provided at the end of this section.

DESCRIPTION/JUSTIFICATION

The Sea Winds mission provides a set of time critical series of global marine wind vector measurements. This mission is in partnership with the National Space Development Agency (NASDA) of Japan for Earth remote sensing. The first instrument of the series, NSCAT, was launched in August 1996 on NASDA's ADEOS spacecraft. The first ADEOS mission was terminated in June 1997 due to a solar array failure. The Japanese will provide the Advanced Earth Observing System II (ADEOS II) spacecraft for the Seawinds instrument to measure ocean surface wind velocity as a follow-on to the NASA Scatterometer instrument on ADEOS-I and the Seawinds instrument on QuikSCAT.

SeaWinds ANSWERS PRIMARY SCIENTIFIC QUESTIONS

SCIENTIFIC QUESTION:	SeaWinds APPROACH
How is the global ocean circulation varying on interannual, decadal, and longer time scales? What are the effects of clouds and surface hydrologic processes on Earth's climate? How are variations in local weather, precipitation, and water resources related to global climate variation? How can weather forecast duration and	SeaWinds has a Ku Band microwave radar with a rotating antenna used to determine radar scattering cross section globally and to infer wind velocity (speed and direction) over 90% of the ice-free ocean surface every two days with a resolution of 25km. SeaWinds will acquire all-weather, high-resolution measurements of near-surface winds over the global oceans. It will determine atmospheric forcing, ocean response and air-sea interaction mechanisms on various spatial and temporal scales as well as combine wind data with measurements from scientific instruments in other disciplines to understand mechanisms of global climate change and weather patterns. SeaWinds will also improve weather forecasts near coastlines by using wind data in numerical weather- and wave-prediction models that will also improve storm warning and monitoring

reliability be improved by new space-based observations, data assimilation, and modeling? How well can transient climate variations be understood and predicted?	

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Observe, understand, and model the Earth system to learn how it is changing and the consequences for life on Earth.

Strategic Plan Objectives Supported: Discern and describe how the global Earth system is changing; Determine how the Earth system responds to natural and human-induced changes; Identify the consequences of changes in the Earth system for human civilization; Enable the prediction of Earth system changes that will take place in the future.

Performance Plan Metrics Supported: See Annual Performance Goals 1A2, 1C1, 1D1, 1E1 as described in scientific question section above.

Key Milestones:	FY 2003 BUDGET DATE	FY 2002 BUDGET DATE	BASELINE DATE	CHANGE (FY02-FY03)	COMMENT
Preliminary Design Review (PDR)	May 1995	May 1995	May 1995		
Critical Design Review (CDR)	March 1999	March 1999	March 1998		
Instrument Delivery	March 1999	March 1999	March 1998		
Del SC I/V Site	September 2001	TBD	Pre ship rev 3/99		
Launch	NET November 2002	TBD	August 1999		Launch delays due to ADEOS II spacecraft delays by NASDA (Japan)

Lead Center: JPL

Other Centers:

Interdependencies: NASDA, Japan

Subsystem	Builder
Spacecraft: ADEOS II	Japan

Instruments	Builder
SeaWinds	JPL

Launch Vehicle: H-IIA	**Tracking/Communications:** Japanese and NASA ground network	**Data Handling:** JPL and EOSDIS

PROJECT STATUS/NOTIFICATIONS/PLANS THROUGH FY 2002

The SeaWinds protoflight model was delivered to Tsukuba, Japan in March 1999 for a launch on the ADEOS II spacecraft by a NASDA H-IIA rocket from Tanegashima, Japan. The spacecraft was shipped to the launch site (Tanegashima) during September 2001. It is currently going through post-shipment tests. After the completion of the tests, the spacecraft will go into storage until the beginning of the launch campaign. This budget assumes a NET July 2002 launch. NASA has recently been advised by NASDA that the Japanese Space Activities Commission (SAC) want to have 3 successful H-IIA rocket launches prior to the ADEOS-II launch. This sets the ADEOS-II launch to take place no earlier than November 2002. The project is currently assessing the impact of this delay on future operational requirements.

PROJECT PLANS FOR FY 2003

Generation of data products will begin in late CY 2002 and continue for 5 years.

SeaWinds LIFE CYCLE COST DATA

$ in Millions	Prior	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	BTC	Total
Initial Baseline (lifecycle)	135.0									135.0
FY03 President's Budget	134.9	4.1	4.5	2.2	1.0	0.5	0.2	0.1		147.5
Development	134.9	4.1	4.5							143.5
Mission Operatins				2.2	1.0	0.5	0.2	0.1		4.0
FTEs (number)										

BASIS OF FY 2003 FUNDING REQUIREMENT

JASON-1

Web Address: http://www.jpl.nasa.gov/missions/current/jason1.html

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
JASON-1 Development *	**7.8**	**1.5**	**--**

* JASON-1 Total life cycle cost data is provided at the end of this section.

DESCRIPTION/JUSTIFICATION

Jason-1 is a Radar Altimetry mission which is a follow-on to the TOPEX/Poseidon. Jason-1 is a cooperative joint mission with the French Space Agency (CNES), with data provided to NOAA for operational purposes. Jason-1 was successfully launched on a Delta II 7920 on December 7, 2001.

JASON-1 ANSWERS PRIMARY SCIENTIFIC QUESTIONS

SCIENTIFIC QUESTION:	JASON-1 APPROACH
How is the global ocean circulation varying on interrannual, decadal, and longer time scales? How are variations in local weather, precipitation, and water resources related to global climate variation?	Jason-1 is an oceanography mission to monitor global ocean circulation. It will also study the ties between the oceans and atmosphere, improve global climate forecasts and predictions, and monitor events such as El Niño conditions and ocean eddies. Jason-1 has been designed to directly measure climate change through very precise millimeter-per-year measurements of global sea-level changes. The Jason-1 satellite, its altimeter instrument and a position-tracking antenna were built in France. The spacecraft also carries a radiometer instrument to measure water vapor, a Global Positioning System receiver and a laser retroreflector array built in the United States.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Observe, understand, and model the Earth system to learn how it is changing and the consequences for life on Earth.

Strategic Plan Objectives Supported: Discern and describe how the global Earth system is changing. Identify the consequences of changes in the Earth system for human civilization.

Performance Plan Metrics Supported: See Annual Performance Goals 1A2, 1D1 as described in scientific question section above.

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-FY03 Change	Comment
Launch	December 2001	NET June 2001	December 1999	6	French Space Agency (CNES) delays; Successfully launched 12/7/01 at VAFB

Lead Center: JPL

Other Centers: KSC (launch vehicle), France-CNES (Spacecraft)

Subsystem	Builder
Spacecraft	French Space Agency (CNES)

Instruments	Builder
Jason-1 Microwave Radiometer (JMR) Engineering Model	TRW
JMR Flight Model	TRW
JMR Reflectors	Composite Optics Inc (COI)
TRSR-Global Positioning Sys	Spectrum Asto Inc (SAI

Launch Vehicle: Delta 7920

Tracking/Communications: JPL

Data Handling: Physical Oceanography Distributed Active Archive Center (PODAAC)

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

Spacecraft operations are nominal.

PROGRAM PLANS FOR FY 2003

Continue operations budgeted under EOSDIS.

JASON LIFE CYCLE COST DATA

$ in Millions	Prior	FY 2001	Y 2002	Y 2003	Y 2004	Y 2005	Y 2006	Y 2007	BTC	Total
Initial Baseline (lifecycle)	**43.3**									**43.3**
FY03 President's Budget	**69.7**	**7.8**	**1.5**							**79.0**
Development	**35.5**	**7.8**	**1.5**							44.8
MO	**34.2**									34.2
FTEs (number)										

BASIS OF FY 2003 FUNDING REQUIREMENT

SPECIAL: SORCE

Web Address: http://lasp.colorado.edu/sorce/

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
SORCE Development *	**24.1**	**18.7**	**4.0**

* SORCE Total life cycle cost data is provided at the end of this section.

DESCRIPTION/JUSTIFICATION

The SORCE Mission replaces the EOS-Solar Stellar Irradiance Comparison Experiment (SOLSTICE) and Total Solar Irradiance Mission (TSIM). These missions were combined as a result of an accommodation study, which recognized both the scientific and financial benefits of combining SOLSTICE and TSIM. The principal goal of the SORCE Mission is to measure both total and spectrally resolved solar irradiance.

The Total Solar Irradiance (TSI) measurement is a continuation of the first space-borne measurements begun by Nimbus 7 in 1978. Currently, three spacecraft are sustaining the TSI database, ACRIMSAT, the Upper Atmosphere Research Satellite (UARS) and the Solar Heliosphere Observer SOHO). Continued and uninterrupted population and monitoring of the TSI data set will provide insight into long-term climate changes. These measurements will continue the total solar irradiance and spectrally resolved solar irradiance measurements being made from UARS since 1991, as well as earlier missions for TSI measurements and will add additional capability. They will be used to further understand the effects of solar variability on long-term global climate change and influences on the stratospheric ozone layer. Additionally, the spectral measurements in the 200-300 nm and 1500 nm spectral regions will fulfill the NPOESS operational requirements as part of a tri-agency partnership with NASA, NOAA, and DoD.

SORCE ANSWERS PRIMARY SCIENTIFIC QUESTIONS

SCIENTIFIC QUESTION:	SORCE APPROACH
What trends in atmospheric constituents and solar radiation are driving global climate?	The SORCE Mission will consist of four instruments to provide solar and stellar irradiance measurements: • Total Irradiance Monitor (TIM) – The TIM is an active cavity radiometer and will provide the TSI measurements. TIM consists of four independent radiometer channels, which provide duty cycle stability and redundancy. TSI data will consist of multiple samples taken each orbit providing 15 measurements per day

	• with an absolute accuracy of 150 parts/million (relative accuracy of 10 parts/million per year). • XUV Photometer System (XPS) – The XPS will provide measurements of the extreme ultraviolet bandwidth (1-31 nm) every orbit. Detectors consist of 12 filtered individual Si photodiodes with six unique, three redundant, and three bare channels. XPS has a spectral resolution of 5 to 10 nm and an absolute accuracy of 20 percent (relative accuracy of 10 percent/year). • Solar Stellar Irradiance Comparison Experiment (SOLSTICE) – SOLSTICE is a scanning grating spectrometer capable of both solar and stellar observations. It consists of two independent and redundant units. Each unit is capable of measuring a FUV bandwidth (115 – 175 nm) and a MUV bandwidth (175 – 300 nm). Solar and stellar observations will be made every orbit with a spectral resolution of 0.1 to 0.2 nm and an absolute accuracy of 1.5 to 5 percent (relative accuracy of 0.5 percent). • Spectral Irradiance Monitor (SIM) – SIM is a scanning prism spectrometer providing coverage of a wide bandwidth from 200 -–2000 nm. It consists of two redundant channels within one unit. The primary detector is an electrical substitution radiometer. Measurements over the visible and near IR solar spectrum will be made every orbit with a spectral resolution 0.2 to 30 nm and an absolute accuracy of 1500 parts/million (relative accuracy of 100 parts/million per year).

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Observe, understand, and model the Earth system to learn how it is changing and the consequences for life on Earth.

Strategic Plan Objectives Supported: Identify and measure primary causes of change in the Earth system.

Performance Plan Metrics Supported: See Annual Performance Goals 1B1 as described in scientific question section above.

Key Milestones:	FY 2003 DATE	FY 2002 DATE	BASELINE DATE	CHANGE (FY02-FY03)	COMMENT
Preliminary Design Review	May 1999	May 1999	May 1999		
Critical Design Review	November 2000	November 2000	October 2000		
Spacecraft Complete	November 2001	October 2001	October 2001	+ 1 month	Spacecraft Bus delay due to OSC avionics box fabrication & testing
Last Instrument Delivery	November 2001	October 2001	October 2001	+ 1 months	Result of Spacecraft Bus delay
Integration &Test Complete	May 2002	May 2002	May 2002		
Deliver Spacecraft to KSC	June 2002	June 2002	June 200		
Launch	July 2002	July 2002	July 2002		

Lead Center: GSFC	**Other Centers**: KSC (Launch vehicle)	**Interdependencies:** University of Colorado at Boulder, Laboratory for Atmospheric and Space Physics (LASP). LASP is performing mission ops for both SORCE and ICESAT.
Subsystem	**Builder**	
Spacecraft:	Orbital Sciences Corp.	
Instruments	**Builder**	**Principal Investigator:** Gary Rottman
SOLSTICE	LASP	
Spectral Irradiance Monitor (SIM)	LASP	
XUV Photometer System (XPS)	LASP	
Total Irradiance Monitor (TIM)	LASP	
Spacecraft	Orbital	
Launch Vehicle: Pegasus XL	**Tracking/Communications**: Ground Network	**Data Handling**: Laboratory for Atmospheric and Space Physics

PROJECT STATUS/NOTIFICATIONS/PLANS THROUGH FY 2002

The SORCE Team successfully completed the Mission Operations Review in April 2001. The SORCE Instruments have completed their final instrument assembly. Critical activities for FY 2002 include completion of observatory integration and test with launch scheduled for July 2002.

PROJECT PLANS FOR FY 2003

Generation of data products will begin in late CY 2002 and continue for 5 years.

SORCE LIFE CYCLE COST DATA

$ in Millions	Prior	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	BTC	Total
Initial Baseline (lifecycle)	52.8	23.0	16.7	4.0	2.0	2.0	2.0	1.8		104.3
FY03 President's Budget	49.4	24.1	18.7	4.0	2.0	2.0	2.0	1.8		104.0
Development	45.9	14.2	9.2	1.5	0.4	0.4	0.4	0.4		72.4
Mission Operations	0.1	0.2	1.3	2.5	1.6	1.6	1.6	1.4		10.3
Launch Vehicle	3.4	9.7	8.2							21.3
FTEs (number)	6	5	1	1	1	1	1	1		

BASIS OF FY 2003 FUNDING REQUIREMENT

ACRIM

Web Address: http://acrim.jpl.nasa.gov/

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
ACRIM Development *	**1.6**	**1.5**	**1.5**

* ACRIM Total life cycle cost data is provided at the end of this section.

DESCRIPTION/JUSTIFICATION

The EOS ACRIMSAT was launched December 20, 1999, and continues the measurement of Total Solar Irradiance (TSI) begun by the ACRIM instruments on the Solar Maximum Mission and Upper Atmospheric Research Satellite (UARS).

ACRIM ANSWERS PRIMARY SCIENTIFIC QUESTIONS

SCIENTIFIC QUESTION:	ACRIM APPROACH
What trends in atmospheric constituents and solar radiation are driving global climate?	The Active Cavity Radiometer Irradiance Monitor III instrument is measuring total solar irradiance from the sun. The instrument, third in a series of long-term solar-monitoring tools built for NASA by the Jet Propulsion Laboratory, will continue to extend the data set first created by ACRIM I, which was launched in 1980 on the Solar Maximum Mission (SMM) spacecraft. ACRIM II followed on the Upper Atmosphere Research Satellite (UARS) in 1991.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Observe, understand, and model the Earth system to learn how it is changing and the consequences for life on Earth.

Strategic Plan Objectives Supported: Identify and measure primary causes of change in the Earth system.

Performance Plan Metrics Supported: See Annual Performance Goals 1B1 as described in scientific question section above.

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-FY03 Change	Comment
Launch	December 1999	December 1999	October 1999		Successfully launched December 20, 1999

Lead Center: JPL

Other Centers: KSC (Launch vehicle)

Subsystem	**Builder**

Instruments	**Builder**
ACRIM Instrument	JPL – In-house

Launch Vehicle: Taurus

Tracking/Communications: Table Mountain Observatory (TMO); JPL

Data Handling: EOSDIS

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

Spacecraft operations are nominal.

PROGRAM PLANS FOR FY 2003

Continue operations.

ACRIM LIFE CYCLE COST DATA

$ in Millions	Prior	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	BTC	Total
Initial Baseline (lifecycle)	19.9	3.8								23.7
FY03 President's Budget	29.6	1.6	1.5	1.5	1.3	0.5				36.0
Development	20.5	0.7	0.6	0.6	0.5	0.1				23.0
Mission Operations	1.1	0.9	0.9	0.9	0.8	0.4				5.0
Launch Vehicle	8.0									8.0
FTEs (number)										

BASIS OF FY 2003 FUNDING REQUIREMENT

SAGE

Web Address: http://www-sage3.larc.nasa.gov/

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
SAGE Development *	**3.0**	**1.3**	**0.1**

* SAGE Total life cycle cost data is provided at the end of this section.

DESCRIPTION/JUSTIFICATION

The Meteor/SAGE-III was successfully launched on December 10, 2001. Scheduled for a three-year mission, the Meteor/SAGE-III is a joint partnership between NASA and the Russian Aviation and Space Agency. A calibration/validation campaign is tentatively scheduled for FY 2003. A second SAGE-III instrument is scheduled to fly aboard the International Space Station in FY 2005.

SAGE ANSWERS PRIMARY SCIENTIFIC QUESTIONS

SCIENTIFIC QUESTION (Annual Performance Goal):	SAGE APPROACH
How is stratospheric ozone changing, as the abundance of ozone-destroying chemicals decrease and new substitutes increase? What trends in atmospheric constituents and solar radiation are driving global climate? How do stratospheric trace constituents respond to change in climate and atmospheric composition?	The Sage-III instruments were manufactured for long-term monitoring of ozone and aerosols. Sage III takes advantage of both solar and lunar osculation to measure vertical profiles of aerosols, ozone, and other gaseous constituents of the atmosphere and will continue a more than 25-year record of calibrated ozone profile data.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Observe, understand, and model the Earth system to learn how it is changing, and the consequences for life on Earth.

Strategic Plan Objectives Supported: Discern and describe how the global Earth system is changing; Identify and measure primary causes of change in the Earth system; Determine how the Earth system responds to natural and human-induced changes.

Performance Plan Metrics Supported: See Annual Performance Goals 1A4, 1B1,1C4 as described in scientific question section above.

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-FY03 Change	Comment
Instrument Delivered	September 1998	September 1998	December 1997		Russian delays
Algorithms (V2)	November 2001	December 2000	December 1997		Commensurate with delay in launch
Launch	December 2001	June 2001	December 1998		Successfully launched on12/10/01 in Baikonur, Russia

Lead Center: LARC **Other Centers: GSFC, Russia LV**

Instruments	Builder
SAGE Instrument	Ball

Launch Vehicle: Zenit 2 **Tracking/Communications:** Russian and US ground Network **Data handling: EOSDIS**

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

Spacecraft is operating nominally.

PROGRAM PLANS FOR FY 2003

Continue operations budgeted under EOSDIS.

SAGE LIFE CYCLE COST DATA

$ in Millions	Prior	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	BTC	Total
Initial Baseline (lifecycle)	67.6	0.0								67.6
FY03 President's Budget	67.0	3.0	1.3	0.1	0.1	0.1	0.1	0.1		71.8
Development	67.0	3.0	1.3	0.1	0.1	0.1	0.1	0.1		71.8
FTEs (number)										

Outyear funds are for storage costsof SAGE Flight of Opportunity

BASIS OF FY 2003 FUNDING REQUIREMENT

SCISAT ELV AND OTHER

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
SCISAT ELV Development	8.9	9.1	--
HQ Institutional Support	10.6	12.8	13.2

DESCRIPTION/JUSTIFICATION

As a result of an Agency level Space Station Memorandum of Understanding (MOU) signed between NASA and the Canadian Space Agency (CSA) in May 1994, the ESE committed to a joint science program where NASA would provide a launch vehicle for the Canadian SciSAT mission in a separate MOU signed October 2000. The Kennedy Space Center negotiated the launch vehicle contract in FY 2000. The launch date was slipped from June 2002 to December 2002 after a detailed review by CSA to mitigate schedule risk.

HQ institutional support funds administrative activity that supports the operation of the Earth Science Enterprise including contract administration requirements.

BASIS OF FY 2003 FUNDING REQUIREMENT

EOS PROGRAM

EOS FOLLOW-ON

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
EOS Follow-on	**55.0**	**109.6**	**238.5**

DESCRIPTION/JUSTIFICATION

The next generation of EOS missions will provide new technology and space systems to meet the scientific needs for the NASA Earth science projects. NASA ESE has identified a mission architecture over the mid-term that will help achieve the specific scientific goals using a combination of systematic and exploratory missions. The new missions selected will capitalize on our investments in advanced technologies to reduce lifecycle time/cost and relate to longer-term scientific questions and practical applications. The approach to mission selection and implementation will assure maturity of key and essential technology during mission definition and formulation for both exploratory and systematic missions (i.e. no missions will go into implementation until key technologies are ready). Missions with firm plans for a hand-off to an operational agency will be continued in FY 2003. No other missions will be started or continued, until a review of the USGCRP , and its relationship to the new CCRI, is complete.

The first set of systematic missions has been under formulation and study during the past year. Therefore, detailed life cycle cost data is not available at this time.

These missions are:

PROJECT DATA- OCEAN SURFACE TOPOGRAPHY

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
Ocean Surface Topography Mission	**0.3**	**9.1**	**32.4**

DESCRIPTION/JUSTIFICATION

The Ocean Surface Topography Mission (OSTM) will provide continuity of ocean topography measurements beyond Topex/Poseidon and Jason-1, for determining ocean circulation, climate change and sea level rise. This mission is currently in formulation and is being led by JPL.

The objective of the OSTM is to continue the measurement made by Topex/Poseidon and Jason-1 that is essential to the understanding of ocean circulation and its effects on climate. To observe and understand how this climatic state will evolve in the next decade is vital to the understanding of long-term climate change. This mission will also provide a bridge to an operational mission to enable the continuation of multi-decadal ocean topography measurements for ocean circulation and climate studies.

The OSTM will use the same measurement approach used by the Jason-1 mission. The OSTM will be developed and operated as a four party international collaboration among NASA, NOAA, CNES, and European Meteorological Satellite (EUMETSAT), with the intent of transferring the responsibility for this measurement beyond OSTM to the operational community.

OCEAN SURFACE TOPOGRAPHY ANSWERS PRIMARY SCIENTIFIC QUESTIONS

SCIENTIFIC QUESTION:	OCEAN SURFACE TOPOGRAPHY APPROACH
How is the global ocean circulation varying on interannual, decadal, and longer time scales?	OSTM is an oceanography mission to monitor global ocean circulation. It will also study the ties between the oceans and atmosphere, improve global climate forecasts and predictions, as well as monitor events such as El Niño conditions and ocean eddies. The potential instruments to be carried on the spacecraft include: 1. Nadir Altimeter to measure ocean topography – provided by CNES 2. Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS) for precision orbit determination – provided by CNES 3. Microwave Radiometer for path delay correction 4. Wide Swath Altimeter for enhanced science measurements (optional) 5. Global Positioning System (GPS) receiver for precision orbit determination 6. Laser Retroreflector Array for precision orbit determination

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Observe, understand, and model the Earth system to learn how it is changing and the consequences for life on Earth.

Strategic Plan Objectives Supported: Discern and describe how the global Earth system is changing.

Performance Plan Metrics Supported: See Annual Performance Goals 1A2 as described in scientific question section above.

Key Formulation Milestones:	**FY 2003 BUDGET DATE**	**FY 2002 BUDGET DATE**	**BASELINE DATE**	**CHANGE**	**COMMENT**
Systems Requirements Review	February 2002		February 2002		
Preliminary Design Review	April 2002		April 2002		
Mission Confirmation Readiness Review	July 2002		July 2002		
Planned launch readiness	2006		2006		

ROJECT STATUS/NOTIFICATIONS/PLANS THROUGH FY 2002

Formulation started in FY 2001 and start PDR in 2002.

PROJECT PLAN FOR FY 2003

Start implementation phase and Preliminary and Detailed Design Reviews.

PROJECT DATA- LANDSAT DATA CONTINUITY MISSION (LDCM)

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
LDCM Development	**1.5**	**12.0**	**45.0**

DESCRIPTION/JUSTIFICATION

LDCM continues the basic global land cover change data set. NASA is hopeful this can be accomplished with a commercial data purchase. NASA has released a Request for Proposal for the formulation phase as the next step in exploring this avenue. Contract awards are anticipated no later than CY 2002. This mission is currently in formulation and is being supported by GSFC and SSC.

The Landsat program has been continually acquiring imagery of the Earth's land surfaces since the launch of Landsat 1 in 1972. Landsat data are used for scientific research as well as a variety of applications including education, land management, and commercial endeavors. The Land Remote Sensing Policy Act of 1992 (P.L. 102-555) addressed maintaining the continuity of Landsat-type data beyond Landsat-7 into the next millennium. P.L. 102-555 also required Landsat Program Management (NASA and the United States Geological Survey (USGS)) to consider various management alternatives, with preference given to commercial involvement.

The LDCM Project will field a data specification-based procurement which leaves the means of providing and delivering those data up to the data vendor. Such a data specification has been written and subjected to public review by both user and vendor communities. The final contract will be for the delivery of these data and not the system that produces it. Technical performance must be demonstrated by the vendor to the Government.

The Government will retain an intimate role in the calibration, validation, and verification of the data itself. In addition, the Government will have complete insight into the concept, design, implementation of the design, and operation of the system producing these data.

LDCM ANSWERS PRIMARY SCIENTIFIC QUESTIONS

SCIENTIFIC QUESTION:	LDCM APPROACH
What changes are occurring in global land cover and land use, and what are their causes? What are the consequences of land cover and land use change for the sustainability of ecosystems and economic productivity? What are the consequences of climate and sea level changes and increased human activity on coastal regions?	Aside from the legal mandate, the objective of the LDCM is to provide synoptic, repetitive, multispectral, high-resolution, digital imagery of the Earth's land surfaces which periodically refreshes a global archive with substantially cloud-free, sunlit data; characterize and monitor change in land-cover and land-surface processes; improve the assessment of both the rates of land-cover change and the local processes responsible for those changes; observe deforestation, ecosystem fragmentation, agricultural productivity, glacier dynamics, and coastal hazards; and monitor volcanoes.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Observe, understand, and model the Earth system to learn how it is changing and the consequences for life on Earth.

Strategic Plan Objectives Supported: Identify and measure primary causes of change in the Earth system; Identify the consequences of changes in the Earth system for human civilization.

Performance Plan Metrics Supported: See Annual Performance Goals 1B2, 1D2, 1D3 as described in scientific question section above.

Key Formulation Milestones:	FY 2003 BUDGET DATE	FY 2002 BUDGET DATE	BASELINE DATE	CHANGE	COMMENT
Release Request for Information	July 9, 1999		July 9, 1999		
Release Draft Data Specification	November 6, 2000		November 6, 2000		
Release Formulation Phase RFP	November 1, 2001		November 1, 2001		
Award Formulation Phase Contracts	April, 2002		April, 2002		
Release Implementation Phase RFP	December, 2002		December, 2002		
Award Implementation Phase Contract	May, 2003		May, 2003		
Mission Design Review/Delta PDR	June 2003		June 2003		
Initial Receipt of Operational data	March 2006		March 2006		

PROJECT STATUS/NOTIFICATIONS/PLANS THROUGH FY 2002

A Request for Proposal for formulation study contracts was released and proposals were received in December 2001. In addition, workshops have been held with potential industry, government and commercial partners as part of the formulation Request for Proposal (RFP) development. During formulation we will be working with the formulation contractors to further define the process to enable a commercial data policy.

PROJECT PLAN FOR FY 2003

Start implementation phase and detailed Design Reviews.

PROJECT DATA- NPOESS PREPARATORY PROJECT (NPP)

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
NPP Development	**45.5**	**67.2**	**153.1**

DESCRIPTION/JUSTIFICATION

NPP continues fulfilling our national commitment to obtain and make available a 15-year data record for fundamental global climate change observations started by MODIS, AIRS, and the combination of AMSU/HSB, which are the primary instruments on the EOS Terra and Aqua satellites. This is also a shared cost precursor mission to the next generation of operational polar weather satellites being developed by the National Polar-Orbiting Operational Environmental Satellite System (NPOESS) Integrated Program Office (IPO), a joint NASA, NOAA, DoD effort. This arrangement assures NASA's long-term science observational needs are met by the operational system, and assures transfer of key technologies NASA developed as part of the EOS program into the next generation of operational satellites.

NPP ANSWERS PRIMARY SCIENTIFIC QUESTIONS

SCIENTIFIC QUESTION (Annual Performance Goal):	NPP APPROACH
How are global precipitation, evaporation, and the cycling of water changing? How is the global ocean circulation varying on interannual, decadal, and longer time scales? How are global ecosystems changing? What trends in atmospheric constituents and solar radiation are driving global climate? What changes are occurring in global	The instruments carried on the NPP spacecraft have the following technical characteristics: • Advanced Technology Microwave Sounder (ATMS) developed and provided by NASA – In conjunction with CrIS, provide daily global observation of atmospheric temperature and humidity profiles – similar to the AMSU/HSB instrument combinations; • Visible Infrared Imaging Radiometer Suite (VIIRS) developed and provided by NPOESS IPO – obtains global observation of land, oceans, and atmosphere for climate research and weather forecasting – similar to the MODIS instrument; • Cross-Track Infrared Sounder (CrIS) developed and provided by NPOES IPO – In conjunction with ATMS, provide daily global observation of atmospheric temperature and humidity profiles – similar to the AIRS, AMSU/HSB instrument combinations.

land cover and land use, and what are their causes? What are the effects of clouds and surface hydrologic processes on earth's climate? How do ecosystems respond to and affect global environmental change and the carbon cycle? What are the consequences of land cover and land use change for the sustainability of ecosystems and economic productivity?	

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Observe, understand, and model the Earth system to learn how it is changing and the consequences for life on Earth.

Strategic Plan Objectives Supported: Discern and describe how the global Earth system is changing; Identify and measure the primary causes of change in the Earth system; Determine how the Earth system responds to natural and human-induced changes; Identify the consequences of changes in the Earth system for human civilization.

Performance Plan Metrics Supported: See Annual Performance Goals 1A1, 1A2, 1A3, 1B1, 1B2, 1C1, 1C2, 1D2 as described in scientific question section above.

Key Milestones:	**FY 2003 DATE**	**FY 2002 DATE**	**BASELINE DATE**	**CHANGE (FY02-FY03)**	**COMMENT**
Preliminary Design Review	4th Qtr 2002	December 2002	December 2002	+ 2 QTRS	Project in formulation. Revised due to schedule maturity
Critical Design Review	2nd Qtr 2003	January 2003	December 2003	+ 1 QTR	Project in formulation. Revised due to schedule maturity
Instrument Delivery to Integration &Test	November 2004	October 2004	October 2004	+ 1 month	
Spacecraft Integration	November 2004	November 2004	November 2004		

&Test			
Launch	NET December 2005	December 2005	December 2005

Lead Center: GSFC	**Other Centers:**	**Interdependencies:** NPOESS – Integrated Program Office (IPO)
Instruments	**Builder**	
Advanced Technology Microwave Sounder (ATMS)	Aerojet	
Spacecraft	TBD	
Ground System	TBD	
Data Processing Center	TBD	
Launch Vehicle: Delta II		

PROJECT STATUS/NOTIFICATIONS/PLANS THROUGH FY 2002

The NPP awarded the second phase of spacecraft study contracts in FY 2001, which will culminate in a Preliminary Design Review in FY 2002. Subsequent to these reviews, the NPP spacecraft provider will be selected in FY 2002. The Advanced Technology Microwave Sounder (ATMS) instrument implementation contract was awarded in FY 2001 and is proceeding toward a Critical Design Review in FY 2002

PROJECT PLANS FOR FY 2003

A joint NASA/IPO NPP Mission Preliminary and Critical design review will be conducted in FY 2003. The tentative launch readiness date is late 2005, which will be finalized as part of formulation process.

OTHER PRE FORMULATION STUDIES

PROJECT DATA- GLOBAL PRECIPITATION MISSION (GPM)

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
GPM Formulation	**2.0**	**11.3**	**8.0**

DESCRIPTION/ JUSTIFICATION

Observations from the Tropical Rainfall Measurement Mission (TRMM) have demonstrated the value of these data in modeling the global water and energy cycle, which is an emerging science theme for both the ESE and the USGCRP. We are currently examining options for this mission.

GPM ANSWERS PRIMARY SCIENTIFIC QUESTIONS

SCIENTIFIC QUESTION (Annual performance Goal):	GPM APPROACH
How are global precipitation, evaporation, and the cycling of water changing? How are variations in local weather, precipitation, and water resources related to global climate variation?	Mission under study.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Observe, understand, and model the Earth system to learn how it is changing and the consequences for life on Earth.

Strategic Plan Objectives Supported: Discern and describe how the global Earth system is changing; identify the consequences of changes in the Earth system for human civilization

Performance Plan Metrics Supported: See Annual Performance Goals 1A1, 1D1 as described in scientific question section above.

PROJECT STATUS/NOTIFICATIONS/PLANS THROUGH FY 2002

Work toward completion of the final Advanced Study Review and draft Letter of Agreement with NASDA in FY 2002. Continue preliminary mission design reviews.

PROJECT PLAN FOR FY 2003

There is no commitment to this mission until the review of the USGCRP is complete.

OTHER PRE-FORMULATION STUDIES

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
OTHER PRE-FORMULATION STUDIES	**5.7**	**10.0**	**--**

SOLAR IRRADIANCE STUDY

This data provides the means to distinguish the external (solar) from internal sources of change in the Earth system. A follow-on mission is required to bridge the gap between the SORCE mission (2002) and NPOESS (2010). We are currently studying various options for technical and programmatic feasibility.

TOTAL COLUMN OZONE STUDY

Total ozone measurements are required to assess the anticipated recovery of the ozone layer as a result of the Montreal Protocol. Aerosols are the largest source of uncertainty in efforts to quantify the forces acting on climate. TOMS currently provides the former (with Aura picking it up in 2004), and SAGE the latter. This combined mission is required to fill the gap between Aura & SAGE, and NPOESS.

OCEAN VECTOR WINDS STUDY

The Ocean Vector Winds Mission (OVWM) will provide continuity of a high-quality, multi-decadal data set of ocean vector winds and wind-driven ocean circulation beyond NSCAT, QuikSCAT and SeaWinds, without any gaps, for climate studies, air/sea interaction studies, and meteorological forecasting. The OVWM scatterometer will use the same measurement approach used by the SeaWinds scatterometer. In preparation for the transition of the measurement to the operational platforms, steps will be taken to reduce the cost of producing the instrument, mass, power, volume, and potentially field of view. Formulation activities for this mission concept will include exploration of several mission implementation options that include collaborations with NASDA and NOAA to reduce the mission cost.

OTHER & FUTURE EOS FOLLOW-ON MISSIONS

In FY 2001, new Follow On studies were initiated in the following areas: Global Winds; Global Earthquake; and New Data and Information Systems and Services (New DISS). In FY 2002 some additional studies will be conducted relating to these and other possible future missions, but none will be initiated pending review of the USGCRP.

BASIS OF FY 2003 FUNDING REQUIREMENT

ALGORITHM DEVELOPMENT

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
Algorithm Development	**89.3**	**83.4**	**59.7**

DESCRIPTION/JUSTIFICATION

The EOS Algorithm activities consist of the development, maintenance, and operation of the algorithms that produce the EOS standard data products, including routine intellectual quality control of these products. As such, these activities serve to unite the flight instruments, science, and the information system. These activities ensure, in the form of the products produced, that the integrity, quality, and rigor of the total process extending from instrument and spacecraft operation to the actual archiving and distribution of the data and information products used by the broad earth science and applications communities are maintained.

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

Continue to develop and complete/deliver algorithms for Aqua, ICESat, and SORCE. Continue development of Aura algorithms and algorithm maintenance for Terra and ACRIM. With the launch of the Aqua mission, the algorithm developers will begin to receive data in late FY 2002 and they will begin the process of assessing the health and status of the instruments and ancillary data from the spacecraft, and the sensors and, subsequently, checking pre-launch algorithms to assess their effectiveness on-orbit. "First-look" data products will need to be produced to demonstrate the operational readiness of the sensors for science and applications and then steps taken to fine-tune the algorithms and attendant code for production of data products.

PROGRAM PLANS FOR FY 2003

Continue Aura algorithm development and algorithm maintenance for Terra, Aqua, and ACRIM. With the launch of ICESat and SORCE, the algorithm developers will begin to receive data and they will begin the process of assessing the health and status of the instruments and ancillary data from the spacecraft and the sensors and, subsequently, checking pre-launch algorithms to assess their effectiveness on-orbit. "First-look" data products will need to be produced to demonstrate the operational readiness of the sensors for science and applications and then steps taken to fine-tune the algorithms and attendant code for production of data and information products.

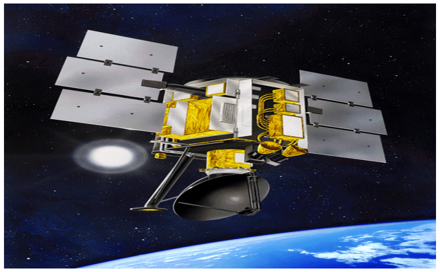
BASIS OF FY 2003 FUNDING REQUIREMENT

QUIKSCAT

Web Address: http://winds.jpl.nasa.gov/missions/quikscat/quikindex.html

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
QUIKSCAT Development *	1.1	1.8	--

* QUIKSCAT Total life cycle cost data is provided at the end of this section.



DESCRIPTION/JUSTIFICATION

The QuikSCAT mission, which is filling the ocean vector wind data gap created by the loss of the NASA Scatterometer (NSCAT) on the Japanese ADEOS I spacecraft, was launched from Vandenberg Air Force Base June 19, 1999. The Scatterometer data was released to the general science community on January 31, 2000. The reprocessing of all the data from the beginning of the mission, with improved rain flag and model function, was completed in July 2000. The Scatterometer has been operating for 29 months (as of November 2001), which is longer than any previous scatterometer. The prime mission ended on June 19, 2001, however, extended operations have been approved until September 30, 2002. The intent is to provide a six-month overlap between QuikSCAT and SeaWinds on ADEOS II to assure cross-calibration prior to phasing out QuikSCAT operations.

QUIKSCAT ANSWERS PRIMARY SCIENTIFIC QUESTIONS

SCIENTIFIC QUESTION:	QUIKSCAT APPROACH
How is the global ocean circulation varying on interannual, decadal, and longer time scales? What changes are occurring in the mass of the Earth's ice cover?	The SeaWinds instrument on the QuikSCAT satellite is a specialized microwave radar that measures near-surface wind speed and direction under all weather and cloud conditions over Earth's oceans. QuikScat is acquiring all-weather, high-resolution measurements of near-surface winds over global oceans. It is helping to determine atmospheric forcing, ocean response, and

What are the effects of clouds and surface hydrologic processes on Earth's climate? How are variations in local weather, precipitation, and water resources related to global climate variation? How can weather forecast duration and reliability be improved by new space-based observations, data assimilation, and modeling? How well can transient climate variations be understood and predicted?	air-sea interaction mechanisms on various spatial and temporal scales. It combines wind data with measurements from scientific instruments in other disciplines to help us better understand the mechanisms of global climate change and weather patterns. QuikScat measurements also enable study of the daily/seasonal sea ice edge movement and Arctic/Antarctic ice pack changes.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Observe, understand, and model the Earth system to learn how it is changing and the consequences for life on Earth.

Strategic Plan Objectives Supported: Discern and describe how the global Earth system is changing; Determine how the Earth system responds to natural and human-induced changes; Identify the consequences of changes in the Earth system for human civilization; Enable the prediction of Earth system changes that will take place in the future.

Performance Plan Metrics Supported: See Annual Performance Goals 1A2, 1A5, 1C1, 1D1, 1E1 as described in scientific question section above.

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-FY03 Change	Comment
Launch	June 1999	June 1999	April 1999		Successfully launched June 19, 1999

Lead Center: JPL	**Other Centers:** GSFC Rapid Spacecraft Development Office (RSDO**)**	
Subsystem	**Builder**	
Spacecraft	Ball – Contract managed by GSFC	
Instruments	**Builder**	
Scatterometer	JPL – In-house	
Launch Vehicle: Titan II	**Tracking/Communications:** Ground Network	**Data Handling:** EOSDIS

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

Spacecraft operations are nominal.

PROGRAM PLANS FOR FY 2003

Continuation of operations beyond FY 2002 is being assessed.

Space Infrared Telescope Facility (SIRTF)

QUIKSCAT LIFE CYCLE COST DATA

$ in Millions	Prior	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	BTC	Total
Initial Baseline (lifecycle)	**84.8**									**84.8**
FY03 President's Budget	**84.4**	**1.1**	**1.8**							**87.3**
Development	**58.8**	**1.1**	**1.8**							61.7
Launch Vehicle	**25.6**									25.6
FTEs (number)										

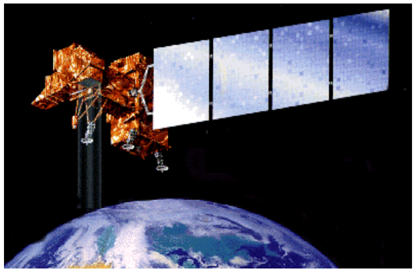
BASIS OF FY 2003 FUNDING REQUIREMENT

LANDSAT 7

Web Address: http://landsat.gsfc.nasa.gov/

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
LANDSAT 7 Development *	1.4	1.7	1.7

* LANDSAT 7 Total life cycle cost data is provided at the end of this section.



DESCRIPTION/JUSTIFICATION

The Landsat-7 satellite was launched on April 15, 1999, and declared operational in July 1999. The satellite continues to return excellent images, which meet or exceed expectations. First data was available to the public mid-August 1999. By agreement with the USGS, NASA operated and funded operations through FY 2000. Landsat-7 is producing 150 Terabytes of data per day. Beginning in FY 2001 and beyond, the USGS is operating and funding the Landsat-7 system. NASA is providing technical and scientific anomaly support as needed

LANDSAT 7 ANSWERS PRIMARY SCIENTIFIC QUESTIONS

SCIENTIFIC QUESTION:	LANDSAT-7 APPROACH
What are the changes in global land cover and land use, and what are their causes? What are the consequences of land cover and land use change for the sustainability of ecosystems and economic productivity?	Landsat-7 systematically provides well-calibrated, multispectral, moderate resolution, substantially cloud-free, sun-lit digital images of the Earth's continental and coastal areas with global coverage on a seasonal basis using the Enhanced Thematic Mapper Plus Instrument.

What are the consequences of climate and sea level changes and increased human activities on coastal regions?	

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Observe, understand, and model the Earth system to learn how it is changing and the consequences for life on Earth.

Strategic Plan Objectives Supported: Identify and measure primary causes of change in the Earth system; Identify the consequences of changes in the Earth system for human civilization.

Performance Plan Metrics Supported: See Annual Performance Goals 1B2, 1D2, 1D3 as described in scientific question section above.

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-FY03 Change	Comment
Launch	April 1999	April 1999	December 1998		Successfully launched April 15, 1999

Lead Center: GSFC

Other Centers:

Subsystem	**Builder**
Spacecraft	Lockheed–Martin, Valley Forge, PA

Instruments	**Builder**
Enhanced Thematic Mapper Plus	Ratheon SBRS

Launch Vehicle: Delta II

Tracking/Communications: U.S. Geological Survey (USGS)

Data Handling: USGS Earth Resource Observation System (EROS)

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

Spacecraft operating nominally.

PROGRAM PLANS FOR FY 2003

Continue operations through USGS.

LANDSAT 7 LIFE CYCLE COST DATA

$ in Millions	Prior	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	Total
Initial Baseline (lifecycle)	**391.3**								**391.3**
FY03 President's Budget	**502.1**	**1.4**	**1.7**	**1.7**	**1.9**				**508.8**
Development	**449.1**	**1.4**	**1.7**	**1.7**	**1.9**				455.8
Launch Services	**53.0**								53.0
FTEs (number)		(1)	(1)	(1)	(1)				

Outyear costs are for on-orbit incentive fees.

BASIS OF FY 2003 FUNDING REQUIREMENT

EOSDIS

Web Address: http://eos.gsfc.nasa.gov/proj-esdis.html

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
		(Millions of Dollars)	
EOS Data and Information System *	**279.1**	**293.0**	**74.3**
Total..	**279.1**	**293.0**	**74.3**

* EOSDIS Total life cycle cost data is provided at the end of this section.

DESCRIPTION/ JUSTIFICATION

The EOSDIS facilitates the goals of Earth science by enabling the public to benefit fully from increased understanding and observations of the environment. The EOSDIS is operating the EOS satellites now in orbit, and retrieving flight data and converting it into useful scientific information. Development of EOSDIS is nearly complete; remaining activities are timed to provide releases to support the upcoming launches of EOS missions through Aura in 2004. The EOSDIS is providing the overall Program data system for EOS missions. NASA has developed and is operating EOSDIS as a distributed interoperable system which can: (1) operate the EOS satellites; (2) acquire instrument (science) data; (3) produce data and information products from the EOS spacecraft; (4) archive all these and other Earth science environmental observation data for continuing use; and (5) make all these data and information easily available for use by the research and education communities, government agencies and all those who can benefit from the data in making economic and policy decisions.

The EOSDIS is based on an evolutionary design to develop capabilities with the phased deployment of the EOS satellites and to enable adaptation to changes in user needs and in technology. The design is modular, allowing for the replacement of individual components without costly overall system changes or disruptions in service.

EOSDIS relies also on other agencies (such as USGS which manages the Landsat Data Processing system) and other countries (such as Japan for the ASTER science data production). EOSDIS allows direct access to data acquired from EOS satellites, selected pathfinder data holdings from the USGS and NOAA, and other heritage and ancillary data. Relationships with Canada, Japan, Russia, Israel, Australia and several European countries have been established for the exchange of data with EOSDIS. Many multi-agency efforts, in addition to the NASA EOSDIS, are working to improve data availability to the public, especially the Interagency USGCRP Data and Information Working Group and the Federal Geographic Data Committee.

The EOSDIS is currently supporting an array of satellites by providing mission operations, data capture, data production, data archive, data distribution, and user support. This system is designed to evolve over time as the data sources, missions, technologies, and user needs change. This has been affected, through the use of a combination of specialized core systems, user specific systems for instruments or scientific disciplines, commercial off-the-shelf items, and cooperative activities with heritage data centers to ensure continued support to established user communities. In addition, the expansion of data services is encouraged through cooperation with the Distributed Active Archive Centers (DAACS) Earth Science Information Partners (ESIPs), Regional Science Applications Centers (RESACs), and the Synergy task. The EOSDIS sustains a partnership with NOAA, USGS, and international partner space agencies.

The EOSDIS development has been divided into six major components:

1. The Polar Ground Stations (PGS) provide command uplink and telemetry downlink. The PGS are now part of the Ground Network (GN).
2. The EOS Data and Operations System (EDOS) which receives the raw data stream from the satellites, separates the data by instrument, and performs the initial processing (packet restoration and temporal ordering) and back-up archiving. EDOS interfaces to the TDRSS ground terminal at the White Sands Complex for Terra data, and will interface to the PGS in Alaska and Norway for data from the Terra, Aqua, ICESat, and Aura missions. The raw data collected from the satellites are sent to the EDOS Level-0 processing center at GSFC, which processes the data and sends them via EBNet to the DAACs and the Science Investigator-led Processing Systems (SIPS);
3. The EOS Mission Support Network (EMSN) delivers the real-time data to and from the mission operations control centers and the science data to the DAACs and SIPS. EMSN was originally developed by GSFC, but is now managed as part of SOMO/NISN;
4. The EOSDIS Core System (ECS) includes the Flight Operations Segment (FOS), which provides command and control capabilities to operate the EOS spacecraft (the present implementation of FOS is called the EOS Mission Operations System (EMOS)), and the Science Data Processing Segment (SDPS) which provides data product generation using science software provided by the Principal Investigators (PIs), data archiving, and distribution. The SDPS is operated at the DAACs;
5. The DAACs produce EOS standard data products using algorithm software provided by the PIs, archive data, and distribute these data to end users. Each DAAC focuses on the data needs of a specific segment of the user community, with User Working Groups advising individual DAACs. The eight DAACs are:
   - Alaska Synthetic Aperture RADAR (SAR) Facility, Geophysical Institute, University of Alaska, Fairbanks, Alaska
   - Earth Resources Observation System (EROS) Data Center (EDC), U.S. Geological Survey, Sioux Falls, South Dakota
   - Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California
   - Langley Research Center (LaRC), Hampton, Virginia
   - National Snow and Ice Data Center (NSIDC), University of Colorado, Boulder, Colorado
   - Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee
   - Socio-Economic Data and Applications Center (SEDAC), Lamont-Dougherty Earth Observatory, Columbia University, Palisades, New York
   - Goddard Space Flight Center, Greenbelt, Maryland

6. The SIPS provide data product generation at Instrument Team sites, and send the data via EMSN to the appropriate DAAC for archiving and general distribution. The SIPS produce data products in a way that takes advantage of the latest technologies and the instrument teams' expertise.

In FY 2003, the operations of EOSDIS will continue, the ECS contract for systems development will end, but a new system Maintenance contract will be established. Starting in FY 2003 the EOSDIS budget is separated into two parts (Development and Operations), to reflect the transition from development into an operational phase.

New Data Information Systems and Services (NewDISS)

NASA is looking to future data system needs and designs in several ways. The EOSDIS Working Prototype Federation experiment, initiated in 1998, is continuing to develop methodologies for decision making and interoperability in a collaborative, yet competitive, distributed data system topology. Members of the Federation represent the broad scientific and applications community and include representatives from educational institutions, industry, regional governments and consortia, and NASA data centers. NASA is also engaged in long-term planning for the evolution of the current Earth science data system. NewDISS is being formulated as a plan to evolve the current ESE data and information systems, infusing Lessons Learned from the NRC-recommended Federation prototype, over the next 6 to 10 years. This evolution will enable NASA to integrate data elements from the new missions now under formulation. The NewDISS concept allows for a heterogeneous mix of interdependent components of numerous individuals and institutions. Because the ESE already has made a considerable investment in existing data system components (e.g., DAACs, ECS, SIPS, and ESIPs), as well as product generation, the near-term NewDISS will necessarily evolve from these existing activities. In the long term NewDISS structure could be quite different from the current, as data systems and services evolve to meet science-driven demands and to take advantage of technological innovation.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: EOSDIS is an activity that enables achievement of all three Earth Science strategic goals.

Strategic Plan Objectives Supported: EOSDIS is an activity that enables achievement of all three Earth Science strategic goals and objectives.

Performance Plan Metrics Supported: Successfully disseminate Earth Science data to enable our science research and applications goals and objectives.

PROJECT SCHEDULE WITH CRITICAL MILESTONES

Version 1 Plan: January 1997 Revised: Replaced	Provide support for science data processing, archival, and management of the data from the two EOS instruments operating on the TRMM spacecraft. The ECS contractor failed initial test readiness for EOSDIS Version 1 and NASA issued a Stop Work Order. Replacement systems were developed by EOSDIS at GSFC and LaRC, (extended "Version 0" in-house system), and the systems are performing successfully.
Version 2 Plan and actual: January 1999 through December 1999	Mission Operations, processing, archiving and distribution for Terra; Processing, archiving and distribution for LANDSAT-7, Archive & distribution for: ACRIMSAT, JASON-1, QuikSCAT, SeaWinds, SAGE III.
Version 3 Plan: December 2000 Revised: July 2001	Provide science processing and flight operations support for Aqua and ICESat. EOSDIS components needed to meet the objectives of Version 3 are ready; integration and end-to-end testing are being carried out to match Aqua and ICESat launch schedules.
Version 4 Plan: September 2002	Provide science processing and flight operations support for Aura. Provide final incremental implementation of ECS A+ requirements. Schedule adjusted commensurate with Aura launch schedule. It is expected that the capabilities needed for Aura will be available per this schedule. However, work on this version will continue to support integration and testing to support the Aura launch in January 2004.

Lead Center: GSFC	**Other Centers:** GSFC, MSFC, LaRC, ARC, JSC, & JPL
Major Subsystems:	**Builder:**
EOSDIS Core System (ECS)	Raytheon
EOS Data & Operations Systems (EDOS)	TRW
Distributed Active Archive Centers (DAACs)	Various
Networks (Communications Systems)	JSC & MSFC
EOSDIS Federation	Various

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

Continued deliveries of the ECS software are planned in FY 2002 to support requirements for the Aura mission, and operations readiness testing will ensure that all systems are ready and able to support the Aqua and ICESat launches. Capabilities will continue to be developed for users to create their own clients for searching and ordering data. The EOSDIS will continue to work to meet its planned performance targets. Indicators of this activity will be to continue making data available to users within 5 days of request and improving on prior year targets for archive, distribution, and number of customers served.

The EOS instrument teams are producing standard products under the SIPS concept based on the working Agreements established between the ESDIS Project and the instrument teams. MODIS, CERES, and MOPITT teams have been processing Terra data into standard products. They will continue their operations during FY 2002 and 2003. MODIS, CERES, AIRS, and AMSR-E teams are preparing to process Aqua data at their SIPS. They have been participating in the end-to-end tests of science data flow and are expected to be ready for the Aqua launch in March 2002. The development of SIPS by the four Aura instrument teams (HIRDLS, MLS, OMI, and TES) is under way and they are expected to be in place or completed in FY03 and be ready for the Aura launch in January 2004.

The EOSDIS is continuing to support processing, archive and distribution of an unprecedented amount of data and information. As a comparison, the EOSDIS effectively handles in one day more Terra data than the Hubble Space Telescope handles in a year or than the Upper Atmosphere Research Satellite (UARS) handles in 1.5 years. Some key indicators of EOSDIS performance are the volume of data archived (over 1000Terabytes at the end of FY 2001, including heritage data), the number of users accessing the DAACs (just under 1.47 million distinct users in FY 2000), and the number of data products delivered in response to user requests (approximately 15 million data products delivered in FY 2001). In the 2 years since the launch of Terra and Landsat 7, the EOSDIS has more than quadrupled NASA's Earth Science data holdings.

EOSDIS has been routinely providing and will continue to provide Earth science data products to end-users within 5 days of receipt of request or following production of the requested data product. These products comprise data from currently operating space assets including interdisciplinary data products from the Terra mission, land cover information from the Landat-7 satellite, ocean wind measurement from the QuikSCAT mission, precipitation measurements and observations of tropical storms from the Tropical Rainfall Measurement Mission (TRMM), ocean productivity measurements from the Sea-viewing Wide Field-of-view Sensor (SeaWiFS), detection of ocean surface height changes used to predict El Niño occurrence and strength from the Topex/Poseidon Mission, solar energy input to the Earth from ACRIMSat, and sea ice motion and Antarctic mapping from U.S./Canada's RADARSAT. Also provided are measurements on stratospheric dynamics and trace chemicals from the UARS, the Antarctic Ozone Hole from the Total Ozone Mapping System (TOMS), land use and land cover from the heritage Landsat missions, and measurements of Earth and solar radiation from the Earth Radiation Budget Experiment (ERBE).

The ECS FOS continued to support the Terra spacecraft and instrument operations through 2001. ECS FOS capabilities have been tested numerous times during FY 2001 as a part of interface tests with the Aqua spacecraft. The FOS Instrument Support Terminals (IST), which allow instrument operations teams to plan for the operation of their instruments and monitor instrument performance from their home institutions, are installed and continue to be operational at all operations sites for the Terra instrument teams. ISTs have been installed at the major U.S. operations facilities in support of the Aqua spacecraft and instruments.

Other elements of EOSDIS are continuing to support the Terra mission. The EDOS overcame early problems with processing and distributing Terra science data (not unusual for a new mission of this complexity) and is successfully managing the Terra science data. Upgrades of EDOS to support Aqua and ICESat were made operational at the end of FY 2001. The EMSN and Polar Ground Stations are continuing to support Terra operations (PGS is backup to TDRSS for Terra) will make the necessary upgrades and enhancements to support the Aqua mission.

Development of the ECS SDPS has progressed well, and the system continues to provide sustained support for Terra and Landsat 7 operations at the DAACs. The data are being processed at better than "keep-up" rates, data from the SIPS are being ingested, and all processed data are being archived and made available for distribution. The system capacities have been augmented according to plan to accommodate planned ramp-ups in processing and reprocessing requirements. System upgrades were also made to improve user interface services, to add capabilities required for support of Aqua instruments, increase system capability, and to update to newer versions of Commercial-Off-The-Shelf (COTS) products.

The EOSDIS Federation experiment continued in FY 2001. The ESIP Federation was recently incorporated as a non-profit foundation, with the intent to serve the national Earth science research priorities such as USGCRP and CCRI and broader needs of the emerging environmental information economy. Such a Federation entity was envisioned in the original National Academy recommendation. The Federation membership has grown from the original 24 ESIPs to 40 ESIPs, including NASA's eight DAACs and one EOS science computing facility (SCF) and NOAA's National Climate Data Center. These groups are developing scientific products, collaborating with one another, both as single entities and in "clusters", and have collectively implemented a simple means of data set interoperability. NASA plans to continue its science-based ESIP program through a competitive solicitation in FY 2002.

The ECS Science and Flight Operations Segments received authority to process in December 2000, in accordance with the NASA Policy and Guidance (NPG) 2810.1 that mandates Information Technology (IT) security requirements for NASA data and systems. During FY 2001, security plans and documentation were completed, additional procedures were established, and Security Firewalls, capable of handling EOS data rates, were selected and procured. The Firewalls will complete testing and be deployed in early CY 2002.

PROGRAM PLANS FOR FY 2003

In FY 2003, the operations of EOSDIS will continue, the ECS development contract will end and a new Maintenance contract will be competed in FY 2002. Starting in FY 2003 the EOSDIS budget has been separated into two parts: (1) Maintenance and Development and (2) Operation. This change was required in order to reflect the operational nature of most of EOSDIS. This realignment reflects the true nature of the operations type activity. We have therefore transferred the appropriate elements into Earth Science Operations to reflect the transition from development to operations starting in FY 2003. The Strategy for Evolution of Earth Science Enterprise Data Systems (SEEDS) formulation activity will continue during FY 2002 and part of FY 2003.

In addition, The EOSDIS will continue to meet its performance goals as described in the FY 2003 performance plan:

Make available ESE acquired data and information on Earth's atmosphere, land and/or oceans to users within 3-5 days of their request.

Increase by 20-30% the total volume of data acquired by and available from NASA for its research programs compared to FY 2002. (This equates to a maximum of 1170 terabytes)

Maintain satisfactory support for the number of distinct NASA ESE data and information center customers compared to FY02. (This equates to 2,019,600 users).

Increase scientific and applications data products delivered from the ESE data and information centers by 10% compared to FY 2002. (This equates to 11,712,800 data products)

User Satisfaction: Maintain or improve the overall level of ESE data center customer satisfaction as measured by User Working Group surveys.

EOSDIS LIFE CYCLE COST DATA

$ in Millions	Prior	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	BTC	Total
Initial Baseline (lifecycle)	**2,049.3**	**283.3**								**2,332.6**
FY03 President's Budget	**1,885.7**	**279.1**	**293.0**	**79.5**	**76.0**	**69.3**	**71.3**	**66.6**		**2,820.5**
Development	**1,821.2**	**260.7**	**274.0**	**62.4**	**59.3**	**52.7**	**56.1**	**57.7**		2,644.1
Federation/External	**60.4**	**13.6**	**11.3**	**8.9**	**8.9**	**8.9**	**8.9**	**8.9**		129.8
Jason/Sage Mission Ops	**4.1**	**4.8**	**7.7**	**8.2**	**7.8**	**7.7**	**6.3**			46.6
FTEs (number)		(104)	(112)	(120)	(132)	(141)	(128)	(128)		
Note: EOSDIS Ops transferred to Mission Ops				[176.6]	[206.3]	[201.7]	[199.8]	[206.6]		

BASIS OF FY 2003 FUNDING REQUIREMENT

EARTH EXPLORERS

Web Address: http://gaia.hq.nasa.gov/ese_missions

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
Total Ozone Mapping Spectrometer	2.0	--	--
Earth System Science Pathfinders	109.7	70.9	70.8
VCL	*13.7*	--	--
GRACE	*10.6*	*6.4*	*2.1*
CALIPSO (formerly PICASSO-CENA)	*30.1*	*31.0*	*33.8*
CloudSat	*47.6*	*23.8*	*27.4*
Program Support/Future missions	*7.7*	*9.7*	*7.5*
Experiments of Opportunity	0.9	2.3	0.4
Triana	24.9	1.0	--
University Class Earth System Science	0.4	--	--
Shuttle Radar Topography Mission	3.7	--	--
Total	141.6	74.2	71.2

DESCRIPTION/JUSTIFICATION

The Earth Explorers Program is the component of ESE that investigates specific, highly focused areas of Earth science research. It is comprised of flight projects that provide pathfinder exploratory and process driven measurements, answering innovative and unique Earth science questions. The program has the flexibility to take advantage of international cooperative efforts. It provides the ability to investigate processes having unique measurement requirements and which call for quick turnaround and reaction. The Earth Explorers Program contains a series of focused, rapid development missions to study emerging science questions and processes utilizing innovative measurement techniques as a complement to the systematic measurements made through the EOS.

The Earth Science System Pathfinder (ESSP) is a science-driven program intended to identify and develop in a relatively short time, small satellite missions to accomplish scientific objectives in response to national and international research priorities not addressed by current projects. ESSP will provide periodic "windows of opportunity" to accommodate ESE scientific priorities. By launching ESSP missions on a regular basis, NASA will provide a mechanism by which pressing questions in Earth System Science may be addressed in a timely fashion, permitting a continual improvement in our understanding of the Earth system and the processes that control it.

The improved understanding, combined with improvements in predictive Earth system models, will provide our nation with the scientific basis for formulating well founded environmental and resource management policies.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Observe, understand, and model the Earth system to learn how it is changing, and the consequences for life on Earth.

Strategic Plan Objectives Supported: Discern and describe how the global Earth system is changing; Identify and measure primary causes of change in the Earth system; Determine how the Earth system responds to natural and human-induced changes; Identify the consequences of changes in the Earth system for human civilization: Enable the prediction of Earth system changes that will take place in the future

Performance Plan Metrics Supported: Annual Performance Goals as shown in Annual Performance Plan:1A1-1A6, 1B1-1B2, 1C1-1C6, 1D1-1D3, 1E1-1E5.

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH FY 2002

GRACE is on track for a March 2002 launch. NASA is currently in the process of selecting the third set of ESSP missions via ESSP Announcement of Opportunity (AO) #3. Mission selections for the formulation phase are planned for June 2002.

PROGRAM PLANS FOR FY 2003

Continue Development activities associated with CloudSat and CALIPSO in preparation for their co-manifested April 2004 launch.

BASIS OF FY 2003 FUNDING REQUIREMENT

EARTH EXPLORERS PROGRAM - PROJECTS IN IMPLEMENTATION

GRAVITY RECOVERY AND CLIMATE EXPERIMENT (GRACE)

Web Address: http://www.csr.utexas.edu/grace/

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
GRACE Development*	10.6	6.4	2.1

***** GRACE Total life cycle cost data is provided at the end of this section.

DESCRIPTION/JUSTIFICATION

The GRACE mission (the 2nd ESSP mission) is led by a Principal Investigator from the University of Texas at Austin with significant participation by the German Aerospace Center (DLR). DLR is providing mission operations, launch services and science data analysis. GRACE will utilize an advanced microwave ranging system between two identical formation flying spacecraft to measure the Earth's gravitational field to an unprecedented accuracy by measuring the distance between the two satellites to within one micron. The planned launch date of GRACE on a contributed ROCKOT launch vehicle is March 2002.

The objective of the GRACE mission is to obtain accurate global and high-resolution models for both the static and the time variable components of the Earth's gravity field. The gravity field estimates obtained from data gathered by the GRACE Mission will provide, with unprecedented accuracy, integral constraints on the global mass distribution and its temporal variations. In the oceanographic community, the knowledge of the static geoid, in conjunction with satellite altimeter data, will allow significant advances in the studies of ocean heat flux, long term sea level change, upper oceanic heat content, and the absolute surface geostrophic ocean currents. Further, the estimates of time variations in the gravity field obtained from GRACE, in conjunction with other in-situ data and geophysical models, will help the science community unravel complex processes in oceanography (e.g. deep ocean current change and sea level rise), hydrology (e.g. large scale evapo-transipiration and soil moisture changes), glaciology (e.g. polar and Greenland ice sheet changes), and the solid Earth sciences. Analysis of the data from GRACE will result in contributions to the understanding of variations in ocean bottom currents, ocean surface currents, ocean heat transport, polar ice and underground liquid reservoirs.

GRACE ANSWERS PRIMARY SCIENTIFIC QUESTIONS

SCIENTIFIC QUESTION:	GRACE APPROACH
How is the global ocean circulation varying on interannual, decadal, and longer time scales? What are the motions of the Earth and the Earth's interior, and what information can be inferred about Earth's internal processes?	GRACE will utilize an advanced microwave ranging system between two identical formation flying spacecraft to measure the Earth's gravitational field by measuring the variation in distance between the two satellites to unprecedented accuracy of one micron.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Observe, understand, and model the Earth system to learn how it is changing and the consequences for life on Earth.

Strategic Plan Objectives Supported: Discern and describe how the global Earth system is changing

Performance Plan Metrics Supported: See Annual Performance Goals 1A2, 1A5 as described in scientific question section above.

Key Milestones:	FY 2003 DATE	FY 2002 DATE	BASELINE DATE	CHANGE (FY02-FY03)	COMMENT
Science Data Sys Complete	November 2001	November 2001	March 2000		
Instrument Sys Del	February 2001	September 2000	March 2000	+ 5 months	Late Delivery of Instrument Processing Unit
Precision Accelerometer Del	July 2000	July 2000	February 2000		
Satellite Delivery	March 2001	January 2001	March 2000	+ 2 months	Problems with on-board Data Handling Unit
Observatory & I&T Complete	August 2001	May 2001	March 2000	+ 3 months	Late Instrument Delivery
Ground Sys Dev Complete	October 2001	May 2001	November 1999	+ 5 months	Late documentation from Ground Station

Launch	March 2002	November 2001	June 2001	+ 4 months	Re-planned launch date reflects delays in flight instrument development and hardware anomalies that occurred during spacecraft environmental testing.

Lead Center: GSFC | **Other Centers:** **JPL, LaRC** | **Interdependencies:** Germany, France, Russia

Subsystem	**Builder**	**Pr. Investigator**
Spacecraft:	Astrium	Dr. Byron Tapley, University of Texas

Instruments	**Builder**
Microwave Range Instrument	JPL/SS/Loral
Precision Accelerometer	ONERA, France
Science System	UT – CSR
Launch Vehicle System	German Aerospace Center (DLR) Germany
Ground System, Operations	DLR, German Space Ops Center (GSOC)
Spacecraft Development & Integration	Astrium

Launch Vehicle: German Rockot: Breeze KM upper stage, launched from Plesetsk Cosmodrome, Russia

Tracking/Communications: Polar Ground Network

Data Handling: University of Texas

PROJECT STATUS/NOTIFICATIONS/PLANS THROUGH 2002

The two GRACE spacecraft have completed environmental testing. The Operations Readiness Review was successfully conducted in November 2001 and the ground system is ready to support mission operations. The Pre-Ship Review occurred in December 2001. GRACE is scheduled to launch in March 2002.

PROJECT PLAN FOR FY 2003

Generation of data products will begin in late CY 2002 and continue for 5 years.

GRACE LIFE CYCLE COST DATA

$ in Millions	Prior	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	BTC	Total
Initial Baseline (lifecycle)	64.6	15.0	1.7	1.5	1.4	1.8				86.0
FY03 President's Budget	74.2	10.6	6.4	2.1	2.0	1.3	0.2			96.8
Development	74.2	10.6	3.6							88.4
Mission Operations			2.8	2.1	2.0	1.3	0.2			8.4
FTEs (number)		(3)	(1)	(1)						

BASIS OF FY 2003 FUNDING REQUIREMENT

Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO)

Web Address: http://www-calipso.larc.nasa.gov/picasso.html

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
CALIPSO Development *	**30.1**	**31.0**	**33.8**

* CALIPSO Total life cycle cost data is provided at the end of this section.

DESCRIPTION/ JUSTIFICATION

The CALIPSO mission, (formerly PICASSO-CENA) was selected in December 1998. CALIPSO is designed to address the role of clouds and aerosols in the Earth's radiation budget. It will employ innovative Lidar instrumentation to measure the vertical distribution of clouds and aerosols in Earth's atmosphere. CALIPSO consists of a partnership between NASA and France's Centre Nationale D'Etudes Spatiale (CNES). CNES is providing a PROTEUS spacecraft, the imaging infrared radiometer (IIR), payload-to-spacecraft I&T, and spacecraft mission operations. CALIPSO will fly in formation with AQUA to provide a unique 3-year coincident global set of data on aerosol and cloud properties, radiative fluxes, and atmospheric state. This enables new observationally based assessments of the radiative effects of aerosol and clouds that will greatly improve our ability to predict the future state of Earth's climate. Together, CALIPSO and AQUA provide: (1) a global measurement suite from which the first observationally-based estimates of aerosol direct radiative forcing of climate can be made, (2) a dramatically improved empirical basis for assessing aerosol indirect radiative forcing of climate, (3) a factor of 2 improvement in the accuracy of satellite estimates of long wave radiative fluxes at the Earth's surface and in the atmosphere, and (4) a new ability to assess cloud-radiation feedback in the climate system. CALIPSO is co-manifested with Cloudsat and is scheduled to launch in April 2004.

CALIPSO ANSWERS PRIMARY SCIENTIFIC QUESTIONS

SCIENTIFIC QUESTION:	CALIPSO APPROACH
What trends in atmospheric constituents and solar radiation are driving global climate? What are the effects of clouds and surface hydrologic processes on earth's climate?	CALIPSO will provide key measurements of aerosol & cloud properties needed to improve climate predictions. CALIPSO will fly a 3-channel lidar and passive instruments in formation with Aqua and CloudSat to obtain coincident observations of radiative fluxes and atmospheric state. This comprehensive set of measurements is essential for accurate quantification of global aerosol and cloud radiative effects.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Observe, understand, and model the Earth system to learn how it is changing and the consequences for life on Earth.

Strategic Plan Objectives Supported: Identify and measure primary causes of change in the Earth system; Determine how the Earth system responds to natural and human-induced changes.

Performance Plan Metrics Supported: See Annual Performance Goals 1B1, 1C1 as described in scientific question section above.

Key Milestones:	FY 2003 BUDGETDA	FY 2002 BUDGET	BASELINE DATE	CHANGE (FY02-FY03)	COMMENT
Instrument Del to I&T	May 2003	March 2002	2001	+ 14 months	Mission Replan
S/C Bus Del to I&T	May 2003	March 2002	2001	+ 14 months	Mission Replan
Launch	April 2004	TBD	2003		Launch Slip from March 2003 to 4/04

Lead Center: GSFC

Other Centers: LaRC, KSC

Interdependencies: CNES (France)

Subsystem	Builder	
Spacecraft	CNES France	

Instruments	Builder	Pr. Investigator
Instrument Payload & Science Data Ground Sys (LIDAR, and Visible Wide-Field Camera)	Ball Aerospace	Dr. David Winker
Imaging Infrared Radiometer	CNES (France)	
Spacecraft	CNES (France)	

Launch Vehicle: Delta 7420 Co-manifested w/Cloudsat

Tracking/Communications: France Ground Station

Data Handling: France Ground Station and LARC

PROJECT STATUS/NOTIFICATIONS/PLANS THROUGH FY 2002

CALIPSO successfully completed the confirmation review process and proceeded into the implementation phase in April 2001. The payload CDR and Satellite Manufacturing Readiness Review were conducted in November 2001. Mission CDR is planned for February 2002.

The launch was moved from 2003 to April 2004 as a result of the Mission Confirmation Review finding that the planned mission was too aggressive to meet the earlier launch date given the risks associated with the laser development.

PROGRAM PLANS FOR FY 2003

Payload delivery is expected in Spring 2003.

CALIPSO LIFE CYCLE COST DATA

$ in Millions	Prior	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	BTC	Total
Initial Baseline (lifecycle)	30.2	35.4	23.9	16.0	4.5	2.2				112.2
FY03 President's Budget	26.4	30.1	31.0	33.8	19.0	5.9	2.9	1.9		151.0
Development	26.4	17.9	31.0	22.3	11.9					109.5
Mission Operations					0.8	5.9	2.9	1.9		11.5
Launch Vehicle		12.2		11.5	6.3					30.0
FTEs (number)		(4)	(3)	(3)						

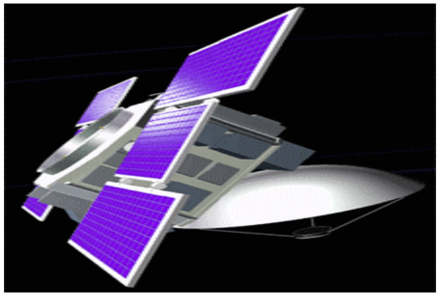
BASIS OF FY 2003 FUNDING REQUIREMENT

CLOUDSAT

Web Address: http://cloudsat.atmos.colostate.edu

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
CLOUDSAT Development*	**47.6**	**23.8**	**27.4**

* CLOUDSAT Total life cycle cost data is provided at the end of this section.



DESCRIPTION/JUSTIFICATION

CloudSat's primary objective is to furnish atmospheric observations needed to evaluate and improve the way clouds are parameterized in global models, thereby contributing to better predictions of clouds and their role in Earth's climate system. CloudSat will also fly for the first time in space a milli-meter wave radar that is capable of seeing practically all clouds and precipitation, from very thin cirrus clouds to thicker thunderstorms producing heavy precipitation. Cloudsat is co-manifested with CALIPSO and is expected to launch in April 2004. Cloudsat is a collaboration between NASA, the Canadian Space Agency (CSA), and the U.S. Air Force. CSA is contributing instrument components and the U.S. Air Force is contributing ground operations.

CLOUDSAT ANSWERS PRIMARY SCIENTIFIC QUESTIONS

SCIENTIFIC QUESTION:	CLOUDSAT APPROACH
What are the effects of clouds and surface hydrologic processes on earth's climate?	CloudSat is designed to measure the vertical structure of clouds from space. CloudSat will fly a millimeter-wave (94 GHz) radar that is capable of seeing a large fraction of clouds and precipitation from very thin cirrus clouds to thunderstorms producing heavy precipitation. CloudSat will furnish data needed to evaluate and improve the way clouds are represented in global models, thereby contributing to better predictions of clouds and a more complete knowledge of their role in climate change.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Observe, understand, and model the Earth system to learn how it is changing and the consequences for life on Earth.

Strategic Plan Objectives Supported: Determine how the Earth system responds to natural and human-induced changes.

Performance Plan Metrics Supported: See Annual Performance Goals 1C1 as described in scientific question section above.

Key Milestones:	FY 2003 BUDGET DATE	FY 2002 BUDGET DATE	BASELINE DATE	CHANGE (FY02-FY03)	COMMENT
Instrument Del to I&T	November 2003	2002	2002	+ 1 year	Delay due to CALIPSO replan
S/C Bus Del to I&T	November 2003	2002	2002	+ 1 year	Delay due to CALIPSO replan
Launch	April 2004	2003	2003	+ 1 year	Co-manifest w/CALIPSO

Lead Center: GSFC

Other Centers: JPL, KSC

Interdependencies: Canadian Space Agency (CSA)

Subsystem	Builder
Spacecraft	Ball Aerospace

Instruments	Builder	Pr. Investigator
Spacecraft Bus	Ball Aerospace	Dr. Graem Stephens, Colorado State
Adv Cloud-Profiling Radar	JPL	
Klystron for Radar	Canadian Space Agency (CSA)	
Electronics for Radar	Canadian Space Agency (CSA)	

Launch Vehicle: Delta 7420 Co-manifested w/CALIPSO Launch

Tracking/Communications: USAF Research Support Complex, NM

Data Handling: Colorado State

PROJECT STATUS/NOTIFICATIONS/PLANS THROUGH 2002

Cloudsat successfully completed mission CDR in August 2001. In the 2nd quarter of 2002 The Cloud Profiling Radar Flight Model will be delivered and Spacecraft Bus I&T will start. Instrument I&T with the Spacecraft will begin 3rd quarter of 2002.

PROJECT PLAN FOR FY 2003

The Pre-Environmental Review is scheduled for 1st Qtr. 2003. System I &T will continue in 2003 along with continued Operations System Development. CloudSat will be put in storage awaiting co-manifested launch with CALIPSO in April 2004.

CLOUDSAT LIFE CYCLE COST DATA

$ in Millions	Prior	FY 2001	FY 2002	Y 2003	FY 2004	FY 2005	FY 2006	FY 2007	BTC	Total
Initial Baseline (lifecycle)	21.3	49.8	29.8	10.3	3.1	1.5				115.8
FY03 President's Budget	20.7	47.6	23.8	27.4	16.5	2.6	1.6			140.2
Development	20.7	35.7	23.8	15.9	8.4					104.5
MO					1.8	2.6	1.6			6.0
Launch Vehicle		11.9		11.5	6.3					29.7
FTEs (number)		(1)	(1)							

BASIS OF FY 2003 FUNDING REQUIREMENT

EARTH EXPLORERS PROGRAM – ESSP OTHER

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
Earth Explorers Program – ESSP Other	**21.4**	**9.7**	**7.5**

VEGETATION CANOPY LIDAR (VCL)

The principal goal of the VCL mission (selected under the first ESSP AO) is the characterization of the three-dimensional structure of the Earth's vegetation. The two main science objectives are land cover characterization for terrestrial ecosystem modeling, and generation of a global reference data set of topographic spot heights and transects. VCL contributes primarily to the Land Cover Change & Global Productivity theme in the Earth Science Enterprise Strategic Plan.

Delays in instrument development due to technical complications have led to a TBD launch date. After a program reassessment by NASA, VCL funding was suspended in FY 2001 until the laser technology issues can be overcome. The laser related activities are continuing as a technology effort in FY 2002

PROGRAM SUPPORT/FUTURE MISSIONS

Provides for the evaluation of the 3rd ESSP Announcement of Opportunity (AO) as well as administrative and program support activities.

BASIS OF FY 2003 FUNDING REQUIREMENT

EARTH EXPLORERS PROGRAM – OTHER

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
Total Ozone Mapping Spectrometer (QuikTOMS)	2.0	--	--
Experiments of Opportunity	0.9	2.3	0.4
Triana	24.9	1.0	--
University Class Earth System Science	0.4	--	--
Shuttle Radar Topography Mission (SRTM)	3.7	--	--

QuikTOMS

The scientific objectives of the TOMS project were to measure the long-term changes in total ozone and to verify the chemical models of the stratosphere used to predict future trends. The TOMS flights build on the experience that began in 1978 with the launch of a TOMS instrument (flight model 1) on Nimbus-7 and continued with the TOMS instrument (flight model 2) on a Russian Meteor-3, launched in 1991, a TOMS (flight model 3) launched on the Japanese ADEOS in 1996 and the Earth Probe spacecraft also launched in 1996. The development of a fifth TOMS instrument flight model 5 was launched on September 21, 2001 on QuikTOMS. The QuikTOMS spacecraft was procured through the Indefinite Delivery Indefinite Quantity (IDIQ) rapid delivery spacecraft contract. The QuikTOMS observatory was launched as a secondary payload with Orbview 4; unfortunately, the QuikTOMS mission was lost due to a Taurus launch vehicle failure.

Experiments Of Opportunity

This project offers a capability to undertake short duration flights of instruments on the Space Shuttle and other platforms. The ESE has used the capability of Shuttle/Spacelab development in the important areas of design, early test and checkout of remote sensing instruments for free flying missions, and short-term atmospheric and environmental data gathering for scientific analysis. Instrument development activities have supported a wide range of instrumentation, tailored for Space Shuttle and airborne missions. Current experiments include:

- SAC-C, a joint mission between NASA and the Argentine Space Agency (CONAE) was launched November 2000. SAC-C is currently operational and is providing science data.

- Infrared Spectral Imaging Radiometer (ISIR), the follow-on of the (ISIR), the COmpact Visible and Infrared Imaging Radiometer (COVIR) Instrument developed under the Instrument Incubator Program (IIP), completed full design as a shuttle hitchhiker instrument. In FY 2002, a major issue is to manifest the COVIR hitchhiker experiment on a shuttle mission (dependent on developments in the shuttle program). If manifested, will complete the COVIR hitchhiker payload and complete a shuttle test flight with the Shuttle Laser Altimeter (SLA-03).

- (SLA-03), improved software for laser footprint geolocation and completed reprocessing of SLA-01 and SLA-02 data. Hardware design was reconfigured to incorporate new laser altimeter technologies developed in the IIP Micro altimeter experiment. Instrument redesign will be finalized by the end of December 2001. By December 2002, will complete integration and test of SLA-03 instrument, in preparation for delivery to the Shuttle Small Payload Hitchhiker Project (flight on STS mission is TBD, pending manifest).

- Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC), is a joint U.S. and Taiwan project that will use the radio occultation/limb sounding technique to estimate important weather and climate parameters such as atmospheric temperature, moisture, and pressure. COSMIC will also measure electron density in the ionosphere. The source of the radio signals will be transmissions from the GPS satellites. COSMIC will consist of six low-Earth-orbit micro satellites, each equipped with GPS receivers designed by JPL. By providing more than 3,000 soundings per day, globally, and in all weather, the COSMIC constellation will significantly augment the current global observing systems and provide much-needed data for improved forecasting of terrestrial and space weather, ionospheric and climatic research, and monitoring of climate variability and change. COSMIC partners include the University Corporation for Atmospheric Research (UCAR), the National Science Foundation (NSF), Taiwan's National Space Council (NSC) and National Space Program Office (NPSO), NASA/JPL, the U.S. Naval Research Laboratory, the University of Arizona, Florida State University, the University of Texas, and the Orbital Sciences Corporation.

Triana

The Triana mission is an Earth observation spacecraft to be located at the Sun-Earth L1 point providing a near-term real time, continuous scientific observations of the full sun-lit disc of the Earth. During 1998 the mission was studied at GSFC and NASA Headquarters released an AO in July soliciting proposals for full Triana mission implementation. A selection was made in October 1998 for the Scripps Institution of Oceanography to build and conduct the Triana mission. Triana is designed to carry the Earth Polychromatic Imaging Camera built by Lockheed Martin Advanced Technology Company, a radiometer built by the National Institute of Standards and Technology, and a plasma magnetometer that measures solar wind built by GSFC and the Massachusetts Institute of Technology. In October 1999, the Triana mission suspended work per Congressional direction, while the National Academy of Science (NAS) conducted its review of the scientific merits of the mission. In April 2000, after a favorable finding, work was restarted. However, the stand down resulted in Triana being unable to support the previously assigned Shuttle Transportation System (STS) launch. The Triana instruments and spacecraft have completed environmental testing as an observatory and are currently in storage awaiting launch readiness call-up.

Shuttle Radar Topography Mission (SRTM)

The SRTM was flown on STS-99 in February 2000. SRTM was a joint NASA and National Imaging and Mapping Agency (NIMA) mission, which collected an unprecedented 8 Terabytes of interferometric Synthetic Aperture Radar (SAR) data (equivalent to about

12,300 CDs). This data will be processed to provide topographic data products over approximately 80% of the Earth's landmass (between 60° North and 56° South latitude).

BASIS OF FY 2003 FUNDING REQUIREMENT

RESEARCH and TECHNOLOGY

Web Address: http://earth.nasa.gov/

RESEARCH AND TECHNOLOGY

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
Earth Science Program Science	350.2	340.5	353.9
Applications, Commercialization and Education	114.1	--	--
Applications, Education, and Outreach (FY 2002 and out)	--	94.8	61.7
Technology	99.9	101.8	87.3
Construction of Facilities	--	--	3.4
Total	564.2	537.1	506.3

PROGRAM GOALS

The goal of Research and Technology is to advance our understanding of the Earth system with focus on earth's climate system and its variations due to natural forces and human activities, and the provision of numerical models and other tools necessary for assessing the future state of global climate and its variations.

DESCRIPTION/JUSTIFICATION

The Research and Technology program is divided into three components:

- Scientific investigations focused on applied and basic Earth science research, analysis, and data analysis of related EOS and other mission science data. Included is the Suborbital Science Program of crewed aircraft and uninhabited aircraft available to researchers and PIs. There is both disciplinary-oriented science that typically focuses on one component or process of the Earth system and interdisciplinary science that emphasizes the linkages between Earth system components. Also included is funding to support the provision of computing infrastructure. The Applications Program serves the Nation by demonstrating practical uses of NASA sponsored ***observations*** from remote sensing systems and ***predictions*** from scientific research. NASA implements projects through partnerships with public, private, and academic organizations. These partnerships focus on innovative approaches for using Earth science information to provide decision support that can be adapted in applications nationwide.

- The Applications Program transfers scientific knowledge, spatial information and data, and technical capabilities of Earth science between the research domain and the operational domain. The Applications, Education, and Outreach functions provide key linkages between NASA and its partners and constituencies in the public, private and academic sectors. Earth Science advanced technology focused on development of key technologies to enable our future science missions by reducing their development time and cost while reducing their development risks in support of ESE future missions.

- The Earth Science advanced technology program is focused on development of key technologies to enable our future science missions by reducing their development time and cost.

The major components of Research and Technology are focused on the ESE goals and objectives with specific major milestones, deliverables and measures of their performance.

BASIS OF FY 2003 FUNDING REQUIREMENT

RESEARCH AND TECHNOLOGY

EARTH SCIENCE PROGRAM SCIENCE

Web Address: http://www.earth.nasa.gov/science/

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
Research and Analysis – Science......................................	169.8	156.1	162.2
EOS Science..	48.4	49.2	53.6
Mission Science Teams - Research	96.2	94.6	102.6
Airborne Science and Applications	22.6	23.0	--
Sub Orbital Science	--	--	25.0
Uncrewed Aerial Vehicles (UAV)	3.5	4.0	--
Information Systems	9.7	13.6	10.5
Total	350.2	340.5	353.9

DESCRIPTION/JUSTIFICATION

Scientific investigations focused on applied and basic Earth science research, analysis, and data analysis of related EOS and other mission science data. Included is the Suborbital Science Program of crewed aircraft and uninhabited aircraft available to researchers and PIs. There is both disciplinary-oriented science that typically focuses on one component or process of the Earth system and interdisciplinary science that emphasizes the linkages between Earth system components. Also included is funding to support the provision of computing infrastructure.

PROGRAM GOALS

The goal of Earth Science Program Science research is to develop a scientific understanding of the Earth system and its response to natural or human-induced changes to enable improved prediction capability for climate, weather, and natural hazards. The Earth Science Program supports the research and analysis and integration of critical observations, with earth system models needed to characterize the variability in the earth system and the natural and human-induced forcing factors that affect it; to understand the process by which the Earth system responds to forcing; to assess the regional and global consequences of Earth system variability; and to develop the predictive capability for the Earth system.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Observe, understand, and model the Earth system to learn how it is changing, and the consequences for life on Earth.

Strategic Plan Objectives Supported: Discern and describe how the global Earth system is changing; Identify and measure primary causes of change in the Earth system; Determine how the Earth system responds to natural and human-induced changes; What are the consequences of change in the Earth system for human civilization? Identify the consequences of changes in the Earth system for human civilization; How well can we predict future changes in the earth system?

Performance Plan Metrics Supported: Annual Performance Goals as shown in Annual Performance Plan:1A1-1A6, 1B1-1B2, 1C1-1C6, 1D1-1D3, 1E1-1E5.

CONTENT

Research and Analysis - The intellectual capital for both the planning and exploitation of Earth system observations is vested in a robust research and analysis program. Research and analysis constitute the conceptual source of Earth system science questions, and strategies to address them. The research program is at the origin of new scientific ideas and emerging research approaches. It supports the early development of innovative observing techniques (including both instruments and the linkage of instruments with platforms) and processing algorithms, organizes field tests, and generally charts the path of scientific and engineering developments that enable future advances. It assures the linkage between global satellite observations, ground-, aircraft- and balloon-based observation. In addition, it includes those used for studies of long-term Earth system evolution and shorter-term process-oriented studies. It also includes computational models used to provide both a framework for interpretation and assimilation of observations and a tool for prediction.

EOS Science - Consists of research aimed to assure that the EOS data can be accurately validated to ground, airborne and other space-based measurements, as well as interdisciplinary investigations. These interdisciplinary investigations are oriented towards improving understanding of how the Earth works as a system involving multiple interacting components. The former is needed to assure the quality of data produced by EOS instruments, many of which will be producing the first space-based data of their type. The latter are needed to assure creative use of multiple data types together with research models to address high priority ESE scientific questions associated with Earth system components and the linkage among them.

Mission Science Teams - Contribute to interpreting and exploiting scientific knowledge similar to Research and Analysis while focusing on optimum utilization of the on-orbit ESE instruments. Specific teams analyze data sets from operational spacecraft that support global climate change research focused on answering high priority ESE science questions in atmospheric ozone and trace chemical species, the Earth's radiation budget, aerosols, sea ice, land surface properties, and ocean circulation and biology.
Sub Orbital Science - Combines the Airborne Science and Uninhabited Ariel Vehicle UAV) programs into one program. The program enables the 1) Calibration/ Validation of space borne sensors, 2) Science Data Collection not available through space borne systems, and 3) Flight demonstration of future earth science sensors. By integrating UAV with Airborne Science under one program

ESE will be able to integrate all available observational capabilities in an end-to-end approach focused on answering its high priority science questions and be better able to manage the transition from the ESE current airborne assets to new platforms as technologies provide more capabilities or reduced operations costs. The ESE current operational platforms are two ER-2s, one DC-8 aircraft, and one P-3B. This includes operation and support of a core of remote sensing instruments and a facility for analyzing and calibrating data from those instruments. ESE also makes arrangements for use of other aircraft when they provide the most cost effective means of providing a platform for observations for specific studies.

Information Systems – Compliments the ESE modeling and data assimilation activities by providing a balanced system of high performance computers, software engineering tools, mass storage systems, workstations, and appropriate network connectivity between researchers and components of the system. A major portion of the project funding supports operation of a supercomputing center (the NASA Center for Computational Sciences) at GSFC and ARC. A full range of computational services is provided to a community of approximately 1,400 users representing all disciplines of Earth and space sciences. The project monitors and participates in advanced technology projects, such as the High Performance Computing Center (HPCC) program and National Science Foundation's gigabit test bed programs. The project is focused on providing early access to emerging technologies for the Earth and space science communities. The early access to new technology provides the project with the opportunity to influence vendors and system developers on issues unique to the Earth science researchers such as data intensive computation and algorithm development. Early access also prepares a subset of the research community to adopt and incorporate advanced software and hardware engineering computational methodology to exploit the new technologies and to champion them to their colleagues and peers.

SCHEDULE AND OUTPUTS

Research & Analysis	FY 2001 Estimate/Actual	FY 2002 Estimate	FY 2003 Estimate
Number of principal investigators	1,208/975	930	985
Number of research tasks under way	1,906/1,547	1,475	1,560
Average duration of research tasks	3 years	3 years	3 years
Number of science solicitations released	12/3	6	6
Number proposals received	1,125/539	1,125	1,300
Number of proposals rated very good to excellent	317		
Number of proposals selected	219		
Time to process proposal (selection through obligation)	45 days	45 days	45 days
Number of days until funding is released	Simultaneously with award	Same	Same
Percent of R & A funding obligated:			
Current Budget Authority:	95%/85%	95%	95%
Prior Budget Authority:	100%	100%	100%
Percent of program reviewed by science peers	90%	90%	90%

MAJOR RESEARCH & ANALYSIS RESULTS IN PAST YEAR

NASA's annual results in Earth Science are measured in terms of progress made toward answering the five research questions. In previous years, NASA developed a Performance Plan with specific research objectives which if met will constitute substantial progress in our understanding of the research questions. NASA ESE is currently developing roadmaps for each of its research objectives, which will be used to assess progress in future years. Outlined below are samples of ESE performance plan activities accomplished in FY 2001 that have advanced our understanding of Earth System Science.

- GSFC produced the first global record of the Earth's biosphere, showing the uptake and release of carbon by land and oceans continuously over three years. NASA-sponsored research showed that the growing season over parts of the Northern hemisphere has lengthened over the past two decades, with an accompanying increase in the lushness of vegetation.

- NASA and EarthSAT Corporation released the first consistent 30-m resolution land cover map for the U.S., and are nearing completion of the global map. These data are from 1990 and provide a basis for comparison of future change; plans are in work to repeat the process for 2000 and beyond.

- Results from a major NASA/NSF -led international research campaign indicate that aerosols from dust and pollution may be reducing evaporation and thus slowing the global water cycle.

- Results from comparing the 2000 and 1997 Antarctic Mapping Missions have led to new estimates of change in the Antarctic ice sheet; ice in the Lambert glacier flows from the interior to the "mouth" where it reaches a rate of 1 kilometer per year.

- In the Northern hemisphere, NASA researchers identified patterns of change in sea ice extent over a twenty-year period; overall, Arctic sea ice extent has decreased since 1978.

- Continued monitoring of global ocean topography showed that the Pacific Decadal Oscillation governs climate impacts of the Pacific in non- El Niño/La Nina years, and allowed the prediction of last winter's chill across the northern U.S. and relative warmth across the South.

- ESE also made major advances in computing for climate modeling, using a partnership among two NASA Centers and Silicon Graphics, Inc. to simulate 900 days of Earth's climate in one day, up from the prior capability of 70 days per day; performance on end-to-end climate simulation improved ten fold. This greatly enhances climate modelers' ability to perform the multiple runs of many years of climate simulations needed to generate useful projections of climate change.

- Tracked hazardous smoke and smog around the globe using the ESE Total Ozone Mapping Spectrometer Earth Probe (TOMS-EP) and international partnerships. Early warning of pollution events can help to mitigate their potentially hazardous affects on human health.

- Announced the beginning of summer with data collected from the EOS Terra spacecraft showing the Sun's affects on our planet. Based on Terra's ability to collect data twice per day over the entire planet, researchers were able to gauge the year's heat wave in California.

- Expanded knowledge of atmospheric chemistry by conducting a successful international field experiment, called the Transport and Chemical Evolution over the Pacific (TRACE-P) airborne campaign, in March/April 2001. The primary mission objectives were to understand the atmospheric plume flowing out of East Asia, the way in which it changes as it moves eastward over the Pacific Ocean, and its contribution to global atmospheric chemical composition. To conduct this research, ESE scientists combined data collected by two specially equipped NASA airplanes flying near Hong Kong and Japan with satellite and ground station measurements taken over the 45-day campaign. By studying the seasonal airflow from Asia across the Pacific, researchers gained insight into the way in which natural and human-induced changes affect our global climate.

- Discovered that during periods of increased solar activity the U.S. might become cloudier. Through a scientific paper published in the Geophysical Research Letters, NASA-funded researchers suggested that solar activity affects the jet stream over North America, possibly causing a change in cloud cover patterns.

- Discovered that hazardous bacteria and fungi might be crossing the Atlantic via dust plumes from Northern Africa and causing human health problems in the Virgin Islands and/or Miami. NASA and USGS researchers analyzed NASA Sea-viewing Wide Field-of-view Sensor data and field measurements to make this conclusion.

- Conducted the Fourth Convection and Moisture Experiment in August 2001. The field campaign was a complex space, air, and sea effort designed to study how hurricanes are born, how they choose the course they take, and how their tremendous power transports water and energy into the atmosphere. The mission combined the resources of five NASA centers, the NOAA, the Air Force and some 80-university researchers.

- Researched aerosols (small liquid droplets or particles in the air) and coastal ocean characteristics along the U.S. East Coast through the Chesapeake Lighthouse and Aircraft Measurements for Satellites campaign. The space, air, and water-based field campaign improved satellite-based estimates of aerosols and coastal ocean characteristics.

- Produced the first-ever global map of air pollution in partnership with the Canadian Space Agency. Used data from the EOS Terra satellite policymakers and scientists now have a way to identify the major sources of air pollution and can closely track movement of the pollution anywhere on the globe.

- Detailed the effect of the Hawaiian Islands on thousands of miles of ocean and winds. In a *Science Magazine* paper, scientists at the NASA JPL and their colleagues at the University of Hawaii discussed how the wake of the islands affects the local atmosphere and Pacific Ocean.

PROGRAM PLANS THROUGH FY 2003

The baseline ESE program is pursuing a targeted research program, focused on the science questions. ESE performance will be measured in terms of progress made toward answering these questions. Below is a sampling of planned activities.

How is the global Earth system changing? The Earth and Sun constitute a complex dynamic system that varies on all time-scales, from minutes to days in the case of severe weather disturbances, to many millions of years in the case of tectonic phenomena. The first challenge is to observe and understand this variability on all spatial and temporal scales.

- Implement passive and active rainfall retrievals from the TRMM to establish a benchmark for long-term global precipitation data records in support of the World Climate Research Program.

- Use calibrated data sets for determining long term trends in the total column and profile abundances of stratospheric ozone with sufficient precision to enable the later assessment of expected ozone recovery.

- Provide the first record of changes and variability in extent of Greenland ice sheet surface melt over the 21 years, 1979-1999, and produce the first high-resolution synthetic aperture radar "mini-mosaics" for key coastal regions in Antarctica to be used as a baseline for comparison to past and present high-resolution imagery. These products will provide information as to whether Polar Regions are in the process of losing mass and contributing to the current observed sea level rise.

- Use sub-monthly analysis from a data-assimilating global ocean model, using NASA and other agency satellite and in situ observations, to evaluate ocean circulation changes such as those associated with El Niño. This work is done in the context of the Global Ocean Data Assimilation Experiment. Establishing the basis for variations in the temperature and circulation of the upper ocean can be used to help assess any changes that may be affecting the Earth's weather and climate.

What are the primary forcings of the Earth system? Forces acting on the Earth system are both external and internal, and both natural and human-induced. The larger challenge is to quantify these forces accurately enough to detect trends and discern the patterns of change they bring about in climate and ecosystems.

- Use data assimilation techniques to combine Carbon Monoxide and Methane measurements from MOPITT with chemical transport models of the atmosphere to help characterize inter-annual differences in global emissions.

- Provide first comprehensive multi-instrument/multi-angle integrated data set for study of sources/sinks and distribution of tropospheric aerosols over land based on data from TOMS, MODIS, and MISR instruments.

- Reduce the uncertainty in the retrievals of upper troposphere/lower stratosphere water vapor (from microwave soundings) by 10 – 30% through improved laboratory spectroscopic measurements of the water vapor continuum, which will lead to improved parameterization of water vapor distribution in the vicinity of the tropopause where it provides a major contribution to climate forcing.

- Characterize the role of land cover changes associated with natural fires in determining the carbon balance of ecosystems in at least two major regions of the boreal forests and quantify their impact on the global carbon budget, which will allow for improved knowledge of carbon sources and sinks that may be used in developing the models used to represent future evolution of atmospheric CO_2 and CH_4 amounts.

- Characterize the role of deforestation in the carbon balance of ecosystems of the Amazonian tropical forest, quantify the impact on the global carbon budget, which will provide policymakers with an understanding of the contribution to atmospheric carbon fluxes of land use within the world's largest tropical forest.

How does the Earth system respond to natural and human-induced changes? Earth's response to forces of change can turn into secondary causes of Earth system variability. The key to understanding this process is the development of models which couple the ocean, atmosphere, and land together in order to probe causes and affects which cross boundaries among Earth system components.

- Use results of the Cirrus Regional Study of Tropical Anvils and Layers – Florida Area Cirrus Experiment (CRYSTAL-FACE) field study to determine the upper tropospheric distribution of ice particles and water vapor and associated radiation fluxes on storms and cloud systems, and on cloud generation, regeneration and dissipation mechanisms and their representation in both regional-scale and global climate models, which will lead to improved estimates of climate forcing, the impact of these cloud systems on the hydrological cycle and weather system modeling.

- Demonstrate the feasibility of using remote sensing imagery to identify functional groups of phytopplankton in the ocean and develop a relationship between oceanic primary productivity and export of carbon to the deep-sea based on remote sensing observations and ocean biology models, which will provide an understanding of how fishery habitats and their distribution are affected by marine and coastal food sources.

- Evaluate measurement approaches for vegetation recovery and biomass change following forest clearing and impact of this secondary growth on removal of water from the atmosphere, which will allow for improved estimation of the effects of land cover change on regional ecology and hydrology and the resulting impacts on the carbon and water cycles.

- From TOPEX time series, in situ observations of the World Ocean Data Assimilation Experiment, and assimilation of these data into ocean models, ascertain whether detectable changes in the deep ocean have occurred over the last decade to provide improved knowledge of the way oceans may reflect the overall warming in the Earth system, which can then be used to improve climate models used for long-term assessment.

- Use twenty years of “Fram Strait” sea ice flux from RADARSAT and passive microwave ice motion to improve the accuracy of climate models used in assessments. Sea ice flux through the Fram Strait represents export of fresh water from the Arctic Ocean, which in turn influences deep ocean circulation and climate variations.

- Characterize the atmospheric plume from East Asia and assess its contribution to regional and global atmospheric chemical composition by completing the archival of the Transport of Chemical Evolution over the Pacific (TRACE-P) airborne mission and associated data sets, which will allow improved assessment of intercontinental transport of pollution.

What are the consequences of change in the Earth system for human civilization? Small changes in the global distribution of Earth system properties such as mean surface temperature or sea-level pressure, can entail changes of much greater significance in regional weather, productivity patterns, water resource availability, and other environmental attributes that directly impact human lives.

- Use the inter-annual variations of deep tropical convection utilizing existing and new satellite-based datasets to understand relations between large-scale surface and atmospheric forcing and tropical forcing and enable improved knowledge of how tropical phenomena affect weather and water availability globally.

- Demonstrate impact of assimilation of TRMM rainfall data on forecasting track and intensity of tropical storms by showing improvement in near real-time hurricane and typhoon forecasts in a variety of cases/conditions.

- Use models incorporating the biophysical, socio-economic, institutional, and demographic determinants of land use and land cover change in Amazonia that will enable more realistic representation of human-induced changes on carbon uptake and emissions in that region, which can then be used to improve global carbon models used for assessments.

- Increase the coverage of space-based maps of coral reef distribution by 25% beyond current estimates using remotely sensed imagery, which will provide a more complete data set that can be used to better assess the state of the health of coral reefs and serve as an improved baseline for future studies of their evolution.

How well can we predict future changes in the Earth system? The overarching purpose of Earth System Science is to develop the knowledge basis for predicting future changes in the state of the Earth and assessing the risks associated with such changes. A first step towards predicting the future of the Earth system is building a capability to simulate realistically the present state and its evolution both in the past few decades, and the future.

- Develop new analysis methods that integrate global observations from the complete suite of satellite (and conventional) weather measurements into a single, self-consistent analysis of water-related phenomena (diabatic heating by radiation and precipitation, water vapor and clouds, inference of water and energy fluxes and transports). This development provides for developing requirements for new satellite sensors and new data assimilation techniques leading to improved prediction capabilities.

- Deliver ensembles of forecast products (e.g., surface temperature, precipitation, upper level winds) to Operational agencies (e.g., National Center for Environmental Prediction (NCEP), International Research Institute (IRI). Forecasts with and without the use of satellite-based data will be used to document the impact of such remotely sensed data on forecast quality.

- Estimate and document potential predictability, based on multi-year reanalysis data and modeling, of regional climate variability in order to evaluate the relative contributions of seasonal-to-interannual and decadal climate variability on specific regions, with a focus on occurrence of major floods and droughts in North America and the Asian-Australian monsoon regions.

- Develop, implement, and document advanced cloud radiation and moist physics schemes in NASA climate models, and validate them against remotely sensed radiation data, in order to improve overall skill of climate model simulations of the global energy and water cycles.

- Quantify and document the role of different forcings (greenhouse gases, ozone, water vapor, solar irradiance, stratospheric and tropospheric aerosols) and unforced (chaotic) variability in determining the evolution of global climate over the past 50 years, to develop confidence in quantitative model predictions of future climate system.

BASIS OF FY 2003 FUNDING REQUIREMENT

RESEARCH AND TECHNOLOGY

APPLICATIONS

Web Address: http://gaia.hq.nasa.gov/eseapps/

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
		Millions of Dollars)	
Research and Analysis – Applications	**41.1**	--	--
Commercial Remote Sensing	**51.1**	--	--
Education	**21.9**	--	--
EOS Fellowships and New Investigators	7.0	--	--
Education and outreach	9.9	--	--
GLOBE	5.0	--	--
Subtotal Without Education Agency Investment	**114.1**	--	--
Education Agency Investment	[10.3]	--	--
Total	**[124.4]**	--	--
Research and Analysis - Applications		**77.3**	**43.6**
Program Planning and Analysis		5.6	5.4
Applications Research		33.8	15.4
Applications Development		37.9	22.8
Education		**16.5**	**17.1**
Informal Education		**1.0**	**1.0**
Formal Education		**14.5**	**15.1**
(K-16)		2.1	7.1
GLOBE		5.0	--
Graduate Fellowships and New Investigators		7.4	8.0
Professional Education/Development		**1.0**	**1.0**
Outreach		**1.0**	**1.0**
Total		**94.8**	**61.7**

DESCRIPTION/ JUSTIFICATION

The Applications Program serves the Nation by demonstrating practical uses of NASA sponsored ***observations*** from remote sensing systems and ***predictions*** from scientific research. NASA implements projects through partnerships with public, private, and academic organizations. These partnerships focus on innovative approaches for using Earth science information to provide decision support that can be adapted in applications nationwide.

The Applications Program transfers scientific knowledge, spatial information and data, and technical capabilities of Earth science between the research domain and the operational domain. The Applications, Education, and Outreach functions provide key linkages between NASA and its partners and constituencies in the public, private, and academic sectors.

PROGRAM GOALS

The program goal is to expand and accelerate the realization of economic and societal benefits from Earth science, information, and technology. Applications are accomplished through projects that demonstrate productive uses of Earth system science results. Education is accomplished through programs that create and disseminate materials to stimulate interest in Earth science. Outreach is accomplished by contributing knowledge and leadership through participation in national and regional committees, workshops, studies, and other activities that involve multiple agencies and organizations.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Expand and accelerate the realization of economic and societal benefits from Earth science, information, and technology.

Strategic Plan Objectives Supported: Demonstrate scientific and technical capabilities to enable the development of practical tools for public and private sector decision-makers; Stimulate public interest in and understanding of Earth system science and encourage young scholars to consider careers in science and technology.

Performance Plan Metrics Supported: Annual performance goals IIA1 and IIB1.

CONTENT

The Applications Program contributes to the NASA vision by enabling organizations and people in the public and private sectors to routinely deliver and use Earth science information that saves lives, improves the quality of life, and saves resources through improved decision making.

Specific elements of program contributions to the vision are:

- Provide enhanced and improved space-derived observation data to improve accuracy and duration of decision processes
- Provide the Federal agencies with appropriate data and information about Earth science (e.g., weather, climate, and natural hazards) to enhance existing, and develop new, products and services that can be delivered through state, local, and tribal organizations to serve citizens
- Provide valuable Earth science observations, data assimilation, research, and modeling in support of research needs for decision support and policy-making

NASA supports scientific research and policy by providing critical Earth system science observations, data assimilation, research results, and modeling as part of the USGCRP. NASA's unique space-based Earth observations also serve essential global change and solid Earth and natural hazard research needs of the National Science Foundation, USDA, Department of Defense (DoD), Department of Energy (DOE), Department of the Interior (DOI), Environmental Protection Agency (EPA), and Department of Health and Human Services and National Institutes of Health (HHS/NIH). NASA research and observations are employed in international scientific assessments by such organizations as the World Meteorological Organization, the Food and Agriculture Organization of the United Nations, the United Nations Environment Program, and the Intergovernmental Panel on Climate Change. The knowledge and information needs of organizations are expected to grow substantially in the coming decade, thus providing additional opportunities for NASA applications of remote sensing technologies, data, and programs.

In addition to supporting research, NASA works with USDA, NOAA, DoD, DOE, DOI, EPA, HHS/NIH, Federal Emergency Management Agency (FEMA), the Army Corps of Engineers (Corps), NIMA, Department of State, and others at the Federal level, and with a variety of state, local, and tribal organizations to demonstrate applications of Earth science. NASA and its partners extend research and developments in observations, processing, data assimilation, and modeling to serve national priority needs for a range of spatial information requirements for decision support.

The overarching objective is to bridge the gap between Earth system science research results and the adoption of data and prediction capabilities for reliable and sustained use in decision support. Related objectives are to:

- Simplify and integrate the use of Earth system science data and prediction results for adoption in national applications that enable improved decision-making.

- Enhance the availability, interoperability, and utility of ESE and U.S. private sector data sets, communications, computing, and modeling capabilities as inputs to serve specific applications and research.

- Produce prototypes, guidelines, assessments, and documentation of project results that are citizen-centered, results-oriented, and market-driven.

- Enable the project results to serve as benchmarks for policy and operational uses that benefit citizens through our Federal, state, local, and tribal partners.

A brief description of the program line items under Applications Research and Analysis is as follows:

1) **Program Planning and Analysis (PP&A) -** employs a systematic approach to identifying high priority applications that are evaluated using a specific set of prioritization criteria (NASA ESE Applications Strategy 2002).
2) **Applications Research -** evaluates the potential of Earth science and technology results and capabilities to address specific applications of national and global significance.
3) **Applications Development -** provides for the verification and validation of science and technology results to determine their feasibility for serving a specific application. The development activity employs system-engineering support to create prototypical applications to be evaluated in an operational setting. Validation involves the systematic and documented technical measurement, test, or evaluation of ESE and other (public agency or private) technologies, data, and/or models against standards, user-defined requirements, processes, and/or best practices.

The Education element includes

1) **Informal Education -** increases public awareness and understanding of how the Earth functions as a system and NASA's role in enabling development of knowledge of the Earth system.
2) **Formal Education -** enables the use of Earth science information for teaching and learning at all levels of education. Formal education includes continued training of interdisciplinary scientists at the graduate and early-career levels to support the study of the Earth as a system
3) **Professional Development -** builds capacity for productive use of Earth science results, technology, and information in resolving everyday practical problems.

Outreach encompasses the NASA participation in national and regional committees, workshops, task forces, and studies, including the Federal Geographic Data Committee, the Commercial Imagery Task Force, and the State Department Humanitarian Information Unit.

MAJOR APPLICATIONS RESULTS IN THE PAST YEAR

- In the AG 2020 with USDA and four growers associations representing 100,000 farmers, ESE is demonstrating the use of remote sensing technologies for improving the efficiency of crop productivity, reducing risks to crop health, and mitigating environmental impacts of excess fertilizers, pesticides, and herbicides.

- In support of the Aviation Safety program coordinated with the Federal Aviation Administration (FAA), the use of interferometric synthetic aperture radar (IFSAR) from the Shuttle Radar Topography Mission(SRTM) and data provided through the Science Data Purchase project from the EarthWatch/Intermap team was used to verify, validate, and demonstrate compliance with RTCA SC193 guidelines for aviation terrain specifications.

- Three ESE satellites tracked devastating wildfires in the western U.S. throughout the summer, providing data to the U.S. Forest Service and regional authorities. As a result, U.S. Forest Service is investing in direct broadcast receiving stations to rapidly acquire and disseminate timely data from NASA's Terra satellite throughout the western U.S.

- A Broad Agency Announcement (BAA) for state, local, and tribal government applications established 15 research and development projects in 13 states focused on the four applications themes of resource management, disaster management, community growth, and environmental assessment. The purpose of these projects is to accelerate the adoption of Earth science and remote sensing solutions to enhance routine decision support in state, local, and tribal governments.

- The "Carbon Cycle Science and Related Opportunities in Biology and Biogeochemistry of Ecosystems and Applications" NASA Research Announcement established 14 projects including two focused on soil carbon sequestration. The purpose of these projects is accelerate and expand the use of Earth science and remote sensing related to carbon cycle, land use/land cover change, and terrestrial ecology.

- The Science Data Purchase project provided the global mosaic of Landsat data (circa 1990) from EarthSat Corporation that is supporting the State Department, USGS, USDA, and other agencies. The mosaic provided the foundation for the National Imagery and Mapping Agency (NIMA) to build the global land use/land cover (LULC) classification. A benefit of the LULC product is the water mask used in the production of the digital elevation model products being developed from SRTM. NASA has enabled the development of three very important global data sets.

- ESE supported FEMA in evaluating the use of lidar and IFSAR data to create digital elevation models (DEM) required for the Flood Map Moderation Program. FEMA has used knowledge gained from the partnership to create specifications for lidar and IFSAR-based DEM products to serve flood plain mapping.

- ESE partnered with the Department of Transportation (DOT) to implement a program in remote sensing applications that awarded four grants to university consortia to perform research on use of remote sensing and related technology to transportation issues including environmental management, infrastructure development, and emergency response. DOT also awarded eleven individual project grants in remote sensing applications.

- ESE funded research results enabled the creation of 52 stories of broad public interest that were the basis of over 20% of the major stories on Earth Systems Science covered in print and over the radio. The stories reached the audience of *Earth and Sky* science radio programming, providing information to over 3 million impressions per month in the U.S. alone.

- More than 400 educator training sessions where held across the country with more than 8,600 educators trained on ESE content. New undergraduate courses were created for pre-service education students at institutions, which previously did not teach Earth System Science. The Earth System Science Educators Alliance (ESSEA) continued to reach all 50 states by extending its membership to Alaska.

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2003

RESEARCH AND ANALYSIS – APPLICATIONS

Program Planning & Analysis (PP&A) employs systematic approaches to identify, select, and conduct applications that will serve the Nation by extending the benefits of Earth science and remote sensing technologies. ESE evaluates existing and planned capabilities in the public and private sector that are capable of supporting Earth science research as well as the readiness of partnering agencies and organizations to integrate the Earth science and technology-based products and information for operational use. ESE develops an Applications Investment Portfolio on an annual basis that includes a suite of prioritized opportunities based on estimates of risk, payoff, and timelines.

There is a wide range of potential applications of ESE data and predictive capabilities. To systematically address application priorities in the national interest, ESE conducts its program planning in three stages. ESE considers candidate applications based on the extent to which they exhibit the following characteristics:

- Identified as a national priority by the Executive and/or Legislative branches
- Relevant to national program(s) of one or more Federal agencies or national organizations (of state and local agencies)
- Requirements validated (by other agencies) with the potential to be served by Earth science and remote sensing research and development results
- Significant societal and/or economic value in terms of clearly defined metrics, such as quality of life improvements, potential lives saved, and economic or resource savings

- Initial candidate applications to be reviewed using the prioritization criteria include:
    - Hurricane, flood, and earthquake prediction and assessment for community disaster preparedness
    - Weather and climate predictions for energy forecasting
    - Early warning systems of vector borne disease initiation and/or migration for human health
    - Land, air, and ocean monitoring of carbon sequestration indicators in support of carbon assessments
    - Global monitoring of air, land, and water quality parameters for homeland security
    - Weather prediction for transportation (aviation, maritime, and land-based)

Review of candidate applications take into consideration the potential impact. For instance, an independent assessment of the impact of improved weather forecasting is that the annual cost of electricity could decrease by at least $1 billion if the accuracy of 30-hour weather forecasts improved 1 degree Fahrenheit.

Applications Research focuses on discovery and testing Earth science and technology results and capabilities with the potential to contribute to applications of national and global significance. Plans through FY 2003 include:

- ESE is working with FEMA to research the potential of QuickScat, Terra, Aura, SRTM and other pertinent data sources to serve the information needs of the FEMA HAZUS model used to provide risk assessment and early warning for earthquakes, hurricanes and flooding.

- ESE is working with the Aviation Safety program at Langley Research Center and with the FAA to evaluate the potential of the Geostationary Infrared Fourier Transform Spectrometer (GIFTS) atmospheric sounder to provide key measurements enabling the prediction of more accurate weather patterns and turbulence for use in the Advanced Weather Information System (AWIN) and the Synthetic Vision Systems (SVS) to support improved efficiency and safety for air travel. The intended impact is to realize the projected annual savings of over $2 billion by operating aircraft using advanced Synthetic Vision Systems at just 10 airports in the U.S. (NASA report NS002S1 – Benefit Estimates of Synthetic Vision Technology, 2000)

- ESE will conduct assessment of the potential applications of the near-global SRTM 30-meter topographic data for global geologic and geomorphic process studies. The SRTM is providing the first continuous digital elevation model of 80% of the Earth's surface for better understanding the composition and processes on the Earth's surface. Candidate applications include better urban and infrastructure planning, environmental assessments, aircraft flight planning for aviation safety, and better natural hazards assessment and overall disaster management.

- ESE is working with USGS to develop and implement the Landsat Data Continuity Mission (LDCM) to support the long-term availability of moderate resolution imagery with emphasis on transitioning to the provide sector sources.

- ESE plans to work with EPA to develop projects in identifying indicators for mapping and monitoring pollutants in the air. The mapping project will include a workshop with USGS on the use of LIDAR data for water resource mapping.

- Completion of Southern California Integrated GPS Network (SCIGN) will provide a near real time capability for the evaluation of crustal deformation associated with earthquakes. ESE plans to enable the posting of ground deformation information within hours of an earthquake as opposed to the months required for traditional post-seismic GPS surveys. ESE plans to develop the algorithms and technology of the SCIGN network to improve its utility to both the science community and to civilian, municipal, county, and state government for risk assessment and disaster management activities.

- ESE plans to test an automatic volcano eruption detection procedure using EOS Terra data sets that will automatically detect eruptions and monitor and track plumes, and will distribute the resulting procedures into joint NASA and Federal Aviation Administration (FAA) aircraft routing and warning systems efforts. This information will help promote safe air travel. ESE will continue to work with USGS and other International volcano monitoring programs on the implementation of low-cost GPS arrays and the use of interferometric SAR data for the development of warning systems regions vulnerable to explosive volcanic eruptions.

- ESE will continue to support Homeland Security activities through working with the DOD, USGS, NIMA, and Office of Homeland Security by evaluating EO-1, Terra, Aura, SRTM, and other mission support as well as atmospheric, oceanic, hydrologic, and terrestrial models for air, water, and land quality assessments.

- ESE will continue to contribute to early warning systems for human health through working with the National Institutes of Health and the Environmental Protection Agency in extending the results of science developments in environmental conditions for the initiation and transport of infectious diseases supported by measurements from the Terra, QuickScat, and Aura missions.

Applications Development involves field-testing science and technology results in a realistic setting to determine their fitness for a target application, and creating proto-typical applications in pre-competitive yet near real operational settings. The planned FY 2002 and FY 2003 demonstrations will include:

- The use of Earth science and remote sensing technologies to the agricultural community through continuation of the agricultural initiative with USDA (Ag 20/20) that leads to a joint solicitation and total award of 15 - 20 partnerships, with 4 - 6 competitively selected partnerships with cotton, corn, wheat, and soybean growers. These partnerships will focus on improvements in farm management practices utilizing geospatial technologies that can lead to increases in efficiencies of food and fiber production.

- ESE will provide state, local, and tribal government access to scientific results through demonstrations conducted in partnership with key organizations. Demonstrations will be provided through venues arranged by the National States Geographic Information Council (NSGIC), Western Governors Association (WGA), International City Managers Association (ICMA), Aerospace States Association (ASA), National Association of Counties (NACO), Mid-America States Consortium and National Conference of State Legislatures (NCSL). Regional workshops will be held to increase communication and expand collaboration with and among the State and Local government user communities. The workshops will demonstrate ESE data products and science results to the state and local government community for their use in practical decision-making.

Applications Verification and Validation - Involves the systematic and documented technical measurement, test, or evaluation of ESE and external (pubic agency or private) technologies, data, models with the objective of validating these against standards, user defined requirements, processes, and best practices. The planned FY 2002 and FY 2003 validation developments will include:

- ESE is developing, fostering, and promulgating formats, standards, and protocols for calibration, validation and dissemination of geospatial data both national and internationally. ESE is working with the Federal Geographic Data Committee (FGDC) and the Geospatial One-Stop e-government initiative.

- ESE supports a Joint ESE and American Society for Photogrammetry and Remote Sensing (ASPRS) multi-disciplinary team to develop Digital Imagery Mapping Guidelines and refinement of draft Digital Imagery Standards and digital certification techniques. This team provides a lead role in the development of LIDAR and Thermal guidelines.

- ESE is a partner in the Joint Committee on Imagery Evaluation (JACIE) support to the USGS and NIMA in performing systems characterization activities including working with the Department of Energy (DOE) on the Multi-Thermal Imager, evaluations of commercial data products including DigitalGlobe QuickBird and Resource 21 data simulations and validation, and future missions including Landsat Data Continuity Mission (LDCM) and Tropospheric winds missions trade studies.

EDUCATION

Education includes three program areas to accelerate the packaging and delivery results of NASA Earth science to the educational community: (1) Informal Education, (2) Formal Education, and (3) Professional Development. These three elements are integrated and coordinated using educational themes that will unify content, topics and messages across these areas. All ESE educational efforts (i.e., those associated with flight projects, field campaigns, research grants, cooperative agreements, and Center activities) are aligned using these themes. This thematic integration and coordination is enhanced by a partnership with the Digital Library for Earth System Education funded by the National Science Foundation that enables sharing of content among educational audiences.

- In FY 2003, ESE will continue its activities in Informal Education focused on broad public awareness and understanding of the Earth as a system, the related technologies and applied uses, and the relevance to our daily lives via broadcast media (the mode by which most Americans learn about science and technology). Efforts will focus on activities to improve the awareness of ESE content within the museum community; e.g., workshops, presentations and exhibits at conferences, and the Crosscutting partnership with NSF will focus on access and usability of content by this community.

- The two pilot efforts with the Girl Scouts are directed to increase cognizance and aptitude of Earth science to this target audience. The pilots focus on scaling-up in both leader training and badge endorsement at the national level. Pilot efforts will begin in FY 2003 with the National 4-H Council.

- In FY 2003, NASA will continue conducting workshops to train teachers in the use of Earth Science education products, and coordinate with the education organizations to affect systemic integration of ESE content into established curricular materials and learning venues. The K-16 Formal Education will place particular focus on systemic improvement activities by identifying and filling content/concept gaps in the array of curriculum support materials, and on establishing a scalable and affordable approach to educator enhancement. GLOBE will be integrated into the K-16 Formal Education with increased emphasis on systemic improvement so that the numerical performance goals of GLOBE migrate from a focus on schools to a focus on educators, classrooms and district-wide participation in science learning.

- ESE will continue its annual solicitation and selection of graduate student fellowships, and also support at least 30 active early-career education research grants in Earth system science.

- ESE will continue new efforts in Professional Development, focused on: 1) training of professionals currently in the workforce who are allied with a funded applied applications activities at the federal, state and local level (e.g., in-service professionals), and 2) training of undergraduates in key applied fields so that they enter the marketplace with discipline specific skills in applied remote sensing (measurement, analysis, interpretation)

OUTREACH

ESE participates in multi-participant organizations at the international, national, regional, state, local, and tribal levels to contribute Earth science knowledge and leadership. ESE provides consistent support to committees, task forces, delegations, workshops, studies and other organized activities that facilitate and accelerate the transfer of information to serve the respective communities.

BASIS OF FY 2003 FUNDING REQUIREMENT

RESEARCH AND TECHNOLOGY

TECHNOLOGY PROGRAM

Web Address: http://esto.nasa.gov/

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
Technology Infusion	78.2	80.0	68.3
New Millennium Program...	35.0	35.8	28.0
Advanced Information Systems Technology	15.4	9.5	9.8
Advanced Technology Initiatives	12.8	19.7	8.5
Instrument Incubator Program	15.0	15.0	22.0
Computational technologies (formerly HPCC)	21.7	21.8	19.0
Total...	99.9	101.8	87.3

DESCRIPTION/JUSTIFICATION

The Earth Science advanced technology program is focused on development of key technologies to enable our future science missions by reducing their development time and cost.

PROGRAM GOALS

The Earth Science Technology program develops and demonstrates technologies that will enable future missions, reduce the cost of future missions, and enable a maximum 3-year acquisition timeline for flight and ground systems. The program consists of five major areas that will lead to the successful and timely development and infusion of technologies into future programs.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Develop and adopt advanced technologies to enable mission success and serve national priorities.

Strategic Plan Objectives Supported: Develop advanced technologies to reduce the cost and expand the capability for scientific Earth observation; Develop advanced information technologies for processing, archiving, accessing, visualizing, and communicating Earth science data.

Performance Plan Metrics Supported: Annual Performance Goals as shown in Annual Performance Plan: IIIA1 IIIB1, IIIB2.

TECHNOLOGY PROGRAM CONTENT

New Millennium Program

The New Millennium Program (NMP) validates innovative measurement concepts, associated enabling instrument technologies and space platform technologies required for future missions. NMP identifies, develops, and selects technologies that required space validation before these new technologies can be flown on science or operational missions. The NMP reflects a commitment to capitalize on U.S. investments in advanced technologies by reducing the risk to the first users through validation of the technologies in space. The NMP focus is on development of new technology to meet the scientific needs of the next few decades and to reduce future Earth science mission costs through focused technology demonstrations for Earth orbiting missions. The ESE has joined the Space Science Enterprise (SSE) in the management of NMP in order to realize the benefits from common work in core technology development projects and specific spacecraft and instrument studies. The program identifies and demonstrates advanced technologies that reduce cost and improve performance of all aspects of missions for the 21st century, (i.e., spacecraft, instruments, and operations). The program objectives are to spawn “leap ahead” technology by drawing the best capabilities available from several sources within the government, private industries, and universities via open competition. These low-cost, tightly controlled developments, Earth Observing (EOS) projects, will take more risk in order to demonstrate the needed technology breakthroughs and thus reduce the risk of using that technology in future science missions. Missions will be selected based on their ability to meet the science needs of the future by innovative technology that would also decrease the cost and improve the overall performance of Earth science missions.

Advanced Information Systems

Advanced Information Systems Technology (AIST) develops advanced end-to-end mission information system technologies to capitalize on the technological advances of future missions. Information technology advances play a critical role in collecting, handling, and managing very large amounts of data and information in space as well as on the ground. The objectives of the ESE AIST program are to identify, develop, and (where appropriate) demonstrate advanced information system technologies which:

- Enable new Earth observation measurements and information products,

- Increase the accessibility and utility of Earth science data, and
- Reduce the risk, cost, size, and development time of OES space-based and ground-based information systems.

Advanced Technology Initiative

Advanced Technology Initiatives (ATI) focuses and refines ESE technology requirements and advance key component and subsystem technologies required for the next generation of exploratory and systematic space-based missions. Investment strategies within the ATI are structured to develop key technologies focused on enabling future ESE missions, from advanced concepts, through technology advancements up the Technology Readiness Level (TRL) ladder, to readiness for infusion into future missions. Emphasis is being placed on developing new capabilities for Earth science sensors; integrated, autonomous, self-calibrating instruments and visionary architectures for future Earth Science observing systems.

Instrument Incubator Program

The Instrument Incubator Program (IIP) develops new instruments and measurement techniques at the system level. The IIP is expected to reduce the cost and development time of future scientific instruments for Earth science. The instrument incubator program aggressively pursues emerging technologies and proactively closes the technology transfer gaps that exist in the instrument development process. The program takes detectors and other instrument components coming from NASA sponsored fundamental technology development projects and other sources, and focuses on combining them into new instrument systems. This includes key follow-on instruments that will provide measurements in support of the decadal Science Research Plan.

Computational Technologies (Formerly HPCC)

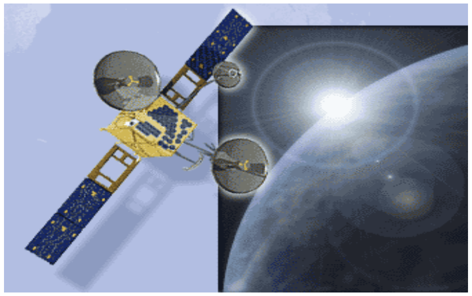
The goals of Computational Technology (CT) program are to accelerate the development, application, and transfer of high performance computing technologies to meet the engineering and science needs of the NASA Earth science program. The CT investment will focus on advanced developments of particular interest in Earth and space science. CT develops and applies scalable computational technologies and software tools to further the development of a suite of multidisciplinary models, simulations, and analyses of data products. The goal is to provide scalable global simulations coupling many disciplines and to simulate complex multiple-scale problems associated with space science. High resolution, multidisciplinary models are important for their predictive value and for their ability to extrapolate beyond our ability to measure and observe systems directly. CT research increases NASA's capability to produce, analyze, and understand its science and mission data while reducing the investment in money, time, and human resources.

BASIS OF FY 2003 FUNDING REQUIREMENT

NEW MILLENNIUM PROGRAM Missions Funded in the FY 2003 Budget

NMP Earth Observing 3 (Eo-3)

Web Address: http:// gaia.hq.nasa.gov/ese_missions/



The EO-3 Geosynchronous Imaging Fourier Transform Spectrometer (GIFTS) will validate a new low-cost, high performance approach to atmospheric sounding for weather prediction. This mission is intended to demonstrate technologies required to measure atmospheric temperature within 1 degree K and 1 Km vertical resolution from geostationary orbit for the first time. Such a measurement will enable significant improvements in accuracy of short-term weather forecasts, as well as enable measurements of atmospheric chemical composition from this orbit for the first time. In addition, GIFTS will enable advanced technologies including large area focal-plane array, new data readout and signal processing electronics, and passive thermal switching. These technologies which will be used for measuring temperature, water vapor, wind and chemical composition with high resolution in space and time. EO-3 is being planned as a partnership with the Office of Naval Research in the Department of the Navy (DON) and the NOAA. This partnership will include provision of funding for spacecraft and launch for the mission, validation of the data products by the National Weather Service, investment in technology infusion for the next generation of NOAA operational sounders, as well as transferring the GIFTS operation to extended Indian Ocean observations. The details of this partnership are still being negotiated. The current plan for the launch of the mission is October 2005. The launch is to be provided by the Air Force Space Test Program (STP).

Objectives:
- Validate advanced technologies for new low cost, geosynchronous, optical remote sensing systems.
- Provide an altitude-resolved water vapor winds measurement capability for revolutionary improvements in operational weather observation and prediction

Funding (Millions of Dollars):

FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
19.0	30.0	22.3

Critical New Technologies Demonstrated:

- Imaging Interferometer – demonstrate a cryogenic Michelson interferometer optimized for sounding applications
- Long-wave Focal Plane Array (LFPA) and Advanced cryogenic cooling – demonstrate a large area detector array and readouts as well as associated miniaturized cryo-coolers
- High speed signal processing – demonstrate high-speed, ultra-low-power signal processing
- Data compression – demonstrate a radiation hardened vector processor for on-board real-time signal processing and data compression
- Autonomous pointing and control – demonstrate autonomous pointing and control systems for precise imaging stabilization and feature tracking
- Low power radiation tolerant microelectronics – demonstrate radiation protection and ultra-low-power electronics
- Lightweight structures and optics - demonstrate lightweight optics and structures to minimize instrument mass

Key Formulation Milestones:	**FY 2003 BUDGET DATE**	**FY 2002 BUDGET DATE**	**BASELINE DATE**	**CHANGE (FY02-FY03)**	**COMMENT**
PDR	March 2000	--	March 2000		
CDR	April 2002	--	April 2002		
Instruments delivered	June 2004	--	June 2004		
Launch Readiness Date	September 2005	--	September 2005		

Lead Center: LaRC	**Other Centers:**	**Interdependencies:** Navy and NOAA
Subsystem	**Builder**	
Spacecraft	TRW & U.S. Navy	
Sensor Subsystem (optical)	Space Dynamics Laboratory, UT	
Electronics Subsystem	LaRC	
Instruments	**Builder**	**Principle Investigator:** Dr. William Smith at LaRC
Geosynchronous Imaging Fourier Transform Spectrometer (GIFTS)	Space Dynamics Laboratory, and LaRC	
Launch Vehicle: Delta 7320	**Tracking/Communications:** U.S. Navy	**Data Handling:** NOAA

MAJOR TECHNOLOGY RESULTS IN THE PAST YEAR

Outlined below are FY 2001 technology achievements that benefit ESE by enabling future missions, reducing the cost of future missions, or that will enable a 3-year acquisition timeline for future flight and ground systems.

- The launch and activation of the Earth Observing 1 (EO-1) technology demonstration satellite, the first ESE New Millennium Program mission. One of the main mission objectives was to demonstrate new and cheaper technologies compared to the current standard Landsat series. In doing so, EO-1 included new instruments for better characterization of the Earth, such as the world's first space-based hyper spectral sensor. This sensor will open new frontiers for the next great science and applications opportunities in Earth remote sensing. At one-quarter the mass and one-third the cost of traditional Landsat satellites, EO-1 demonstrated our ability to produce Landsat-like imagery at a fraction of the previous Landsat mission costs with better performance. EO-1 flies in formation with our EOS Terra satellite, Landsat-7 and a joint U.S./Argentina satellite to demonstrate the satellite constellation concept in which the combined capabilities create a super-satellite. Most importantly, several of the EO-1 technologies, once validated, will be turned over to the private sector for commercial development.

- 9 of 26 (35%) IIP technologies were advanced at least one Technology Readiness Level. This exceeded the goal of 25%.
- Two advanced information systems technologies and concepts for processing, archival, access, and visualization of ESE data was developed. Researchers selected under a Cooperative Agreement Notice entitled, "The Increasing Interoperability and Performance of Grand Challenge Applications in the Earth, Space, Life, and Microgravity Sciences" (CAN-00-OES-01) are working on the multi-year project seeking to integrate various climate models into one framework global climate model.
- Developed seven technologies (including one new instrument) to demonstrate in space with the third New Millennium Earth Observer (EO-3) satellite GIFTS. The technologies GIFTS demonstrates will enable improvement in the general capability of future remote sensing satellites, as well as reductions in their cost. Additionally, the technologies GIFTS tests in space will also help revolutionize the observation and prediction of our weather, enabling scientists and meteorologists to forecast the weather with a new level of accuracy in the future.
- At least two technology developments were transferred to a commercial entity for operational use. NASA, other federal agencies, and commercial partners are working to validate all nine of the technologies aboard EO-1. As part of that partnership, after the technologies have been validated, the commercial partners can market them. The EO-1 X-Band Phased Array Antenna (Boeing and Lewis) and the EO-1 Carbon-Carbon Radiator (Amoco Polymers, BF Goodrich, Lockheed Martin) were validated and transferred to commercial entities.
- A breakthrough in climate modeling was announced in July 2001. Using the newly developed 512-node silicon graphic supercomputer, ESE researchers were able to simulate more than 900 days of the Earth's climate in one day of computer time. Previous capability had been limited to the simulation of 70 days. This supercomputer is of great value for Earth scientists because it enables more accurate computer models of climate change using global satellite observation data collected by NASA. For example, in FY 2001, researchers were able to demonstrate experimental seasonal climate predictions using ESE data sets from the TOPEX/Poseidon, SeaWiFS, TRMM, and Terra satellites. The combination of a faster computer,

more accurate climate models, and the use of more global satellite observations will result in improved accuracy of climate prediction for economic and policy decision makers. Ultimately, ESE would like to develop the supercomputing capability to integrate all the components of the climate system into models of the living, breathing Earth.

- Demonstrating the use of ESE science and technology to government officials by hosting five workshops around the U.S. Over 550 decision-makers representing nearly every state attended these workshops. A survey conducted during the workshops found that 35% of respondents had never used satellite data. A follow-up survey after the workshops demonstrated that the number fell to 20%. This effort supported the ESE goal of improving access to and understanding of remote sensing data by economic and policy makers.

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2003

FY 2002 and FY 2003 technology performance goals are defined in the FY 2002 and FY 2003 ESE Performance Plans. Stated performance goals are listed below followed by a sampling of major activities planned in each program area.

- Annually advance 25% of funded technology developments by one Technology Readiness Level (TRL).

- Annually mature at least three (3) technologies to the point where they can be validated in space or incorporated directly into a science and/or operational project(s).

- Annually infuse at least one (1) technology development to a commercial entity; into a remote sensing or in-situ project; or into the ES information systems infrastructure.

- Annually establish at least one (1) joint agreement with a program external to NASA's ESE that results in the inclusion of at least one new ESE technology requirement.

New Millennium Program

- Mission Confirmation for the GIFTS program is anticipated in FY 2002

Advanced Information Systems Technology

- The annual technology performance goals for FY 2002 and FY 2003 require the accomplishment of activities from the first AIS NRA closed on January 25, 2000. Thirty proposals were selected for award covering a variety of topics ranging from satellite on-board processing, data collection and analysis, information transmission and wireless networks, to satellite platform control and flight operating systems. Technology Infusion plans active management of these tasks to insure optimum technology advancement

- The near-term investment strategy for AIS continues the Advanced Prototyping System (APS) effort in support of EOSDIS, the next generation DIS, and other ESE ground system development technology needs. Prototyping is accomplished through the Quick Response System (QRS), and the objectives are to leverage technologies to reduce costs and enhance the use of EOS data, and to explore technologies to enable the next generation DIS. Technologies are currently categorized into five areas: science processing, storage management, interactive access, data server access and infrastructure, and open distributed architecture.

Advanced Technology Initiative

- In FY 2002 ATI will issue an NRA to address key component technologies to support measurements required in the ESE Science Plan.

- In FY 2002 and FY 2003 activities from the first ATI instrument solicitation awarded in January 2000 will begin to mature. The 23 awards address a broad range of technology categories to reduce the risk, size and development costs for Earth observing instruments and enable new Earth observation measurements. Awards were made for instrument components in active and passive optical, active and passive microwave as well as advanced electronic components for future ESE instruments.

Instrument Incubator Program

- An NRA was issued in May 2001 and closed in July 2001 that solicited technology developments in the focus areas of lasers and lidar systems, passive microwave radiometers, and radar systems. NASA received 64 proposals of which 11 have been selected and will be under contract in FY 2002. Most of these IIP projects represent efforts to reduce the cost, size, mass, and resource use of current measurement approaches. Several will enable or improve measurements that cannot be made satisfactorily today. The projects have start dates ranging from October 2001 to January 2002. The projects range in length from 2 ~~1~~ to 3 years and will end between November 2004 and February 2005.

  The next solicitation will focus on the next generation of systematic and exploratory instruments to be launched in the 2008 to 2010 timeframe. By mid-2002 the first set of Incubator projects will be complete, the second set will be underway, and the post-2002 mission composition will be much better defined. Gaps in measurement technology will be analyzed at that time to target specific measurement areas. The emphases may include stratospheric chemistry, further airborne in-situ measurements, cloud and aerosol characterization, and ice sheet mass balance measurements.

- For FY 2002 a project was started to address laser transmitter technologies. This project grew out of concern that there are no lasers as active sources for space-based remote sensing that have been space qualified for long-term science measurements. Presently, the risks inherent in developing these technologies have been born by science programs. The intention of this project is therefore to mitigate risks in certain areas so that programs such as IIP can further the maturation of the instruments prior to science infusion. The project will invest in several critical areas:

- Advancing transmitter technologies to enable ESE science measurements (tropospheric ozone, water vapor, winds, and altimetry)
- Development and qualification of space-based laser diode arrays
- Advancing nonlinear wavelength conversion technology for space-based lidars

Computational Technologies

- Eleven diverse scientifically important Investigations were selected in FY 2001 through a Cooperative Agreement Notice and full Headquarters peer review whose code products will be used by other groups, especially through identifiable provider/customer relationships. Investigator teams are working to advance the performance of specific application codes and expand their reusability and interoperability with other related codes within self-defined multidisciplinary scientific communities. Development of an Earth System Modeling Framework and movement of a critical mass of the national Earth system modeling community to it is a top priority. Desired outcomes include fostering reusability among software components and portability among high-end computing architectures; enabling of software exchange between major centers of research; structuring of systems for better management of evolving codes; and reduction in the time required to modify research application codes.

BASIS OF FY 2003 FUNDING REQUIREMENT

Construction of Facilities

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
		(Millions of Dollars)	
Construction of Facilities (CoF)......................................	--	--	3.4
Total...	--	--	3.4

DESCRIPTION/ JUSTIFICATION

Construction of a Flight Projects Center Phase 2 at JPL. Refer to Co F Section for Project description and justification. This CoF project is funded by ESE (15%) and the Space Science Enterprise (85%) as the primary beneficiaries.

In the Initial FY 2002 Operating Plan Change Request, $2.5M has been allocated across numerous JPL related activities. It is anticipated that the FY 2003 funds will be allocated across numerous JPL related activities as well.

BASIS OF FY 2003 FUNDING REQUIREMENT

MISSION OPERATIONS

Web Address: http://gaia.hq.nasa.gov/ese_missions/

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
Mission Operations	**57.8**	**47.6**	**28.8**
(Upper Atmosphere Research Satellite)	10.6	2.9	--
(Total Ozone Mapping Spectrometer)	6.9	5.0	2.7
(Ocean Topography Experiment (TOPEX)	6.7	6.6	0.7
(Tropical Rainfall Measuring Mission)	14.7	13.8	13.5
(Earth Science)	18.9	19.3	11.9
Earth Science Operations	**--**	**--**	**219.0**
Total	**57.8**	**47.6**	**247.8**

DESCRIPTION/ JUSTIFICATION

This program supports the observations and data management portion of Earth science activities. Operations, Data Retrieval and Storage (ODRS) provides the data and data products from EOS precursor missions, including the UARS, TOPEX, TOMS, NSCAT, and TRMM. These data and data products are required to understand the total Earth system and the effects of humans on the global environment.

In FY 2003, the operations of EOSDIS will continue, the ECS development contract will end and a new EOSDIS Maintenance and Development (EMD) contract will be established. Starting in FY 2003 the EOSDIS budget has been separated into two parts; Development and Operation. This change was required in order to reflect the operational nature of most of EOSDIS. This realignment reflects the true nature of the operations type activity. We have therefore transferred the appropriate elements into Earth Science Operations to reflect the transition from development to operations starting in FY 2003. This element also includes Space communications ground network activity transferred from the HEDS account. The ESE is accepting NASA-wide management and funding responsibility for space communications data services, systems upgrades, and space communications technology for the ground network component of spell Space Operations Management Office (SOMO). This streamlines SOMO management and enables more emphasis on the direct role of the customer in defining, weighing cost vs. benefit, and paying for the services as needed.

The objectives of the mission operations program are to acquire, process, and archive long-term data sets and validated data products. These data sets support global climate change research in atmospheric ozone and trace chemical species, the Earth's radiation budget, aerosols, sea ice, land surface properties, and ocean circulation and biology. Funding provides for operating spacecraft such as UARS, TOPEX, ERBS, TOMS, TRMM, and processing of acquired data.

Under the Earth Science element, Alaska Synthetic Aperture RADAR (SAR) Facility (ASF) missions includes the European Space Agency Remote Sensing Satellite (ERS-1-2), the Canadian (RADARSAT) for new acquisitions, Japanese Earth Remote Sensing Satellite (JERS-1), and RADARSAT mission for historical and archival missions. Key participants involved in the ASF include the European Space Agency, Japan NASDA, Canadian Space Agency, NASA/Goddard Space Flight Center, NASA/Wallops Flight Facility (WFF), the Jet Propulsion Laboratory (JPL, the Ohio State Byrd Polar Research Center, and University of Alaska which hosts the ASF). SAR data acquisition and usage involved countries throughout the world, including, Italy, Saudi Arabia, China, Australia, France, Canada, Brazil, the United Kingdom, and Germany.

CURRENT/PROJECTED MISSIONS IN OPERATION:

The following is a comprehensive list of all Earth Science spacecraft that are, or are expected to be, operational at any time between January 2001 and September 2003.

MISSION	LAUNCH DATE	MISSION END	Mission Objectives/Status
SORCE	**July 2002**	**July 2007**	Continuation of measurement of both solar and stellar irradiance.
AQUA	**NET March 2002**	**March 2008**	Variety of measurements related to the Earth/atmosphere system, including atmospheric temperature and humidity profiles, clouds, precipitation, snow cover over land, sea ice cover over ocean, sea surface and land-surface temperatures, soil moisture and Earth's radiation budget.
GRACE	**March 2002**	**March 2007**	GRACE will utilize an advanced microwave ranging system between two identical formation flying spacecraft to measure the Earth's gravitational field to an unprecedented accuracy.
SAGE III	**December 10, 2001**	**December 2004**	Measurement of both solar and lunar occultation to measure vertical profiles of aerosols, ozone, and other gaseous constituents of the atmosphere.
JASON	**December 7, 2001**	**December 2006**	Follow On mission to Topex/Poseidon. Extend ocean topography measurements into the 21stt century
ACRIM	**December 20, 1999**	**December 2004**	Providing for the continuation of the long-term, quantitative understanding of the solar forcing of Earth's climate.
Terra	**December 18, 1999**	**December 2004**	100% operational. Terra is processing 200 gigabytes of data per day. Obtain information about the physical and radiative

			properties of clouds and aerosol; exchange of energy, carbon and water between the air, land, and water, as well as measurements of important trace gases in the atmosphere and volcanology.
QuikScat	**June 19, 1999**	**September 2002**	Instruments to collect sea surface wind data. Is filling the gap in such critical data between ADEOS 1, which failed in June 1997 after seven months on-orbit, and ADEOS II.
Landsat-7	**April 15, 1999**	**April 2004**	NASA operated the satellite through FY 2000. 100% operational. Processing 250 scenes/day. USGS assumed operation and funding responsibility beginning October 1, 2000. Making high spatial resolution measurements of land surface and surrounding coastal regions used for global change research.
SeaStar / SeaWiFS / Ocean Color	**August 1997**	**N/A**	This is a data buy from Orbital Science Corporation (OSC) and the operation of the spacecraft is an OSC responsibility. 100% operational. Processing 41,700 Bytes/second.
TRMM	**November 1997**	**November 2000** Operations funded thru Mid FY 2004	Launched with a 3-year mission life. All operations are nominal, except the CERES instruments, which is non-operational due to an anomaly with Data Acquisition Assembly Converter. 95% operational. Processing 250,000 Bytes/second.
TOMS FM3	**July 1996**	**July 2001** Operations funded thru Mid FY 2004	The TOMS-EP spacecraft was launched in July 1996 with an expected 5-year mission life. It has completed its primary mission phase. The first global ozone image was produced and released September 13, 1996. Automated processing and distribution of science products began September 20, 1996 and Internet distribution started on October 7, 1996. 100% operational. Processing 250 Bytes/second.
ERBS/ERBE/SAGE II	Oct. 1984, December 1 984 and September 1986	Operations funded thru FY 2002	The ERBS spacecraft launched in October 1984. It has gone well beyond the expected mission life. 67% operational. SAGE processing 1,600 Bytes/second. ERBE processing 200 Bytes/second. The ERBS mission is planned for decommissioning by the end of FY 2002.
TOPEX	**August 1992**	**August 1995** Operations funded thru	Launched with an expected 3-year mission life. The extended mission is now in its tenth year of mission life. Satellite and sensors are 100% operational, with continuous science date return of >99% Cross-calibration and tandem

		FY 2002	mission activities will commence following the launch of Jason-1. Processing 2000 Bytes/second
UARS	**September 1991**	**September 1994** Operations funded thru FY 2002	Launched in September 1991 with an expected three-year mission life. It has gone well beyond the expected mission life providing data to support improvements monitoring the processes that control upper atmospheric structure and variability, the response of the upper atmosphere to natural and human-induced changes, and the role of the upper atmosphere in climate variability. The spacecraft is transitioning to real-time operations due to a second recorder failure in November 1999. 95% operational. Processing 4,000 Bytes/second. The UARS mission is operating in the "data trace ability" mode and is planned for termination effective September 30, 2002.
Alaska SAR Facility Missions: ERS-1 (launched 1991) JERS-1 (launched 1992) ERS-2 (launched 1995) RADARSAT (launched 1995) ADEOS (launched 1996) ADEOS-2 (launch 2002) Antarctic Mapping Mission (2001)			The Alaska SAR Facility is a ground receiving station and data processing station, which now supports ERS-2 and RADARSAT operational missions and continues to support ERS-1, JERS-1, ERS-2, and RADARSAT historical and archival missions.

At least 90% of the total on-orbit instrument complement will be operational during their design lifetime.

BASIS OF FY 2003 FUNDING REQUIREMENT

INVESTMENTS

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
Minority University Research & Education Program (MUREP)*	8.8	--	--
Education**	1.5	--	--
Total	10.3	--	--

* FY 2000 and FY 2001 MUREP covered in Applications, Commercialization and Education (ACE).
** In FY 2002, this activity has been transferred to the Agency Education program.

PROGRAM GOALS

The above funding requirements represent the ESE budget contribution to the Minority University Research and Education Programs (MUREP) and the Education Program.

STRATEGY FOR ACHIEVING GOALS

The ESE investments in higher education institutions include federally mandated outreach to the Nation's Historically Black Colleges and Universities (HBCUs) and Other Minority Universities (OMUs), including Hispanic-Serving Institution and Tribal Colleges and Universities. This outreach is achieved through a comprehensive and complementary array of strategies developed in collaboration with the Office of Equal Opportunity Programs. These strategies are designed to create a broad-based, competitive aerospace research capability within Minority Institutions (MI's). This capability fosters new aerospace science and technology concepts by integrating ESE related cutting-edge science and technology concepts, practices, and teaching strategies into MI's academic, scientific, and technology infrastructure. As a result, increasing the production of more competitive trained U.S. students underrepresented in NASA-related fields who, because of their research training and exposure to cutting-edge technologies, are better prepared to enter graduate programs or the workplace. Other initiatives are focused on enhancing diversity in the ESE programs and activities. This includes exposing faculty and students from HBCUs and OMUs, and students from under-served schools, with significant enrollments of minority students, to the ESE research efforts and outcomes, educational programs, and activities. To support the accomplishment of the ESE mission, these programs are implemented through NASA Centers and JPL. The Centers and JPL support the MUREP through use of their unique facilities, program management and grant administration, and commitment of their personnel to provide technical assistance and assist in other facets of program implementation. Extensive detail as to how this funding is utilized is located under the MUREP portion of the budget.

In carrying out its Education Program, NASA is particularly cognizant of the powerful attraction the ESE mission holds for students and educators. The unique character of Earth Science exploration, scientific, and technical activities has the ability to captivate the imagination and excitement of students, teachers, and faculty, and channel this into an investment which support NASA's Education Program.

In fulfilling its role to support excellence in education as set forth in the NASA Strategic Plan, the NASA Education Program brings students and educators into its missions and its research as participants and partners. NASA provides the opportunity for educators and students to experience first hand involvement with ESE scientists and engineers, facilities, and research and development activities. Examples of such opportunities include the Learning Technologies Program, a new Undergraduate Internship Program, and the Graduate Student Researchers Program. The participants benefit from the opportunity to become involved in research and development endeavors, gain an understanding of the breadth of Earth Science activities, and return to the classroom with enhanced knowledge and skills to share with the entire education community. Detail as to how this funding is utilized is located under the NASA Education portion of the budget.

BASIS OF FY 2003 FUNDING REQUIREMENT

EARTH SCIENCE INSTITUTIONAL SUPPORT

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
		(Millions of Dollars)	
Research and Program Management (R&PM)	**249.9**	**267.9**	**296.7**
Personnel and related costs	179.4	173.5	195.1
Travel	5.3	5.2	5.6
Research Operations Support (ROS)	65.2	89.2	96.0
Construction of Facilities (CoF) - (Non-Programmatic)	**27.8**	**20.5**	**21.2**
Total...	**277.7**	**288.4**	**317.9**
Total Direct and Indirect Civil Servant Full-Time Equivalent (FTE) Work Years	**1,913**	**1,747**	**1,848**

PROGRAM GOALS

The two primary goals of this budget segment are to:

1. Acquire and maintain a civil service workforce that reflect the cultural diversity of the Nation and, along with the infrastructure, is sized and skilled consistent with accomplishing NASA's research, development, and operational missions with innovation, excellence, and efficiency for the ESE.

2. Ensure that the facilities critical to achieving the ESE are constructed and continue to function effectively, efficiently, and safely, and that NASA installations conform to requirements and initiatives for the protection of the environment and human health.

RESEARCH AND PROGRAM MANAGEMENT (R&PM)

Program provides the salaries, other personnel and related costs, travel and the necessary support for all administrative functions and other basic services in support of research and development activities at NASA installations. The salaries, benefits, and supporting costs of this workforce comprise approximately 66% of the requested funding. Administrative and other support is approximately 32% of the requests. The remaining 2% of the request are required to fund travel necessary to manage NASA and its programs.

The FY 2002 funding estimate for ROS includes $4.5M provided in the Emergency Supplemental to enhance NASA's security counterintelligence and counter-terrorism capabilities. The FY 2003 funding estimate is $2.3M.

CONSTRUCTION OF FACILITIES (CoF)

Budget line item provides for discrete projects required for components of the basic infrastructure and institutional facilities and almost all are for capital repair. NASA facilities are critical for the ESE, to sustaining the future of aeronautics and advanced space transportation, which both support military and private industry users. NASA has conducted a thorough review of its facilities infrastructure, finding that the deteriorating plant condition warrants the need for a steady repair and renovation rate to avoid safety hazards to personnel, facilities, and mission, and that some dilapidated facilities need to be replaced.

ROLES AND MISSIONS

The detail provided here is for the support of the ESE institutions - Marshall Space Flight Center, Stennis Space Center, Ames Research Center, Dryden Flight Research Center, Langley Research Center, Goddard Space Flight Center, and NASA Headquarters. The Jet Propulsion Laboratory (JPL) is a Federally Funded Research and Development Center; therefore, the JPL employees are not civil servants, and their personnel and related costs are included in direct program costs.

MARSHALL SPACE FLIGHT CENTER (MSFC)

The ESE funds approximately 2% of MSFC’s Institution cost. Through the Global Hydrology and Climate Center (GHCC), a joint venture with academia, MSFC engages in research, education, and the development of Earth science applications. The GHCC focuses on using advanced technology to observe and understand the global climate system and applies this knowledge to agriculture, urban planning, water resource management, and operational meteorology.

STENNIS SPACE CENTER (SSC)

The ESE funds approximately 35% of SSC’s Institution cost. Through the Applications Program, SSC will enhance U.S. economic competitiveness via commercial partnership programs that apply remote sensing technologies in business applications and reduce new product development costs. As part of the Applied Research and Data Analysis program, SSC will conduct fundamental and applied research, which increases our understanding of environmental systems sciences, with emphasis on coastal research of both land and oceans.

AMES RESEARCH CENTER (ARC)

The ESE funds approximately 6% of ARC's Institution cost. ARC builds instruments and computer models for measurement and analysis of atmospheric constituents and properties from aircraft platform are being developed. Applied research and developments to enhance the use of remote and in-situ sensing technology for Earth resources applications continues. ARC provides information systems and high end computing support for Earth Sciences knowledge acquisition.

DRYDEN FLIGHT RESEARCH CENTER (DFRC)

The ESE funds approximately 7% of DFRC's Institution cost. DFRC conducts flight operations in support of Airborne Science Missions utilizing aircraft for data collection and observation.

LANGLEY RESEARCH CENTER (LaRC)

The ESE funds approximately 14% of LaRC's Institution cost. LaRC performs an agency-designated Atmospheric Science mission role in support of the ESE in the NASA Strategic Plan. As Lead Center for Focused Atmospheric Science Missions, LaRC conducts a world-class peer reviewed and selected atmospheric science program in support of national goals in preserving the environment and in fundamental science. Specific LaRC discipline areas of expertise are Earth radiation research, particularly the role of clouds in the Earth's energy budget; middle and upper atmospheric research; and tropospheric research. LaRC performs innovative scientific research to advance the knowledge of atmospheric radioactive, chemical, and dynamic processes for understanding global change; develops innovative passive and active sensor systems concepts for atmospheric science measurements. LaRC conducts a technology development program that develops advanced laser and LIDAR technologies for Earth science missions; advanced passive remote sensing technologies; develops advanced ultra-lightweight and adaptive materials, structural systems technologies and analytical tools for significantly reducing the end-to-end cost and increasing the performance of earth observation space instruments and systems. LaRC conducts an Application, Education and Outreach program that utilizes scientific data for non-scientific applications and in support of science and math education. LaRC also serves as a Primary Data Analysis and Archival Center (DAAC) for Earth Radiation and Atmospheric Chemistry for the Earth Observing System.

GODDARD SPACE FLIGHT CENTER (GSFC)

The ESE funds approximately 38% of GSFC's Institution cost. GSFC is the Lead Center for Earth Science. This process and modeling research effort will provide the basis for establishing predictive global change models for policy makers and scientists.

GSFC manages the Earth Explorers Program and conducts science correlation measurements from balloons, sounding rockets, aircraft and ground installations. It also manages, on a reimbursable basis, the acquisition of meteorological observing spacecraft for the National Oceanic and Atmospheric Administration (NOAA).

Lead Center for the Independent Verification & Validation (IV&V) Facility in Fairmont, West Virginia. The IV&V Facility is responsible for providing independent assessments of project software and for the management of all software IV&V efforts within the Agency.

JET PROPULSIN LABORATORY (JPL)

The ESE funds approximately 14% of JPL's Institutional cost. The JPL funding requirements include the Emergency Supplemental to enhance NASA's security counterintelligence and counter-terrorism capabilities, the environmental cleanup effort, and the CoF activities.

NASA HEADQUARTERS (NASA HQ)

The ESE funds approximately 20% of NASA HQ's Institution cost. The mission of NASA HQ is to plan and provide executive direction for the implementation of U.S. space exploration, space science, Earth science, aeronautics, and technology programs. This includes corporate policy development, program formulation, resource allocations, program performance assessment, long-term institutional investments, and external advocacy for all of NASA.

At NASA HQ, the broad framework for program formulation will be conducted through ESE. Consistent with the NASA strategic plan, the ESE develops program goals and objectives to meet the needs of external customers within the policy priorities of the Administration and Congress.

SCIENCE AERONAUTICS & TECHNOLOGY
FY 2003 ESTIMATES BUDGET SUMMARY
OFFICE OF AEROSPACE TECHNOLOGY
SUMMARY OF RESOURCE REQUIREMENTS

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET	Page Number
		(Millions of Dollars)		
Revolutionize Aviation	**572.5**	**599.4**	**541.4**	
Aviation Safety Program	75.8	96.1	95.0	SAT 4-14
Vehicle Systems Program	370.8	369.4	321.3	SAT 4.22
Airspace Systems Program	125.9	133.9	125.1	SAT 4-40
Advanced Space Transportation	**391.2**	**578.0**	**879.4**	
2nd Generation Reusable Launch Vehicle Program (SLI)	289.4	467.0	759.2	SAT 4-52
Space Transportation & Launch Technology (STLT)	101.8	111.0	120.2	SAT 4-61
Pioneer Revolutionary Technology	**278.0**	**276.7**	**274.9**	
Computing, Information, & Communications Technology (CICT)	165.6	155.9	154.0	SAT 4-67
Engineering for Complex Systems	--	28.0	28.0	SAT 4-77
Enabling Concepts & Technologies	112.4	92.8	92.9	SAT 4-83
Commercial Technology	**162.4**	**163.8**	**146.9**	
Commercial Programs and Technology Transfer Agents	51.3	48.7	35.6	SAT 4-89
Small Business Innovation Research Programs	111.1	115.1	111.3	SAT 4-92
Investments	**[18.0]**	**[29.5]**	**[14.0]**	
[Construction of Facilities - included above]	[18.0]	[29.5]	[14.0]	
Aerospace Institutional Support	**808.7**	**889.8**	**973.2**	SAT 4-93
Total	**2,212.8**	**2,507.7**	**2,815.8**	

OFFICE OF AEROSPACE TECHNOLOGY

DISTRIBUTION OF PROGRAM AMOUNT BY INSTALLATION
($Millions)

	FY 2001*	FY 2002	FY 2003
		(Millions of Dollars)	
Johnson Space Center	28.2	29.2	26.7
Kennedy Space Center	22.9	33.5	33.7
Marshall Space Flight Center	331.3	466.4	794.1
Ames Research Center	435.2	474.4	429.7
Langley Research Center	464.1	539.7	545.2
Glenn Research Center	438.3	459.2	479.1
Goddard Space Flight Center	85.1	89.3	73.7
Jet Propulsion Laboratory	42.2	34.3	37.6
Dryden Flight Research Center	155.0	150.3	160.8
Stennis Space Center	76.5	49.9	38.4
Headquarters	134.0	181.5	196.8
Total	**2,212.8**	**2,507.7**	**2,815.8**

* FY 2001 restructured to reflect new FY 2002 Two Appropriation Structure

Aerospace Technology Direct Full-Time Equivalent (FTE) Workyears	**4581**	**4495**	**4618**

2000 STRATEGIC PLAN LINKAGE TO THIS BUDGET

The Aerospace Technology Enterprise mission is to advance U. S. preeminence in aerospace research and technology. The Enterprise aims to radically improve air travel, making it safer, faster, and quieter as well as more affordable, accessible, and environmentally sound. The Enterprise is also working to develop more affordable, reliable, and safe access to space; improve the way in which air and space vehicles are designed and built; and ensure new aerospace technologies are available to benefit the public.

The Aerospace Technology Enterprise program work breakdown structure (WBS) has been reorganized to create a clear linkage between National policies, the Enterprise strategic goals and the program management structure. This restructuring creates an unambiguous linkage from the Agency strategic plan to this budget and provides a foundation for transparent, measurable performance reporting through the Government Performance and Results Act. This change also ensures that the Agency fulfills the intent of the language in House Report (107-272) accompanying H.R. 2620, "Departments of Veterans Affairs and Housing and Urban Development, and Independent Agencies Appropriations Act, 2002" whereby:

The conferees agree with the House that by merging the budgets for aeronautics and space into a single 'aerospace technology' program element several years ago, NASA has made it virtually impossible to account for the current investment in aeronautics. For this reason, the conferees direct NASA to reestablish a consolidated aeronautics line in the fiscal year 2003 budget submission that comprehensively covers all research base, focused, and advanced technology programs, and related test facilities and civil service costs. NASA should also provide a clear budget crosscut identifying all aeronautics programmatic activities in the current budget structure in its initial fiscal year 2002 operating plan.

The Enterprise approach for implementing the program begins with investment decisions based on rigorous systems analysis. By integrating and consolidating long- and mid-term technology development with customer needs, the Enterprise will develop a stronger, clearer linkage between basic research and advanced development. Independent programmatic and expert reviews will provide supplemental information that will be incorporated in management decisions. Annual program reviews will be used to measure progress (technical, schedule and cost) against requirements and deliverables, and outside expert technical reviews will assure the quality of the products, research performers, and future directions to meet strategic goals. The Enterprise will strengthen National government and industry partnerships with clear roles with investments balanced across in-house efforts, industry and academia. Investments at the NASA Centers will concentrate on critical core competencies that can enable new capabilities and missions and that cannot be developed or performed elsewhere.

A trace from the program structured presented in the FY 2002 request to the proposed structure is detailed in the 4 following pages. Additionally, while the program names have changed to be consistent with the new structure, only in a few cases have the programs been reformulated to increase investment in "leap-frog" technologies (primarily Vehicle Systems program under Revolutionize Aviation and Enabling Concepts and Technologies under Pioneer Revolutionary Technology). The FY 2003 request is largely consistent with the planned out years of the FY 2002 request.

Changes to Aerospace Technology Program Structure

FY 02 Structure

Aerospace Focused R&T Programs

« Aviation Safety
« Aviation System Capacity
  D Advanced Air Transportation Technology
  D Virtual Air Space Modeling
« Small Aircraft Transportation System
« Ultra-Efficient Engine Technology
« Quiet Aircraft Technology
« 2nd Generation RLV

Aerospace Base R&T Programs

« Vehicle Systems Technology
« Propulsion & Power
« Flight Research
« Space Transfer & Launch Tech
« Computing, Information & Communication Tech
  D Aerospace Operations Research
  D Information Technology Base
  D Autonomy *
  D Intelligent Systems (IS)
  D Design for Safety
« Space Base
« Space NRAs

FY 03 Structure

Revolutionize Aviation Programs

« Aviation Safety
« Airspace Systems
  D Advanced Air Transportation Technology
  D Virtual Air Space Modeling
  D Small Aircraft Transportation System
  D Aerospace Operations Research
« Vehicle Systems
  D Ultra-Efficient Engine Technology
  D Quiet Aircraft Technology
  D 21st Century Aircraft
  D Breakthrough Technologies
  D Propulsion & Power
  D Flight Research
  D Advanced Concepts

Advance Space Transportation Programs

« 2nd Generation RLV
« Space Transfer & Launch Technology

Pioneer Revolutionary Technology Programs

« Computing, Information & Communication Tech
  D Information Technology Strategic Research
  D Computing, Network & Information Systems
  D Space Communications
  D Intelligent Systems (IS)
« Engineering for Complex Systems
« Enabling Concepts & Technologies

Changes to Aerospace Technology Program Structure

Trace from FY 2001 President's Budget to New FY 2003 Budget Structure

Aerospace Technology Budget Structure Crosswalk		FY 2003 Budget Structure								
FY 2001 Budget (Millions of Dollars)		Revolutionaize Aviation			Advanced Space Transportation		Pioneer Revolutionary Technology			Commercial Technology
FY 2002 Budget Structure	FY 2001 Initial Op Plan	Aviation Safety	Vehicle Systems	Airspace Systems	2nd Generation RLV	Space Transfer & Launch Tech	CICT	Engineering for Complex Systems	Enabling Concepts & Technologies	Commercial Technology Programs
Aerospace Technology Summary	**1,404.1**	**75.8**	**370.8**	**125.9**	**289.4**	**101.8**	**165.6**	**0.0**	**112.4**	**162.4**
Research and Technology Base	**714.1**									
Computing, Information & Communications Technology (CICT)	158.2		10.5	16.9			130.6		0.2	
Vehicle System Technology *Base*	184.2		134.3			11.4			38.5	
Propulsion & Power	129.1	4.9	63.7			22.1	12.9		25.5	
Flight Research	83.3		83.3							
Rotorcraft	31.6			31.6						
Space Transfer & Launch Technology	76.6					68.3			8.3	
Aerospace Base NASA Research Announcements	39.9								39.9	
Aerospace Investments	11.2		11.2							
Focused Programs	**527.6**									
High Performance Computing & Communications	22.1						22.1			
Aviation Systems Capacity	68.4			68.4						
Aviation Safety	70.9	70.9								
Ultra-Efficient Engine Technology (UEET)	47.9		47.9							
Small Air Transport System (SATS)	9.0			9.0						
Quiet Airplane Technology (QAT)	19.9		19.9							
X-34 Technology Demonstrator	17.9				17.9					
2nd Generation RLV	271.5				271.5					
Commercial Technology Programs	**162.4**									162.4

Changes to Aerospace Technology Program Structure

Trace from FY 2002 President's Budget to New FY 2003 Budget Structure

Aerospace Technology Budget Structure Crosswalk		**FY 2003 Budget Structure**								
FY 2002 Budget (Millions of Dollars)		**Revolutionaize Aviation**			**Advanced Space Transportation**		**Pioneer Revolutionary Technology**			**Commercial Technology**
FY 2002 Budget Structure	FY 2002 Initial Op Plan	Aviation Safety	Vehicle Systems	Airspace Systems	2nd Generation RLV	Space Transfer & Launch Tech	CICT	Engineering for Complex Systems	Enabling Concepts & Technologies	Commercial Technology Programs
Aerospace Technology Summary	**1,617.9**	**96.1**	**369.4**	**133.9**	**467.0**	**111.0**	**155.9**	**28.0**	**92.8**	**163.8**
Research and Technology Base	**721.2**									
Computing, Information & Communications Technology (CICT)	206.4	4.0	6.0	11.5		5.0	151.9	28.0		
Vehicle System Technology *Base*	207.5		154.5			20.5			32.5	
Propulsion & Power	126.1	6.1	79.8			21.7	4.0		14.5	
Flight Research	59.1		59.1							
Rotorcraft	12.5			12.5						
Space Transfer & Launch Technology	69.6					63.8			5.8	
Aerospace Base NASA Research Announcements	40.0								40.0	
Aerospace Investments	0.0									
Focused Programs	**732.9**									
High Performance Computing & Communications	0.0									
Aviation Systems Capacity	94.4			94.4						
Aviation Safety	86.0	86.0								
Ultra-Efficient Engine Technology (UEET)	50.0		50.0							
Small Air Transport System (SATS)	15.5			15.5						
Quiet Airplane Technology (QAT)	20.0		20.0							
X-34 Technology Demonstrator	0.0									
2nd Generation RLV	467.0				467.0					
Commercial Technology Programs	**163.8**									163.8

Changes to Aerospace Technology Program Structure

Trace from FY 2003 Budget Request to New FY 2003 Budget Structure

Aerospace Technology Budget Structure Crosswalk		**FY 2003 Budget Structure**									
FY 2003 Budget (Millions of Dollars)		**Revolutionaize Aviation**			**Advanced Space Transportation**		**Pioneer Revolutionary Technology**			**Commercial Technology**
FY 2002 Budget Structure	FY 2003 PRES BUDGET	Aviation Safety	Vehicle Systems	Airspace Systems	2nd Generation RLV	Space Transfer & Launch Tech	CICT	Engineering for Complex Systems	Enabling Concepts & Technologies	Commercial Technology Programs
Aerospace Technology Summary	**1,842.6**	**95.0**	**321.3**	**125.1**	**759.2**	**120.2**	**154.0**	**28.0**	**92.9**	**146.9**
Research and Technology Base	**666.9**									
Computing, Information & Communications Technology (CICT)	202.4	4.0	9.9	10.5			150.0	28.0		
Vehicle System Technology *Base*	156.9		125.6						31.3	
Propulsion & Power	74.9	6.0	50.2				4.0		14.7	
Flight Research	65.6		65.6							
Rotorcraft	0.0									
Space Transfer & Launch Technology	127.1					120.2			6.9	
Aerospace Base NASA Research Announcements	40.0								40.0	
Aerospace Investments	0.0									
Focused Programs	**1,028.8**									
High Performance Computing & Communications	0.0									
Aviation Systems Capacity	94.6			94.6						
Aviation Safety	85.0	85.0								
Ultra-Efficient Engine Technology (UEET)	50.0		50.0							
Small Air Transport System (SATS)	20.0			20.0						
X-34 Technology Demonstrator	0.0									
Quiet Airplane Technology (QAT)	20.0		20.0							
2nd Generation RLV	759.2				759.2					
Commercial Technology Programs	**146.9**									146.9

__Enterprise Goals__	__Objectives__	**Strategy**	**Enabling Program / Mission**
Revolutionize Aviation	**Increase Safety -** Reduce the aircraft accident rate by a factor of 5 by 2007 and by a factor of 10 by 2022	**System Monitoring and Modeling -** Develop technologies for using the vast amounts of data available within the aviation system to identify, understand, and correct aviation system problems before they lead to accidents. **Accident Prevention -** Identify interventions and develop technologies to eliminate the types of accidents that can be categorized as "recurring." **Accident Mitigation -** Develop technologies to reduce the risk of injury in the unlikely event of an accident.	**Aviation Safety Program** **Vehicle Systems Program**
	Reduce Emissions - Reduce oxides of nitrogen (NOx) emissions of future aircraft by 70% by 2007 and by 80% by 2022 (Baseline: 1996 ICAO Standard). Reduce carbon dioxide (CO_2) emissions of future aircraft by 25% by 2007 and by 50% by 2022	**Airframe Weight and Drag Reduction -** Develop airframe technologies that reduce fuel consumption and therefore reduce CO_2 and NO_x emissions. **Propulsion Optimization -** Develop advanced engine system technologies to reduce emissions such as NO_x that have an impact on local air quality and those such as CO_2 that affect the global climate. **Operation Optimization -** Develop more efficient operations at and around airports, in order to reduce aviation fuel burn and thereby reduce emissions. **Alternative Vehicle Concepts -** Develop advanced concepts for propulsion systems, airframe structures, and fuels that dramatically reduce or completely eliminate emissions from civil aviation aircraft.	**Vehicle Systems Program**
	Reduce Noise - Confine noise within the airport boundary by reducing the perceived noise of future aircraft by a factor of two (10 decibels) by 2007 and by a factor of four (20 decibels) by 2022 using 1997 subsonic aircraft technology as the baseline	**Propulsion System Source Noise Reduction -** Develop technologies to reduce engine noise at the source. **Aircraft System Source Noise Reduction -** Develop technologies to diminish airframe-related noise. **Operational Noise Reduction -** Develop advanced aircraft operating procedures, including steeper glide-slopes and precision, wind-compensated flight paths.	**Vehicle Systems Program**

Enterprise Goals	Objectives	Strategy	Enabling Program / Mission
	Increase Capacity - Double the capacity of the aviation system within 10 years and triple within 25 years based on 1997 level	**Infrastructure and Operation Optimization -** Optimize use of the current infrastructure without adding new airports or new runways by developing Air Traffic Management (ATM) technologies that increase the efficiency and capacity of the NAS. **Alternative Vehicle Concepts -** Develop new civil aviation vehicle concepts that are designed to use segments of the NAS not suited for traditional commercial aircraft, such as short runways and vertical take-off and landing pads. **Alternative Infrastructure Concepts -** Develop entirely new concepts and systems, such as fully automated towers and airports that would increase the use and capacity of the Nation's 5000 public-use airports.	**Airspace Systems Program** **Vehicle Systems Program**
	Increase Mobility - Reduce the time for inter-city door-to-door transportation by half by 2007 and by two-thirds by 2022, and reduce long-haul transcontinental travel time by half by 2022	**Small Aircraft Transportation -** This thrust will focus on developing vehicle, communication, and information technologies to allow small aircraft to operate easily and affordably at small, underused airports in most weather conditions. **Supersonic Transportation -** Develop technologies critical to the economic viability of supersonic transport, such as propulsion concepts that meet stringent noise and emissions criteria. **Advanced Mobility Concepts and Technology -** Investigate non-traditional vehicles and operations concepts to take advantage of operational airspace that is currently underused.	**Airspace Systems Program** **Vehicle Systems Program**

<u>Enterprise Goals</u>	**<u>Objectives</u>**	**Strategy**	**Enabling Program / Mission**
Advance Space Transportation	**Mission Safety** - Reduce the incidence of crew loss for a second generation Reusable Launch Vehicle (RLV) to 1 in 10,000 missions (a factor of 40) by 2010 and to less than 1 in 1 million missions (an additional factor of 100) for a third generation RLV by 2025	**Reusable and Robust Propulsion Systems** - Develop technologies for inherent reliability, more robust subsystems, and an increased performance margin for propulsion and power systems. **Integrated Vehicle Health Management (IVHM)** - Develop advanced sensors and algorithms to integrate intelligence, such as real-time failure detection and isolation, into vehicle systems. **Crew Escape** - Develop systems to remove the crew safely from a vehicle in the event of catastrophic failure during the highest risk phases of a mission, including vehicle ascent and descent.	**2nd Generation Reusable Launch Vehicle Program** **Space Transfer and Launch Technology Program**
	Mission Affordability - Reduce the cost of delivering a payload to Low-Earth Orbit (LEO) to $1,000 per pound (a factor of 10) by 2010 and to $100 per pound (an additional factor of 10) by 2025. Reduce the cost of inter-orbital transfer by a factor of 10 within 15 years and by an additional factor of 10 by 2025	**Reusable and Robust Propulsion Systems** - Develop long-life, highly reusable engine systems and inherently reliable integrated propulsion systems. **Low-Cost, Lightweight Materials and Structures** - Reduce the overall system weight of vehicles using lightweight, long-life primary structures and low-cost metallic and non-metallic propellant tanks. **Operations Optimization** - Develop the capability for autonomous checkout and vehicle control, modular payload systems, and new launch site operations. **Risk Reduction** - Develop key technologies for full-scale development of a second-generation RLV system.	**2nd Generation Reusable Launch Vehicle Program** **Space Transfer and Launch Technology Program**

<u>Enterprise Goals</u>	<u>Objectives</u>	Strategy	Enabling Program / Mission
	Mission Reach - Reduce the time for planetary missions by a factor of 2 by 2015 and by a factor of 10 by 2025.	**Advanced Propulsion Concepts -** Identify and develop breakthrough technology for advanced propulsion systems. **Materials and Structures -** Develop lightweight airframes, tanks, and micro-components using nanotechnology and ultra-high temperature ceramics.	**Enabling Concepts & Technologies Program**
Pioneer Technology Innovation	**Engineering Innovation -** Within 10 years, demonstrate advanced full life-cycle design and simulation tools, process, and virtual environments in critical NASA engineering applications; and within 25 years, demonstrate an integrated, high-confidence engineering environment that fully simulates advanced aerospace systems, their environments, and their missions	**Process and Concept Innovation -** Develop new processes and concepts for accomplishing full-life-cycle ("cradle-to-grave") planning and design of new, revolutionary aerospace systems. **Validation and Implementation -** Develop technologies and concepts for new ways of certifying and fielding new aerospace systems. **Information Technologies -** Develop computational capabilities and knowledge bases necessary to design new aerospace systems. **Advanced Engineering and Analysis Technologies -** Develop design tools and the ability to model any part of a new vehicle design during any part of the system's lifespan and under all operating conditions and environments.	**Computing, Information, & Communica-tions Technology Program** **Engineering for Complex Systems Program**

Enterprise Goals	Objectives	Strategy	Enabling Program / Mission
	Technology Innovation - Within 10 year, integrate revolutionary technologies to explore fundamentally new aerospace system capabilities and missions; and within 25 years, demonstrate new aerospace capabilities and new mission concepts in flight	**Core Competencies -** Build and advance the critical technology competencies that have potential for major benefits to aerospace applications that cannot be found in government, academia, or industry today. **Enabling New Missions -** Develop technologies for missions that are currently unrealistic, from personal air transportation to interstellar travel. This thrust will remove barriers such as high technology costs, limits to human endurance, and immense mission timeframes, to open exciting new possibilities. **Enabling New Capabilities -** Develop capabilities that are not possible today, such as autonomy sufficient to conduct an entire mission without human intervention, or self-repair of a vehicle's skin.	**Computing, Information, & Communica-tions Technology Program** **Enabling Concepts & Technologies Program**

Enterprise Goals	**Objectives**	**Strategy**	**Enabling Program/ Mission**
Commercialize Technology	**Innovation-**NASA's CT Program supports the NASA R&D mission through partnerships with industry. It facilitates the transfer of NASA inventions, innovations, and discoveries developed by NASA personnel or in conjunction with its many partnerships to the private sector for potential commercial application. The SBIR program (inclusive of the Small Business Tech Transfer programs) helps NASA develop innovative technologies by providing competitive research contracts to U.S.-owned small businesses, and by fostering commercialization	**Industry Partnerships -** The establishment of productive technology development and application partnerships with industry. **Outreach -** An extensive outreach program (technology dissemination and marketing); An electronic commerce/information network (via the Internet) that greatly facilitates the transfer of technology and allows very efficient implementation of our technology business contacts and services; Training and education of NASA employees to emphasize program relevance to national needs and to facilitate program implementation; **Metrics -** The use of metrics that address management processes as well as bottom-line results.	**Commercial Programs** **Small Business SBIR/STTR Programs**

BASIS OF FY 2003 FUNDING REQUIREMENT

AVIATION SAFETY PROGRAM (AvSP)

Web Address: http://avsp.larc.nasa.gov/

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Aviation Safety Program	**75.8**	**96.1**	**95.0**
Vehicle Safety Technologies	43.0	58.0	49.8
Weather Safety Technologies	17.4	17.9	20.9
System Safety Technologies	15.4	20.2	24.3

DESCRIPTION/JUSTIFICATION

The worldwide commercial aviation major accident rate has been nearly constant over the past two decades. While the rate is very low (approximately one hull loss per two million departures), increasing traffic over the years has resulted in the absolute number of accidents also increasing. The worldwide demand for air travel is expected to increase even further over the coming two decades - more than doubling by 2017. Without an improvement in the accident rate, such increasing traffic volume would lead to 50 or more major accidents a year — a near weekly occurrence. Given the very visible, damaging, and tragic effects of even a single major accident, even approaching this number of accidents would have an unacceptable impact upon the public's confidence in the aviation system, and impede the anticipated growth of the commercial air-travel market. The safety of the general aviation (GA) system is also critically important. The current GA accident rate is many times greater than that of scheduled commercial transport operations. The GA market may grow significantly in future years. Safety considerations must be removed as a barrier if this growth is also to be realized. For commercial aircraft, Controlled-Flight Into Terrain (CFIT) and loss of control account for the largest number of accidents, with weather, approach and landing, and on-board fire as additional significant accident categories. For each of these categories, human error is most often cited as the prime-contributing factor.

In February 1997, to aggressively address these issues, a new national goal to reduce the fatal accident rate for aviation by 80% within 10 years was established. This national aviation safety goal is an ambitious and clear challenge to the aviation community. NASA responded to the challenge with an immediate major program planning effort to define where NASA research could contribute to meeting this goal. Four industry- and government-wide workshops were conducted in early 1997 to define research needs with four hundred persons from over one hundred industry, government, and academic organizations actively participating. This effort led to NASA's aviation safety initiative and a redirection of the Aeronautics Research and Technology Base in FY 1998 to immediately augment aviation safety research. The Aviation Safety Program (AvSP) is NASA's next step in responding to the challenge. Consistent with the national goals set in 1997, the goal of the AvSP is to develop and demonstrate technologies that contribute to a reduction in the aviation accident fatal rate by a factor of 5 by the year 2007 compared to the 1994-1996 average.

The NASA AvSP approach for contributing to the national goal is to develop and demonstrate technologies and strategies to improve aviation safety by reducing both aircraft accident and fatality rates. Program planning gives high priority to those strategies that address factors determined to be the largest contributors to fatal accidents as well as those that address multiple classes of factors. Research and technology development will address accidents involving hazardous weather, CFIT, human-error-caused accidents and incidents, and mechanical or software malfunctions. The safety program will emphasize not only accident rate reduction, but also a decrease in injuries and fatalities when accidents do occur. The program will develop and integrate information technologies needed for a safer aviation system. This effort will provide support to pilots and air traffic controllers, as well as providing information that will be used to assess and identify potentially unsafe situations and trends before they lead to accidents. The focus of each program project is the development of one or more prevention, intervention, or mitigation strategies aimed at one or more causal, contributory, or circumstantial factors associated with aviation accidents.

The AvSP will work as partners with the Federal Aviation Administration (FAA) in implementing the program and will maintain close coordination with the Department of Defense and other government agencies. Additionally, the program will work in concert with the full spectrum of commercial, rotorcraft, and GA industry manufacturers, suppliers, and operators in implementing the effort. Langley Research Center (LaRC) is the program's Lead Center and works as a team with program personnel at Ames Research Center (ARC), Glenn Research Center (GRC), Dryden Flight Research Center (DFRC), and Goddard Space Flight Center (GSFC).

The AvSP programmatic and technical approach has been developed in close cooperation with the FAA as well as the broad aviation community. The Aviation Safety Program Manager is a member of the Commercial Aviation Safety Team and the General Aviation Joint Steering Committee, the government/industry leadership groups developing and managing overall National aviation safety strategies. NASA aviation safety research and development efforts will therefore complement both FAA and industry activities as a coordinated effort.

NASA's Aerospace Technology Enterprise has set aside funding for continuing aviation safety improvements beyond the current AvSP timeline. These new efforts, reflected as a Future Aviation Safety Technologies project, are planned to begin in FY05 and will build on the success and foundation of AvSP. A decision point will be inserted prior to the start of these new efforts to determine the appropriate needs and content of these new efforts.

STRATEGIC OBJECTIVE:	**PROGRAM APPROACH:**
Increase Safety	Program is structured around developing technologies along three major thrusts: (1) Aviation system monitoring and modeling to help aircraft and aviation system operators identify unsafe conditions before they lead to accidents. (2) Accident prevention in targeted accident categories, including system-wide, single aircraft, and weather. (3) Accident mitigation, is focused on increasing accident survivability to reduce fatalities in those cases when accidents do occur

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Revolutionize Aviation
Strategic Plan Objectives Supported: Increase Safety
Performance Plan Metrics Supported: APG 3R1

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-03 Change	Comment
Simulation database for adverse conditions and loss of control		1/01	9/00	Complete	Completed development of preliminary simulation database, mathematical models, and 6-degree of freedom (DOF) vehicle simulations to characterize adverse conditions, failures, and loss-of-control Database & models validated in wind tunnel tests, Wind tunnel upgrade repair delayed test entry by 2 months.
Complete the development of flight crew knowledge and proficiency standards for automation	.	12/00	12/00	Complete	Documentation defining flight crew knowledge and proficiency standards for automation delivered to industry and academia.
Demonstrate in an operational environment, tools for merging heterogeneous databases to aid causal and risk assessment.	3/02	3/02	9/01		
Define an architecture for an integrated onboard health management system		9/01	9/01	Complete	A ground demonstration of the integrated onboard health management system concept, Aircraft Condition Analysis and Management Systems (ACAMS), was conducted in July 2001. In this demonstration intentional faults were injected into recorded flight data from the NASA B757 ARIES aircraft while running in real time simulation and processed through ACAMS. The ACAMS logic successfully identified the faults and provided an assessment of the impact on continued airworthiness prior to the conditions resulting in critical failure levels.
Evaluation of synthetic vision system (SVS) concepts in simulations and flight-tests		9/01	9/01	Complete	SVS display concepts, both in-house and industry-partner developed, intended for retrofit in commercial and business aircraft that were demonstrated in flight tests conducted in the terrain-challenged

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-03 Change	Comment
					environment of Eagle County Regional Airport, CO. during the period of August – September 2001
Identify concepts to reduce fuel system flammability		9/01	9/01	Complete	Three technical approaches were identified that offer promise of increasing the flash point temperature and thus decreasing the flammability of present day civil jet fuel while maintaining practicality and cost-effectiveness.
Complete the design criteria for low false-alarm fire detection systems		9/01	9/01	Complete	Validation of low false alarm fire detection design concepts was accomplished through testing and analytical modeling of cargo compartment fire signatures. Monitoring for non-smoke components of fire signatures, such as the build-up of CO and CO_2 gases, was shown to give the capability to reliably screen out false alarms.
Safety improvement concepts developed		9/01	9/01	Complete	The Aviation Safety Program has made significant technical progress and completed conceptual designs for its planned safety-improvement systems. This includes evaluation and documentation of a runway incursion prevention system concept, definition and documentation of weather information concepts for both GA and commercial operators, development and wide\ distribution of a cockpit automation textbook and a dual-volume icing hazards CD-ROM for pilot training, definition and baselined an architecture for onboard health management system, validated and documented a low false-alarm fire detection system concept, designed and applied performance monitoring concepts to Air Traffic Control system and documented user feedback.
Flight demonstration of forward-looking warning system	09/2002	06/2002	06/2002	+3 months	AvSP addressed skill and workforce shortages through a replanning activity that resulting in balancing of available resources
Demonstration of flight critical system validation methods	03/2003	06/2002	06/2002	+9 months	Delay in systems development due to contract negotiations
Computational models of present and future contexts	02/2003	06/2002	06/2002	+8 months	Complexity of the modeling work has caused the milestone to slip into FY 2003

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-03 Change	Comment
Interim integrated program assessment	06/2002	06/2002	06/2002		Internal assessment of programs toward goal achievement will be used to guide future investment decisions
National Aviation Operation Monitoring System (NAOMS) adds the general aviation (GA) pilot community to the survey system	06/2002	09/2002	09/2002	-3 months	Projected to complete early due to closer than expected cooperation from GA community
Demonstrate national capability for graphical display of weather information	09/2001	09/2002	09/2002	Complete	Near-term technology graphical weather displays for Transport and General Aviation (GA) aircraft were developed and demonstrated in flight under NASA Cooperative Research Agreements (CRA). Flight demonstrations included the following: United Airlines evaluated the Honeywell Weather Information Network transport system. Benefits demonstrated included turbulence mitigation. The Rockwell Enhanced Weather Radar system was evaluated on the NASA 757 research airplane, demonstrating the display of uplinked weather data combined with on-board radar data on a graphical weather information system. The display of weather products in a GA cockpit was demonstrated on a Cessna 180 using their Weather Hazard Information System developed under CRA. The impact of graphical weather on GA pilot decision-making was evaluated on the NASA B200 King Air research airplane using a tethered display developed by Honeywell under a separate CRA. Overall, collaboration between NASA and Industry through CRA's resulted in the technology readiness level for graphical weather display technologies to reach the target of TRL-6 one year earlier than originally planned.
Analysis tools for structural Crashworthiness predication	08/2002	09/2002	09/2002	-1 month	Projected to complete early due to software coding improvements.

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-03 Change	Comment
Demonstrate loss of control and Recovery models in high-fidelity 6-DOF simulation environment	09/2002	09/2002	09/2002		
Provide new software certification procedures intended for FAA incorporation into DO-178C	02/2003		02/2003		
Simulations and Flight Test Evaluations of Safety-Improvement Systems within AvSP Complete	03/2003		03/2003		
Integrated Synthetic Vision Systems Display Concepts Initial Flight Evaluation	03/2003		03/2003		
Demonstrate capability of fast-time simulation for reliable prediction and assessment of system-wide risk	03/2003		03/2003		
Initial Evaluation of Next-Generation Cockpit Weather Information and Digital Datalink Technologies.	06/2003		06/2003		
Smart Icing System (IS) – Ice Management System Demonstration	06/2003		06/2003		

Program Lead Center: Langley Research Center	**Other Centers:** Glenn Research Center, Ames Research Center, Dryden flight Research Center, Goddard Space Flight Center	**Interdependencies:** FAA
Project	**Project Lead Center**	**Industry Contractor (Location)**
Vehicle Safety Technologies	Langley Research Center	Rockwell, BAE Systems, Research Triangle Institute, Jeppensen, AVROTEC, Lockheed Martin, ARINC, Honeywell, Delta Airlines
Weather Safety Technologies	Glenn Research Center	Honeywell, Rockwell, ARNAV, NCAR, FAA
System Safety Technologies	Ames Research Center	San Jose State University, New York University, Raytheon, Boeing, University of Idaho, Battelle Memorial

		Institute,
Program Product	**Builder (Location)**	**Product Benefit**
Aviation Weather Information System	Multi-contractor effort	Demonstrate and deliver at least 2 operational graphical weather products available via VHF broadcast over CONUS at 5000 ft or greater altitude, projected to reduce fatal weather-induced accidents by 25% (GA – 50%)
Turbulence Predication and Warning System	Multi-contractor effort	Demonstrate and deliver certifiable detection products providing at least 30 seconds advanced warning of severe turbulence, projected to reduce turbulence injuries by 25%
Synthetic Vision Display System	Multi-contractor effort	Demonstrate and deliver certifiable synthetic vision technologies with wire-frame displays and terrain resolution of 100m for enroute operations, projected to reduce commercial Controlled Flight Into Terrain fatal accidents by 50%
Precision Approach and Landing and Display System	Multi-contractor effort	Demonstrate and deliver certifiable precision approach and landing technologies highlighting the selected runway and ground-identified potential conflicts, projected to reduce the number of runway incursion fatal accidents by 50%.
Human Error Assessment Methodologies	Multi-contractor effort	Demonstrate improved training modules, maintenance procedures, and system design assessment methodologies, projected to reduce citing of human error as a causal factor in commercial aviation accident reports by 5% (
Health and Usage Monitoring Technologies	Multi-contractor effort	Demonstrate and deliver certifiable Health and Usage Monitoring technologies for commercial transport aircraft, projected to reduce failed equipment-citings in fatal accident reports by 5%
Advanced structural and material designs	Multi-contractor effort	Demonstrate and deliver advanced structures, materials, and system designs, projected to improve crash survivability and fire hazard mitigation in fatal accidents by 10%

Integrated Aviation System monitoring tools and Infrastructure design	Multi-contractor effort	System tools operational with at least two major air carriers and at least one corporate air service provider by 2004 This will provide the companies with an advance warning of potential safety problems and adverse trends and suggest corrective actions.

PROGRAM STATUS/PLANS THROUGH 2002

The program is successfully demonstrating component technologies that will lead to system demonstrations as well as downselects to the "best" concepts. In FY01 the program developed safety-improvement concept designs for all projects within the program. The following research and technology efforts were completed: evaluated and documented runway incursion prevention system concepts; defined and documented weather information concepts for both general aviation and commercial operators; developed and widely distributed a cockpit automation textbook and a dual-volume icing hazards CD-ROM for pilot training (distribution for both products included flight schools and major air carriers); defined and baseline architecture for onboard health management system; validated and documented low false-alarm fire detection system concepts; and designed and applied performance monitoring concepts to the Air Traffic Control system.

In FY 2002 the program will conduct an interim integrated program assessment in which the program will be reassessed against technical risk, safety benefit, implementation schedule, cost and return-on-investment (ROI), and a projection will be made as to the impact upon the reduction of the fatal accident rate. The following research and technology efforts will be completed in FY 2002: develop simulation models and subsystem concepts for loss-of-control prevention and recovery in a simulation environment; flight demonstration of a forward-looking onboard turbulence warning system that results in an advance warning of 30 seconds or better, for a significant portion of hazardous turbulence; demonstrate, in an operational environment, tools for merging heterogeneous databases to aid causal analysis and risk assessment; add general aviation pilot community to the National Aviation System Operational Monitoring Service (NAOMS) survey system; perform initial verifications, through analytical modeling and limited impact testing of aircraft components, of occupant crash load estimation methods for use by the FAA and industry.

PROGRAM PLANS FOR FY 2003

NASA will work with, and rely on, industry and FAA partners to Demonstrate or evaluate eight safety-improvement systems including: flight evaluation by airline and test pilot of synthetic vision system (SVS) products integrated with precision approach and landing and display system concepts intended for commercial and business aircraft; initial flight evaluation of a next-generation cockpit weather information digital datalink and turbulence system for increasing situation awareness and decision making tools; demonstration of a smart icing management system for automatic management of ice protection systems; demonstration of a vehicle health management system lab; demonstration of disturbance recovery methods for flight critical systems; demonstration of an engine disk crack detection monitoring system in the relevant environment; demonstration of a fast-time simulation for reliable prediction of system-wide risk.

BASIS OF FY 2003 FUNDING REQUIREMENT

VEHICLE SYSTEMS PROGRAM

Web Address: http://www.aero-space.nasa.gov/programs/vs.htm

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Vehicle Systems Program	**370.8**	**369.4**	**321.3**
Quiet Aircraft Technology (QAT)	19.9	20.0	20.0
21st Century Aircraft Technology (TCAT)	6.7	29.0	29.0
Ultra-Efficient Engine Technology (UEET)	47.9	50.0	50.0
Propulsion & Power	79.7	92.4	66.8
Flight Research	59.8	52.5	58.9
Advanced Vehicle Concepts	61.2	42.3	34.7
Breakthrough Vehicle Technologies	84.4	83.2	61.9
Minority University Research and Education Program	11.2	--	--

DESCRIPTION/JUSTIFICATION

Over the last century, aviation has evolved to become an integral part of our economy, a cornerstone of our national defense, and an essential component of our way of life. Aviation generates more than $1 trillion of economic activity in the United States every year. Military aviation forms the backbone of the U.S. security strategy. All military services (Air Force, Navy, Army, and Marines) possess aviation capability, and nearly a third of the Defense Department's budget relates to aviation activities. Americans per capita use aviation more than any other country in the world. Today personal travel accounts for more than 50 percent of commercial air transportation, and the percentage of people who have flown increases at an average of 2 percent per year.

As the nation and the world become more dependent on moving goods and people faster and more efficiently by air, important and difficult challenges have emerged. Saturation of the civilian air transportation system is causing delays and disruptions in air service. Military challenges have become more complex. The fight against international terrorism has replaced the Cold War. As a result, our military strategy has shifted from the traditional "threat-based" defense planning of the past to a "capabilities-based" model in the future.

Advances in technology have paced aviation's evolution throughout its first century. Human ingenuity once the only bounds to growth in aviation, have produced a highly complex, integrated, and regulated aviation system. To move aviation ahead in the next century, we will need to capitalize on the convergence of a broad front of multidisciplinary advances in technology. Advances in information technologies are already enabling major changes in aviation. Aviation materials have improved dramatically over the last century; the coming revolution in nanotechnologies promises to accelerate that progress. Likewise, biological sciences are providing a new way to look at machines. Mimicking nature will enhance flight safety and result in more reliable air vehicles.

In FY 2001, the Aerospace Technology Enterprise developed a blueprint for aeronautics for the 21st century. The blueprint describes a vision of the revolutionary technology advances that could change aviation. It does so with the understanding that the combined efforts of NASA, the Departments of Defense (DoD) and Transportation (DoT), the FAA, academia and industry will be needed to realize the vision. The technology advances discussed will help solve today's impending crises and create a new level of performance and capability in aviation. They are targeted to produce:

- Advanced concepts for the Airspace System,
- Revolutionary vehicles with significantly greater performance,
- New paradigms for aviation security and safety, and
- Assured development of a capable engineering workforce for the future.

U. S. competitors are targeting aviation leadership as a stated strategic goal. Without careful planning and investment in new technologies, near- term gridlock, constrained mobility, unrealized economic growth, and the continued erosion of U. S. aviation leadership could result.

The Vehicle Systems Program is organized into seven program areas to develop new aircraft vehicle technologies in support of the aeronautics blueprint: Breakthrough Vehicle Technologies, Propulsion & Power, Flight Research, Ultra-Efficient Engine Technology, Quiet Aircraft Technology, 21st Century Aircraft Technology, and Advanced Vehicle Concepts.

Breakthrough Vehicle Technologies investigates and develops breakthrough technologies to maintain the superiority of U.S. aircraft, to ensure the long-term environmental compatibility of aircraft systems, and to improve their safety and efficiency. Deliverables are technologies for various vehicle components and sub-systems, such as new ultra-light weight materials; computational models and design tools; and smart sensors and actuator systems. Technology will be demonstrated in a laboratory environment to show the feasibility of a research approach and evaluation by independent peer review. Technology demonstration and peer evaluation are the foundation to manage the vehicle technology investment portfolio and determine whether a given technology warrants further maturation. These breakthrough technologies will feed other NASA aviation programs like Aviation Safety, Quiet Aircraft Technology, and 21st Century Aircraft Technology.

The objectives of **Propulsion & Power** are to investigate and develop breakthrough technologies to maintain the superiority of U.S. engines, to ensure the long-term environmental compatibility of engine systems, and to improve their safety and efficiency. Deliverables are technologies for various engine components and sub-systems, such as new combustor concepts, new materials for high temperature applications, or new engine concepts. Technology will be demonstrated in a laboratory environment to show the feasibility of a research approach- and evaluated by independent peer review. The technology demonstration and peer evaluation are the foundation to manage the propulsion technology investment portfolio and determine whether a given technology warrants further maturation. These technologies will feed other NASA aviation programs including Aviation Safety, Ultra Efficient Engine Technology, Quiet Aircraft Technology, and 21st Century Aircraft Technology.

The objectives of **Flight Research** are to safely conduct, enable, and improve NASA's atmospheric flight research capability. It promotes technology innovation, discovers new phenomena, and accelerates development of new aerospace concepts. Concept input to the project may come from the other Vehicle Systems program projects, industry, academia, or DoD. Technology is demonstrated to show the feasibility of a technology concept in a relevant (flight) environment.

The primary objective of **Ultra-Efficient Engine Technology** is to address two of the most critical aviation propulsion issues: performance-efficiency and reduced emissions. High performance, low emissions engine systems will lead to significant improvement in local air quality, minimum impact on ozone depletion, and an overall reduction in aviation impact on global climate change.

The goal of **Quiet Aircraft Technology** (QAT) is to develop technology that, when implemented, reduces the impact of aircraft noise to benefit airport neighbors, the aviation industry, and travelers. QAT will directly improve the quality of life of our citizens by reducing their exposure to aircraft noise, thereby eliminating constraints on the air transportation system.

Twenty First Century Aircraft Technology (TCAT) is a next step in reaching the long-term aspect of the Revolutionize Aviation Goal of enabling the development of an environmentally friendly global air transportation system with unquestionable and higher levels of safety that improves the Nation's mobility during the next century. The technologies developed in TCAT and the concepts enabled by these technologies will impact all of the objectives of the goal, particularly the emissions objective. The TCAT Project will utilize systems analysis to quantify potential project benefits and to guide future project investment decisions.

The goal of **Advanced Vehicle Concepts** (AVC) is to accelerate the development and maturation of advanced and innovative vehicle concepts and technologies using system level integration, ground demonstration and flight validation testing. Flight-testing of new vehicle concepts and technologies is required to validate system concepts in a relevant flight environment and accelerates technology insertion into commercial and military applications. The AVC approach is to execute a continuing series of cost effective, high-technical-risk flight demonstration and validation experiments, and research using modularized, subscale flight demonstrators. For example, the Hyper-X goal is, for the first time ever, to fly the X–43A supersonic combustion ramjet-powered aircraft at its Mach 7 and 10 test points to validate hypersonic design and analysis tools and ground facility capabilities. This will provide the Nation with a new high-speed propulsion system for space launch or military aviation applications. The demonstrations will use either subscale flight demonstrators (such as unpiloted, ground controlled vehicles), modifications to existing flight test aircraft, or all new aeronautical vehicles to achieve the AVC technology outcomes.

OBJECTIVE:	**PROGRAM APPROACH:**
Revolutionize Aviation □ Increase Safety □ Reduce Emissions □ Reduce Noise □ Expand Aviation Capacity □ Improve Mobility	The program integrates all aircraft vehicle technology efforts. It consists of a balance of mid- and far-term technology development activities. Three projects—Breakthrough Vehicle Technologies, Propulsion & Power and Flight Research—develop the fundamental technologies needed to enable new functionality in 21st century aircraft. Three projects—Ultra-Efficient Engine Technology, Quiet Aircraft Technology and 21st Century Aircraft Technology—focus on the maturation and integration of these

	technologies into subsystems and systems that can be developed with industry partners into high leverage products. The Advanced Vehicle Concepts project takes those vehicle and technology concepts which require flight testing through additional systems analysis, concept development and flight testing.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Revolutionize Aviation
Strategic Plan Objectives Supported: Increase Safety, Reduce Emissions, Reduce Noise, Expand Aviation Capacity, Improve Mobility
Performance Plan Metrics Supported: APG 3R1

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-03 Change	Comment
Vehicle Systems Program Develop a program roadmap of an integrated vehicle systems contribution to the 25-year revolutionize aviation goal.	10/02	N/A	10/02		
Based on demos and tests of emerging technologies (e.g., morphing, carbon nanotube fabrication), assess progress to ensure performance relevance against program objectives.	9/03		9/03		
Conduct an interim assessment of the potential noise and emissions reductions enabled by the mid-term airframe and engine technologies.	9/03		9/03		
Conduct a series of flight experiments to provide initial validation for rapid technology insertion into military and commercial aircraft.	9/03		9/03		
Evaluate combustor sector configurations for 70 percent reduction of oxides of nitrogen (NOx) during landing and take-off.	9/03		9/03		

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-03 Change	Comment
Demonstrate a prototype electric powered UAV capable of sustaining 14 hrs of operation above an altitude of 50,000 ft with a UAV that has growth potential for extreme duration of greater than 96 hours.	9/03		9/03		Fourteen hours is more than double that duration about 50,000 ft that has currently being achieved with electric aircraft. With the technology challenges still being resolved with the closed-cycle regenerative fuel cells, we have decided to go with primary hydrogen fuel cells for the flight test. This decision is in concert with the industry interests in UAV extreme duration technology. Further, the FY 2002 milestone, "*Complete development of laboratory (heavy weight) energy storage*" has demonstrated the initial 96-hour test.
Develop initial physics-based noise prediction models	9/03		9/03		
Breakthrough Vehicle Technologies					
Envelope expansion of Airframe Integrated, Dual-Mode Scramjet powered vehicle in flight at Mach 7.		6/01	12/00	Flight Failure	During its first flight, the launch vehicle for the X-43A hypersonic test vehicle experienced a failure, deviated from its flight path and was deliberately terminated. The planned follow-on flight program has been suspended pending the results of the Mishap Investigation Board, which are to be released in early CY 2002.
Complete systems analysis of STOL and ESTOL studies to understand the benefits of these vehicles to the small transportation system.			6/01	Deleted	Deleted in FY01 in favor of higher priority activities
Obtain wind-tunnel performance data of hingeless control surfaces on a full-span 30% geometric scale "smart" uninhabited combat air vehicle (UCAV) model		9/01	9/01	Complete	Test in TDT completed and objective achieved.
Demonstrate an airframe integrated, dual-mode scramjet powered vehicle in flight at Mach 10	TBD	6/02	9/01	TBD	The flight test date is to be determined until the Mishap Investigation Board releases its report in early CY 2002.
Real-time piloted simulation validation of the reconfiguration intelligence component of central nervous system		6/01	3/01	Complete	Validated the reconfiguration intelligence component via real-time simulation

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-03 Change	Comment
Protocols and Test Methods Needed For Accelerated Testing of Space Transportation		3/01	3/01	Complete	Initial protocols for accelerated test methods developed. Protocols provide guidelines for systematically establishing degradation mechanisms and damage modes associated with long-term exposure of polymeric composites to mechanical load, elevated temperature, moisture and oxygen
Demonstrate an Airframe Integrated, Dual-Mode Scramjet powered vehicle in flight at Mach 7.	TBD	12/01	6/01	TBD	The flight test date is to be determined until the Mishap Investigation Board releases its report in early CY 2002.
Identify approaches for fabrication of structures inspired by biology.		9/01	6/01	Complete	Successfully demonstrated free form fabrication that allows achievability of ultra-lightweight structural components.
Complete National Transonic Facility (NTF) testing of 777 baseline cruise wing configuration and NTF/computational fluid dynamic (CFD)/ flight assessment of cruise condition.		9/01	9/01	Complete	Data obtained for use in ground to flight scaling.
Validate developed noise reduction technology at large scale to reduce technical risk of future technology implementation.		9/01	9/01	Complete	Successfully validated large-scale noise reduction by 4098 static engine test, STAR 40 x 80 test, Falcon/Lear flight test, interior noise tone reduction flight test and laboratory assessment.
Complete integrated system flight and simulation testing of Advanced General Aviation Technology Experiment (AGATE) Highway in the Sky (HITS) operating capability, DIF system, and simplified flight controls.		9/01	9/01	Complete	Final closeout reports have been delivered. Plans for use of DIF underway in Small Aircraft Transportation System and AWIN.
Publish design guidelines, system standards, certification bases and methods to document lessons learned in the AGATE project.	12/01	9/01	9/01	+3 months	Final closeout reports received. Distribution and archival of reports on schedule for completion by 12/01.
First demonstration of flow control via oscillatory blowing with leading and trailing edge actuators to enable simplified high-lift systems for high aspect ratio wings.	3/02	3/02	3/02		
Capability developed & demonstrated for viscous, solution-adaptive system using high-fidelity modeling, generating an unstructured-grid CFD from a geometry model for a complex aerospace vehicle in 1 day.	6/02	6/02	6/02		

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-03 Change	Comment
Demonstrate the feasibility of fabricating carbon nanotubes in an aligned configuration	9/02	9/02	9/02		
Demonstrate adhesives for non-autoclave composite processing.	9/02	9/02	9/02		
Propulsion and Power					
Complete inlet test for pulse detonation engine Flight Research project		5/01	5/01	Deleted	Independent review team recommended no flight test at this time.
Downselect of ground-based remote sensor technologies for a prototype ground-based system to sense icing conditions.		6/01	6/01	Complete	Assessment resulted in the selection of a ground-based icing remote sensing system to be further developed.
Demonstrate viability of hot section foil bearing		8/01	8/01	Complete	Bearings tested through range of high-speed, sustained load, and elevated-temperature conditions.
Demonstrate the durability of cast Titanium-Aluminum (crack resistant blades) for Low-Pressure Turbine (LPT) applications		9/01	9/01	Complete	Six factors were evaluated. Cast g-TiAl LPT blades are expected to survive domestic object damage observed during normal engine operating conditions.
CD-ROM icing pilot training module	6/02	6/02	6/02		
Demonstrate reaction transfer molded polymer matrix composite with 550 °F use temperature.	9/03	9/02	9/02	+12 months	Milestone slip due to Enterprise-level adjustments in priority activities between Propulsion and Power and Advanced Space Transportation Programs.
Conduct spin and burst tests to evaluate the effect of dual microstructure heat treatment processing technology on disk life	9/02	9/02	9/02		Milestone wording was changed from FY2002 Narrative (“*Mature UltraSafe propulsion technologies transferred to Aviation Safety Project*”) to more clearly indicate specific advanced technology to be transferred to Aviation Safety Program.
Mature UltraSafe propulsion technologies transferred to Aviation Safety program	9/02	9/02	9/02		
Engine test a coated polymer matrix composite inlet guide vane	9/03	9/02	9/02	-12 months	Milestone moved forward due to anticipated benefits and potential collaborations with industry partner.
Assess hybrid fuel cell and liquid hydrogen fueled optimized turbofan concepts	9/02	9/02	9/02		Issue a report on conceptual application of LH2 propulsion concepts to subsonic transport aircraft, including propulsion system and airframe concepts characterizations complete with mission emission characterizations.

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-03 Change	Comment
Demonstrate concepts for reduction in gaseous, particulate, and aerosol emissions	9/02	9/02	9/02		Demonstrate revolutionary fuel injector concepts in flame tube tests. Concepts will utilize advanced technology, including ceramics, MEMS technology, and active control aimed at achieving 80% NOx reduction goal, and reducing particulate and aerosol emissions.
Downselect Pulse Detonation Engine-based propulsion concept(s) for system or critical sub-system experimental demonstration based on PDET conceptual design and component research activities	9/02	9/02	9/02		Milestone adjusted from FY2002 Narrative to more accurately account for technical challenges uncovered in early systems analyses and research phases of the project. Technology area remains high potential for revolutionary advances in propulsion.
Revolutionary aerospace propulsion concepts identified and preliminary performance assessed.	9/02	9/02	9/02		
Flight Research					
Demonstrate functionality of autonomous station keeping for a two aircraft formation.		3/01	3/01	Complete	The trailing aircraft maintained autonomous formation control in the lateral and vertical axes to within 5 feet of the commanded position.
Complete development of laboratory (heavy weight) energy storage	1/02	9/01	9/01	+4 months	Electrolyzer, fuel cells, and control system delivered. Integration and testing should be complete by end of January.
Demonstrate solar power remotely piloted aircraft flight to 100,000 feet		9/01	9/01	Complete	The Helios aircraft completed a record-breaking flight that established the altitude record for sustained level flight at 96,833 feet.
Complete development, validation, and flight-testing of a differential carrier-phase Global Positioning System receiver coupled with an Inertial Measurement Unit using a Kalman filter.	10/01	9/01	9/01	Complete	Maintained control performance to less than ±5 feet.
Demonstrate robust taxi capability with contingency planning for an autonomous vehicle (UCAV).	10/01	9/01	9/01	Complete	Demonstrated autonomous taxi control algorithms.
Demonstrate turbo-prop, remotely piloted aircraft capabilities that exceed the minimum Earth Science altitude and duration requirements.	9/02	9/02	9/02		

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-03 Change	Comment
Utilize DFRC's core flight research capabilities by using the specially configured F-15 B testbed aircraft to provide NASA, industry and academia with flight research opportunities. Complete at least 4 flight experiments on the F-15B. Experiments currently being considered for FY 2002 include the Propulsion Flight Test Fixture (PFTF), Airborne Schlieren Imaging, Supersonic Natural Laminar Flow II, an Axisymmetric Rocket Based Combined Cycle (RBBC) experiment, and a supersonic high-mass flow inlet.	9/02	9/02	9/02		
Twenty First Century Aircraft Technology					
Demonstrate a methodology for scaling laws to validate the Reynolds number for on-set of aerodynamic flow separation.	3/02	3/02	3/02		
Demonstrate the ability to dynamically alter the localized flow instabilities over advanced lifting surfaces with micro-adaptive flow control devices.	6/02	6/02	6/02		
Develop concepts for design and analyses of algorithms for control of colonies of fluidic flow control effectors.	6/02	6/02	6/02		
Develop concepts and analyses of advanced composites including nanotube reinforced polymers to characterize processing uncertainties on material properties	9/02	9/02	9/02		
Conduct electromagnetic impact assessment on critical flight control hardware through physics-based modeling of the electromagnetic field.	9/02	9/02	9/02		

Quiet Aircraft Technology					
Discovery and initial assessment of concepts to achieve 3 dBA airplane system noise reduction		9/01	9/01		Defined the technology baseline against which program progress will be measured by assessing the outcome of the previous Noise Reduction program. Deferred the initial assessment of new technology concepts to focus attention on the technology baseline and foundation for discoveries. The remaining portion of this milestone will subsumed in the effort to determine the technologies required to meet the 10 dBA noise reduction goal (FY 2002 milestone - 3/02)
Identify community noise impact reduction technology required to meet 10-year, 10 dBA Enterprise goal	3/02	3/02	3/02		
Ultra-Efficient Engine Technology					
Propulsion-Airframe Integration: Prediction of propulsion-airframe integration (PAI)		9/01	9/01	Complete	An advanced PAI concept, boundary layer ingestion nacelles integrated to the Blended Wing Body (BWB), will be fabricated as a wind tunnel model and tested in the NTF in FY 2003 to validate the design study at Mach 0.85 and near-flight Reynolds number.
Turbomachinery: Flow control concepts for advanced propulsion systems		9/01	9/01	Complete	Hardware to evaluate the concept selected for Low Pressure Turbine (LPT) flow control will be fabricated and rig tested. This test, which should occur in the FY 2004-2006 time period.
Integration and assessment: definition of advanced propulsion options		9/01	9/01	Complete	The study results and system concepts will be updated and modified as appropriate as baselines to be used to assess overall impact of the individual propulsion technologies.
Materials and Structures: High temperature turbomachinery disk alloy		9/01	9/01	Complete	This completed NASA's immediate efforts to develop and transition to industry a revolutionary turbomachinery disk material.
Integrated Component Technology Validation: Aspirating seal demonstration	3/02	3/02	3/02		
Integrated Component Technology Validation: Integrated component technology demonstrations plan	4/02	4/02	4/02		

Emissions Reduction: Initial low NOx combustor sector test	9/02	9/02	9/02		
Materials and Structures: Ceramic thermal barrier coating system	9/02	9/02	9/02		
Materials and Structures: Ceramics Metrics Composites complex part demonstrated in rig test		12/02	12/02	Deleted	This was deleted to enable the addition of revolutionary work such as the 3000°F CMC material system and the single crystal Nickel-based alloy computational tools development.
Advanced Vehicle Concepts					
Complete Blended Wing Body (BWB) Critical Design Review			6/01	Deleted	Deleted in favor of higher priority activities
IFCS (C-17) – Integration and demonstration of Intelligent Flight Control (IFC) into a C-17 simulation.	3/02	3/02	3/02		
IFCS (F-15) – Risk Reduction Flight Test	6/02	6/02	6/02		

Lead Center: Headquarters	**Other Centers:** Ames Research Center, Dryden Flight Research Center, Glenn Research Center, Langley Research Center	**Interdependencies:** FAA
Projects	**Lead Center**	**Major Contractors / Partners**
Breakthrough Vehicle Technologies	Langley Research Center	Luna Innovation, Blue Road Research, Lockheed Martin, Sciaky. General Electric, Northrup, Grumman, Boeing, Integral Wave Technology, Department of Defense (DoD), NIST, Oak Ridge National Labs, Sandia National Labs
Propulsion and Power	Glenn Research Center	Williams International, Allison Advanced Development Corp., General Electric Aircraft Engines, Pratt & Whitney, Boeing, United Technologies, Honeywell, Multiple universities, DoD
Flight Research	Dryden Flight Research Center	DoD
Ultra-Efficient Engine Technology	Glenn Research Center	Williams International, Allison Advanced Development Corp., General Electric Aircraft Engines, Pratt & Whitney, Boeing, Honeywell, Lockheed Martin, Georgia Tech, DoD
Quiet Aircraft Technology	Langley Research Center	Raytheon Aircraft Company, Rolls Royce, Pratt & Witney, Boeing, Delta Airlines, Honeywell, Cessna Aircraft. Lockheed Martin, FAA, DoD, DOT

Twenty-First Century Aircraft Technology	Langley Research Center	Boeing, Honeywell, Lightning Technologies Inc., Nielson Engineering, WILCO International, M-Dot Aerospace Gellman Research Associates, Los Alamos Labs, NCARR, DoD, FAA
Advanced Vehicle Concepts	Langley Research Center	Boeing, Lockheed Martin, Pratt & Whitney, Sikorsky, DoD, Australia Aeronautical and Maritime Research Lab.

Program Product	**Builder (Location)**	**Product Benefit**
In-depth scientific understanding of a set of emerging aircraft technologies	Multiple Contractors	Most promising emerging aircraft technologies identified for further maturation to support the Revolutionize Aviation objectives of increasing safety, reducing environmental impact, and increasing mobility.
Flight test new vehicle concepts.	Multiple Contractors	Validated performance of new aircraft technologies to accelerate insertion into, and hence their benefits in commercial and military applications.
Noise reduction technologies validated through subscale testing and simulations.	Multiple Contractors	Technologies ready for further maturation to reduce community noise impact by 5 dB by 2005 and investigate technologies and vehicle concepts for the next 10 dB reduction.
Emission reduction technologies validated in ground tests.	Multiple Contractors	Technologies transferred to industry to enable 70% reduction in NOx emissions and 25% reduction in CO_2 emissions.
Advanced vehicle and propulsion concepts and technologies demonstrated in laboratory environment.	Multiple Contractors	Technologies and concepts identified for further maturation and risk reduction to expand the future capability of the aviation system with safe, affordable and direct service to all of America's communities.

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

In FY 2001, the **Aerospace Vehicle System** Technology program successfully completed the large-scale validation of noise reduction technologies and the flight-testing of the general aviation system concepts, leading to a smaller noise-footprint at the airport. The completion of these tests concludes the noise reduction and general aviation projects that were begun as part of the Advanced Subsonic Technology Program. Identification of protocols and methodologies for accelerated testing of space transportation materials was completed. A key workshop was held in 2001 to assess the state of turbulence research and determine future research needs to accurately predict aerodynamic flow and noise generation. Also, tests were completed to provide a benchmark to the National Transonic Facility for ground-to-flight scaling on a cruise wing configuration of a transport aircraft. The annual OAT goals assessment was completed to understand progress toward Enterprise goals. Hingeless control surfaces were evaluated in wind tunnel testing. Systems analysis was begun on personal air vehicle concepts to understand benefits of these vehicles to the small transportation system. Real-time piloted simulation validation was completed to determine potential viability of a vehicle central nervous system, one of the first stages of a warping-wing to create a bird-like aircraft. Free-form ultra-lightweight structural component fabrication was demonstrated: The first-order material/structural properties of carbon-nanotube-based materials was characterized, an important first step to enable simulation tools that accurately predicts performance. The design of a prototype carbon nanotube electromagnetic field sensor that will use less power than current sensor technology was completed. The program developed a thin-film polymer actuator for shape control of membrane structures. Analysis tools for film-based and gossamer structures were validated via testing of a variety of components. These tools required development of test and measurement techniques. Development of an expert tool that provided efficient, rapid and highly reliable selection of space-capable materials that meet the requirements of specific engineering applications will be completed.

In FY2001, the **Hyper-X (X-43A)** sustained a boost failure on the first flight (planned for Mach 7) in June 2001. A mishap investigation was formed and its findings were reported in early CY 2002. In addition to continuing work on vehicles two and three, the program also supported the work related to determining the cause of the booster mishap including a major series of wind tunnel tests in late FY 2001 and early FY 2002.

For the **Propulsion and Power** Program, during FY2001, work was completed on the durability of cast Titanium Aluminum (TiAl) low pressure turbine blades for engine safety improvement. Additionally, foil bearings, which will enable oil-free turbine engines, were tested in a core engine section. Results indicate that the foil bearings can withstand conditions in excess of expected engine operating conditions. Oil-free turbomachinery technology could lead to simpler, easier to maintain engines. Additionally, significant progress was made in the area of zero CO_2 emissions research by testing a hydrogen-fueled gas turbine engine and a fuel-cell-based propulsion system. Significant advances were made in reducing the permeability of lightweight polymer-composite, liquid-hydrogen tanks for safe and efficient storage of low-density liquid hydrogen and in determining the fracture toughness of solid oxide fuel cell electrolytes for high-pressure hydrogen/air fuel cells. The Aircraft Icing project made significant contributions to alleviation of aircraft icing hazards. The project assessed the potential for a ground-based icing sensor system and proceeded with down-selecting a system for further development. Also, nanotechnologies, as applied to the harsh operating environments encountered in turbine engine systems, were investigated. During FY2002, Propulsion and Power will continue to work on controlling combustion instability in engines, thus enabling lower emissions operations. Revolutionary fuel injector concepts that utilize advanced technology, including ceramics, MEMS, and active combustion control aimed at reducing NOx emissions by 80% and to further reducing particulate and aerosol emissions will be demonstrated. The fundamental aspects of noise generation and propagation and the identification of advanced noise reduction concepts will continue. This activity will provide enabling capabilities for new, high-risk, high-payoff technologies that are of long term strategic importance in noise reduction. An assessment of hybrid fuel cells and liquid hydrogen-optimized turbofan concepts will be completed; pointing the way toward feasible concepts for further development for reducing or eliminating CO_2 emissions. Identification and preliminary performance assessment of revolutionary aeropropulsion concepts and technologies will be completed. In addition, we will establish two Research, Education, and Training Institutes (RETIs) in propulsion and power research. To ensure the highest quality research and training and infusion of new ideas, these RETIs will be subject independent, external reviews with recompetition at regular intervals, including mandatory sunsets after ten years.

In FY2001, **Flight Research** the Environmental Research Aircraft and Sensor Technology (ERAST) project conducted record-breaking flights of the Helios aircraft, a 247-foot wingspan aircraft, to an altitude of 96,833-feet. Flight Research also initiated C-17 testbed experiments, continued F-15B testbed experiments and made significant advancements in Autonomous Formation Flight (AFF) research activities in FY 2001. Fiscal Year 2002 promises to be a productive year of flight research. In ERAST, Flight Research will demonstrate a turbo-prop UAV capability that exceeds the minimum Earth Science altitude (40,000') and duration (24 hour) requirements. Flight testbed activities this year may include: PFTF Envelope Expansion, Airborne Schlieren Imaging, Supersonic Natural Laminar Flow II, and Axisymmetric Rocket Based Combined Cycle experiments. This fiscal year the Intelligent Flight Control Systems (IFCS) activities will begin in earnest – the integration and demonstration of IFCS into a C-17 simulation will transfer the F-15 IFC software into a transport configuration, validating IFC technology in a transport type aircraft simulator. The F-15 IFCS activity will initiate risk reduction flight test. In pursuit of efficiency and affordability an F-18 testbed aircraft will continue its modification and systems checkout in preparation of FY 2003 flights to investigate Active Aeroelastic Wing (AAW) technology. The Autonomous Formation Flight (AFF) activities in FY 2002 will demonstrate drag reduction and substantial fuel savings as a result of coordinated autonomous aircraft operations.

In FY 2001, the **Ultra Efficient Engine Technology** Program completed work on a new disk alloy that will advance the state of the art for commercial and military airplane turbine engines. The new alloy, a nickel-based powder metallurgy superalloy, can withstand temperatures over 1300 degrees F, a 150-degree increase over disks currently in operation. With the increase in operability at high temperatures, engines can function at higher-pressure ratios than current engines, translating into increased fuel efficiency and lower fuel burn resulting in reduced aircraft emissions. In addition, the disk alloy is estimated to be able to operate 30 times longer than current disks, resulting in increased time between required maintenance In FY 2002 the Ultra Efficient Engine Technology Program continued to evaluate promising propulsion technology approaches for emissions reduction (NO_x and CO_2) through laboratory tests, computational simulation evaluations, and in two cases integrated component technology demonstrations in partnership with industry. Specifically engine testbed demonstrations (TRL6) of a 200 deg F ceramic matrix composite (CMC) combustor liner and a low-pressure turbine aspirating seal concept were conducted in partnership with General Electric Aircraft Engines. Initial combustor sector tests (TRL4) of ultra low emissions approaches were conducted with four of the major partners (GE, Pratt & Whitney, Allison, and Honeywell). These initial test results will provide insight into the most attractive approaches to pursue to reach the program goal of 70% landing/takeoff (LTO) NO_x reduction. (In each case the industrial partner in kind contribution at least equaled the NASA research investment.)

In FY 2001 **Quiet Aircraft Technology** defined the technology baseline against which program progress will be measured by assessing the outcome of the previous Noise Reduction program. In FY 2002 Quiet Aircraft Technology will develop technology that, when implemented, reduces the impact of aircraft noise to benefit airport neighbors, the aviation industry, and travelers. The QAT Project will directly improve the quality of life of our citizens by reducing their exposure to aircraft noise, thereby eliminating constraints on the air transportation system. The QAT Project goals are to develop and laboratory-validate physics-based noise prediction models; use the physics-based codes to discover and develop laboratory-validated technologies necessary (but not sufficient) to achieve the Enterprise 10-year, 10 dB objective; and develop a framework using the physics-based noise prediction codes to initially identify technologies necessary to meet the 25-year, 20dB Enterprise objective. Specifically in FY 2002 the project will complete a system study to identify the community noise impact technologies required to meet the 10-year, 10 dB Enterprise Goal

In FY 2002, **Breakthrough Vehicle Technologies** will complete annual OAT goals assessment and system studies of several revolutionary concepts will be completed. The first demonstration of open loop flow control via oscillatory blowing with leading and trailing edge actuators to enable simplified high-lift systems will be completed. Demonstrations of a viscous solution adaptive system using high fidelity modeling and generating an unstructured grid CFD mesh and solution from a CAD model in one-day will also be completed. To increase structural efficiency of polymer matrix materials, candidate processes for fabricating aligned carbon nanotubes reinforced polymer fibers will be evaluated. Concepts for advanced sensory materials and for embedding sensors into aerospace structural materials will be developed. Finally, BVT will establish a University Research, Education, and Training Institutes (URETI) in Materials and Structures research. To ensure the highest quality research and training and infusion of new ideas, this URETI will be subject independent, external reviews and recompetition at regular intervals, including a mandatory sunsets after ten years.

In FY 2002 **Twenty-First Century Aircraft Technologies** will focus on the development of the following technologies: Demonstrate the methodology to produce scaling laws to validate the Reynolds's number for on-set of aerodynamic flow separation. Demonstrate the ability to dynamically alter the local flow instabilities over advanced lifting surfaces with micro-adaptive flow control devices. Develop concepts for design and analysis of algorithms for control of colonies of fluidic flow control effectors. Develop concepts of nondeterministic analysis of advanced composites including nanotube-reinforced polymers to characterize processing uncertainties of material properties. Conduct electromagnetic impact assessment on critical flight control hardware through physics based modeling of the electromagnetic field.

In FY 2002, **Advanced Vehicle Concepts** will focus on the following specific activities: Fabricate and test proof of concept Blended Wing Body wing to validate design and fabrication process. Integrate and demonstrate Intelligent Flight Control in a C-17 simulation. The demonstration of IFCS in a C-17 simulation will transfer the F-15 IFC software into a transport configuration, validating IFC technology in a transport type aircraft simulator. Additional FY 2002 activities in the **Hyper-X (X-43A)** program include accomplishing all required return-to-flight fixes and reviews, preparation of t he second X-43A and booster for flight at Mach 7 pending findings of the Mishap Investigation Board report in early CY 2002.

PROGRAM PLANS FOR FY 2003

During FY 2003, **Propulsion and Power** will investigate fluid-dynamic and structural "morphing" of gas turbine components. These technologies have the potential to enable an engine to adapt itself to any given flight condition, thus ensuring optimum efficiency and minimal emissions at every point in the flight mission. Engine subsystems, including foil and magnetic bearings, that have the potential to completely eliminate the need for oil and lubrication systems will be investigated. Other technologies, such as a high temperature-capable actuator, which is planned for fabrication and test in FY2003, will help to enable gas turbine engine self-diagnosis, self-reconfiguration, and self-repair. Also, in FY 2003 Propulsion and Power will demonstrate the utilization of a high temperature Polymer Matrix Composite in a harsh environment that consists of a rapid heat-up from cryogenic temperatures, short durations at extremely high temperatures, and rapid cool down over hundreds of cycles; while decreasing the overall design weight of the component by 25 - 30%. Further, in FY 2003, Propulsion and Power will continue investing in non-combustion-based propulsion systems.

The driving research activities for **Flight Research** in FY 2003 will be flight demonstration of Intelligent Flight Control Systems applications in the F-15 and C-17 platforms and continued expansion of the Helios aircraft's flight duration capabilities. The C-17 testbed aircraft will begin flight-testing with a Research Flight Control System (REFLCS) that will provide an unparalleled in-flight research capability. The Active Aeroelastic Wing (AAW) technology program will demonstrate closed loop control of flight utilizing wing twist in a modern aircraft. The F-15B testbed aircraft will complete experiments in Laminar Flow, Space-based Telemetry And Range Safety (STARS), and F-5 Shaped Boom Demonstration.

In FY2003 **Ultra Efficient Engine Technology** will begin to transition its most promising technology approaches from laboratory tests into experimental evaluations of more realistic configurations. Specifically sector tests of promising ultra low NOx combustor concepts will be completed and the most promising large engine and small engine concepts will be carried forward into full scale annular rig designs (working in partnership with industry). These TRL5 tests will be conducted in the remaining years of the program. The ceramic thermal barrier coating selected in FY2002 will be used along with the baseline ceramic matrix composite (CMC) to design a complex part (i.e. turbine vane) which will validate a material system with a 3000 °engine flow path capability (2700 °vane surface temperature capability). The most promising approach for active flow control will be demonstrated in a small-scale wind tunnel test of a Blended Wing Body (BWB) S-inlet. An interim technology benefits assessment will be conducted of all the technologies being developed in the UEET Program and their individual and collective impact on meeting the overall program goals. Construction will begin on the Dual-Spool Turbine Facility (DSTF) in FY2003, with the DSTF being ready for testing in FY2004.

In FY 2003 **Quiet Aircraft Technology** will develop physics-based models related to noise generation and propagation physics for airframe and engine noise sources as well as noise interaction between engine and airframe. The models will be used to design, optimize, and implement the noise reduction concepts developed in QAT, and used by our industry partners to implement the QAT-developed noise reduction concepts on their products. The validated models enable an understanding of the details of noise production and propagation which is essential for the discovery and development of advanced noise reduction concepts as well solutions to issues not even envisioned today.

In FY 2003, **Breakthrough Vehicle Technologies** will the annual OAT goals assessment and system studies of several revolutionary concepts. Breakthrough Vehicle Technologies will demonstrate the viability of a preliminary set of miniaturized NDE (Non-Destruct Evaluators) end-effector technologies for low cost inspections of critical components for use in inaccessible regions or hazardous environments. Breakthrough Vehicle Technologies will also demonstrate the ability for laboratory-scale production of carbon nanotube laminates with a high performance polymer matrix. Breakthrough Vehicle Technologies will develop validated figures of merit and design guidelines for the prevention of abrupt wing stall in future fighter designs. Test the Stingray vehicle (supporting the Morphing Project) to demonstrate open-loop distributed micro flow control enabling advanced vehicle maneuvering through virtual aerodynamic shaping. Breakthrough Vehicle Technologies will evaluate adaptive drag reduction technologies that may include shock wave manipulation, near wall turbulent structure manipulation, and the delay of laminar to turbulent transition.

In FY 2003 the **Twenty-First Century Aircraft Technologies** Project will focus on the development of the following technologies: Flutter risk assessment of a high speed slotted wing to provide experience with flutter mechanisms, flutter prediction capabilities and confidence to proceed with industry high-speed airplane concepts. Validate nonlinear structural analysis tools for determining the stiffness and strength response of a noncircular multi-cell structure subjected to combined loads. Develop transient disturbances recovery strategy for implementation in the SPIDER (Scaleable Processor Independent Design for Electro-Magnetic Resilience) architecture to ensure the aircraft's flight control system is robust. Quantify the benefits of a suite of conventional and unconventional vehicle/architecture configuration and technology solutions on future vehicle concepts. Demonstrate a dual channel (one propulsion and one secondary power channel) regulated, integrated, and Propulsion and Power system test bed – the first end-to-end demonstration of an electric P&P system including fuel cell power generation and realistic loads, actuators and motors) configured for aircraft requirements.

In FY 2003 **Advanced Vehicle Concepts** will focus on the following specific activities: Conduct Parameter identification flights of the Active Aeroelastic Wing to measure wing twist (flexible wing) effectiveness in flight on an F-18 to determine available roll power and demonstrate closed loop control of wing twist (flexible wing) on the F-18. Generation I flight testing of the F-15 flight test vehicle and the Research Flight Computing System (REFLCS) will begin during this year. Activities in the **Hyper-X (X-43A) program** in FY 2003 will include preparations for and the final flight that will be at Mach 10. These flights will establish the capability of U.S. advanced hypersonic design tools and provide the foundation for the transition to the NASA/Air Force X-43C project, a part of the Advanced Space Transportation Program, which will demonstrate acceleration from Mach 5 to 7 under scramjet power.

(Budget Authority in Millions of Dollars)

ERAST – LIFE CYCLE COST (LCC)	**PRIOR**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**TOTAL**
BOLD ERAST	119.1	10.5						129.6
ERAST II	12.0	11.5	20.0	0.0	0.0	0.0	0.0	43.5
TOTAL (EXCLUDES CIVIL SERVICE COST ($M)	121.1	22.0	20.0	0.0	0.0	0.0	0.0	173.1
(ESTIMATED CIVIL SERVICE FTEs *								
CIVIL SERVICE COMPENSATION ESTIMATE ($M) *								

* ERAST is a project within the Flight Research program: NASA tracks Civil Service FTEs and compensation only down to the program level, thus no separate data is available for ERAST.

(Budget Authority in Millions of Dollars)

Hyper-X – LIFE CYCLE COST (LCC)	PRIOR	2002	2003	2004	2005	2006	2007	TOTAL
HYPER-X PROJECT	175.0	25.0	17.0	0.0	0.0	0.0	0.0	217.0
TOTAL (EXCLUDES CIVIL SERVICE COST ($M)	175.0	25.0	17.0	0.0	0.0	0.0	0.0	217.0
(ESTIMATED CIVIL SERVICE FTEs *								
CIVIL SERVICE COMPENSATION ESTIMATE ($M) *								

* HYPER-X is a project within the Vehicle Systems Technology program: NASA tracks Civil Service FTEs and compensation only down to the program level, thus no separate data is available for HYPER-X

BASIS OF FY 2003 FUNDING REQUIREMENT

AIRSPACE SYSTEMS PROGRAM

Web Address: http://www.asc.nasa.gov

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Airspace Systems Program	**125.9**	**133.9**	**125.1**
Terminal Area Productivity (TAP) project	5.4	--	--
Short Haul Civil Tiltrotor (SHCT) project	3.4	--	--
Advanced Air Transportation Technologies (AATT) project	59.6	71.4	71.6
Small Air Transportation System (SATS) project	9.0	15.5	20.0
Virtual Airspace Modeling and Simulation (VAMS) project	--	23.0	23.0
Airspace Operations Systems (AOS) project	16.9	11.5	10.5
Rotorcraft	31.6	12.5	--

DESCRIPTION/JUSTIFICATION

The Airspace Systems (AS) program will enable the development of revolutionary improvements to, and modernization of, the air traffic management (ATM) system, as well as the introduction of new vehicle systems and classes whose operation can take advantage of an improved, modern ATM system. The customers for this technology are the Federal Aviation Administration (FAA), commercial and private aviation operators, and aircraft developers and system suppliers.

The primary objective of the AS Program is to enable new aircraft capabilities and air traffic technology to increase the capacity and mobility of the air transportation system. The secondary objectives are to assure safety, security and environmental protection while maximizing operational efficiency, flexibility, predictability and access into the airspace system. The public is the beneficiary of this program - both from an economic viewpoint as well as from an improved life style. The benefits to the user will be reduced travel delays and increased community access. The major challenges are: to accommodate projected growth in air traffic while preserving and enhancing safety and security; provide all airspace system users more flexibility and efficiency in the use of airports, airspace and aircraft; enable new modes of operation that support the FAA commitment to “Free Flight” and the Operational Evolution Plan (OEP), and maintain pace with a continually evolving technical environment.

The capacity of the airspace system can be increased by: (1) increasing the number of runways, (2) increasing the throughput of airport runway and taxiways in weather, (3) improving gate-to-gate air traffic flow/management/control, (4) off-loading main runways of small aircraft for use by large transports, and (5) increasing use of alternate small airports.

Airspace Systems consists of four projects: Airspace Operations Systems (AOS), Advanced Air Transportation Technologies (AATT), Virtual Airspace Modeling and Simulation (VAMS), and Small Aircraft Transportation System (SATS). The major focus of the AOS, AATT, and VAMS projects is to improve the capacity of transport aircraft operation at and between major airports in the National Airspace System. The focus of the SATS project is a demonstration of the use of general aviation to improve mobility. The **TAP** project, which was successfully completed in FY 2000, developed technologies to increase the throughput of single and parallel runways and taxiways in weather conditions that cause low visibility. The **SHCT** project, which was successfully completed in FY2001, developed technologies to enable a quiet and safe capability to off-loading small aircraft from the runways at large airports so that large transport aircraft can use them.

The **AOS** project develops fundamental understandings, models and tools needed to conceive and model the NAS and its human operators as well as to provide the foundations for development and operation of safe systems.

The **AATT** Project is developing decision support tools to help air traffic controllers and pilots improve the air traffic management and control process from gate-to gate. The goal of the AATT project is to increase the effectiveness (capacity, efficiency, flexibility, predictability and safety) of the national and global air transportation system. The specific objectives are to:

- Enable user flexibility to the maximum degree possible so that users may minimize direct operating costs by making trade-offs between time and routing.
- Improve the effectiveness of high-density operations in regions on the ground and in the air where maximum user flexibility may not be possible.
- Enable operation in a smooth and efficient manner between high user flexibility and lower user flexibility regions of the NAS.
- Provide system improvements that are easily deployable anywhere in the world. The VAMS project is exploring the next generation of ATM concepts and developing the analytical and simulation capability needed to analyze and validate these concepts.

The **VAMS** project is exploring the next generation of ATM concepts and developing the analytical and simulation capability needed to analyze and validate these concepts. The goal of the VAMS project is to explore new concepts and develop modeling/simulation capabilities that will be precursors to a 200% increase (tripling) in the NAS capacity by 2022 based on 1997 levels. The overall objectives/approach of the VAMS project are to:

- Develop and assess advanced system-level air transportation concepts.
- Conduct system-level assessments of this concept set.
- Develop the capability to model and simulate behavior of the air transportation system operations to never-before-achieved levels of fidelity.
- Develop a set of analytical and computational models and methods to conduct detailed assessments of candidate operational concepts.

The major focus of the **SATS** project is to improve public mobility and community access to aviation by enabling use of under-utilized airports across the country. The goal of the five-year SATS project is to develop key airborne technologies and provide a proof of concept through an integrated technology evaluation and validation of precision guidance of small aircraft to virtually any touchdown zone at small airports. The SATS project has four objectives centered on enabling operational capabilities that are not possible in the current National Air Space (NAS) environment. These objectives are:

- Higher Volume Operation at Non-Towered/Non-Radar Airports.
- Lower Landing Minimums at Minimally Equipped Landing Facilities.
- Increase Single-Pilot Crew Safety and Mission Reliability.
- En Route Procedures and Systems for Integrated Fleet Operations.

The key airborne technologies to support the creation and evaluation of SATS-oriented operating capabilities would enable near all-weather operations by new generations of aircraft at virtually any landing facility in the nation.

Funding is included under this program for selected Congressional special interest initiatives identified in the FY 2002 Appropriations Act.

STRATEGIC OBJECTIVE:	**PROGRAM APPROACH:**
Revolutionize Aviation - Increase Capacity	Develop and transfer to the FAA and airlines decision support tools to help air traffic controllers and pilots improve the air traffic management and control process from gate-to gate. Develop the analytical and simulation capability needed to analyze and validate next generation air traffic management concepts.
- Increase Mobility	Develop key airborne technologies for precise guided accessibility for small aircraft in near all-weather conditions to virtually any small airport in non-radar, non-towered airspace. Conduct proof of concept demonstrations of these technologies.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Revolutionize Aviation
Strategic Plan Objectives Supported: Expand Aviation Capacity, Improve Mobility
Performance Plan Metrics Supported: APGs 3R4, 3R5

Milestones	**FY03 Date**	**FY02 Date**	**Baseline Date**	**FY02-03 Change**	**Comment**

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-03 Change	Comment
Rotorcraft Analytic model predictions of rotorcraft crashworthiness		2/01	1/01	Complete	Finite element modeling has been used to characterize the airframe, aircraft skins, impact media (water and soil), and contact surface. A simulation of the crash tests in both soft soil and water have been computed, along with resulting accelerations and damage to the rotorcraft structure. Crash tests in both water and soft soil have been performed with full-scale hardware. January 2001 test results have validated the models
Health and usage monitoring systems (HUMS) certification protocol		2/01	2/01	Complete	The RITA (Rotorcraft Industry Technology Association)-Health Usage & Maintenance System (HUMS) open architecture protocol includes 5 separate specifications, developed in collaboration with the FAA and DoD. Each of these specifications have been submitted to SAE for review and are expected to transition to SAE standards. The specifications define the aircraft data system and data bus, transducers, signal conditioning and data protocols, and the ground data system.
Ultra-safe gear design guide		3/01	3/01	Complete	The guide predicts crack propagation paths and has been validated using the NASA Gear Fatigue Test Rig.
Flight-validate advanced control laws/modes		9/01	9/01	Complete	A control system, representative of a small civil helicopter, was designed and implemented on RASCAL (Rotorcraft Aircrew Systems Concepts Airborne Laboratory) using the RFCS (Research Flight Control System), and verified by flight-testing. The flight tests verified that CONDUIT (Control Designer's Unified Interface) could design to level 1 HQ for flight tasks typical of the most demanding civil operations.

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-03 Change	Comment
Rotorcraft technology documented		9/01	9/01	Complete	Over 160 technical experts and technology managers, members of the NRTC/RITA (National Rotorcraft Technology Center / Rotorcraft Industry Technology Association)* organization, met to share results of all the projects completed this year. In the three-day meeting technology transfer reports were presented for 96 of 98 projects for the year 2000 NRTC/RITA* technical program, which exceeded the goal of presenting at least 85% of the projects.
Short-Haul Civil Tiltrotor					
Comprehensive mission simulation database of integrated cockpit and operating procedures for complex, low-noise flight paths		9/01	9/01	Complete	See discussion in the accomplishments section below.
Large scale database for validation of rotor noise reduction and validated design for noise capability (TRAC)		9/01	9/01	Complete	See discussion in the accomplishments section below.
Airspace Operations Systems					
Characterize the demands of concurrent task management and patterns of errors		5/01	5/01	Complete	Published the second and third of a series of reports characterizing the demands of managing concurrent tasks and laying the groundwork for developing methods pilots can use to reduce their vulnerability to forgetting to perform critical actions because of preoccupation with other duties
Develop initial bio-mathematical model enabling prediction of flight crew performance based on sleep and circadian models		6/01	6/01	Complete	Findings demonstrate that brief, hourly in-flight activity breaks reduce physiological and subjective sleepiness for at least 15 minutes during the circadian trough, and may have continued effects for up to 25 minutes.
Model for planning flight crew scheduling	6/02	6/02	6/02		
Provide strategies for improving training and procedures to reduce misunderstandings between pilots and air traffic controllers	6/03		6/03		

Advanced Air Transportation Technologies					
Develop and demonstrate transition airspace decision support tools. These tools will enable information exchange between ATC/airline operations centers and ATC/cockpits for collaborative decision-making. These tools will also enable prediction of aircraft conflicts both by ATC and flight crews.		9/01	9/01	Complete	See discussion in the accomplishments section below.
Develop and evaluate a traffic flow management decision support tool for system-wide prediction of sector loading	12/01		12/01		
Develop and demonstrate an interoperable suite of decision support tools for arrival, surface and departure operations	3/02	3/02	3/02		
Develop, demonstrate initial functionality, and evaluate human factors for a decision support tool for complex airspace	12/02		12/02		New milestone in response to Independent Annual Review request for additional milestone detail.
Develop, demonstrate initial functionality, and evaluate human factors for one active terminal-area decision-support tool	9/03		9/02	+12 months	Slipped one year and reduced to one tool due to FY2002 congressional budget reduction and unfunded earmarks.
Virtual Airspace Modeling & Simulation					
Complete VAST real-time environments definitions and preliminary design	9/02	9/02	9/02		
Identify candidate future Air Transportation System capacity-increasing operational concepts	9/02	9/02	9/02		

Complete Build 1 of state-of-the-art airspace models toolbox with the ability to assess economic impact of new technology and NAS operational performance, and the ability to model the dynamic effects of interactive agents	3/03		3/03		
Small Aircraft Transportation System					
Systems engineering documents baselined	3/02	12/01	12/01	+3 months	Baselining of documents will occur in March-2003 when SATS Consortium is established.
Initial SATSLab flight experiments conducted	9/03		9/03		
Technology downselect for flight experiments	12/02		12/02		

Lead Center: Ames Research Center	**Other Centers:** Glenn Research Center, Langley Research Center	**Interdependencies:** FAA
Project	**Lead Center**	**Industry Contractors**
Airspace Operations Systems	Ames Research Center	Numerous grants
Advanced Air Transportation Technologies	Ames Research Center	Raytheon, CSC, and their partners; NRA with SAIC and SRC
Virtual Airspace Modeling & Simulation	Ames Research Center	Raytheon, CSC, and their partners; new competitive NRA and contracts
Small Aircraft Transportation System	Langley Research Center	Broad public-private partnership encompassing industry, academia, and government entities utilizing a cost-sharing Joint Sponsored Research Agreement
Program Product	**Builder (Location)**	**Product Benefit**
Terminal Decision Support Tools	Multi-contractor	Terminal throughput increased by 10 percent using near-term decision support tools for scheduling, runway assignment and landing order. Terminal throughput increased by 15 percent using mid-term and far-term decision support tools and operating concepts for multi-Center traffic coordination, air-ground data exchange, interoperable surface/departure operations, and air/ground collaboration for arrival spacing.

En route Decision Support Tools	Multi-contractor	En route throughput increased by 10 percent using near-term, mid-term, and far-term decision support tools and concepts for metering or spacing of traffic, efficient conflict-free routing, and air/ground collaborative TFM and control.
Decision Support Tools for Flexibility and Collaboration	Multi-contractor	Three decision support tools/ concepts developed that provide new capabilities for flexibility or collaboration for airspace users and service providers.
Airspace Modeling Toolbox	Multi-contractor	Complete VAST airspace models toolbox with the ability to assess economic impact of new technology and NAS operational performance, and to model the effects of interactive agents and weather, suitable for use in evaluating advanced OpsCons.
Real-Time Virtual Airspace Simulation System	Multi-contractor	Complete development of real-time VAST capabilities for use in evaluating advanced OpsCons. Provide capability for integrated air traffic control and aircraft simulation.
Innovative Concepts for National Airspace System	Multi-contractor	Explore innovative NAS concepts that will enable throughput increases of an additional 50% based on 1997 levels.
Non-Procedural Separation in Non-Radar Terminal Airspace	Multi-contractor	Demonstrate the ability to eliminate "procedural separation" requirements in IMC in non-radar terminal airspace and allow 2 or more simultaneous operations at a time (> 6 landings per hr)
IFR-type Approach/Landing at VFR-only Airports	Multi-contractor	Demonstrate the ability to provide precision- like approach and landing guidance that requires no new land acquisition, no approach lighting, and minimal new ground-based equipment with minimum ceiling and visibility requirements of 200 ft and 1/2 miles respectively at a currently VFR-only airport
Single Pilot System	Multi-contractor	Single-pilot precision, safety, and mission reliability equal to that of a single ATP crewmember with current instrumentation
Airborne Enabling Technologies	SATS Alliance	Elimination of "procedural separation" requirements in IMC in non-radar terminal airspace and allow 2 or more simultaneous operations at a time.

		Ability to provide precision like approach and landing guidance that requires no new land acquisition, no approach lighting, and minimal new ground-based equipment with minimum ceiling and visibility requirements of 200 ft and 1/2 mile, respectively, at a currently VFR-only airport. Single-pilot precision, safety, and mission reliability equal to that of a single ATP crewmember with current instrumentation.
Transportation Systems Analysis and Assessment	SATS Alliance	Analysis of the impact of operations enabled by SATS technologies on higher en route air traffic flows and terminal airspace operations in the current NAS.

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

In FY 2001 the **Short Haul Civil Tiltrotor** project was successfully completed on schedule. Completed final SHCT full mission simulation experiment incorporating all knowledge gained from SHCT project. The experiment included cockpit and low-noise flight operations research on safe manual control in adverse weather with simulated emergency conditions. Takeoffs, landings, go-arounds and engine failure recoveries were investigated in a congested airspace scenario based upon a vertiport at San Francisco International airport. Developed initial strategy for simultaneous non-interfering operations at a hub airport. Steep 9-degree final approach found to maximize separation altitude from transport aircraft on runways while lowering noise footprint. Cockpit technologies and design/certification procedures transferred to Bell Textron BA609 commercial tiltrotor design. The SHCT project demonstrated flight operational noise footprint reductions of up to 10dBA, exceeding the target performance of 6 dBA. Completed the large-scale database and the prediction code for design-for-noise capability. The program finalized the database for low-noise proprotor designs, analysis capability for design and evaluation of low-noise tiltrotors, and validation of design for noise capability. Finalized and delivered Tiltrotor Aircraft Noise Prediction Code (TRAC) to Bell, Boeing and Sikorsky. The SHCT project demonstrated reductions of up to 12.5 dBA in proprotor noise, exceeding the target performance of 6-dBA reduction in source noise.

In FY 2001, there was an orderly close-out of the **Rotorcraft Base R&T Program**. An Ultra-Safe Gear Design Guide was published. A composite structures certification methodology was delivered for inclusion in Mil-Std Handbook 17. A new physics-based design tool was provided for prediction of composite structure stringer/ skin separation mode of failure. Flight tests were completed that demonstrated and validated control laws for low pilot workload under typical civil operations. Crashworthiness tests on rotorcraft demonstrated mitigation of damage to airframe structures due to crash/ harsh landings. New HUMS (Health and Usage Monitoring Systems) protocols were developed for improved safety and maintenance. There was a demonstration conducted for the new "express- tool" technology that reduced design to fabrication time by 50%. Although the Rotorcraft Research Program was concluded in FY 2001, NASA will fund the NASA/Army Rotorcraft University Centers of Excellence in FY 2002 as directed in the VA, HUD, and Independent Agencies Appropriations Act. NASA does not anticipate funding this program in FY 2003. In addition, NASA will use the remaining directed funding to continue the Runway Independent Aircraft (RIA) activity and identify key enabling technologies for these vehicles. In FY 2002, this includes examination key issues associated with operating tilt-rotor like air vehicles in the approaches and terminal areas. We plan to focus on aerodynamics, vehicle management and information systems, and operational issues connected with large rotor, large aircraft and with controllable, quiet, and safe operations in the low speed regime near terminals. Future NASA work in rotorcraft will be assessed and prioritized against other approaches to increasing nation's air systems capacity under the other Airspace Systems projects described below.

In the **Airspace Operations Systems** project for FY 2001, training research was concentrated on characterizing how the demands of managing multiple concurrent tasks contribute to crew errors in aviation incidents and accidents. This work will lead to later development of methods to train pilots to manage concurrent task demands safely and operating procedures to reduce excessive demands. Fundamental modeling of human performance and the interaction of human operators with automated systems continued. Cognitive tools were developed and documented for task evaluation and management as they support human performance. These tools were developed using a combination of empirical investigation, modeling, and direct measurement of brain activity. Technologies for the ground-based remote sensing of aviation icing conditions were reviewed and evaluated leading to the selection of candidate systems to develop for future field tests. These systems will lead to improved pilot interpretation and management of icing hazards, better management of air traffic in adverse weather conditions, and reduced in-flight icing incidents and accidents during approach and landing.

During FY 2002, the **Airspace Operations Systems** project will enter a new phase in countermeasures for flight crew fatigue with the development of tools to assist aircraft operators in scheduling flight crews. An initial bio-mathematical model will be developed to predict crew behavioral performance based on sleep and circadian variables. New perceptual measurement tools for evaluating display effectiveness as they support human performance will be validated. This research is conducted using a combination of psychophysical studies, eye tracking, image processing, visual system modeling, auditory system modeling, virtual environment technologies, and interactions of perceptual factors with displays and controls. A methodology for the design and verification of task-driven human-automation systems will be developed. This methodology will enable verification that a given human-automation interface is "clean" of design errors and enable the building of interfaces that are sound and efficient.

In FY 2001 the **Advanced Air Transportation Technologies** project completed all work associated with the Collaborative Arrival Planner (CAP) tool. CAP provides the airlines with Air Traffic Control (ATC) situational awareness previously available only to the FAA to enable better decisions regarding flight diversions, pushback times, and other factors leading to improved operational efficiency. CAP is currently operational in the American Airlines operations center and the Delta ramp tower at Dallas Ft. Worth Airport. It was also distributed to the airlines through the collaborative decision-making network operated by the Volpe National Transportation Systems Center. A flight evaluation of Enroute Data Exchange (EDX) was completed. Under an MOU with United Airlines, the FAA and NASA, 48 Boeing 777 aircraft were outfitted with the EDX software to provide automatic real-time extraction and transfer of aircraft state and intent information to the NASA Center TRACON Automation System (CTAS). Data was collected from over 1000 flights during a 6-month period. Utilization of these data by the CTAS trajectory prediction algorithm resulted in significant improvements in the predicted trajectories of the aircraft. The Direct-to (D2) tool completed its first extensive field test at the Dallas-Ft. Worth (DFW) Center. Direct-to automatically identifies to the enroute air traffic controller any aircraft that can save flight time by flying directly to a waypoint further along its flight path. The D2 also probes for potential conflicts and allows the controller to trial flight plan to resolve conflicts quickly. Significant flight time savings were achieved including consistent savings of 50 to 60 seconds for one DFW departure route. During FY 2002, the Advanced Air Transportation Technologies project will demonstrate through simulation an interoperable suite of decision support tools for arrival, surface and departure operations. Development work in FY 2002 will lead to the transfer of surface management system technology to the FAA Free Flight Phase 2 Program in FY 2004. This capability will reduce arrival and departure delays and inefficiencies that occur on the airport surface due to surface issues and downstream restrictions.

During FY 2002, the **Virtual Airspace Modeling** project will develop requirements and preliminary design for a high fidelity modeling and simulation environment for the real-time investigation and validation of revolutionary operational and technological concepts for the next generation of airspace systems. The project will also identify and define the first new operational concept for future investigation using the new virtual airspace simulation technology capability.

In FY 2001 the **Small Air Transportation System** project established four SATSLab teams Virginia, Florida/Southeast, North Carolina/Upper Great Plains, and Maryland. They will perform work through May 2002 in four areas: system engineering, systems analysis, flight demonstration planning, and technology integration. Each team includes representatives from the state aviation/transportation departments, private industry, general aviation user groups, and academia and other non-profit organizations. This work is the precursor to the formation of a SATS Alliance. The SATS Alliance structure will be defined and implemented in March 2002, which will include a signed Joint Sponsored Research Agreement, a draft business operating handbook and an implementation plan for co-location of consortium and NASA personnel. Additionally, the SATS project will complete the project's baseline system engineering and technology documents, which form the basis for all technology investment and down-select decisions. The systems architecture necessary to enable the four operating capabilities will be defined. Additional environmental and economic impact studies to support the program assessment process will be initiated in FY2002 as will a total system cost study. A key activity for FY 2002 is the development of a simulation environment in which the flight path management and flight deck technologies will be assessed. Technology ground based experiments, which begin in FY2002, will establish the technology sets to be evaluated during the FY 2003 flight experiments. In support of these experiments, modifications to the flight research test beds will begin in FY 2002. Sites used for technology development flight experiments, integrated technology validation flight tests and integrated technology flight demonstration will be selected. The process by which sites will be selected for each phase will be mutually agreed upon between NASA and the SATS Consortium. NASA expects that the number of integrated technology flight demonstration sites will be a limited subset of those sites used during the technology development and validation phases of the SATS project.

PROGRAM PLANS FOR FY 2003

In FY 2003 the **Airspace Operations Systems** project will develop strategies to improve training and procedures to reduce misunderstandings between pilots and air traffic controllers. The results of this study will be provided to the operational community.

In FY 2003 the **Advanced Air Transportation Technologies** project will develop, demonstrate initial functionality, and evaluate human factors for a decision support tool for complex airspace. The project will also develop, demonstrate initial functionality, and evaluate human factors for an active terminal-area decision-support tool. These demonstrations and evaluations will be conducted in either a high fidelity simulation or a shadow field-test and enable user flexibility to the maximum degree possible so that users may minimize direct operating costs by making trade-offs between time and routing.

In FY 2003 the **Virtual Airspace Modeling and Simulation** project will complete Build 1 of a toolbox of state-of-the-art models of the airspace system. This toolbox will include the capability to model the dynamic effects of interactive agents in the National Airspace System. These models will provide the capability to assess the economic impact of new technologies on the operational performance of the National Airspace System as well as the commercial air transport industry.

In FY 2003 the **Small Air Transportation System** project will select candidate technologies for experimental flight evaluation based on their impact on mobility either through reduced system cost, improved doorstep-to-destination time, increased trip reliability, and/or improved safety. The project will complete initial experimental flight evaluations of key enabling technologies. These flight experiments, in conjunction with the technology analyses and assessments, will evaluate individually, at the sub-system level, the impact of selected technologies on lowering required landing minimums and increasing the volume of operations at non-towered landing facilities in non-radar airspace during instrument meteorological conditions.

BASIS OF FY 2003 FUNDING REQUIREMENT

2ND GENERATION REUSABLE LAUNCH VEHICLE (2ND GEN) PROGRAM

Web Address: http://SLInews.com

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
2nd Generation Reusable Launch Vehicle Program	**289.4**	**467.0**	**759.2**
Systems Engineering and Requirements Definition	49.9	83.8	64.1
RLV Competition / Risk Reduction	94.8	280.1	501.5
NASA Unique Systems	41.7	28.4	108.8
Alternate Access	39.9	48.7	62.7
Future X / X-37	45.2	26.0	22.1
X-34	17.9	--	--

DESCRIPTION/ JUSTIFICATION

The Space Launch Initiative (SLI), also known as the 2nd Generation Reusable Launch Vehicle (2nd Gen RLV) Program, is the central element of NASA's Integrated Space Transportation Plan (ISTP), which is NASA's long-range strategy for safer, more reliable, and less expensive access to space. ISTP consists of three major elements Space Shuttle safety investments and competitive sourcing, the 2nd Gen RLV Program, and far-term technology investments (Space Transfer and Launch Technology) – that are closely coordinated to address NASA's near-, mid- and far-term launch needs.

The 2nd Gen RLV Program is NASA's comprehensive plan to improve access to space in the mid-term. 2nd Gen RLV investments during the first half of this decade aim to enable a mid-decade competition for full-scale development of a launch architecture that could dramatically increase safety and reduce costs. By reducing risk through requirements trades, technology maturation, and cost-effective testing in relevant environments, 2nd Gen RLV will form the foundation for full-scale development of a new launch architecture in the latter half of this decade leading to flight operations early next decade.

The 2nd Gen RLV Program consists of three major elements: Systems Engineering and Requirements Definition, RLV Risk Reduction and Competition, and NASA Unique Systems risk reduction. In addition, a fourth element, Alternate Access to the International Space Station (ISS), seeks to provide NASA with commercial means of servicing the Space Station this decade. Building on 20 years of success with America's 1st Generation RLV— the Space Shuttle — the 2nd Gen RLV is the plan of action to design and develop NASA's next-generation RLV. The 2nd Gen RLV Program, is based on the philosophy that meeting NASA's human space flight needs on highly reliable, commercial competitive, privately- operated reusable launch vehicles will significantly reduce the cost of space access, allowing the Agency to focus resources on its core missions of scientific discovery and exploration.

In partnership with the Department of Defense (DoD), the U.S. aerospace industry, and academia, NASA will perform systems engineering, technology development and architecture definition trade studies to define at least two launch architectures that will best meet mission requirements. The NASA Research Announcement (NRA) 8–30 procurement for 2nd Generation RLV design and development activities took into account extensive NASA studies and contractor-provided input from NRA 8–27, which focused on detailed requirements evaluation, updated market projections, and risk-reduction priorities and plans. This systematic approach targets the research and development of high-priority technologies — such as lightweight structures, long-life rocket engines, advanced crew systems, life support, rendezvous and docking systems, flight control and avionics, and thermal protection systems — to be integrated into at least two vehicle architectures that will compete to go into full-scale development around mid-decade, with operations early next decade.

STRATEGIC OBJECTIVE:	**PROGRAM APPROACH:**
Advance Space Transportation - Mission Safety - Mission Affordability	Perform systems engineering, technology development and architecture definition trade studies to define at least two 2nd Generation RLV architecture designs that will best meet the requirements to make access to space safer, more reliable, and less expensive for present and future customers. The systematic approach targets the research and development of high-priority advanced technologies to be integrated into at least two vehicle architectures to provide the foundation for future potential full-scale development decisions.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Advance Space Transportation
Strategic Plan Objectives Supported: Mission Safety, Mission Affordability
Performance Plan Metrics Supported: APGs 3R6, 3R8

Milestones	**FY03 Date**	**FY02 Date**	**Baseline Date**	**FY02-03 Change**	**Comment**
NASA Research Announcement					
NRA 8-30 Cycle II Contract(s)	11/02	11/02	11/02		
Request for Proposal	11/02	11/02	11/02		
Non-advocate Review	10/02	10/02	10/02		
Systems Requirements Review	11/02	11/02	11/02		
Interim Architecture Technology Review	3/02	3/02	3/02		
NASA Research Announcement Contract Award	5/01	4/01	1/01	+1 month	Evaluation and selection process required additional time to complete and make the necessary notifications prior to public announcement

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-03 Change	Comment
Initial Architecture Review (IAR)	3/02	2/02	2/02	+1 month	IAR has been combined with the (Risk Reduction Review (RRR) to form an integrated Interim Architecture and Technology Review (IATR). The IATR is a 12 week process that will conclude with final reporting in March 2002
Propulsive Small Expendable Deployer Systems (ProSEDS) Complete	9/02	8/01	12/00	+13 months	Experiment is a secondary payload on Delta II and has been re-manifested for a June 2002 launch.
X-37 roll out		9/01	9/01	Deleted	The planned rollout of the X37 was delayed due to the program restructure and negotiations with the contractor. No planned date has been announced at this time
X37 Atmospheric Drop test		1/02	1/02	Deleted	The atmospheric drop test has been delayed until the mid FY05 timeframe. Program is currently working issues with the test article and the B52 test platform. The atmospheric drop test has been delayed until the mid FY05 timeframe. Program is currently working issues with the test article and the B52 test platform.
X37 First Orbital Flight		6/03	9/02	Deleted	The orbital flight of the X37 vehicle has not been scheduled. The actual date will depend upon the needs and requirements of the Space Launch Initiative and the Flight Demonstrations Project
COBRA Engine Critical Design Review	10/02		10/02		This milestone is dependant upon results of the IATR
RS-83 Engine Preliminary Design Review	2/03		2/03		This milestone is dependant upon results of the IATR
Request for Proposal (RFP) Release	2/03		2/03		Contract awards to selected architectures leading toward a preliminary design level of 2nd Generation RLV

Lead Center: Marshall Space Flight Center	**Other Centers:** Glenn Research Center, Langley Research Center, Ames Research Center	**Interdependencies:**

Project	**Lead Center**	Industry Contractors
System Studies and Architecture Definition	Marshall Space Flight Center	Boeing, Lockheed Martin, Orbital Sciences, Futron, Northrop Grumman
Airframe	Langley Research Center	Northrop Grumman, Boeing Seal Beach, Oceaneering, Lockheed Martin, North Carolina State University, Materials Research and Design, Southern Research Institute
Vehicle Subsystems	Glenn Research Center	Boeing Seal Beach, Lockheed Martin
Operations	Kennedy Space Center	Boeing, Sierra Lobo, PHPK Technologies, Lockheed Martin
IVHM	Ames Research Center	Northrup Grumman, Honeywell Space Systems, Lockheed
Upper Stages	Marshall Space Flight Center	General Kinetics, Rocketdyne, Moog, Pratt & Whitney
Flight Mechanics	Marshall Space Flight Center	Universal Space Lines, Ohio University
Propulsion	Marshall Space Flight Center	Rocketdyne, Pratt & Whitney, TRW, Boeing Seal Beach, Aerojet, Andrews Space & Technology
NASA Unique Systems	Johnson Space Center	Lockheed, Honeywell Engines & Systems
Flight Demonstrations	Marshall Space Flight Center	Orbital Sciences DART, Kistler K-1

Program Product	**Builder (Location)**	**Product Benefit**
Architecture Definitions: A minimum of 2 RLV architecture definitions and system designs.	Multiple	Defining the architectures allows for focusing of technology maturation leading to the optimum low cost, high reliability RLV.
Control Surface Structure and Joining Technology, Cryotank Producibility analysis, Durable Thermal Protection System (TPS) airframe technology development	Multiple	Advanced ceramic and metallic composite materials will reduce operations costs and increase reliability of future launch vehicles.
Power Technology, Actuators Technology	Multiple	Maturation of these technologies will reduce vehicle weight thus reducing development costs and increase payload capability.

Concept definition of Advanced Checkout, Control, & Maintenance Systems, Plans for Densified Propellant operations	Multiple	Reduction in turn-around time to flight allows for increased flight rate, thus decreasing the overall cost per launch.
IVHM Architecture definition, Systems Analysis and Optimization	Multiple	Real-time health monitoring of vehicle systems and subsystems allows for the forecasting and detection of system failures. This capability enables appropriate actions to be taken in a timely manner in flight thus increasing vehicle safety. Post-flight vehicle status reports provided by IVHM also reduce turn-around time and operations costs.
Upper stage propulsion system technologies	General Kinetics, LLC. Lake Forrest, CA	Will determine the operating and performance limitations of catalyst beds and characterize their sensitivity to propellant stabilizers and contaminates in upper stage propulsion systems, which will result in increased systems reliability.
Integrated Guidance & Control System	Ohio University	Develop innovative entry and autonomous abort control reconfiguration and an auto commander that integrates the guidance attitude controller. This robust software gives the vehicle more abort options decreasing the loss of vehicle probability toward 1 in 10,000.
Main engine and reaction control system development (RCS) and testing	Multiple	Maturation of these technologies has the greatest impact on reducing costs and increasing reliability associated with RLV development and operations.
NASA Unique Systems for crew escape and other human elements	Honeywell International Corporation Glendale, CA	Increases vehicle usability enabling higher launch rate thus decreasing overall launch costs.
Integrated technology validation	Kistler Aerospace Corporation, Kirkland, Washington, Orbital Sciences Corporation, Dulles, VA	Flight demonstration verifies technology readiness of critical technologies. Verification of technology to allow for low cost operations through autonomous flight operations near other orbiting vehicles such as Space Station.

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

The **Space Launch Initiative (SLI)** is based upon a system engineering approach. The initial phase of the program is to solicit, integrate and refine mission needs and requirements for NASA's next generation of reusable launch vehicles. All contracts awarded under NRA 8-30 Cycle I were for a base period of 10 months to be followed by options for 1 or 2 additional years. The base period will conclude in March 2002. At that time the program will also conclude an Interim Architecture and Technology Review (IATR). The IATR is a four-month effort that culminates the Phase I Base Period and will provide the basis for architecture and technology down-selects. This is the next major milestone in the Space Launch Initiative. The outcome of the IATR will directly influence all follow-on activities. It will provide the basis to exercise Cycle I NRA 8-30 options or to terminate projects. Cycle II of the NASA Research Announcement (NRA 8-30) solicitation will be released in January 2002. Anticipated contract awards are scheduled for September 2002. This solicitation is the second under the 2nd Generation RLV program and will provide the first opportunity to address the technical gaps that were identified in the first round of solicitations. An Industry Briefing on Cycle II is scheduled for January 2002. The final amount and scope of contracts awarded under the Cycle II solicitation will depend upon the IATR results.

Program Office created and staffed at MSFC with 9 Project Offices at 6 NASA centers created and staffed. NRA 8-30 Cycle I solicitation is complete with multiple awarded contracts for the initial 2nd Generation RLV program solicitation (NASA Research Announcement NRA 8-30). Contracts were awarded in 10 technical task areas totaling approximately $800 million (includes base + options) to 23 companies. Specific areas include:

<u>System Studies and Architecture Definition</u>: Focused on research and technology development activities pertaining to system architectures and their appropriate risk reduction tasks. Integrated contracts were awarded to 4 industry partners and an additional contract was awarded under this task to conduct comprehensive market research and analysis. Results of the base period of these contracts will be presented during the Interim Architecture and Technology Review in March 2002.

<u>Airframe</u>: This task area focuses on the development and demonstration of the enabling technologies for robust, low cost, low maintenance structures, tanks, thermal protection systems and integrated thermal structures. Contracts were awarded to seven industry and academia partners.

<u>Vehicle Subsystem</u>: This task focuses on the definition, development and demonstration of a fault tolerant Vehicle Subsystems Architecture, and for the development and testing of power systems technologies, and high power flight control actuators. Two contracts were awarded to industry partners.

<u>Operations</u>: The task focuses on the development and integration of technologies for autonomous checkout and control of operational systems. The initial awards under this task are in the areas of advanced checkout and maintenance systems, and densified propellants.

<u>Integrated Vehicle Health Management</u>: The task focuses on the demonstration of the potential impact of an IVHM system to the program's safety and cost goals and the incorporation of enabling IVHM technologies into launch vehicle systems. Three contracts were awarded under in this area.

<u>Upper Stage Propulsion</u>: The contracts awarded under this task area are focused on non-cryogenic, low-toxicity propellant propulsion systems and the development of prototype component and systems for flight qualification. A total of four contracts were awarded during the initial selections.

Flight Mechanics: This effort is focused on the advancement of the current state-of-the-art flight software technologies that will enable robust guidance, navigation, and control systems for the next generation RLV. Two contracts were awarded during the initial selection process.

Propulsion: Contracts were awarded to six industry teams for the development of next-generation propulsion systems. The project includes tasks for main propulsion systems, orbital maneuvering system/reaction control systems (OMS/RCS), upper stages, main engines, and propellant management. Prototype hardware testing is scheduled for the 2004-2006 timeframe. Flight main engine design will be initiated in 2003 and will progress to Preliminary Design Review (PDR), at which time the 2nd Generation RLV program will make a decision for full-scale development.

NASA Unique: This activity is focused on the development of technologies for cargo carriers, rendezvous and docking systems, crew escape systems, and crew situational awareness. The initial solicitation process awarded two contracts under this task area. Additional contracts were awarded in December 2001 to initiate studies in crew-survivability and crew-escape systems technologies.

Flight Demonstrations: Currently this area consists of two tasks awarded under NRA 8-30 and the X37 project. The primary focus of the flight demonstrations project is the advancement and risk reduction of architecture enabling technologies: thermal protection systems, IVHM, flight operations, flight mechanics, and automated rendezvous. Successfully completed a series of X-40A flight tests and delivered the X-37 lower-fuselage assembly to Palmdale.

Program Documentation has been developed consistent with Agency Requirements, Program Plan, Level I Requirements Document, and Project Plans for all Technical areas, Risk Management Plan, and Systems Requirements Review documents.

Project Level Risk Reduction Reviews (RRR) will be conducted as an integral part of the IATR. The RRR will provide an integrated summary and status of the risk reduction activities performed by the industry partner for each technical task area.

The Interim Architecture Technology Review (IATR) is scheduled to conclude in March 2002. This activity will provide the basis for future architecture and technology decisions.

PROGRAM PLANS FOR FY 2003

The Space Launch Initiative plans to complete its Systems Requirements Review (SRR) in November 2002. This is the next step in the integration and synthesis of NASA, Industry and potential DoD requirements. This important review will result in more focused attention on fewer space transportation architectures and technology areas. .

Another Request for Proposal release is planned for February 2003, with contract awards planned for September 2003. This RFP is the next major milestone in the SLI process of focusing on architectures and technologies required to increase the safety and decrease the cost of space transportation systems. The solicitation will select the most promising architecture(s) to proceed toward a detailed preliminary design of competing 2nd Generation Reusable Launch Vehicle designs.

The program is executing the critical propulsion technology maturation as identified in NASA's prior Space Transportation Architecture Studies. To significantly increase the safety and reliability of space transportation systems and reduce their development and operational costs, the propulsion project is aggressively pursing multiple system concepts:

1) The Pratt and Whitney COBRA (Co-Optimized Booster Reusable Application) is a LOX/LH2 prototype engine with a single liquid/liquid fuel-rich preburner. The COBRA Engine Prototype Preburner Test Readiness Review will occur in December 2002, followed by the powerhead Test Readiness Review in March 2003 and the prototype engine system Critical Design Review in September 2003.

2) The Boeing/Rocketdyne RS-83 is a Fuel-Rich Staged Combustion (FRSC) engine design utilizing high-pressure turbopumps with integral low-pressure pumps and a gas/liquid main injector. Beginning in October 2002, the prototype engine Preliminary Design Review will be conducted followed by the Critical Design Review in June 2003. Subsystem level testing will begin in February 2003 with the Integrated Powerhead Demonstration test series and continuing forward with preparation for the Cross Feed system test later that year.

Propulsion development for vehicle on-orbit maneuvering and control systems will be initiated in November 2002 with the Technology Readiness Review of a two new auxiliary propulsion system (APS) designs: Lox/Ethanol and Lox/LH2. A prototype system will undergo a Critical Design Review in July 2003. These propulsion milestones will be subject to change pending the results of the IATR.

The Flight Demonstration project will greatly contribute to the program goals by servicing the needs of the technology projects through ground and flight demonstrations. Among the flight platforms, the **X-37 Approach and Landing Test Vehicle (ALTV)** will continue toward vehicle roll-out in early FY 2004 with the successful end-to-end hardware and software integration and testing. The ALTV will demonstrate critical autonomous approach and landing technologies as well as validate vehicle aerodynamics for the orbital X-37 vehicle.

The SLI program has also identified the need to develop the capability for the 2nd Generation RLV to perform autonomous rendezvous and proximity operations around a target vehicle such as the International Space Station. This capability will greatly reduce the cost of vehicle operations while on-orbit by reducing the manpower associated with proximity operations and docking. The **Demonstration of Automated Rendezvous and Technology (DART)** project, if selected beyond the base period of the current contract in CY 2002, will continue toward the launch of an orbital vehicle in FY 2004 with final hardware and software integration and testing followed by the Systems Acceptance Review. This vehicle will demonstrate the guidance, navigation, and control software and hardware sensors necessary to autonomously operate and rendezvous with a passive target vehicle. Multiple vehicle approach methods will be demonstrated as well a simulated Collision Avoidance Maneuver.

Vehicle Airframe Technology activities will continue in FY 2003 with the integration of an advanced **Integrated Vehicle Health Monitoring (IVHM)** sensor with completion of corresponding structural analysis algorithm development. Later in the year, this sensor will undergo actual flight tests to validate sensor performance. Also undergoing extensive thermal modeling and analysis is the Ultra High Temperature Ceramic (UHTC) thermal protection system. This material has been developed to reduce thermal loading experienced on a vehicle during orbital reentry without adding additional weight. A new high temperature Ceramic Matrix Composite (CMC) material, for protecting "sharp edged" flight control surfaces will also be evaluated this year.

Vehicle **Propellant Tank** development activities will proceed with component level tests of new tank joint concepts. The test results will lead to new joint designs enabling dissimilar materials and geometries to be joined for strength while eliminating leaks. Finally, results of these tests will lead to specifications for new cryogenic tank designs as well as developing engineering tolerances and post-flight inspection requirements.

Vehicle **Flight Operations** research and development in FY 2003 will gain a new "smart" umbilical quick disconnect (QD) prototype. This connector will allow automated connections of the vehicle to service facilities, thereby eliminating risk to service personnel, speeding operations and reducing overall costs. Innovative design concepts for ground equipment, which produce increased propellant density and performance, will undergo formal design review. The documented results will provide the foundation for the more detailed Critical Design Review (CDR) to follow later in the program.

In May of FY 2003, the **Flight Mechanics** project will test and demonstrate an interim release of advanced mission design software. This software technology is crosscutting as it applies to all vehicle architectures currently being investigated. A successful demonstration will advance the state-of-the-art by performing end-to-end mission design and automated flight software and mission-load generation, thus greatly reducing the operations cost currently associated with software development and mission design.

(Budget Authority in Millions of Dollars)

X-37 – LIFE CYCLE COST (LCC)	PRIOR	2002	2003	2004	2005	2006	2007	TOTAL
X-37 ACTIVITIES	95.5	26.0	22.1	0.0	0.0	0.0	0.0	143.6
TOTAL (EXCLUDES CIVIL SERVICE COST ($M)	95.5	26.0	22.1	0.0	0.0	0.0	0.0	143.6
(ESTIMATED CIVIL SERVICE FTEs	202	70	40	0	0	0	0	312
CIVIL SERVICE COMPENSATION ESTIMATE ($M)	19.1	6.7	3.8	0.0	0.0	0.0	0.0	29.6

BASIS OF FY 2003 FUNDING REQUIREMENT

SPACE TRANSFER AND LAUNCH TECHNOLOGY (STLT) PROGRAM

Web Address: http://www.spacetransportation.com/ast/astp.html

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
STLT PROGRAM	**101.8**	**111.0**	**120.2**
Rocket-Based Combined Cycle Project	20.4	29.4	37.2
Turbine-Based Combined Cycle Project	14.1	10.2	20.4
Hypersonics Flight Demonstrator Project (X-43C)	--	15.2	28.0
Revolutionary Technology	67.3	56.2	34.6
In-Space (Included above: Transfers to Space Science in FY02).	[9.7]	--	--
Construction of Facilities (Included above)	[12.0]	[18.0]	[4.0]

DESCRIPTION/JUSTIFICATION

The Space Transfer and Launch Technology (STLT) will pioneer the identification, development, verification, transfer, and application of high-payoff space transportation technologies. STLT is responsible for implementing the 3rd generation (Hypersonics) element of NASA's Integrated Space Transportation Plan. Other elements of the STLT are responsible for implementing in partnership with the Department of Defense long-term Reusable Launch Vehicle (RLV) research and space Science-funded In-Space technology developments. As a result of NASA's participation in the National Hypersonics Plan development, NASA has focused its 3rd Generation Reusable Launch Vehicle efforts on the unique, critical technologies required to meet these ambitious goals. The refocused efforts are centered around integrated ground demonstrations of rocket based combined cycle systems, turbine based combined cycle systems and flight demonstration of high speed scramjet propulsion/airframe integration.

STLT will conduct research and develop technologies that will provide the greatest total safety improvements and cost savings over the life cycle of a space transportation system or the life span of approved missions that would utilize that transportation system. The STLT will seek to advance technologies that enable missions that are currently not technically or economically feasible. These missions include airline-like earth-to-orbit transportation (3rd Generation RLV's) to enable new commercial space markets, ensure seamless aerospace national security and enable the human exploration and development of space. Fulfilling NASA's role as an investment in America's future, the STLT is looking well beyond the immediate space missions at hand, further toward routine access with airline-like operations along a vastly enlarged highway to space.

STLT is responsible for cross cutting research, technology development and demonstrations that provide revolutionary technology products that support internal and external customer needs. Technology maturity will be measured using the NASA Technology Readiness Level (TRL) scale. First, STLT will develop a long term foundational technology "pipeline" through low TRL (1-3) research investments. These will primarily be executed through the Propulsion Research and Technology (PR&T) and Airframe Research and

Technology Projects and will have strong in-house and university participation. Second, STLT will develop and demonstrate technology at the component and subsystem level (TRL 4–5). These will also primarily be executed through the Propulsion Technology and Integration (PT&I) and Airframe Research and Technology Projects. Third, STLT will demonstrate technologies at the system level in high-fidelity, focused ground demonstrations (TRL 5–6). These will also be executed in the PT&I Project. Current investments include parallel systems demonstrations of Rocket Based Combined Cycle (RBCC) and Turbine Based Combined Cycle (TBCC) systems. Fourth, STLT will demonstrate technologies (where required) in relevant flight environments through focused experimental vehicles. A large-scale vehicle/propulsion demonstrator will ultimately validate these technologies in-flight. These will be executed in the Hypersonic Flight Demonstrators Project. Current activities are focused on demonstrating hydrogen and hydrocarbon scramjet engines in-flight (X-43C) and planning for potential future combined cycle flight demonstrations. Technology products will be transferred to internal and external customers at all levels of development.

STLT will advance the state of the art in propulsion systems for low-cost, reliable and safe earth-to-orbit space transportation. Furthermore, STLT will develop technologies that are focused on advanced, breakthrough technologies in air-breathing and rocket systems and cross cutting activities that are the basis for improvements in these disciplines. STLT objectives are to increase safety, reliability, and operability through robust designs and applications while reducing operations, manufacturing, and development costs through advanced design techniques and robust testing.

STRATEGIC OBJECTIVE:	**PROGRAM APPROACH:**
Advance Space Transportation □ Mission Safety □ Mission Affordability	STLT will use an incremental approach, which includes decision points for programmatic change and provides valuable demonstrations. This will be done in a three-pronged approach: system studies for vision vehicles, research and focused technology development, and incremental ground and flight demonstrations. System studies will screen many launch vehicle options at a low level of fidelity, and selected options at a high level of fidelity. These systems studies will address architectures including Single Stage to Orbit and Two Stage to Orbit; Horizontal Takeoff and Horizontal Landing and Vertical Takeoff and Horizontal Landing; hydrogen, hydrocarbon, and dual-fuel; and many other propulsion options. The ground and flight technology demonstrators are focused on air-breathing propulsion systems. By going to flight, these demonstrator vehicles will also include airframe systems critical to affordable hypersonic flight. Following the X-43C testing, scramjet development will continue, both for the hydrocarbon, and hydrogen fueled engines. Development of the HyTech engine will continue to improve its robustness. Additional efforts will focus on integration of this engine into combined-cycle and combination engine applications. Development of the hydrogen fueled scramjets system will concentrate on hyper-velocity (Mach 10-16) flight conditions and include scramjet-to-rocket mode transition. Flight demonstration may be performed using a rocket-launched liquid-hydrogen-

	cooled/fueled vehicle. Flight validation of the complete hypersonic systems will allow development of a 3rd generation launch vehicle for NASA, or military applications. Authority to proceed is scheduled for late in the next decade with initial operating capability in the decade after next. In addition, spin-off research and technology can support other hypersonic military applications, such as missiles and global-reach vehicles, as well as commercial hypersonic vehicles.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Advance Space Transportation
Strategic Plan Objectives Supported: Mission Safety, Mission Affordability
Performance Plan Metrics Supported: APGs 3R7, 3R9

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-03 Change	Comment
Composite Cryogenic Tank and Integrated Structures demonstration		7/01	11/00	Complete	
RBCC Demonstrator conceptional design complete		9/01	11/00	Complete	
Initial Flowpath Definition & Testing Completed for RBCC Demonstrator		9/01	9/01	Complete	
ISTAR RBCC Demonstrator Systems Requirements Review (SRR) Completed	6/02	6/02	11/00		
Conduct RTA TBCC PRR and SRR	6/02	6/02	11/01		
Complete an external independent review of three revolutionary hypersonic propulsion technology systems demonstrations that include the RBCC, TBCC, and scramjet engines.	12/03	10/02	10/02	+3 months	Provide the time needed to ensure all concepts are be mature before review

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-03 Change	Comment
Complete the High Temp Composites Demonstration where significant weight reduction for RLV engine systems can be quantified through actual test data.	9/03	9/02	11/00	+12 months	Funding reprioritization delayed supporting technology development

Lead Center: Marshall Space Flight Center	**Other Centers:** Ames Research Center, Dryden Flight Research Center, Glenn Research Center, Johnson Space Center, Langley Research Center, Stennis Space Center	**Interdependencies:**
Projects	**Project Lead Center**	**Contractor / Location**
ISTAR RBCC	Marshall Space Flight Center	Boeing Rocketdyne Propulsion & Power / Canoga Park, Ca. Gencorp Aerojet / Sacramento, Ca. Pratt & Whitney / West Palm Beach, Florida
RTA TBCC	Glenn Research Center	Allison Advanced Development C0. / Indianapolis, Indiana GE Aircraft Engines / Endale, Ohio Pratt & Whitney / East Hartford, Ct Williams International / Walled Lake, Mi
X-43C	Langley Research Center	Allied Aerospace Industries Inc. (Micro Craft and GASL) / Tullahoma, TN and Ronkonkoma, NY Boeing Company / St Louis, MO and Long Beach, CA Pratt & Whitney / West Palm Beach, Florida
Program Product	**Builder (Location)**	**Product Benefit**
ISTAR RBCC	Boeing Rocketdyne Propulsion & Power / Canoga Park, Ca. Gencorp Aerojet / Sacramento, Ca. Pratt & Whitney / West Palm Beach, Florida	Develops rocket based, cutting-edge vehicle propulsion system utilizing propellants collected during flight
RTA TBCC	Allison Advanced Development Co. / Indianapolis, Indiana	Develops turbine based cutting edge vehicle propulsion system utilizing propellants collected during flight

	GE Aircraft Engines / Endale, Ohio Pratt & Whitney / East Hartford, Ct Williams International / Walled Lake, Mi	
X-43C	Allied Aerospace Industries Inc. (Micro Craft and GASL) / Tullahoma, TN and Ronkonkoma, NY, Boeing Company / St Louis, MO and Long Beach, CA, Pratt & Whitney / West Palm Beach, Florida	Demonstrates cutting edge vehicle propulsion system utilizing propellants collected from rarified atmosphere during flight

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

The initial flowpath definition and concept design iteration for the ISTAR RBCC demonstrator was also completed during September 2001. The initial flowpath definition was used as criteria for the ISTAR RBCC demonstrator engine selection.

The **Hypersonics Flight Demonstrator** project initiated the development of the X-43C concept in 2001. With project requirements defined, vehicle design candidates were proposed and the Vehicle Advanced Studies and Conceptual Design Contract was awarded. In addition, the project successfully completed the Composite Cryogenic Tank and Integrated Structures Demonstration, meeting a program-level milestone and resulting in significant weight reduction for RLV cryotanks. A five-month, $1.3M conceptual design effort resulted in a revised configuration, yielding improved performance and increased margins. A Project Requirements Review (PRR) and Interim Design Review (IDR) were also completed.

The **ISTAR RBCC** project achievements included the first ever trajectory simulation of an RBCC flowpath, transitioning from air-augmented rocket, to ramjet, to scramjet modes in a single test and sea-level static testing of Aerojet strutjet flowpath rocket thrusters. Pursuing flight demonstration of an RBCC engine system as the next logical step in combined cycle propulsion development, the ISTAR RBCC Project completed a major system study effort to help select an industry RBCC concept. The Aerojet strutjet concept was selected by this study for initial ISTAR RBCC development activities, successfully reaching the milestone for Initial Flowpath Definition for the RBCC Demonstrator. In 2001, accomplishments for the ISTAR Project included the Preliminary Requirements Review (PRR) and Conceptual Design Review (CoDR), successfully achieving mixing test requirements. System analyses were completed which resulted in a decision to use hydrogen peroxide as oxidizer for the demonstrator engine. In November, contract was awarded for the completion of the conceptual design activity to an industry consortium, RBC^3, consisting of Boeing Rocketdyne, Gencorp Aerojet, and Pratt & Whitney. The Systems Requirements Review (SRR) for the RBCC Demonstrator Engine will be completed in FY 2002.

In 2001, the **RTA TBCC** Project successfully completed an initial round of airframe and propulsion systems studies to evaluate potential TBCC concepts that show promise for meeting the ASTP goals for cost and safety. Specifically, a Two Stage To Orbit (TSTO) vehicle trade study was completed which determined TBCC thrust and speed requirements for a vehicle concept that was projected to have acceptable weight limits. A Mid Term Review (MTR) was held in July 2001 to review the four TBCC concepts that are being developed by the turbine engine manufacturers: General Electric, Pratt & Whitney, Williams International, and Allison Advanced

Development Company. These paper evaluation studies currently being performed will lead to an FY2002 downselect to the preferred approach for follow-on technology development and demonstration in the out years of the ASTP Program. Magnetic bearings have been identified to be an enabling technology for all TBCC approaches. In FY 2002, an initial test of a magnetic bearing concept was completed at NASA Glenn Research Center. This test demonstrated that the requirements for temperature, thermal cycles, and hours of operations could be met. Major events to be completed in FY 2002 will be the Preliminary Requirements Review (PRR) and Systems Requirements Review (SRR).

PROGRAM PLANS FOR FY 2003

In FY 2003, STLT will demonstrate advanced adhesives for non-autoclave composite processing where significant manufacturing cost reduction will be demonstrated. Additionally, STLT will complete an external independent review of the three revolutionary hypersonic propulsion technology systems demonstrations that include the RBCC, TBCC, and scramjet engines. Other achievements will include the High Temperature Composites Demonstration where significant weight reduction for RLV engine systems can be quantified through actual test data.

BASIS OF FY 2003 FUNDING REQUIREMENT

COMPUTING, INFORMATION AND COMMUNICATIONS TECHNOLOGY (CICT) PROGRAM

Web Address: http://www.cict.nasa.gov/

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
CICT Program	**165.6**	**155.9**	**154.0**
Intelligent Systems	53.8	63.8	79.7
Computing, Networking and Information Systems	50.2	44.2	37.0
Space Communications	19.2	9.1	7.6
Information Technology Strategic Research	42.4	38.8	29.7

DESCRIPTION/JUSTIFICATION

The CICT Program will research, develop, and use advance computing, information, and communications technologies to allow NASA to accomplish its commitments to United States taxpayers with greater mission assurance, for less cost, and with increased science return. CICT research and development, as an integral element of the Federal information technology investment, will also act as a catalyst for continued national excellence in information technologies.

Through its Strategic Plan, NASA has made the following commitments:

- To advance and communicate scientific knowledge and understanding of the 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 and space technologies.

In order to achieve these commitments, NASA must accelerate the infusion of new technologies and capabilities into its future missions. The Aerospace Technology Enterprise plays a fundamental role in achieving NASA's mission through the identification, development, verification, transfer, and commercialization of high-pay-off aerospace technologies. Within this role, the Enterprise seeks to pioneer basic research in revolutionary technologies, including information technology, nanotechnology, and biotechnology. The CICT Program supports the Enterprise's role by directly addressing the strategic goal of the Enterprise to pioneer technology innovation and its following objectives:

- Develop advanced engineering tools, processes, and culture to enable rapid, high-confidence, and cost-efficient design of revolutionary systems
- Develop revolutionary technologies and technology solutions to enable fundamentally new aerospace system capabilities and missions

To address these objectives, the CICT Program has established a Program goal to enable NASA's scientific research, space exploration, and aerospace technology missions with greater mission assurance, for less cost, and with increased science return through the development and use of advanced computing, information and communications technologies. Four Projects of CICT will meet this Program goal:

The **Intelligent Systems Project** will enable smarter, more adaptive systems and tools that work collaboratively with humans in a goal-directed manner to achieve NASA's twenty first century mission/science goals, including:

- Robotic exploration of deep space;
- Combined human-robotic exploration of Mars;
- Safe and cost effective operation of the Space Shuttle and follow-on launch vehicles;
- Use of Earth-orbiting satellites to establish cause and effect relationships associated with such important phenomena as global warming;

The **Computing, Networking and Information Systems Project** will enable seamless access to ground-, air-, and space-based distributed hardware, software, and information resources to enable NASA missions in Earth, Space and new Aerospace Technology capabilities.

Through seamless access to NASA assets, scientists and engineers will be able to focus on making new discoveries in science, designing the next generation space vehicle, controlling a mission or developing new concepts for the National Airspace system rather than on the details of using specific hardware, software and information resources.

The **Space Communications Project** will enable broad, continuous presence and coverage for high rate data delivery to users from ground-, air-, and space-based assets directly.

High rate data delivery is an enabling technology for NASA's twenty-first century missions, including:

- The Earth Science Enterprise Digital Earth Vision, in which all observing spacecrafts are in a distributed network to provide real–time multi-sensor information transfer directly to users.
- The HEDS Enterprise missions requiring multi-gigabit Internet-based communications in near-Earth orbit.
- The Space Science Enterprise missions requiring high rate communications from scientific spacecraft traveling to our outer planets and beyond in addition to intra-planetary networks for surface exploration.

The **Information Technology Strategic Research Project** will research, develop, and evaluate a broad portfolio of fundamental information and bio/nanotechnologies for infusion into future NASA missions.

Many of the missions in NASA's future will rely on technologies that are new and dramatically different from those in current practice today. The challenges of deep space exploration, hostile environments, and remote science create a need for new technologies that employ new materials, smaller, lighter, and less power consuming devices, highly reliable software and reconfigurable computing and information technologies.

In addition to these four Projects, two additional Projects are envisioned for initiation in the 2005 fiscal year following successful evaluations during the later part of the 2003 fiscal year of key predecessor technologies and capabilities. These two Projects are Systems Autonomy and Information Grid Systems. Based on successful development of key component autonomy technologies from the Intelligent Systems Project, the Systems Autonomy Project will conduct the research and development necessary to integrate various ground-based and on-board autonomy components into a fully integrated system. Meanwhile, the Information Grid Systems Project will build upon the advances in ground-based and space-based computing and networking advances to ultimately provide a seamless information environment for NASA's exploration and science missions.

By integrating and applying focused leadership to the Agency's information technology investments, the CICT Program will make coordinated and cost-effective strategic investments in fundamental computing, information and communication technology advancements required to enable and enhance a broad class of future NASA missions. The CICT Program will work closely with other NASA programs to ensure that relevant technologies are pursued for NASA missions.

STRATEGIC OBJECTIVE:	**PROGRAM APPROACH:**
Pioneer Revolutionary Technology - Engineering Innovation - Technology Innovation	Develop and demonstrate revolutionary computing, information and communications technologies in the specific areas of autonomy, human-centered systems, intelligent data understanding, advanced computing and networking, information environments, and fundamental information, bio- and nano-technologies. Integrate and transfer these new technologies into aerospace system capabilities and missions.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Pioneer Revolutionary Technology
Strategic Plan Objectives Supported: Engineering Innovation, Technology Innovation
Performance Plan Metrics Supported: APGs 3R11, 3R12

Milestones	**FY03 Date**	**FY02 Date**	**Baseline Date**	**FY02-03 Change**	**Comment**
Combine propulsion controlled aircraft (PCA) control laws with the intelligent flight control system (IFCS)		3/01	3/01	Complete	Conducted a full flight simulation demonstration of integrated PCA and IFCS for a representative transport aircraft. Ability to control and land aircraft with significant control surface failures has been demonstrated.

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-03 Change	Comment
Develop system software tools and techniques to enhance application performance		6/01	6/01	Complete	Demonstrated software tools to reduce parallelization time from months to one week while maintaining 50% application performance compared with manual parallelization
Develop tools and techniques to measure computing and communication capabilities		9/01	9/01	Complete	Demonstrated execution benchmarks (aerodynamic shape optimization for 3-dimensional transonic wing) implemented on nonlinear potential (TOPS) and Navier-Stokes flow solvers (ARC2D)
Adapt application codes for high performance testbed		9/01	9/01	Complete	Parallelized three relevant application codes and documented evaluation of parallelization tools. 3X performance in applications for aerospace through the integration of networking enhancements into application codes.
Demonstrate advanced networking tools and techniques on NASA mission-oriented applications		9/01	9/01	Complete	Demonstrated 3 applications inter-operating on multiple QoS enabled networks; 50Mbps (aggregate internal) multicast; gigabit performance between 2 NASA sites; and 2 applications utilizing enhanced hybrid networking
Research and Education Network (NREN) Project closeout.		9/01	9/01	Complete	Technology advances achieved in the Research and Education Network (NREN) Project were archived and documented for use by other programs.
Computational Aerospace Sciences (CAS) project closeout.		9/01	9/01	Complete	Technology advances achieved in the Computational Aerospace Sciences (CAS) project were archived and documented for use by other programs.
Develop and apply technologies to measure and enhance performance on high-performance computing testbed.		9/01	9/01	Complete	Demonstrated improvements on the parallelization of 6 aerospace analysis and design codes. Improved automated parallelization techniques to achieve at least 50% efficiency improvements over manual parallelization techniques.
Successfully complete reviews of the Intelligent Systems Program by External Technical Review Council and Mission Needs Council.		9/01	9/01		Partially completed. External Technical Review Council reviews conducted. Mission Need Council review cancelled and to be addressed in CICT Program Review planning.
Demonstrate a prototype data communications scheme for the National Airspace System.		9/01	9/01	Complete	Flight demonstrated (DC-8) communications architecture capable of secure multi-priority and multi-channel digital information transfer for future National Airspace System communications.

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-03 Change	Comment
Demonstrate remote connectivity to high data-rate instruments and distributed real-time access to instrument data.		9/01	9/01	Complete	Demonstrated remote connectivity to NASA experimental facilities and University laboratory/ instruments. Demonstrated 50Mbits communication rates functioning on distributed computing architecture.
Develop a combinatorial chemistry approach to define optimum catalyst composition for carbon nanotube growth coupled with an electrical field enhanced nanotube alignment approach.		9/01	9/01	Complete	Developed an approach for nanotube growth and alignment that was validated with the successful growth and alignment of a nanotube.
Demonstrate tools capable of directly verifying aerospace software with minimal effort and demonstrate 10-time improvement over baseline state of practice using the Mars Pathfinder Code		12/01	12/01	Complete	Demonstrated use of static analysis techniques to identify code errors and inconsistencies not detectable through standard compilation procedures. Use of this technique will reduce the requirements for time-consuming testing to detect and isolate these errors.
Complete a case-study demonstrating software verification and validation techniques that are applicable to Mars mission software, and benchmark current state-of-the-art.	6/02	6/02	6/02		
Develop and demonstrate in flight next-generation neural flight control technologies for aircraft and reusable launch vehicles.	6/02	6/02	6/02		
Participate as part of the MER 2003 flight team applying human-centered computing analysis and modeling techniques to evaluate and improve man-machine system performance for operations and science.	8/02	8/02	8/02		

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-03 Change	Comment
Develop conceptual high-level autonomy architecture for rovers collaboratively between Ames, JPL, CMU and other partners	8/02	8/02	8/02		
Demonstrate improvement in time-to-solution for aerospace applications through high-end computing and end-to-end networking capabilities.	9/02	9/02	9/02		Planned efforts have been updated based on program planning, prioritization and reorganization. Efforts will be integrated with CICT Exploratory Grid Environment milestone in 9/02
Demonstration of Space Communication Link Technology Operating at 622 Mega-bit per second for Direct Space Data Distribution to Users	9/02	9/02	9/02		
Design, fabricate and evaluate carbon nanotube electronic devices	9/02	9/02	9/02		
Human-centered computing Mars exploration rover study: Complete initial task analysis of planned Mars'03 mission operations	9/02	9/02	9/02		
Develop an exploratory grid environment that supports location-independent use of heterogeneous data sets and high confidence tools.	9/02	9/02	9/02		
Demonstrate the capability to perform pilot-in-the-loop redesign for an Enterprise-relevant aerospace vehicle design effort during a single test entry in a flight simulation facility using integrated, CFD, flight test, and wind tunnel data.	9/02	9/02	9/02		

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-03 Change	Comment
Demonstrate feasibility of nanotechnology-based chemical and biosensors and of manufacturing approaches for low-power nanoelectronic components.	9/02	9/02	9/02		
Demonstrate distributed analysis and data processing to support new problem solving paradigms.	6/03				
Discover a novel feature in skewed data using advanced data mining and feature extraction technologies	7/03				
Demonstrate individual autonomy component technologies to be included in a larger, integrated demonstration for the Mars smart landing mission	8/03				
Demonstrate very high power microwave sources to achieve 2 to 3 times increase in data transmission from Mars to Earth and as well as 10 times from Earth orbit to ground for the Mars smart landing mission	9/03				
Development and demonstration of molecular-electronics based chemical sensor technology for environmental health monitoring.	9/03				
Demonstrate certifiable program synthesis technology for verification and verification of advanced software for autonomy and aerospace vehicle control	9/03				

Lead Center: Ames Research Center	**Other Centers:** Dryden Flight Research Center, Glenn Research Center, Goddard Space Flight Center, Jet Propulsion	**Interdependencies:** NASA Space Science, AST, Earth Science, BPR, and HEDS Enterprises

	Laboratory, Johnson Space Center, Kennedy Space Center, Langley Research Center, Marshall Space Flight Center	
Project	**Project Lead Center**	**Industry Contractor (Location):**
Computing, Networking and Information Systems (CNIS)	Ames Research Center	
Space Communications	Glenn Research Center	
Intelligent Systems	Ames Research Center	
Information Technology Strategic Research	Ames Research Center	
Product	**Builder (Location):**	**Product Benefit**
Automated Reasoning	NASA in-house, multi-contractor and university effort	Autonomous science exploration missions that achieve high-level goals without instruction from human controllers
Human-Centered Systems	NASA in-house, multi-contractor and university effort	Technology which will allow for the elimination of at least one shift of operators for planetary exploration missions
Intelligent Data Understanding	NASA in-house, multi-contractor and university effort	Automatically discovery of new feature in large, distributed, heterogeneous database
Computing and Networking Environments	NASA in-house, multi-contractor and university effort	Technologies enabling ground-based and hybrid space/terrestrial computational grid
Information Environments	NASA in-house, multi-contractor and university effort	Integrated and collaborative environments for problem solving, research, and information management
Component Space Communications Technologies	NASA in-house, multi-contractor and university effort	Greater than 622 Mbits/second for near-Earth missions and 8 times the current data rate capability for planetary or deep-space missions
Space Communications Architecture	NASA in-house, multi-contractor and university effort	Architectures based on asymmetric heterogeneous networks designed for 50% coverage of Earth and planetary missions of Earth and planetary surfaces
Fundamental Info-, Bio- and Nano-Technologies	NASA in-house, multi-contractor and university effort	New bio, nano, or information technologies appropriate for transfer to another NASA program or project, or insertion into a NASA mission

PROGRAM STATUS/PLANS THROUGH 2002

In FY 2002, the **Computing, Information and Communication Technologies (CICT)** Program will continue to develop a seamless distributed computing and information system to support increased fidelity and reduced time-to-solution for NASA applications. Specifically, the CICT Computing Network and Information Systems (CNIS) Project will demonstrate key capabilities within relevant NASA aerospace design activities, including advanced space transportation vehicles research problems executed on an operational NASA communications grid. The NASA grid will represent an exploratory grid environment for location-independent utilization of data, computing assets, and high-confidence tools. Building upon previous advances in the integration of flight simulation capabilities into the design environment, CICT CNIS will also demonstrate the capability to perform pilot-in-the-loop redesign of an Enterprise-relevant aerospace vehicle during a single test entry in a flight simulation facility using integrated, CFD, flight test, and experimental data. Earlier, a prototype system was developed to demonstrate the feasibility and viability of this capability, which will enable the real-time evaluation and analysis of performance and handling characteristics from pilots for assessing aerospace vehicles that don't yet exist. Extending computing and communications into space, CICT Space Communications will advance high-end networking for NASA's future needs through the demonstration of Space Communication Link Technology operating at 622 Mega-bit per second. This will represent a dramatic improvement in the amount of data that can be transmitted and returned for scientific analysis and research.

In the CICT Intelligent Systems (IS) Project, FY 2002 will see the completion of major steps towards autonomous science exploration, including the development of the conceptual high-level autonomy architecture for planetary rovers. Collaborations have been formed with the Mars 2003 mission team to demonstrate the benefits of advanced planning and scheduling technology for automated sequence generation. The technology will be integrated into existing tools to be used by the mission and will be considered for incorporation into the mission following the demonstration. This effort is expected reduce by a factor of four the total amount of time required to generate an initial rover command sequence, allowing increased interaction between the science and engineering teams while also increasing the overall robustness of the sequence generation process. A human-centered computing study of planned Mars 2003 mission operations will provide valuable feedback and information for efficiency improvements in mission operations. CICT IS will also develop tools to improve the verification of autonomous software. A demonstration will be performed on aerospace software that will show a factor of 10 improvements in the time required to identify and isolate coding errors. This capability will also be exercised and validate on the Mars Pathfinder code. Later in the fiscal year, these tools and techniques will be further extended and will be applicable to future Mars mission software.

The CICT Information Technology Strategic Research (ITSR) Project will be making advances in the area of next-generation neural flight control technologies. These technologies will improve the safety and reliability of aircraft, and reduce the cost of control development for future aerospace vehicles. In FY 2002, CICT ITSR will also develop methodologies for producing revolutionary devices and structural materials by exploiting the interface between biotechnology and nanotechnology. Research will focus on creation of devices that exploit physical phenomena at the atomic/molecular level. Emphasis will be placed on the creation of nanoelectronic devices, as well as on increasing production of single-wall carbon nanotubes and on characterizing the first-order behavior properties of carbon nanotube materials. The feasibility of molecular level sensors and manufacturing approaches for low-power components will lead to the development and demonstration of a nanosensor in FY 2003.

Finally, the National Research Council's Aeronautics and Space Engineering Board will evaluate the ECT Program for research performer quality, technical and program quality, and customer relevance in FY 2002.

PROGRAM PLANS FOR FY 2003

In FY 2003, the **CICT Program,** through its CNIS Project will extend the capabilities of the NASA Communications Grid Environment through the demonstration of distributed analysis and data processing to support new problem solving paradigms. Specifically, the NASA Grid will be enhanced to address multi-Enterprise applications including demonstrations of key relevant aerospace and Earth science applications. CICT Space Communications (SC) will complete the development of ad-hoc space communications networks. This in-space networking capability will vastly improve science return by enabling the deployment of on-demand networking protocols in support of NASA's space and planetary exploration assets and inter-spacecraft communications. Very high power microwave sources will be demonstrated by the CICT SC Project to achieve a two- to three-fold increase in data transmission from Mars to Earth and as well as ten-fold increase from Earth orbit to ground. Power sources will be based on advance design of high power traveling wave tubes and semiconductor power amplifiers. These sources may be used as early as 2005 for Mars mission communications.

FY 2003 advances from the CICT Intelligent Systems Project will include a major demonstration of tools and techniques for intelligent data understanding. Specifically, feature recognition algorithms will be completed enabling the capability to automatically discover a novel feature within a skewed dataset. This will greatly enhance the capability to extract information and knowledge from the vast amounts of observational science data from Space Science and Earth Science missions. FY 2003 will also see significant advances in the development of autonomy technologies for NASA missions through the simulation of an autonomous science exploration mission. In particular, the demonstration of autonomous components operating independently during a mission simulation will be completed in FY 2003

In FY 2003, the CICT ITSR Project will develop efficient algorithms for automated generation of software designs and code, from requirements and specifications. This will include the development of program synthesis (or auto-coding) technology that enables product-oriented certification, rather than certification for flight based on traditional methods. This development will represent a significant advancement in the ability to certify and implement advanced software concept in mission critical systems. Also from ITSR, advances in Bio-Nanotechnology will see the development and demonstration of molecular-electronics based chemical sensor technology for environmental health monitoring. Additional future applications of this technology would include remote science exploration and sensor arrays.

BASIS OF FY 2003 FUNDING REQUIREMENT

ENABLING CONCEPTS AND TECHOLOGIES PROGRAM

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Enabling Concepts and Technologies Program	**112.4**	**92.8**	**92.9**
Energetics	33.9	20.31	21.6
Advanced System Concepts	6.0	13.0	12.0
Advanced Spacecraft and Science Components	32.6	19.5	19.3
Space NRA's	39.9	40.0	40.0

DESCRIPTION/JUSTIFICATION

The spectrum of potential NASA missions identified by science and exploration enterprises far exceeds NASA's ability to execute them using known technology. These missions span the understanding of the Earth as a system, probing the nature of the Sun and its interactions with the Earth, exploration of Mars and the other planets of the Solar System, and seeking the origins of the Universe and life within it. The scope and depth of the knowledge sought far exceeds the capability and affordability of NASA to deliver it. Revolutionary technologies are needed to enable missions that are currently technically infeasible or economically impractical.

The Enabling Concepts and Technologies (ECT) Program pioneers the identification, development, verification, transfer, and application of high-payoff aerospace technologies that are applicable across many types and classes of systems needed to accomplish NASA's missions. It is the front end of the enabling technology pipeline that feeds the focused technology development programs of the Enterprises. In FY 2003, the ECT Program encompasses the spacecraft systems and science instruments parts of the former Cross-Enterprise Technology Development Program (CETDP), adds a new advanced systems effort to guide technology investments, and introduces new incentives for transition of technologies to customer applications. The program invests in potentially high pay-off technologies that may involve considerable risk to achieving successful or rapid development.

The charter of the ECT Program is to provide revolutionary technologies that can enable NASA's strategic visions and expand future mission possibilities. The ECT Program provides fundamental research in advanced mission system concepts coupled with high-payoff spacecraft component technologies such as micro-electronic and mechanical systems (MEMS), high performance materials, and nanotechnology to stimulate breakthroughs that could enable new system concepts. Three technology development projects have been formulated to accomplish ECT Program objectives.

The **Advanced Systems Concepts Project** performs conceptual studies and systems analysis of revolutionary aerospace systems and concepts that have the potential to leap well past current plans, or to enable new visions for NASA's strategic plans. NASA Enterprise customers participate in these studies and provide input on system needs for requirements. Potentially enabling breakthrough technologies are examined in mission models and aggregated benefits of technology investments across multiple missions and mission classes are evaluated.

The **Energetics Project** seeks to develop advanced energetics technology to provide power and propulsion for enhanced mission capabilities and to enable missions beyond current horizons. NASA Enterprise customers provide inputs on system needs and requirements and regularly participate in reviews of the relevance of Energetics investments to their missions. Its technology foci include solar power generation, energy conversion and storage, power management and distribution, on-board spacecraft propulsion, and nuclear-electric concepts.

The **Advanced Spacecraft and Science Components Project** addresses advanced technology for sensing and spacecraft systems to enable bold new missions of exploration and to provide increased scientific return at lower cost. NASA Enterprise customers provide inputs on system needs and requirements and regularly participate in reviews of the relevance of Advanced Space and Science Components investments to their missions The project emphasizes advanced spacecraft and instrument systems technologies, including miniaturized sensors, micro-spacecraft components and subsystems, advanced active instruments, distributed spacecraft and sensor systems, resilient materials and structures, multifunctional and adaptive structures, space environment models, and analytical tools to predict environmental effects.

Two future projects, expected to start in FY 2005, Multi-Technology Integrated Systems, and Revolutionary Space Flight Research, will integrate advanced technology products from multiple projects into proof-of-concept systems to identify technical issues, to mature designs, and to validate performance in applications that will benefit future NASA missions.

The ECT Program departs significantly from past practice in NASA cross-enterprise technology programs that funded the delivery of a technology to a specific readiness level, and left it to chance as to whether it would reach end users. Instead, approximately 50 percent of ECT Program funding will be allocated for transition and insertion of technology products into the focused technology development and validation programs of Enterprises. Customer investment is required for the transition and insertion phases and is sought through negotiation with mission technology developers and competitive proposals to customer solicitations. Progress of tasks toward transition or insertion is considered in annual program reviews. Failure to attract partnerships for follow-on phases leads to a termination review in which the viability of continuing tasks without further customer investment is determined.

The ECT Program will develop systems analysis of mission classes to identify high-payoff technology areas and to establish performance goals for technology products in representative mission applications. In the exploration phase, systems analysis will be used to guide the selection of new tasks, and to assess the potential benefits of technology products currently under development relative to the state-of-the-art. In the transition phase, systems analysis will be used to prioritize areas for continued investment.

Broadly announced peer-reviewed NASA Research Announcements (NRAs) and other competitive announcements are used to capture innovative ideas from external organizations and to augment emerging critical capabilities. In FY 2002, $47M, almost half of the funding for the ECT Program, was devoted to tasks originally selected through broadly announced NRAs. The Advanced Systems Concepts Project sponsors annual solicitations for revolutionary systems concepts via an NRA managed by the university-led NASA Institute of Advanced Concepts. The ECT Program continues in FY 2003 a set of 112 tasks awarded in FY 2001 under the

Advanced Cross-Enterprise Technologies NRA issued in 1999 by the Office of Space Science. These tasks, managed by the Advanced Spacecraft and Science Components Project and the Energetics Project, encompass a wide range of technical disciplines including power and propulsion, sensors and instruments, optics, structures and materials, robotics, communications, and advanced computing infrastructures. These research projects are scheduled for completion by the second quarter of FY 2004. In FY 2001 an additional NRA for advanced polymer battery technology and, in FY 2002, for advanced space environmental effects technology, were awarded that will continue through FY 2003. Beginning in FY 2003 and continuing yearly afterward, the program will release NRA or other broadly announced solicitations from the ECT projects to fund new multiyear developments and activities for award in FY 2004. The solicitations will exclude NASA Centers and JPL from participation in order to enhance opportunities for cooperation between the NASA Centers and all potential awardees that can lead to successful transition, integration, and insertion to missions. Approximately 75 percent of funds for new technology will be applied to this broad solicitation process in which NASA centers do not compete. Funding is included under this program for selected Congressional special interest initiatives identified in the FY 2002 Appropriations Act.

STRATEGIC OBJECTIVE:	**PROGRAM APPROACH:**
Pioneer Revolutionary Technology • Technology Innovation	Seek and develop advanced ideas and concepts in spacecraft and science systems to enable new observation and measurement capabilities, vast improvements in efficiency of on-board resources supplied coupled with significant decreases in on-board resources required by science and mission systems, and breakthrough concepts in materials properties, structural packaging, and functional integration that can significantly improve the launch efficiency of mission payloads. Technologies that are applicable to a wide set of mission classes are emphasized. New ideas are sought in broad public announcements and within NASA. After an initial exploration period, promising developments are down-selected for transitional maturation toward potential mission applications. Customer involvement in the selection and funding of the transitional phase is actively pursued.
Advance Space Transportation • Mission Reach	Develop revolutionary approaches to reduce the time required for planetary missions by advanced propulsion technologies such as electromagnetic, nuclear fusion, and beamed energy sources. New ideas are sought in broad public announcements and within NASA. After an initial exploration period, promising developments are down-selected for transitional maturation toward potential mission applications. Customer involvement in the selection and funding of the transitional phase is actively pursued.

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Pioneer Technology Innovation, Advance Space Transportation
Strategic Plan Objectives Supported: Technology Innovation, Mission Reach
Performance Plan Metrics Supported: APGs 3R10, 3R12, 3R13

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-03 Change	Comment
Science Sensors and Detectors					
Demonstrate prototype 2.5 Terra-Hz local oscillator	1/03		1/03		
Demonstrate high-efficiency, tunable, narrow-line 2 micron laser transmitter for differential absorption LIDAR	7/03		7/03		
Large and Distributed Space Systems					
Demonstrate shape-memory-deployable composite boom	11/02		11/02		
Demonstrate shape-memory-deployable composite boom	11/02		11/02		
Demonstrate GPS-based multiple spacecraft attitude control for formation flying in a realistic environment	8/03		8/03		
Micro and Multi-Purpose Spacecraft Components and Systems					
Demonstrate proof-of-concept sun angle sensor on chip	5/03		5/03		
Power and Electric Propulsion Systems					
Demonstrate > 25% efficiency micro-ion engine	4/03		4/03		
Demonstrate feasibility of high efficiency (>30%) multi-band-gap solar cell on silicon substrate.	9/03		9/03		

Lead Center: Headquarters	**Other Centers:** Glenn Research Center, Goddard Space Flight Center, Jet Propulsion Laboratory, Langley Research Center, Marshall Space Flight Center	**Interdependencies:** NASA Space Science, AST, Earth Science, BPR and HEDS Enterprises
Project	**Project Lead**	**Contractors/Partners**
Energetics	Glenn Research Center	Ohio Aerospace Institute, Case Western Reserve University, over 20 universities and companies
Advanced System Concepts	Langley Research Center	NASA Institute of Advanced Concepts, Swales, Boeing
Advanced Spacecraft and Science Components	Headquarters	DARPA, NOAA, AFRL, over 40 universities and companies

Products	Developer	Project Benefit
New concepts for ultra-efficient spacecraft power and on-board propulsion	Glenn Research Center, Marshall Space Flight center, Jet Propulsion Laboratory, multiple contractors and universities	Significant spacecraft mass reduction, power and fuel efficiency increase, extended mission range and life
Revolutionary concepts for space mission systems	Langley Research Center, Jet Propulsion Laboratory, Goddard Space Flight Center, multiple contractors and universities	Identification of heretofore impossible or impractical missions enabled by revolutionary approaches and technologies
New concepts for ultra-compact and low power-draw spacecraft and instrument systems	Goddard Space Flight Center, Jet Propulsion Laboratory, Langley Research Center, Marshall Space Flight Center, multiple contractors and universities	Heretofore impossible or impractical science measurements and significantly reduced spacecraft power and launch volume/mass requirements

PROGRAM STATUS/PLANS THROUGH 2002

FY 2002 is a transition year for the **Enabling Concepts and Technologies (ECT)** Program. The Program is in the final year of scheduled development on approximately 200 three-year exploratory technology tasks in ten technology thrusts begun in FY 2000 under the Office of Space Science and the second year of approximately 115 exploratory tasks in the same ten themes awarded by NASA Research Announcements (NRA) in FY 2001. Investigators are distributed across university, industry, government and private laboratories, and NASA field Centers. Products being developed include a broad range of spacecraft and sensor devices that promise significantly reduced power and mass requirements, innovative antenna and optics concepts, and breakthrough concepts for energy generation and storage, and robotic exploration devices. In order to fully realize the value of the large number of technologies emerging from these exploratory studies, systems analyses are being devised to compute aggregated potential benefits of the technologies across NASA's mission classes. Mission technologists across NASA's enterprises are evaluating technology products from soon-to-be-completed tasks to determine where potential transition to mission application is warranted and whether further development of promising immature products for their needs is desired. In addition to the systems assessments and enterprise customer evaluations, the National Research Council Aeronautics and Space Engineering Board will evaluate the ECT Program for research performer quality, technical and program quality, and customer relevance in FY 2002.

PROGRAM PLANS FOR FY 2003

In FY 2003, the **ECT Program** will be restructured from the original ten themes into three projects that emphasize technologies to enable breakthrough capabilities in active science instruments, highly distributed, ultra-efficient and resilient space systems, and revolutionary mission systems studies. In response to the NASA Independent Assessment Team Report, a transition/insertion phase will be added to the ECT Program to address the difficult problem of assuring that new technology is advanced beyond the proof-of-concept stage to mission use. Beginning in FY 2003, a significant portion of program funds (eventually up to 50 percent) will be applied to advancing the most promising products from completed exploratory tasks for transition to mission applications based on customer and quality reviews and systems analyses performed in FY 2002. NRAs and in-house solicitations will be issued for the next phase of exploratory tasks for new ideas that can revolutionize NASA's mission capabilities with non-NASA awards comprising at least 75 percent of exploratory funding. Investment priorities will derive from FY 2002 systems studies and independent review results. Openly competed NASA Research Announcements (NRA) will be made and selections completed for award in FY 04 to replace the NRA tasks ending in FY 2003. Specific technology investments will include the following:

Advanced Systems Concepts Project - Revolutionary aerospace concepts selected annually through competitive NASA Research Announcements and internal competition. In-depth investigations of concepts down-selected from initial studies conducted in FY 2002 will be conducted. The renewal contract for operation of the NASA Institute of Advanced Concepts for external solicitation of advanced concepts will be openly competed.

Energetics Project - Advanced spacecraft energy production and storage systems including all-plastic batteries, long-life fuel cells, compact, high-speed flywheels, and advanced power management technologies. Advanced electric, electromagnetic, and nuclear propulsion technologies that offer the far term potential to revolutionize launch and orbital transfer.

Advanced Spacecraft and Science Components Project - Space-capable LIDAR instruments and efficient, long-life lasers to enable them; active sensor and focal plane concepts to enable new observation and measurement capabilities, formation flying control methods and spacecraft components to enable distributed instrument networks; and advanced multifunctional materials as well as spacecraft and instrument components that capitalize on their capabilities.

BASIS OF FY 2003 FUNDING REQUIREMENT

ENGINEERING FOR COMPLEX SYSTEMS (ECS) PROGRAM

Web Address: http:// dfs.arc.nasa.gov /

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Engineering for Complex Systems Program	**- -**	**28.0**	**28.0**
System Reasoning & Risk Management	- -	9.7	9.1
Knowledge Engineering for Safe Systems	- -	5.4	4.9
Resilient Systems & Operations	- -	12.9	14.0

DESCRIPTION/JUSTIFICATION

Recent problems in some NASA missions, along with similar or related problems in aerospace and general aviation, are symptomatic of the difficulty in synthesizing operational and design parameters. Safety is a system property, encompassing components, subsystems, software, organizations, human behavior, and their interactions. Yet, typically system design and analysis is de-coupled, addressing only components and subsystems; analysis of risk factors is usually sporadic, and deferred until integration occurs.

Engineering for Complex Systems is a paradigm shift in how systems engineering and operations are performed, and aims to place risk estimation and risk countermeasures for overall mission and human safety on a more rigorous, explicit, and quantifiable basis. This would allow design trades to be evaluated based on a risk factor, with the same fidelity and confidence used for other mission or system properties such as cost, schedule, and performance.

To address the human contribution to errors, and hence risk, models of human performance on certain tasks have been and continue to be developed. Such models, for instance, the frequency of incorrect assembly of a component or performance of some task can be defined as an error probability and built up from prior knowledge of human performance on similar sub-components of the complex task being undertaken. But, determining the required probability distribution functions for such operations can be difficult to obtain, or completely unavailable, causing us to rely on loose estimates, prior experience, or potentially unreliable computation in an uncertain environment.

As such, the key to Engineering for Complex Systems risk assessment will be the ability to reason about very large systems in a logical manner – rather than just by analyzing them mathematically. Indeed this is what the human expert does and the Engineering for Complex Systems program is intended to provide the human expert with a ‘cognitive prosthesis’ -- an extended reasoning capability -- to allow analysis of much larger systems using a computer’s ability to consider very large numbers of alternative combinations.

Although commercial and general aviation would undoubtedly benefit from the research technologies from this program, the spectrum of systems (vehicles and ground operations) of primary focus includes: (1) NASA and commercial space activity; (2) Manned, Reusable, and Expendable Launch Vehicles; (3) Planetary space missions; and (4) Military aerospace vehicles. The ECS Program will be closely coordinated across each of the NASA Enterprises as well as DOD, DOE, NIST, NSF, industry, and universities -- via partnerships and consortia. Customers for ECS developed capabilities, in addition to all of the NASA Enterprises, include aerospace industries, commercial software vendors and developers, and other government agencies, with potential to benefit major industries reliant on interdependent complex technologies – such as the energy development and distribution industry and the transportation industry.

The primary areas of research of the program are:

<u>System Reasoning and Risk Management (SRRM)</u> -- SRRM will conduct research into system complexity, design, and risk propagation profiles. The products from this research and development activity will include tools that better support risk analysis, design robustness, failure modeling, and system trade-offs throughout the entire engineering life cycle of the program. Model Based Reasoning will be a key technology to help systemize and automate the risk analysis, and accommodate the growing size and complexity of current and future programs.

<u>Knowledge Engineering for Safe Systems (KESS)</u> -- KESS will address several key issues. First, human and organizational risk factors play a critical role in all systems and their life-cycle phases, but there is significant under-representation of human and organizational risk factors in current systems engineering tools. Second, to understand the risk that these factors introduce into a system, it is essential to develop technologies and methodologies to capture and discover the effect of the human and organizational interactions - a knowledge management issue. Third, the lack of adequate knowledge management systems for discovery of trends from databases of lessons learned and system historical information must be addressed.

<u>Resilient Systems and Operations (RSO)</u> -- RSO will address Rigid, Non-adaptive Systems, by developing intelligent software technologies that provide robust and resilient operations, as well as advanced testing, validation, and diagnostic tools for risk reduction of these cutting edge software capabilities.

Through these research areas, the program will focus on technologies for understanding potential mishap precursors, addressing currently inadequate methodologies, and capitalizing on critical opportunities. As systems have become more complex and interdependent, the roles of software and human operators are causing problems with greater frequency; in contrast, hardware component failures are a decreasing subset of accident initiators. Current accident models are not adequate to guide risk and safety analyses under these conditions.

Simultaneously, existing probabilistic risk assessment (PRA) technology is unable to account for human errors, software deficiencies, and design flaws. Furthermore, PRA analyses aggregate the probabilities of failure based on linear, de-coupled events; yet events are more tightly coupled due to the increasing complexity. Therefore, new techniques and enhanced uncertainty distributions are needed to explore the large number of combinations for “what if” scenarios.

Although human errors have a higher likelihood of occurring than hardware failures, they are also the most adaptable when an unanticipated hazard occurs. New methods are needed to assess human and organizational risk to support individual and organizational responsibility for success. Learning from the adaptive capabilities of humans, autonomous systems will make systems and missions more resilient.

Another key point is that current knowledge is not available dynamically; instead it is often incomplete and usually inaccessible on demand. ECS will enable knowledge derived from experience and analytical reviews to be available at critical design and decision points.

NASA's Office of the Chief Engineer and Office of Safety and Mission Assurance will provide inputs to ECS on tool needs, requirements, and deliverables that could be incorporated in future NASA engineering and program review processes to improve NASA risk management.

STRATEGIC OBJECTIVE:	**PROGRAM APPROACH:**
Pioneer Revolutionary Technology - Engineering Innovation	Based on past mission mishaps and lessons learned, ascertain maximum coverage of issues that must be addressed, to develop new mishap investigation models including system complexity, human and organizational error, and software failures. Collaborate with industry, academia, and other Government agencies to include methodologies, research, and technologies that may be available from these sources to develop technologies for enhanced probabilistic risk assessment that include full life-cycle distributions of uncertainty. Develop modeling that provides for simulation across every combination of events; and develop reasoning technologies capable of identifying, quantifying, and analyzing risk across the full system life-cycle and which will allow for system response to reconfigure and adapt autonomously. - Infuse these modeling and reasoning technologies and methodologies across NASA Enterprises and collaborating partners, through the application of controlled test-beds to validate their usability at an early stage. Capture and apply lessons learned to allow for dynamic context sensitive advisory systems that support resilient tools to mitigate risk across the full system life cycle

LINKAGES TO STRATEGIC AND PERFORMANCE PLANS

Strategic Plan Goal Supported: Pioneer Technology Innovation
Strategic Plan Objectives Supported: Engineering Innovation
Performance Plan Metrics Supported: APG 3R11

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-03 Change	Comment
Prototype aerospace system mishap database	9/02	9/02	9/02		
Model-based health management system	9/02	9/02	9/02		
Initial organizational risk model	9/03		9/03		
Initial high dependability computing testbed	9/03		9/03		

Program Lead Center: Ames Research Center	**Other Centers:** Jet Propulsion Lab, Johnson Space Center, Kennedy Space Center, Goddard Space Flight Center, Glenn Research Center, Langley Research Center, Dryden Flight Research Center	**Interdependencies:**
Project	**Project Lead Center**	**Industry Contractor (Location)**
System Reasoning & Risk Management (SRRM)	Jet Propulsion Lab	TBD - new program
Knowledge Engineering for Safe Systems (KESS)	Ames Research Center	TBD - new program
Resilient Systems & Operations (RSO)	Ames Research Center	TBD - new program
Program Product	**Builder (Location)**	**Product Benefit**
SRRM - Integrated Risk Management technologies	Expected multi-contractor/university effort	Develop integrating frameworks and architectures to apply traditional risk models, SRRM developed models, and other technologies to improve risk assessment. This will include methods and tools to integrate both qualitative and quantitative information/knowledge in normative risk management decision-making process.
SRRM - Integrated System Modeling & Reasoning	Expected multi-contractor/university effort	Develop and mature tools that use models of system structure, behavior and function to identify hazards and assess risk. Understand how system mishaps occur, with particular emphasis on the role of system complexity as a contributing factor, and on analyzing complex designs using model-based methods for identifying potential system accidents.

SRRM - Sub-System Model Integration Methods	Expected multi-contractor/university effort	Develop and mature subsystem performance and failure models to be integrated into a larger analytical framework for assessing contributive risk of those subsystems.
KESS - Human & Organizational Risk Management	Expected multi-contractor/university effort	Develop methodologies to assess and mitigate human and organizational contributions to risk. Conduct research into the factors involved in individual/team decision making, including how people make decisions and take action, and how safety and risk in both operational and design context is assessed -- examine from individual, team and organizational cognitive perspectives. Develop knowledge products useful for mitigating risks under operational contexts.
KESS - Knowledge Management	Expected multi-contractor/university effort	Develop methodologies and tools to assist in the effective management of large, heterogeneous, distributed, and dynamic data and information systems.
RSO - Intelligent & Adaptive Operations & Control	Expected multi-contractor/university effort	Develop integrated autonomous operations and low-level adaptive flight control technologies to direct actions that enhance the safety and successes of complex missions despite component failures, degraded performance, operator errors, and environmental uncertainty.
RSO - Resilient Software Engineering	Expected multi-contractor/university effort	Develop software engineering tools and methods to reduce the risk of software in complex systems. Emphasis will be on techniques that use well defined, comprehensible and analyzable specifications of systems components and software requirements to manage risks introduced by technical communication gaps among life cycle phases, organizations, and subsystem elements.

PROGRAM STATUS/PLANS THROUGH 2002

In FY 2001 the **Engineering for Complex Systems (ECS)** Program a preliminary analysis of multiple case studies was performed. An initial program concept was defined, and presented at a 2-day workshop with participation from all NASA centers, academia, other Government agencies, and industry. Additionally, multiple workshops were held at the project levels to examine the proposed content. A call for technical concepts and capabilities was made across the agency, providing extensive insight into the current and proposed work from NASA in these areas. Technologies and concepts from other programs were discussed and additional information was obtained, including potential synergies to mature the technologies through the Technology Readiness Level band.

A study of existing technologies applicable to ECS solution set domains, performed by Andersen LLP (Global Aerospace Practice), was based on the initial work breakdown structure. A preliminary assessment of current industry investment in each of the technologies was made through interviews of industry and academia. The results of this study identified areas where industry investment (current and projected) was sufficient to cover technology needs; it also uncovered areas that required additional investment than planned. As a result of this, the work breakdown structure was adjusted to the current content.

A second study, performed by Battelle Labs, proposes measurement approaches for each ECS element for a set of success criteria with practical validated metrics to continuously track progress. Additionally, Battelle characterized alternative approaches to developing quantitative metrics to measure NASA's risk profile and track progress towards enterprise-wide risk reduction goals.

In FY 2002, the Mishap Cause Classification is being performed to define strategic investment areas and educate program personnel about mishap causes. The approach included the definition of a standard taxonomy for classification of mishap causes, which was validated by applying it to a sample of approximately 25 mishap investigations. In addition to this initial sample additional data from Aerospace Corporation and other industry sources will be analyzed utilizing the same taxonomy.

Additionally, ECS has developed program and project plans, decision packages, and detailed briefings for the Program Readiness Review, leading to the Non Advocate Review as a FY 2002 program. Also, long lead items and final feasibility and risk reduction tasks will be implemented during this time period. Planning for a NASA Research Announcement (NRA) solicitation to academia and industry is part of this process. The NRA constitutes a multi-year strategy to invest in key technologies and demonstrate those with the highest risk mitigation potential through applications projects.

PROGRAM PLANS FOR FY 2003

The **ECS Program** will develop the initial model of organizational risk that will serve as the basis for subsequent milestones. This tool will capture and analyze data relevant to social/organizational systems risks. Testing and validation of the model will be mission specific. High-fidelity testbeds will provide initial simulation of at least two NASA software systems; addressing risks in areas of dependability, performance/risk management, and complex, intelligent systems. These products will provide the basis to meet program objectives and deliver tools such as adaptive systems that can learn and react to complex and dynamic environments (FY 06) and decision tools for organizational risk management (FY 05).

BASIS OF FY 2003 FUNDING REQUIREMENT

COMMERCIAL TECHNOLOGY PROGRAMS

Web Address: http://www.nctn.hq.nasa.gov

	FY 2001	FY 2002	FY 2003
	(Millions of Dollars)		
Commercial Technology Programs	**162.4**	**163.8**	**146.9**
Commercial Programs and Technology Transfer Agents	51.3	48.7	35.6
Small Business Innovation Research Programs	111.1	115.1	111.3

DESCRIPTION/JUSTIFICATION

NASA's Commercial Technology Program includes Commercial Programs, Technology Transfer Agents and the Small Business Innovative Research (SBIR) Program. NASA's Commercial Technology Program enhances the NASA R&D mission through technology partnerships with industry, and facilitates the transfer of NASA inventions, innovations, discoveries or improvements developed by NASA personnel or in partnership with industry/universities to the private sector for commercial application leading to greater U.S. economic growth and competitiveness.

Commercial Programs introduces a balanced compliment of practices and techniques, which enable the Agency to more closely align and leverage its way of doing business with that of the private sector. The common denominator in these practices is technology partnerships. Technology partnerships are business arrangements among government, industry, and/or academia wherein each party commits resources to the accomplishment of mutually agreed upon objectives and shares the risks and rewards of the endeavor. By working together, NASA and industry can accelerate the incorporation into NASA of technologies of joint interest as well as commercial application further and faster, while also reducing the costs to both parties.

The success of Commercial Programs is accomplished through:

§ The establishment of productive joint technology development and application partnerships with industry.
§ An extensive outreach program (technology dissemination and marketing);
§ An e-commerce and technology information management network (via the Internet) that greatly facilitates the establishment of dual use technology partnerships with industry and transfer of technology, and which enables very efficient management of our technology business contacts and services;
§ Training and education of NASA employees to emphasize program relevance to national needs and to incorporate commercial practices in R&D program implementation;
§ The use of performance metrics that addresses management processes as well as bottom-line results;

The goal of Commercial Programs is to share the harvest of NASA's technology programs with the U. S. industrial/scientific community. The goal encompasses the commercialization of technology developed in all the Agency's Enterprises, in the recent past as well as current programs. The NASA Commercial Program mission includes a variety of mechanisms for achieving its goals: partnerships with industry/academia; federal/state/local alliances; emphasis on commercialization in new R&D procurements; electronic commerce; training and education of NASA employees/contractors; employee accountability; and application of performance goals/metrics.

The goal of Technology Transfer Agents is to facilitate the joint development of mission relevant technology and transfer of NASA (and associated capabilities) to the U. S. private sector for commercial application. The purpose of this program goal is to enhance U. S. industrial growth and economic competitiveness.

Established by Congress, the goal of the SBIR program (which includes NASA's Small Business Technology Transfer (STTR) programs) is to help NASA develop innovative technologies for use in its missions through competitive research contracts to U.S.-owned small businesses.

NASA's SBIR program pursues the widest possible award of NASA research contracts to the small high tech business and research community and promotes commercialization of the results of this research by the small business community.

Objective:	Commercial Technology **PROGRAM APPROACH**
Commercialize Technology	Establish R&D partnerships with industry to enhance the development of NASA mission technology, and to promote the application of NASA technology in US industry.

<u>LINKAGES TO STRATEGIC AND PERFORMANCE PLANS</u>

Strategic Plan Goal Supported: Commercialize Technology
Strategic Plan Objectives Supported: Commercial Technology Programs
Performance Plan Metrics Supported: 3P7, 3CK3

Milestones	**FY03 Date**	**FY02 Date**	**Baseline Date**	**FY02-03 Change**	Comment
Establish technology partnerships with industry	9/03		9/03		
Transfer NASA technology and innovations to the public sector	9/03		9/03.		

Lead Center:	Other Centers:	Interdependencies:
All centers involved	**All NASA centers & JPL**	**Project Benefit** Establish technology partnerships with industry at a level so that 10% - 20% of NASA's R&D activity is involved in partnerships. Expand the industry sector joint R&D initiatives to leverage industry R&D capabilities to enhance NASA mission focused R&D projects. Include 5 key NASA technology areas in the commercial industry sector initiative. Communicate to the public and to private industry the breadth and depth of NASA technology that is available for use in commercial products and services.

PROGRAM PLANS FOR FY 2003

Initiate plans to leverage and enhance the SBIR program through innovative business-like, but independent, venture capital organization.

Establish new approach to technology sponsorship activities through innovative partnerships with US industry.

Expand joint technology development activities with industry to enhance the return and value to NASA mission R&D programs. This action will include the establishment of new and/or enhanced performance metrics.

BASIS OF FY 2003 FUNDING REQUIREMENT

SBIR/STTR

Web Address: http://www.nctn.hq.nasa.gov

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
SBIR/STTR Program	**111.1**	**115.1**	**111.3**

DESCRIPTION/JUSTIFICATION

The (SBIR) program and Small Business Technology Transfer (STTR) Program help NASA develop innovative technologies by providing competitive research contracts to U.S.-owned small businesses and research institutions.

The SBIR/STTR programs include activities to enhance the commercialization of SBIR/STTR technology and to periodically assess the commercial performance of the NASA SBIR program.

Milestones	FY03 Date	FY02 Date	Baseline Date	FY02-03 Change	Comment
Issue SBIR/STTR solicitation	7/03		7/03		
Select SBIR awardees	12/03		12/03		

SBIR PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

Accomplished issuance of the SBIR solicitation and selection of awardees milestones as planned, and published the first edition of the SBIR commercial assessment. Complete installation of end-to-end web based solicitation, review, award, and contract administration in e-commerce environment.

SBIR PROGRAM PLANS FOR FY 2003

Complete the solicitation and selection actions milestones as scheduled. Issue an update to the SBIR commercial assessment study Develop new pilot program to enhance the SBIR technology utilization in NASA mission programs, and to leverage the investment community to promote commercial performance.

BASIS OF FY 2003 FUNDING REQUIREMENT

AEROSPACE INSTITUTIONAL SUPPORT

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
		Millions of Dollars)	
Research and Program Management (R&PM)	[712.1]	[805.0]	857.7
Labor	[571.9]	[608.8]	663.7
Travel	[15.5]	[16.2]	19.9
Research Operations Support (ROS)	[124.7]	[179.8]	174.1
Environmental	[12.6]	[20.7]	59.4
Construction of Facilities (CoF) - (Non-Programmatic)	[84.0]	[64.3]	56.1
Institutional Support to Aerospace Technology	**[808.7]**	**[889.8]**	**973.2**
Johnson Space Center	[0.4]	[4.7]	4.8
Kennedy Space Center	[7.9]	[5.7]	6.3
Marshall Space Flight Center	[83.8]	[101.8]	126.2
Stennis Space Center	[43.1]	[23.1]	21.4
Ames Research Center	[145.2]	[153.6]	148.8
Dryden Flight Research Center	[51.1]	[62.8]	63.2
Langley Research Center	[199.0]	[210.3]	218.0
Glenn Research Center	[174.6]	[175.0]	225.6
Goddard Space Flight Center	[13.7]	[11.9]	13.2
Jet Propulsion Laboratory	[0.6]	[0.8]	0.7
Headquarters	[89.3]	[140.1]	145.0
Distribution of Program Amount by Installation	**[808.7]**	**[889.8]**	**973.2**

* Numbers in brackets are the prior year totals to reflect a correct representation of the cross-year funding levels.
** The FY 2002 Funding estimate for ROS includes $8.0M provided in the Emergency supplemental to enhance NASA's security and counter-terrorism capabilities.

PROGRAM GOALS

The two primary goals of this budget segment is to:

1. Acquire and maintain a civil service workforce that reflects the cultural diversity of the Nation and is sized and skilled consistent with accomplishing NASA's research, development, and operational missions with innovation, excellence, and efficiency for the Aerospace Technology Enterprise.

2. Ensure that the facilities critical to achieving Aerospace Technology Enterprise program goals are constructed and continue to function effectively, efficiently, and safely; resources are focused on high-priority facilities by appropriately managing underutilized, outdated, and low-priority facilities; and that NASA installations conform to requirements and initiatives for the protection of the environment and human health.

RESEARCH AND PROGRAM MANAGEMENT (R&PM): provides the salaries, other personnel and related costs, travel and the necessary support for all administrative functions and other basic services in support of research and development activities at NASA installations. The salaries, benefits, and supporting costs of this workforce comprise approximately 79% of the requested funding. Administrative and other support is approximately 19% of the requests. The remaining 2% of the request is required to fund travel necessary to manage NASA and its programs.

CONSTRUCTION OF FACILITIES (CoF): provides for discrete projects required for capital repair of basic infrastructure and institutional facilities. Some NASA facilities are critical for the Aerospace Technology Enterprise and to military and private industry users. NASA has conducted a thorough review of its facilities infrastructure finding that the deteriorating plant condition warrants an increased repair and renovation rate to avoid safety hazards to personnel, facilities, and mission; and that some dilapidated, outdated, or underused facilities need to be replaced or shut down. Increased investment in facility revitalization is needed to maintain a facility infrastructure that is safe and capable of supporting NASA's missions.

ROLES AND MISSIONS

The detail provided here is for the support of the Aerospace Technology Enterprise institutions - Ames Research Center, Dryden Flight Research Center, Glenn Research Center, Langley Research Center, Marshall Space Flight Center, Stennis Space Center, and Goddard Space Flight Center.

AEROSPACE TECHNOLOGY RESEARCH CENTERS

AMES RESEARCH CENTER (ARC)

The Aerospace Technology Enterprise funds approximately 66% of ARC's Institution cost. ARC conducts aeronautics research in ground-based and airborne automation technologies, human factors, and operational methodologies for safe and efficient airspace operations. ARC provides Agency-wide leadership in conducting research and technology development to enable and foster the intelligent vehicle of the future through the implementation of integrated vehicle health management as a vehicle discipline. They provide high-fidelity flight simulations to support national goals in aviation safety and capacity, as well as vehicle development requirements. ARC conducts research, spanning computation through flight, for high-performance aircraft, to improve efficiency, affordability, and performance. ARC is also developing an integrated set of experimental and computational technologies built around an embedded information systems backbone, to provide rapid, accurate vehicle synthesis and testing capabilities.

ARC scientists and technologists conduct research on advanced thermal protection systems and perform arcjet testing to meet national needs for access to space and planetary exploration. ARC is the lead center for information technology efforts in the ECS program (formerly called Cross-Enterprise Technology). In addition, Ames is the lead center for the Intelligent Systems program, which provides critical, next-generation information technology capabilities for NASA missions and activities.

DRYDEN FLIGHT RESEARCH CENTER (DFRC)

The Aerospace Technology Enterprise funds approximately 88% of DFRC’s Institution cost. DFRC develops, manages, and maintains facilities and testbed aircraft to support safe, timely, and cost-effective NASA flight research and to support industry, university, and other government agency flight programs. Dryden personnel conceive, formulate, and conduct piloted and unpiloted research programs in disciplinary technology, integrated aeronautical systems, and advanced concepts to meet current and future missions throughout subsonic, supersonic, and hypersonic flight regimes. DFRC also provides flight test support for atmospheric tests of experimental or developmental launch systems, including reusable systems. DFRC's flight research programs are conducted in cooperation with other NASA installations, other government agencies, the aerospace industry, and universities.

GLENN RESEARCH CENTER (GRC)

The Aerospace Technology Enterprise funds approximately 73% of GRC’s Institution cost. As the NASA Lead Center for Aeropropulsion, GRC conducts world-class research critical to Aerospace Technology Enterprise goals of developing and transferring enabling technologies to U.S. industry and other government agencies. The Center’s Aeropropulsion programs are essential to achieving National goals to promote economic growth and national security through safe, superior, and environmentally compatible U.S. civil and military aircraft propulsion systems. The Aeropropulsion program at GRC spans subsonic, supersonic, hypersonic, general aviation, high-performance aircraft, as well as access-to-space propulsion systems. The program pursues innovative applications of research in turbomachinery materials, structures, internal fluid mechanics, instrumentation and controls, interdisciplinary technologies, and aircraft icing. GRC has research expertise in world-class facilities critical to ensuring U.S. leadership in aviation. FAA, EPA, and DOD in particular depend on NASA GRC research for advancements in emissions, noise, engine performance and new materials.

As the NASA Center of Excellence in Turbomachinery, GRC expertise is critical to advancing the Agency’s goals in our aeronautics and space programs and enables GRC to be a cost-effective resource across multiple Agency programs. Turbomachinery-based areas of expertise include air breathing propulsion and power systems, primary and auxiliary propulsion and power systems, on-board propulsion systems, and rotating machinery for the pumping of fuels/propellants.

LANGLEY RESEARCH CENTER (LaRC)

The Aerospace Technology Enterprise funds approximately 79% of LaRC's Institution cost. LaRC conducts advanced research in fundamental aerodynamics; high-speed, highly maneuverable aircraft technology; hypersonic propulsion; guidance and controls; acoustics; and structures and materials. LaRC provides technology base for improving transport, fighter, general aviation, and commuter aircraft. LaRC scientists and technologists conducting to study current and future technology requirements, demonstrate technology applications, and conduct theoretical and experimental research in fluid and flight mechanics to determine aerodynamic flows and complex aircraft motions. LaRC also conducts research to develop technologies and capabilities that permit the integration of widely distributed science, technology, and engineering teams and that provide advanced tools enabling the teams to create innovative, affordable products rapidly.

LaRC develops innovative new airframe systems to improve safety, reduce emissions and cut noise levels. These new airframe systems technologies improve environmental compatibility, increase capacity, and reduce cost per seat mile of commercial transport and general aviation aircraft. LaRC technologists conduct control and guidance research programs to advance technology in aircraft guidance and navigation, develop aircraft control systems, improve cockpit systems integration and interfacing techniques, and enhance performance validation and verification methods. LaRC also conducts research in aircraft noise prediction and abatement. LaRC personnel are pioneering the development of new materials, structural concepts, and fabrication technologies to revolutionize the cost, performance, and safety of future aircraft structures while creating radically new aircraft designs. LaRC provides Agency wide leadership and strategically maintains or increases the nation's preeminent position in structures and materials by serving as the NASA Center of Excellence for Structures and Materials.

LaRC scientists and technologists also conduct aeronautics and space research and technology development for advanced aerospace transportation systems, including hypersonic aircraft, missiles, and space access vehicles using airbreathing and rocket propulsion. Specific technology discipline areas of expertise are aerodynamics, aerothermodynamics, structures, materials, hypersonic propulsion, guidance and controls, and systems analysis. LaRC also conducts long-range studies directed at defining the technology requirements for advanced transportation systems and missions. In addition, LaRC develops technology options for realization of practical hypersonic and transatmospheric flight.

MARSHALL SPACE FLIGHT CENTER (MSFC)

The Aerospace Technology Enterprise funds approximately 33% of MSFC's Institution cost. The MSFC is the NASA Lead Center for space transportation systems development. The MSFC FTE's plan, direct, and execute research, technology maturation, advanced design and development, and sustaining engineering for NASA's next-generation space transportation systems. These systems include reusable launch vehicles and other associated transportation systems and subsystems. MSFC integrates program and project level planning, research, and development to ensure a well-balanced space transportation development program that meets the Agency's aggregate needs in a coordinated and integrated manner. MSFC develops technology in vehicle and propulsion systems, advanced manufacturing processes, and materials and structures. The Center conducts technology efforts, under contract including cooperative agreements, with the U.S. launch vehicle industry, to improve the competitiveness of current systems.

STENNIS SPACE CENTER (SSC)

The Aerospace Technology Enterprise funds approximately 35% of SSC's Institution cost. SSC supports the development of new and innovative propulsion technologies by providing propulsion test capabilities for the Space Launch initiative, including both 2nd Generation and 3rd Generation systems.

GOODDARD SPACE FLIGHT CENTER (GSFC)

The Aerospace Technology Enterprise funds approximately 3% of GSFC's Institution cost. GSFC directs the Wallops Flight Facility which provides institutional and technical support to LaRC, other NASA centers, and commercial users, who conduct flight studies of new approach and landing procedures using the latest in guidance equipment and techniques, pilot information displays, human factors data, and terminal area navigation.

HEADQUARTERS

The Aerospace Technology Enterprise funds approximately 37% of Headquarters' Institution cost. The Enterprise's Institutional Support figure includes an allocation for funding Headquarters activities based on the relative distribution of direct FTE's across the agency. A more complete description can be found in the Mission Support/two Appropriation budget section.

SCIENCE, AERONAUTICS AND TECHNOLOGY

FISCAL YEAR 2003 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE FLIGHT **SPACE OPERATIONS**

SUMMARY OF RESOURCES REQUIREMENTS

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET	Page Number
	(Millions of Dollars)			
Operations	361.2	[318.8]	[82.1]	SAT 5-2
Mission and Data Service Upgrades	73.8	[25.4]	[1.4]	SAT 5-3
Tracking and Data Relay Satellite System Replenishment Project	50.9	[117.5]	[16.5]	SAT 5-4
Technology	35.8	[20.5]	[17.5]	SAT 5-5
[Reimbursements [non-add]]	[[43.0]]	[[45.0]]	[[45.0]]	
Total	521.7	[482.2]	[117.5]	

Distribution of Program Amount by Installation

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
Johnson Space Center	247.6	[26.9]	[21.0]
Kennedy Space Center	37.1	[74.2]	[8.9]
Marshall Space Flight Center	9.5	[72.8]	[57.1]
Dryden Space Flight Center	12.8	[12.4]	[0.0]
Glenn Research Center	8.6	[3.5]	[3.4]
Goddard Space Flight Center	79.9	[111.0]	[14.3]
Jet Propulsion Laboratory	123.9	[175.2]	[7.5]
Headquarters	2.3	[6.2]	[5.3]
Total	521.7	[482.2]	[117.5]

Note – FY 2002 and FY 2003 data for comparison purposes only. See Space Communications and Data Systems under the HSF appropriation to discuss FY 2002 and FY 2003 activity.

BASIS OF FY 2003 FUNDING REQUIREMENT

OPERATIONS

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Space Network	7.0	--	--
Deep Space Network	142.2	[154.3]	--
Ground Network	33.6	[39.6]	[1.0]
Wide Area Network	99.7	[77.0]	[57.1]
Western Aeronautical Test Range	12.5	[12.0]	--
Spectrum Management	4.5	[2.5]	[0.6]
Standards Management	0.3	[0.7]	[0.7]
Operations Integration	58.8	[28.8]	[18.8]
Navigation and Communications Architecture	--	[0.3]	[0.3]
Program Management Support	2.6	[3.6]	[3.6]
Total	361.2	[318.8]	[82.1]

Note - See Space Communications and Data Systems section under the HSF appropriation to discuss FY 2001 activity.

BASIS OF FY 2003 FUNDING REQUIREMENT

MISSION AND DATA SERVICES UPGRADES

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Mission Services	33.9	--	--
Data Services	39.9	[25.4]	[1.4]
Total	73.8	[25.4]	[1.4]

Note - See Space Communications and Data Systems section under the HSF appropriation to discuss FY 2001 activity.

BASIS OF FY 2003 FUNDING REQUIREMENT

TRACKING AND DATA RELAY SATELLITE REPLENISHMENT PROJECT
(Thousands of Dollars)

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Spacecraft Development	14.0	[44.5]	[8.8]
Launch Services	36.9	[73.0]	[7.7]
Total	50.9	[117.5]	[16.5]

Note - See Space Communications and Data Systems section under the HSF appropriation to discuss FY 2001 activity.

BASIS OF FY 2003 FUNDING REQUIREMENT

TECHNOLOGY

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Advanced Communications	12.0	[13.9]	[13.6]
Space Internet	2.1	[0.6]	[0.3]
Virtual Space Presence	4.7	--	--
Autonomous Mission Operations	5.9	[0.9]	--
Advanced Guidance, Navigation, and Control	3.9	[2.6]	[1.0]
Standards	4.8	[2.5]	[2.6]
Technology Program Support	2.4	--	--
Total	35.8	[20.5]	[17.5]

Note - See Space Communications and Data Systems section under the HSF appropriation to discuss FY 2001 activity.

SCIENCE, AERONAUTICS AND TECHNOLOGY

FISCAL YEAR 2003 ESTIMATES

BUDGET SUMMARY

ACADEMIC PROGRAMS

SUMMARY OF RESOURCES REQUIREMENTS

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET	Page Number
	(Millions of Dollars)			
Education Programs	76.8	142.6	61.6	SAT 6.1-1
Minority University Research and Education Programs	55.9	84.7	82.1	SAT 6.2-1
Total	132.7	227.3	143.7	

SCIENCE, AERONAUTICS AND TECHNOLOGY

FISCAL YEAR 2003 ESTIMATES

BUDGET SUMMARY

ACADEMIC PROGRAMS **EDUCATION PROGRAMS**

SUMMARY OF RESOURCE REQUIREMENTS

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET	Page Number
		(Millions of Dollars)		
Student support programs	7.3	20.9	11.3	SAT 6.1-6
Teacher/faculty preparation and enhancement programs	8.4	9.6	9.2	SAT 6.1-8
State-based support of education**	35.8	40.8	30.4	SAT 6.1-10
Educational technology	23.7	69.7	9.1	SAT 6.1-14
Evaluation	1.6	1.6	1.6	SAT 6.1-18
Total	76.8	142.6	61.6	
Enterprise Program Funding *	{7.5}			
Total Program Funding	84.3	142.6	61.6	
Distribution of Program Amount by Installation				
Johnson Space Center	1.0	1.7	1.0	
Kennedy Space Center	0.6	0.6	0.6	
Marshall Space Flight Center	2.0	5.0	2.0	
Stennis Space Center	1.0	1.0	1.0	
Ames Research Center	2.7	5.7	2.7	
Langley Research Center	1.2	1.2	1.2	
Glenn Research Center	1.0	3.9	1.0	
Dryden Flight Research Center	0.5	0.5	0.5	
Goddard Space Flight Center	54.4	118.1	46.7	
Jet Propulsion Laboratory	0.5	0.5	0.5	
Headquarters	11.9	4.4	4.4	
Total	84.3	142.6	61.6	

*Note: $7.5M of the increase received in FY 2002 represents encumbered funding previously included in the Enterprise budgets.
**Renamed “Support for Systemic Improvement of Education” category.

PROGRAM GOALS

NASA's direction for education is set forth in the NASA Strategic Plan through the Agency's Communicate Knowledge crosscutting process objective to support the Nation's education goals:

> ***Educational Excellence.*** *We involve the educational community in our endeavors to inspire America's students, create learning opportunities, and enlighten inquisitive minds.*

This objective is accomplished through implementation of a full range of NASA education programs and activities that contribute to the various efforts and activities of those involved with and in the education community, and benefit the participants as well as advance the mission of the Agency. Progress towards this goal is measured in two ways:

- **Excellence:** NASA seeks to be judged by its customer, the education community, as providing excellent and valuable educational programs and services. Therefore we will attempt to maintain an "excellence" rating ranging between 4.3 and 5.0 (on a 5.0 scale) as rated by our customers.
- **Involvement:** NASA strives to involve the educational community in our endeavors. Therefore, at the proposed funding level, we seek to maintain a current level of participant involvement of approximately 3 million with the education community, including teachers, faculty and students.

STRATEGY FOR ACHIEVING GOALS

In carrying out its Education Program, NASA is particularly cognizant of the powerful attraction the NASA mission holds for students and educators. The unique character of NASA's exploration, scientific, and technical activities has the ability to capture the imagination and excitement of students, teachers, and faculty, and channel this into education endeavors which support local, state, and national educational priorities. In fulfilling its role to support excellence in education as set forth in the NASA Strategic Plan, the NASA Education Program brings students and educators into its missions and research as participants and partners. NASA provides the opportunity for a diverse group of students and educators to experience first hand involvement with NASA's scientists and engineers, facilities, and research and development activities. The participants benefit from the opportunity to become involved in research and development endeavors, gain an understanding of the breadth of NASA's activities, and return to the classroom with enhanced knowledge and skills to share with the education community.

The NASA Implementation Plan for Education provides general guidance for the implementation and continual improvement of the NASA Education Program for fiscal years 1999-2003. Specifically, the plan

- Identifies three leadership strategies to improve and guide the NASA Education Program: (1) contribute to educational excellence; (2) develop alliances; and (3) involve the education community.
- Outlines the education agenda for this period through seven improvement initiatives: (1) focus and coordinate state-based efforts; (2) enhance instructional products and dissemination; (3) improve education program integration and coordination;

(4) facilitate NASA research in the higher education community; (5) support preservice education; (6) target informal education; and (7) implement NASA's comprehensive data collection and evaluation system.
- Delineates the operating principles integral to the conduct of all NASA education activities: customer focus; collaboration; diversity; and evaluation.

- Defines the NASA Education Program and Evaluation Framework, the basis from which our agency-wide and center-based programs are organized, implemented, and evaluated. This framework includes student support, teacher/faculty preparation/enhancement, systemic improvement of education, and educational technology program categories, as further described in this narrative.
- Describes the roles and responsibilities of the various organizational entities that carry out the NASA Education Program.

This plan provides guidance for an agency-wide Education Program as administered by the Office of Human Resources and Education as well as programs and activities carried out by the NASA Enterprise Offices, the Office of Equal Opportunity Programs and the NASA Field Centers.

Program Evaluation

The NASA Education Program and Evaluation Framework was established to serve as a model to guide the implementation and evaluation of NASA's Education Program. NASA continues to further refine and implement the framework and the evaluation system that was first pilot tested in FY 1996. Three levels of performance measures have been developed. At the top level, all programs have measurements that relate to the Program's primary metrics: excellence and involvement. Data showing progress towards these metrics are provided below. At the second level, each implementation approach has specific measures that all programs in a particular category are measured against, such as career goals, program value and overall quality, curriculum integration/use, standards awareness and utilization, partnerships/alliances, service quality, and usage. At the third level, each program, in addition to the applicable second level measures, has program specific measures that show progress as well as participant written feedback that provides quality evaluation data.

ACCOMPLISHMENTS AND PROPOSED RESULTS

FY 2001 Achievements

In FY 2001, the NASA evaluation system was able to collect data on the agency-wide education programs, and many center- or Enterprise-specific programs and activities. The data below summarize the top-level measures that relate to the Education Program's two metrics - - excellence and involvement.

- **Excellence**: NASA seeks to be judged by its customer, the education community, as providing excellent and valuable educational programs and services. Therefore we will attempt to maintain an "Excellence" rating ranging between 4.3 and 5.0 (on a 5.0 scale) as rated by our customers.

Progress towards this metric is measured by a quality rating of NASA's performance by the educational customer. The following data were collected:

Participant ratings of excellence (score: 5=excellent to 1=very poor; total participants reporting: 8,741 to 18,269 participants responding; not all participants are asked all 4 questions; 134 programs reporting)

- 4.63 Recommend to others
- 4.66 Rate staff
- 4.56 Expect to apply what was learned
- 4.62 Valuable experience
- Overall average for excellence: 4.62

Based on this information, the NASA Education Program continues to meet its metric of excellence, as defined by the level of satisfaction expressed by our customers.

- **Involvement**: NASA strives to involve the educational community in our endeavors. Therefore, at the proposed funding level, we seek to maintain a current level of participant involvement of approximately 3 million with the education community, including teachers, faculty, and students.

Progress towards this metric is measured in two ways: (1) total number of participants, including students/teachers/faculty/administrators involved in NASA education programs; and (2) number of partnerships/collaborations. The following data were collected:

Participants

- Total in-person involvement in NASA Education activities: 3,654,916
- Participants identified by type:
  - Students: 28%
  - Teachers/faculty: 35%
  - Administrators, civic, parents, etc.: 37%
- Types of K-12 schools represented (4,097 participants reporting)
  - 29% urban; 31% suburban; 40% rural

Partnerships

- 7,094 instances of alliances (133 programs)
- higher education institutions; industry; contractors; other NASA facilities; Educator Resource Center Network; nonprofits; local community; school districts

It is clear from the numbers provided above that the NASA Education Program continues to exceed the metric of involving 3 million direct participants in our programs, and we anticipate continuing to do so in FY 2002.

FY 2003 PLANS

In FY 2003, NASA's Education Program funding request of $61.6M provides for continued maintenance of a broad, comprehensive education program. This request provides core funding for agency-wide student support, teacher/faculty preparation/enhancement, support for systemic improvement, educational technology, and evaluation programs, as outlined in the following sections. Under this funding scenario, three major challenges continue to confront the Education Program: 1) how to strengthen the competitiveness and the stability of the core university program; 2) how to responsibly manage Congressionally directed programs in ways that meet the intent of Congress, represent responsible use of funds, and fit within the framework of NASA's Education Program; and 3) how to implement the NASA Science and Technology Scholarship Program.

BASIS OF FY 2003 FUNDING REQUIREMENT

STUDENT SUPPORT PROGRAMS

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Elementary and secondary	3.8	4.3	3.9
Higher education	3.5	16.6	7.4
Total	7.3	20.9	11.3

PROGRAM GOALS

To use the NASA mission, facilities, human resources, and programs to provide information, experiences, and research opportunities for students at all levels to support the enhancement of knowledge and skills in the areas of science, mathematics, engineering, and technology.

STRATEGY FOR ACHIEVING GOALS

Student support activities: (1) provide NASA mission experiences and information that are designed to promote students' interest and achievement in science, mathematics, engineering, technology, and geography; (2) provide exposure to NASA research and/or research experiences and activities to promote science, mathematics, technology, engineering, and geography career awareness; (3) provide support to the science and technology workforce pipeline by including greater participation of individuals who are underrepresented in science, mathematics, engineering, technology, and geography in NASA student programs; and (4) increase the number of NASA student support opportunities through partnerships and interagency cooperation and collaboration. Examples of how these objectives are put into practice are provided below.

Activities such as the NASA Student Involvement Program (NSIP) provide general exposure to NASA's mission and stimulate interest in mathematics, science, and technology subject matter by providing opportunities for students to develop experiments to be tested in or on a NASA research facility. Additional activities such as the Summer High School Apprenticeship Research Program (SHARP), demonstrate the applications of mathematics, science and technology by providing research experiences for students who traditionally have not been represented in mathematics, science and engineering fields. These experiences take place at NASA field centers or at university laboratories. At the higher education level, activities such as the Graduate Student Researchers Program (GSRP) provide support to train students in NASA-related disciplines at both the master's and doctoral levels, again providing actual field center experience when applicable.

MAJOR RESULTS IN THE PAST YEAR

In FY 2001, 1,034,701 students participated in NASA education activities. Elementary/secondary students comprised almost 93% of that number, in a variety of programs, projects, and activities. Also in FY 2001, NASA completed the pilot year of the Undergraduate Student Research Program, a coordinated, agency-wide, research opportunity for undergraduate students. This program is designed to increase diversity in the pipeline for NASA and to fill a gap in programs at the undergraduate level, providing a bridge from our high school programs to our graduate programs. For the pilot year, we received over 1100 applications, selecting 107 students. The demographics of this group included: 52 women, 44 minorities; 62 "rising" seniors and 45 juniors; "Class" GPA: 3.65. Applications were received from all states; students placed were from 30 states, plus Puerto Rico.

PROGRAM PLANS FOR FY 2003

In FY 2002, funding for Student Programs has been increased due to the planned development and implementation of a NASA Science and Technology Scholarship Program. These competitive scholarships will be awarded only for study in disciplines critical to NASA's future needs. NASA is seeking authority to establish a service requirement as a condition for receiving these scholarships, to ensure that our investment will provide an important source for bringing the best and brightest into NASA. Additional funding in FY 2002 was provided for an increase in stipends for graduate fellowships and an increase in participant opportunities for undergraduate research. Pending the "for-service" authority, a critical element of the program, no further funding has been requested for this program in FY 2003 and program implementation plans are currently on hold.

BASIS OF FY 2003 FUNDING REQUIREMENT

TEACHER/FACULTY PREPARATION AND ENHANCEMENT PROGRAMS

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Elementary and secondary	3.7	4.2	4.2
Higher education	4.7	5.4	5.0
Total	8.4	9.6	9.2

PROGRAM GOALS

To use the NASA mission, facilities, human resources, and programs:
(1) to provide exposure and experiences to educators and faculty;
(2) to support the enhancement of knowledge and skills; and
(3) to provide access to NASA information in science, mathematics, technology, engineering, and geography.

STRATEGY FOR ACHIEVING GOALS

At the elementary and secondary level, preparation and enhancement activities are designed to (1) provide NASA mission-based programs that introduce the application of science, mathematics, geography, engineering, and technology for use in student learning activities; (2) provide educators with a wider range of alternatives using scientific inquiry, based on the NASA mission; (3) encourage a “multiplier” effect to expand the benefits of the in service program beyond participants to include additional educators; (4) provide access to and promote utilization of NASA related materials and information resources; (5) increase the participation of under-served and under-utilized individuals and groups; and (6) facilitate collaborations between the faculty of teacher preparation departments and the faculty of scientific and technical departments to develop innovative approaches to teacher preparation. Examples of how these objectives are put into practice are provided below.
Pre-service programs such as Project NOVA, and in-service programs such as the NASA Education Workshops (NEW) and the Urban and Rural Community Enrichment Program (URCEP) are designed to enhance and improve the teaching of mathematics, science, and technology by demonstrating their applications in aeronautics and space through workshops around the country, in school districts and at NASA field centers. The Teaching from Space Program continues to provide instructional products that help support these preparation and enhancement workshops, drawing from in-flight experiences of Space Shuttle and International Space Station crews.

At the higher education level, activities are designed to enhance faculty research skills and content knowledge; balance participation so that a cross-section of colleges and universities is represented (i.e., community colleges, four year institutions, institutions that serve significant numbers of underrepresented groups, under funded institutions); and provide opportunities for curriculum expansion/revision that aligns with the mission needs of NASA and universities. Activities such as the NASA Faculty Fellowship Program (NFFP) provide research experiences for faculty at ASA field centers to further their professional knowledge in the engineering and science disciplines, and to ultimately enhance the undergraduate/ graduate curriculum.

MAJOR RESULTS IN THE PAST YEAR

In FY 2001, 1,286,887 educators and faculty participated in NASA education activities. K-12 educators comprised approximately 97% of that number.

In FY 2001 teacher/faculty preparation/enhancement programs expanded the scope of educator enhancement programs to include workshops at each center for institutions in their region that serve informal education and urban/rural systemic efforts; provided education experiences for educators in the effective application of educational technologies; and defined and executed activities that targeted preservice education programs. The year also brought, with the staffing of the International Space Station, the opportunity to integrate ISS into many of our existing teacher workshop activities.

In FY 2002, we will begin the redesign of our center-based NASA Education Workshop (NEW) program, in an effort to better meet the needs of today's educators, and to broaden the reach of the program.

FY 2002 will also mark the first year of the redesigned NASA Faculty Fellowship Program (NFFP). A combination of the Summer Faculty Fellowship Program and the JOVE Program, the NFFP has been redesigned to provide for greater follow-on research opportunities for participating faculty and better linkages with the undergraduate curriculum.

PROGRAM PLANS FOR FY 2003

In FY 2003, funding for Teacher/Faculty Preparation/Enhancement Programs will be maintained at the same approximate level as in FY 2002. Changes in funding reflect some internal programmatic requirements and priorities. Based on the requested funding level, participation levels for K-12 activities should also remain at similar levels. However, challenges such as faculty stipends continue to confront the higher education program.

BASIS OF FY 2003 FUNDING REQUIREMENT

STATE-BASED SUPPORT OF EDUCATION

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Aerospace Education Services Program (AESP)................................	6.2	6.2	--
National Space Grant College and Fellowship Program.....................	19.1	24.1	19.1
Experimental Program to Stimulate Competitive Research...............	10.0	10.0	4.6
Innovative Reform Initiatives...	0.5	0.5	--
State-based programs..	--	--	6.7
Total..	35.8	40.8	30.4

PROGRAM GOALS

To use NASA's unique assets to support local, state, regional science, mathematics, technology, engineering, and geography education improvements through collaboration with internal and external stakeholders.

STRATEGY FOR ACHIEVING GOALS

NASA is committed to supporting state-based initiatives in the areas of science and mathematics education, and its activities vary depending on the needs of the institution, school system, and/or state. Thus, the activities supported by programs included in this category seek to provide a range of support in response to the needs of the customer community.

State-based activities are designed to: (1) coordinate planning among NASA education initiatives to ensure alignment with and support of standards-led improvement initiatives of the states; (2) redirect existing education programs, and ensure new initiatives address state needs and tie together unique education and economic development efforts; (3) support standards-based science, mathematics, technology, and geography education change by aligning NASA educational programs and products with the national/state standards; and (4) expand interactions with external stakeholders involved in the improvement of education at all levels.

A major program at the elementary and secondary education level is the Aerospace Education Services Program (AESP). The AESP's primary focus is teacher enhancement with emphasis on and support for local, state, and regional mathematics, science, and technology education efforts through collaboration of internal and external stakeholders in high impact reform activities.

State-based activities at the higher education level use partnerships, linkages, and collaborations to provide activities and experiences designed to enhance research and educational capabilities, and enhance the collaborative capabilities of a diverse set of academic institutions. Programs such as Space Grant and the Experimental Program to Stimulate Competitive Research (EPSCoR) play a major role in NASA's contribution towards these efforts.

The Space Grant Program, authorized by Congress in 1987, increases the understanding, assessment, development, and use of aeronautics and space resources. All 50 states, Puerto Rico, and the District of Columbia have Space Grant Consortium programs in which more than 790 affiliates participate. These consortia form a network of colleges and universities, industry, state/local governments, and nonprofit organizations with interests in aerospace research, training, and education.

The NASA EPSCoR Program provides research funding that enables eligible states to develop an academic research enterprise directed toward long-term, self-sustaining, nationally competitive capabilities in space and Earth science and applications, aeronautical research and technology, biological and physical research and applications, and space research and technology programs. This capability will, in turn, contribute to the state's economic viability. In FY 2001, the NASA EPSCoR program went through a redesign process to better align the research opportunities funded by the program with the research priorities of the Enterprises. Proposers were required to establish linkages with NASA Centers to ensure that the proposed research was relevant to NASA as well as contributed to the state's research infrastructure.

Systemic improvement at both the pre-college and higher education levels is captured in NASA's Innovative Initiatives program which is supportive of standards-based systemic improvement efforts, and focuses on science, mathematics and technology education. A means of supporting improvement is through partnerships with professional education associations, national aerospace education associations, industries, other Federal agencies, and state and local groups. When NASA becomes a partner with these groups, its role may be one of leadership, participation or facilitation to empower and enable wide reaching educational reform that is systemic in nature. An example of these partnerships is NASA's work with the National Alliance of State Science and Math Coalitions (NASSMC).

MAJOR RESULTS IN THE PAST YEAR

Performance in this area is measured in a variety of ways, including partnerships/alliances, supplemental funding, and standards. In FY 2001, NASA documented 7,094 alliances with a variety of partners (note, a program may be involved in multiple alliances), as measured below:

4% NASA Contractors; 5% Other Industry; 6% Local Community; 2 % Museums/Planetariums; 3% Non Profit; 2% Federal Agencies; 28% Higher Education Institutions; 7% Other NASA; 18% K-12 Schools; 11% K-12 School Districts; 7% NASA HQ Program Office; 1% State Government; 4% Educator Resource Centers. Partners included schools (K-12 and higher education), industry, and nonprofit organizations.

More than $72M was secured in supplemental funding, of which 25% came from other Federal agencies, 11% from state agencies, 28% from educational organizations and institutions; 2% from industry/business, and local organizations.

The data below provide examples of accomplishments of the two largest programs—Space Grant and EPSCoR:

Space Grant (FY 2000 data)

- 52 University-based Consortia
- Space Grant involves 792 affiliates which include:
  - 513 colleges and universities
  - 69 business/industry
  - 41 State and local government agencies
  - 169 other affiliates (science museums, not for profits, etc.)
- $55M in matching funds (31% university; 29% other Federal, 10% industry; 19% other; 11% local/state government)
- 2,249 fellowships and scholarships (75% undergraduate; 22% under represented groups; 42% women)

- 557 research programs; $6M funded proposals; 307 publications
  - 1,160 education programs; $5M funded proposals
- 408 public service programs; 3.0M people served

EPSCoR

- Program grant awards to 20 states
  - Alabama, Arkansas, Connecticut, Idaho, Kansas, Kentucky, Louisiana, Maine, Mississippi, Montana, Nebraska, Nevada, North Dakota, Oklahoma, Puerto Rico, South Carolina, South Dakota, Vermont, West Virginia, Wyoming
- 35 Research awards to 19 states
  - Alabama, Arkansas, Connecticut, Idaho, Kansas, Kentucky, Louisiana, Maine, Mississippi, Montana, Nebraska, Nevada, Oklahoma, Puerto Rico, South Carolina, South Dakota, Vermont, West Virginia, Wyoming
- Research awards by Enterprise
  - Aerospace Technology – 6
  - Earth Science – 11
  - HEDS – 4
  - Biological and Physical Research – 6
  - Space Science – 8

PROGRAM PLANS FOR FY 2003

General plans for State-based activities in FY 2002 and FY 2003 include providing professional development to NASA's internal education community; reviewing existing NASA education initiatives to ensure their alignment with the vision and philosophy for state-based activities; designing new programs or redesigning existing programs to ensure that all NASA efforts align with the science, mathematics, technology, and geography education standards and supporting the needs of those engaged in the implementation of standards-based education at the state and local levels; continuing to leverage the use of NASA programs and resources by expanding NASA interactions and cooperation with all stakeholders involved in national and state systemic initiatives; and implementing a plan through the field centers that supports the needs of individual states.

Congressional direction in FY 2002 increased the funding for the Space Grant Program to $24.1M. This additional funding will be used to run a competition enabling eligible consortia to become a “designated” Space Grant Consortium and receive the highest level of funding, and to offer competitive awards focused on workforce development to all 52 consortia to improve the NASA workforce pipeline and strengthen the relationships between the Space Grant consortia and the NASA Centers. In FY 2002 the Space Grant Program funding was augmented by Congressional direction. The FY 2003 request returns the program funding to its base level of $19.1M.

Congressional direction in FY 2002 also increased the funding for the NASA EPSCoR Program to $10.0M. This will enable NASA to continue the funding commitments made in the FY 2001 program. One of our challenges with this program is how, under the current funding structure, to both broaden and strengthen the reach of the NASA EPSCoR Program. In FY 2002 the EPSCoR Program funding was augmented by Congressional direction. The FY 2003 request returns the program funding to its base level of $4.6M.

In FY 2003, funding and therefore, participation levels, for other Systemic Improvement activities will be maintained at approximately the same level as in FY 2002.

BASIS OF FY 2003 FUNDING REQUIREMENT

EDUCATIONAL TECHNOLOGY

	FY 2001	FY 2002	FY 2003
	(Million of Dollars)		
Learning tools	3.2	3.3	3.3
Demonstrations	2.0	2.0	2.0
Learning Technologies Project	--	3.8	3.8
Jason XI	2.5	2.4	--
Sagan Discovery	1.0	0.9	--
Ohio View	--	0.9	--
Completion of Science Learning Center in Kenai, AK	1.0	3.0	--
Lewis & Clark – Re-discover Web Tech	2.0	--	--
Univ of San Diego for Science and Education Technology	1.0	--	--
Univ. of Redlands, Academic Infrastructure	3.0	--	--
Science Facilities Initiative, Heidelberg College, OH	1.0	--	--
Univ. of Wisconsin-Milwaukee, Initiative for Math, Science, Tech	2.0	1.5	--
NASA Glenn "Gateway to the Future: Ohio Pilot"	1.0	1.9	--
Santa Ana College Space Education Center, CA	1.5	--	--
Univ. of North Carolina, Chapel Hill – Science Education Facility	0.5	1.5	--
Science Learning Center, Hammond, IN	1.0	--	--
Environmental Science Learning Center, Los Angeles, CA	1.0	--	--
NASA Educator Resource Center, South East Missouri State Univ	--	0.5	--
American Museum of Natural History	--	3.5	--
Sci-Port Discovery Center at Shreveport, LA	--	0.9	--
Challenger Learning Center of Kansas	--	0.5	--
Challenger Learning Center of Illinois	--	0.5	--
Challenger Learning Center at Wheeling Jesuit College	--	0.5	--
Alan Shepard Discovery Center, NH	--	1.9	--
US Space & Rocket Center for Educational Training Center	--	3.0	--
Von Braun Scholarship Program	--	1.9	--
Alabama Math, Sci & Tech Initiative	--	3.0	--
Sci-Quest Hands-on Sci Center	--	2.9	--
Alabama Supercomputer Educational Outreach Program	--	1.6	--
Educational Advancement Alliance	--	1.9	--
Enhance K-12 sci education thru program @ Middle Tennessee State Univ	--	0.3	--

	FY 2001	FY 2002	FY 2003
		(Million of Dollars)	
Planetarium for Clay Center of Arts & Sciences, Charleston, WV	--	5.0	--
Chabot Observatory & Sci Center, CA	--	1.0	--
Des Moines Sci Center, Des Moines, Iowa	--	0.8	--
Infrastructure needs, Mauna Kea Astronomy Ed Center, U HI	--	4.0	--
NASA/Bishop Museum partnership, Honolulu HI	--	1.0	--
Construction of life sciences facility, Brown U	--	3.0	--
Instrumentation & lab development, Rowan U, NJ	--	2.0	--
Infrastructure improvements, Sch of Sci & Math, College of Charleston, SC	--	5.0	--
Muhlenberg Coll, Lehigh Co. PA, to dev natl model for using NASA data ...	--	1.5	--
TX Engineering Experiment Center, TX A&M Univ.	--	0.8	--
Southeast Missouri State U's NASA Educator Resource Center	--	0.5	--
Challenger Learning Center, Ferguson/Florissant, Missouri	--	1.0	--
Total	23.7	69.7	9.1

* FY 01 and FY 02 totals reflect Congressional interest projects added as part of the Congressional appropriation process.

PROGRAM GOALS

To research and develop products and services which facilitate the application of technology to enhance the educational process for formal and informal education and lifelong learning.

STRATEGY FOR ACHIEVING GOALS

The Educational Technology program (1) produces technology-based teaching tools and strategies that are grounded in or derived from the NASA mission; (2) uses emerging technologies for, and applies existing technologies to, educational programs; (3) utilizes technology to facilitate communication within the educational community; (4) involves educators in NASA missions through innovative uses of technologies; and (5) conducts research into new teaching and learning practices that are made possible through NASA mission-derived technology.

The NASA Classroom of the Future (COTF) continues to be a major component of the educational technology program, demonstrating how NASA technologies and research results can be translated into learning tools, demonstrations, and teacher enhancement programs that support standards-based education reform.

Specific learning tools such as NASA CONNECT, an instructional television and web-based series, demonstrating work place math, science, and technology as collaborative processes, and NASA Spacelink, an electronic resource specifically developed for the educational community, provide additional resources for educators to use in and out of the classroom.

The Learning Technologies Project provides demonstration projects and on-line systems dedicated to bringing NASA science to teachers and students in the classroom using examples from NASA's unique missions. The goal of this program is to accelerate the implementation of a national information infrastructure through NASA science, engineering, and technology contributions and to facilitate the use of technologies within the K-12 education systems.

MAJOR RESULTS IN THE PAST YEAR

Performance in this area is measured in a variety of ways, including overall quality, type/number of users; standards application; internet hits; data transferred; searchable pages; and unique IP addresses.

General plans for this program area include providing technology training and support for the persons involved in the operation of the Educator Resource Center Network and the Space Grant program; implementation of a coordinated electronic dissemination system that ensures that all NASA education activities and products are available through appropriate networking technologies; demonstrate NASA's educational technology resources at professional development conferences; develop innovative learning tools and technologies that are integrated with curriculum support and teacher enhancement activities ; develop, implement, and evaluate distance education and virtual mentoring projects; and support distribution of excess NASA equipment to schools and institutions of higher education.

Examples of accomplishments include:

- WWW Requests (Hits): 198M; Data Transfer Volume (GB): 8.5B; Unique IP Addresses: 4.4B
- CD ROMS provided for Curriculum Support: 24,124; NASA materials distributed: 1.6M; NASA materials demonstrated: 29.2K
- 36% of Teachers responding integrate NASA materials into their curriculum
- 116,922 Visits to NASA Educational Resource Centers
- Programs supporting standards: 63% Science; 34% Math; 23% Technology; 15% Geography; 29% State Frameworks; 13% Local Frameworks
- Distance Education: 1,016K "Open Mike Interactive" Students/Teachers"; 56.7M Anonymous Students/Teachers; 234M TV/Radio Audiences
- Programs using NASA facilities: 36% Laboratories; 6% Teleconferencing; 5% Aircraft; 13% Computer Labs; 5% Hangers; 5% Mockup Facilities7% Spacecraft Displays; 9% Wind Tunnels; 21% Clean Rooms.

PROGRAM PLANS FOR FY 2003

FY 2003 requested funding for Educational Technology demonstrations, tools, and the Learning Technology Program is similar to the FY 2002 level and no major program changes are expected. (Note: in FY 2001, funding for the Learning Technologies Program was provided by the Enterprises. This funding has now been incorporated into the Education Program budget for FY 2003. The effect of this transfer in funding was “seamless” to the program as oversight continues to be provided by the Education Division, Office of Human Resources and Education).

Educational Technology activities in FY 2001 included funding for the following activities directed by Congress in the Conference Report accompanying the VA-HUD-Independent Agencies Appropriation Act: continuing funding for Jason XI; Sagan Discovery Center, Science Learning Center in Kenai, AK, Lewis & Clark web tech program, University of San Diego for a science/ educational technology program, and the University of Redlands. New programs include: Science Facilities Initiative at Heidelberg College (OH), Initiative for Math, Science, Technology at the University of Wisconsin-Milwaukee, NASA Glenn Gateway to the Future project, Space Education Center at Santa Ana College (CA), Science Education Facility at the University of North Carolina in Chapel Hill (NC), Science Learning Center in Hammond (IN), and an Environmental Science Learning Center in Los Angeles (CA).

Educational Technology activities in FY 2002 include funding for the following: Continuing funding for Jason XI; Sagan Discovery Center (NY); Completion of Science Learning Center in Kenai, AK; Univ. of Wisconsin-Milwaukee, Initiative for Math, Science, Technology; NASA Glenn “Gateway to the Future: Ohio Pilot”. New programs include: Ohio View; NASA Educator Resource Center, South East Missouri State University (MO); American Museum of Natural History (NY); Sci-Port Discovery Center at Shreveport, LA; Challenger Learning Center of Kansas; Challenger Learning Center of Illinois; Challenger Learning Center at Wheeling Jesuit College; Alan Shepard Discovery Center, NH; US Space & Rocket Center for Educational Training Center (AL); Von Braun Scholarship program (AL); Alabama Math, Science and Technology Initiative; Sci-Quest Hands-on Science Center (AL); Alabama Supercomputer Educational Outreach Program; Educational Advancement Alliance; Enhance K-12 science education through program at Middle Tennessee State University; Planetarium for Clay Center of Arts and Sciences, Charleston, WV; Science Discovery Outreach Center, University of North Carolina, Chapel Hill, NC; Chabot Observatory and Science Center, CA; Des Moines Science Center, Des Moines, Iowa; Infrastructure needs, Mauna Kea Astronomy Education Center, University of Hawaii; NASA/Bishop Museum partnership, Honolulu, HI; Construction of life sciences facility, Brown University (RI); Instrumentation and lab development, Rowan University (NJ); Infrastructure improvements, School of Science and Math, College of Charleston, SC; Muhlenberg College, Lehigh Co. PA to develop national model for using NASA data; TX Engineering Experiment Center, Texas A&M University; Southeast Missouri State University's NASA Educator Resource Center; and the Challenger Learning Center, Ferguson/Florissant, Missouri.

BASIS OF FY 2003 FUNDING REQUIREMENT

EVALUATION

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Evaluation	1.6	1.6	1.6

PROGRAM GOALS

To provide a substantive accounting and evaluation of the performance of NASA's Education Program, with its associated projects and activities, in the implementation of its goals by developing and maintaining a systematic strategy for collecting, aggregating, and reporting evaluation indicator data.

STRATEGY FOR ACHIEVING GOALS

NASA has undertaken a comprehensive effort to evaluate its Education Program in order to demonstrate the accomplishment of achievable and measurable goals and objectives. A set of standard, agency-wide indicators, metrics, and evaluation instruments has been developed for agency-wide use. The data are collected on-line in a single database capable of providing correlation and report generation capability. External, third-party education evaluation experts provide additional guidelines and criteria for the analysis of qualitative and quantitative data facilitating in-depth evaluations of various programs.

MAJOR RESULTS IN THE PAST YEAR

NASA continues to refine a comprehensive system to evaluate its Education Program in order to demonstrate the accomplishment of achievable and measurable goals and objectives. Based on recommendations provided by a study of the NASA Education Program by the National Research Council (NRC), NASA established program goals and defined a comprehensive Education Framework that captures the elements of NASA's Education Program. This framework is detailed in NASA's *Implementation Plan for Education*, and supported by implementation plans developed by the Enterprises and NASA field installations between FY 1995 and the present. NASA utilizes an Internet-based system, for the collection, analysis, evaluation and reporting of standard and program unique data and program outcomes for all NASA education programs.

PROGRAM PLANS FOR FY 2003

NASA's Education Data Collection and Evaluation System (EDCATS), continues to add programs incrementally until all NASA education programs are included. As programs compile a firm set of baseline data, selected annual program targets will be established or reviewed, as needed or required. By FY 2002 the system will be fully operational, tracking data and evaluation metrics for the entire NASA Education Program.

In FY 2001 NASA chartered a review of its education program by a panel of external experts. The NASA Education Program Evaluation Review (NEPER) Panel addressed five key questions regarding the NASA Education Program. The NEPER Panel endorsed NASA's role in education and affirmatively answered each of the five questions defined for the review. The Panel recommended that NASA (a) develop an action plan to address all recommendations in the report; (b) institute a standing external review process; and (c) continue to conduct credible, objective program evaluations for major, national programs. NASA will continue to implement these recommendations during FY 2003, while also responding to the NEPER Panel's specific recommendation to collect long-term, longitudinal data.

SCIENCE, AERONAUTICS AND TECHNOLOGY

FISCAL YEAR 2003 ESTIMATES

BUDGET SUMMARY

ACADEMIC PROGRAMS — **MINORITY UNIVERSITY RESEARCH AND EDUCATION PROGRAM**

SUMMARY OF RESOURCES REQUIREMENTS

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
Historically Black Colleges and Universities	31.1	49.0	49.7
Institutional Science, Engineering and Technology Awards	2.8	16.5	17.9
Principal Investigator Awards	2.7	5.2	5.7
Partnership Awards	10.9	12.9	11.2
Math and Science Education Awards	14.7	14.4	14.9
Enterprise Program Funding *	[20.9]		
Other Minority Universities	24,8	35.7	32.4
Institutional Science, Engineering and Technology Awards	3.2	12.6	13.2
Principal Investigator Awards	2.3	2.3	2.8
Partnership Awards	5.2	3.6	2.2
Math and Science Education Awards **	14.1	17.2	14.2
Enterprise Program Funding *	[15.3]		
Total Minority University Research Programs	55.9	84.7	82.1
Enterprise Program Funding *	[36.2]		
Total Program Funding to Minority University Research	**92.1**	**84.7**	**82.1**

* Includes $36.2M encumbered funds transferred from Enterprise Budgets for FY 2002
** Includes $2.6M in Congressional Earmarks for FY 2002

SCIENCE, AERONAUTICS AND TECHNOLOGY

FISCAL YEAR 2003 ESTIMATES

BUDGET SUMMARY

ACADEMIC PROGRAMS **MINORITY UNIVERSITY RESEARCH AND EDUCATION PROGRAM**

Distribution of Program Amount by Installation	FY 2001	FY 2002	FY 2003
	(Millions of Dollars)		
Ames Research Center (ARC)	1.71	1.8	2.0
Dryden Flight Research Center (DFRC)	1.0	1.3	1.1
Glenn Research Center (GRC)	8.0	5.7	7.7
Goddard Space Flight Center (GSFC)	27.6	61.6	52.5
Jet Propulsion Laboratory (JPL)	0.9	0.3	0.2
Johnson Space Center (JSC)	2.3	1.2	3.6
Kennedy Space Center (KSC)	2.7	2.0	2.3
Langley Research Center (LaRC)	2.5	3.1	1.7
Marshall Space Flight Center (MSFC)	6.5	5.1	7.7
Stennis Space Center (SSC)	0.9	0.5	0.9
Headquarters (HQ)	1.8	2.1	2.4
Total	**55.9**	**84.7**	**82.1**

PROGRAM GOALS

The Minority University Research and Education Programs (MUREP) foci are expanding and advancing NASA's scientific and technological base through collaborative efforts with Historically Black Colleges and Universities (HBCU) and Other Minority Universities (OMU) - especially Hispanic-Serving Institutions (HSI) and Tribal Colleges and Universities (TCU) - all hereafter referred to as Minority Institutions (MI). NASA's outreach to MI's in FY 2003 will build upon the prior years' investments in MI research and academic infrastructure; development of the science, engineering and technology pipeline; and promotion of educational excellence at all levels. Through sufficient infrastructure-building support, exposure to NASA's unique mission and facilities, and involvement in competitive peer review and merit selection processes, MI's will develop significant contributions to the Agency's strategic goals. In addition to the Federal mandates for MI's, there are strategic goals that guide NASA's MUREP: (1) foster research and development activities at MI's which contribute substantially to NASA's mission; (2) create systemic and sustainable change at MI's through partnerships and programs that enhance research and educational outcomes in NASA-related fields; (3) prepare faculty and students at MI's to successfully participate in the conventional, competitive research and education process; and (4) increase the number of students served by MI's who enter college and successfully pursue and complete degrees in NASA-related fields. The MUREP are implemented through awards in four categories: (1) Institutional Science Engineering and Technology, (2) Principal Investigator, (3) Partnership, and (4) Mathematics and Science.

Institutional Science, Engineering and Technology (ISET) Awards

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Historically Black Colleges and Universities (HBCU)	2.8	16.5	17.9
Other Minority Universities (OMU)	3.2	12.6	13.2
ISET Research Program Total	6.0	29.1	31.1

Goals

1. Achieve a broad-based, competitive aerospace research capability among the Nation's Minority Institutions (MI);
2. Foster new aerospace science and technology concepts;
3. Expand the Nation's base for aerospace research and development;
4. Develop mechanisms for increased participation by faculty and students in mainstream research; and
5. Increase the productivity of students (who are U.S. citizens and who have historically been underrepresented) with advanced degrees in NASA-related fields.

Content

ISET includes the University Research Center Program (URC) and the Institutional Research Awards (IRA). The URC Awards are collaborative programs conducted in cooperation with each Strategic Enterprise. These awards are designed to achieve a broad-based, competitive aerospace research capability among the nation's MI's that will: foster new aerospace science and technology concepts; expand the Nation's base for aerospace research and development; develop mechanisms for increased participation by faculty and students in mainstream research; and increase the productivity of underrepresented students with advanced degrees in NASA-related fields. The URC's have formed the National Alliance of NASA University Research Centers (NANURC) and the National Conference of the University Research Centers in order to enhance collaborations and explore avenues for increasing the number of advanced degrees being awarded to disadvantaged students.

Institutional Research Awards (IRA) improves academic, scientific and technology infrastructure and broadens the NASA-related science and technology base at MI's. The Enterprise NASA Research Announcement (NRA) for Research Opportunities in Space Science (ROSS) solicits proposals for basic investigations that seek to understand natural space phenomena across the full range of space science programs relevant to the four OSS science themes.

Major ISET Research Results in the Past Year

- Completed annual renewal for continuation of 14 competitively selected URC under Group I and Group II designation.
- Procured third-party assessment of the Group I URC's that recommend extension of successful initiatives at HBCU's.

Program Plans for FY 2003

- Continue funding 10 new University Research Centers started in FY02 as a result of the competitively selected institutions designated as Group III URC.
- Provide technical assistance to ensure development of Minority Institutions so that there is clear progress towards development of competitive capacity

Principal Investigator (PI) Program

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Historically Black Colleges and Universities (HBCU)	2.7	5.2	5.7
Other Minority Universities (OMU)	2.3	2.3	2.8
Principal Investigator Program Totals	5.0	7.5	8.5

Goal

Increase the participation of faculty and other professionals in conducting NASA research, research training and/or administration.

Content

The Faculty Awards for Research (FAR) provide faculty at MI's the opportunity to integrate the research and education components of their careers with the unique mission requirements of a specific NASA Center/JPL. The FAR program provides merit selection of proposals from tenured and tenure-track faculty to provide research support to enable them to demonstrate creativity, productivity, and future promise in the transition to achieving competitive awards in the Agency's mainstream research processes. FAR is implemented through a competitive peer review and merit selection process in collaboration with the NASA Centers/JPL.

The NASA Administrator's Fellowship Program (NAFP) provides opportunities for NASA career employees and the mathematics, science, engineering, and technology (MSET) faculty of minority-serving institutions to compete through peer review for placement in a formal professional development program. In addition to individualized professional development enhancement, NASA employees spend a year teaching or conducting research at a minority-serving institution while MSET faculty spends a year conducting research at a NASA Center.

The Louis Stokes Professional Leadership Program provides competitive, peer review selection of faculty, educators and other scientific and technical personnel with an opportunity to participate in a 4-year professional leadership program designed to assist the HBCU's and OMU's in strengthening the delivery and management of NASA-sponsored scientific research, and MSET educational/training programs. Participants will spend 2 years at a NASA Center/JPL and 2 years at an HBCU or OMU enhancing their knowledge and ability to lead the institutions in better responses to the Federal Financial Assistance Management Improvement Act, Electronic Grants Initiatives, the Government Performance and Results Act, and achievement of better performance outcomes in conducting NASA-funded research and education programs.

Major PI Program Results in the Past Year

- NRA issued for FY 01 Faculty Awards for Research added a provision for planning grants to enable early career professionals an opportunity to visit NASA Installations and develop their research plans for the next NRA.
- NAFP hosted the 2001 NAFP Symposium that included professional development workshops and a reunion. Since its 1997 inception, NAFP has selected 39 fellows. Thirty-one fellows attended the Symposium, sharing research, education, and professional growth. 2001Cohort included four NASA employees and six MSET faculty from Minority Institutions.
- Through an extensive search and peer review process, 12 faculty and administrators were identified to served in the initial Cohort of Louis Stokes Fellows. Former Congressman Stokes was present to receive and address the fellows.

Program Plans for FY 2003

- Issue new solicitation for individual investigator research awards to meet the research agenda of NASA field installations.
- Develop a new solicitation for Phase II FAR awards to provide a pathway to building the human resources capability at MI's.
- Issue new calls within NASA and MI for Engineers, Scientists, and Technologists participants for the NAFP.
- Develop a new announcement for Cohort 2 of the Louis Stokes Professional Leadership Program that will assist the HBCU's and OMU's in strengthening the delivery and management of NASA-sponsored scientific research and education.

Partnership Program

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Historically Black Colleges and Universities (HBCU)	10.9	12.9	11.2
Other Minority Universities (OMU)	5.2	3.6	2.2
Partnership Program Totals	16.1	16.5	13.4

Goal

To enhance academic infrastructure in specific NASA-related disciplines with a focus on interdisciplinary collaborations.

Content

Partnership Awards for the Integration of Research into MSET Undergraduate Education (PAIR) has an interdisciplinary focus that spans more than one MSET academic program, creating a collaborative effort among different academic departments. The enhanced collaboration among MSET academic departments strengthens the MSET baccalaureate degree-producing capacity of the MI's by building upon previous NASA funding. As a result, the outcomes of partnership awards are: (1) innovative interdisciplinary study among MSET academic programs that center on NASA-related course study, research, and technological applications, including collaborative efforts within MSET academic departments; (2) more competitive undergraduate U.S. students, underrepresented in MSET fields who, because of their research training and exposure to cutting-edge technologies, are better prepared to enter MSET graduate programs or MSET employment; (3) enhanced undergraduate courses and curricula including laboratory-based curricula that foster collaborative educational experiences between faculty members and students leading to institutional faculty development efforts; and (4) model HBCU's and OMU's that integrate NASA-related research into the appropriate areas of the undergraduate curriculum and expose more of the academic community to the Agency's cutting-edge technologies.

Major Partnership Results in the Past Year

- Established a partnership with the National Association for Equal Opportunity in Higher Education (NAFEO) to establish an Academy for Scientific Research and Educational Advancement in the NASA Ames Research Center Research Park to: 1) expand research collaborations between NASA and Research Park scientists both on-site and at the partnering institutions, especially in the areas of astrobiology/biotechnology, information technology and nanotechnology; 2) contribute with innovative novel projects designed to examine the new frontiers in space research; 3) focus on integrating faculty and students to current NASA projects and in encouraging them to pursue careers in fields related to NASA interests; and 4) establish a virtual community of faculty and students at HBCU's and OMU's dedicated to supporting NASA's scientific mission including a diverse scientific workforce.

Program Plans for FY 2003

- Continuation funding decisions for the multi-year awards selected under prior year NRA's.
- New NRA for Partnership Awards for the Integration of Research (PAIR) into MSET Undergraduate Education

Mathematics and Science Education (MSE) Awards

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Historically Black Colleges and Universities (HBCU)	14.7	14.4	14.9
Other Minority Universities (OMU)	14.1	17.2	14.2
Mathematics & Science Education Program Totals	28.8	31.6	29.1

Goals

1. Increase the participation and achievement of socially and economically disadvantaged and/or disabled students in MSET fields at all levels of education.
2. Contribute to the national education goals by integrating the contents from the NASA mission into the educational outreach projects at MI's.
3. Contributes to the increase in the number and the strengthening of the skills, knowledge, and interest of students and teachers in mathematics-, science-, engineering-, and technology-based academic programs.

Content

Undergraduate and Graduate Awards provide scholarships, fellowships, internships, and research opportunities in NASA-related fields, and other services to enhance retention and increase graduation rates. These awards contribute to the U.S. scientific and technical leadership by partnering with HBCU's and OMU's to meet the Agency's mission and human resource requirements. These awards encourage students to pursue scholarships in science, mathematics, engineering and technology through research-based academic programs. The ultimate result of such participation is an increased number of individuals from underrepresented groups in the nation's pool of graduate researchers.

Teacher Preparation and Enhancement Awards provide opportunities for MI's to develop diverse and exemplary research-based mathematics, science, technology and geography teacher education curricula that are integrated with content from NASA's mission. The awards will contribute to the participating states' efforts to increase the numbers and percentage of state-certified mathematics, science, or technology teachers employed in hard-to-staff elementary, middle, and secondary schools not normally served by NASA.

Pre-college Awards offer opportunities for MI's, in collaboration with NASA and local school districts, to provide informal educational opportunities that will enhance the numbers and percentage of students enrolled in mathematics and science college preparatory courses. As a result of participating in these awards, students will gain awareness of career opportunities in MSET fields, exposure to NASA's mission and scientific and technical personnel role models, and will enter college pursuing NASA-related career fields.

Major MSE Research Results in the Past Year

- Conducted an Expert Panel Evaluation of the Pre-college Achievement of Excellence (PACE) Program, which concluded that the contributions to an increase in the number of targeted students completing gateway classes were significant. Other recommendations included requiring baseline performance metrics from each PACE grantee
- The new PACE announcement for FY 2002 incorporates the reviewer's recommendations.
- Selection of five new Science Engineering Mathematics Aerospace Academy (SEMAA) sites competitively selected from the FY2001 NRA
- External evaluation of SEMAA validated the conceptual design and clarified appropriate outcome indicators of success.

Program Plans for FY 2003

- New NRA's for PACE
- New NRA's for SEMAA
- Continuation of multi-year awards for prior year grant awards selected under competitive NRA's

SCIENCE, AERONAUTICS AND TECHNOLOGY

FISCAL YEAR 2003 ESTIMATES

BUDGET SUMMARY

ACADEMIC PROGRAMS **MINORITY UNIVERSITY RESEARCH AND EDUCATION PROGRAM**

SUMMARY OF RESOURCES REQUIREMENTS

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
	(Millions of Dollars)		
Historically Black Colleges and Universities	31.1	49.0	49.7
Institutional Science, Engineering and Technology Awards	2.8	16.5	17.9
Principal Investigator Awards	2.7	5.2	5.7
Partnership Awards	10.9	12.9	11.2
Math and Science Education Awards	14.7	14.4	14.9
Enterprise Program Funding *	[20.9]		
Other Minority Universities	24,8	35.7	32.4
Institutional Science, Engineering and Technology Awards	3.2	12.6	13.2
Principal Investigator Awards	2.3	2.3	2.8
Partnership Awards	5.2	3.6	2.2
Math and Science Education Awards **	14.1	17.2	14.2
Enterprise Program Funding *	[15.3]		
Total Minority University Research Programs	55.9	84.7	82.1
Enterprise Program Funding *	[36.2]		
Total Program Funding to Minority University Research	**92.1**	**84.7**	**82.1**

* Includes $36.2M encumbered funds transferred from Enterprise Budgets for FY 2002
** Includes $2.6M in Congressional Earmarks for FY 2002

ACADEMIC PROGRAMS **MINORITY UNIVERSITY RESEARCH AND EDUCATION PROGRAM**

Distribution of Program Amount by Installation	FY 2001	FY 2002	FY 2003
	(Millions of Dollars)		
Ames Research Center (ARC)	1.71	1.8	2.0
Dryden Flight Research Center (DFRC)	1.0	1.3	1.1
Glenn Research Center (GRC)	8.0	5.7	7.7
Goddard Space Flight Center (GSFC)	27.6	61.6	52.5
Jet Propulsion Laboratory (JPL)	0.9	0.3	0.2
Johnson Space Center (JSC)	2.3	1.2	3.6
Kennedy Space Center (KSC)	2.7	2.0	2.3
Langley Research Center (LaRC)	2.5	3.1	1.7
Marshall Space Flight Center (MSFC)	6.5	5.1	7.7
Stennis Space Center (SSC)	0.9	0.5	0.9
Headquarters (HQ)	1.8	2.1	2.4
Total	**55.9**	**84.7**	**82.1**

PROGRAM GOALS

The Minority University Research and Education Programs (MUREP) foci are expanding and advancing NASA's scientific and technological base through collaborative efforts with Historically Black Colleges and Universities (HBCU) and Other Minority Universities (OMU) - especially Hispanic-Serving Institutions (HSI) and Tribal Colleges and Universities (TCU) - all hereafter referred to as Minority Institutions (MI). NASA's outreach to MI's in FY 2003 will build upon the prior years' investments in MI research and academic infrastructure; development of the science, engineering and technology pipeline; and promotion of educational excellence at all levels. Through sufficient infrastructure-building support, exposure to NASA's unique mission and facilities, and involvement in competitive peer review and merit selection processes, MI's will develop significant contributions to the Agency's strategic goals. In addition to the Federal mandates for MI's, there are strategic goals that guide NASA's MUREP: (1) foster research and development activities at MI's which contribute substantially to NASA's mission; (2) create systemic and sustainable change at MI's through partnerships and programs that enhance research and educational outcomes in NASA-related fields; (3) prepare faculty and students at MI's to successfully participate in the conventional, competitive research and education process; and (4) increase the number of students served by MI's who enter college and successfully pursue and complete degrees in NASA-related fields. The MUREP are implemented through awards in four categories: (1) Institutional Science Engineering and Technology, (2) Principal Investigator, (3) Partnership, and (4) Mathematics and Science.

Institutional Science, Engineering and Technology (ISET) Awards

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Historically Black Colleges and Universities (HBCU)	2.8	16.5	17.9
Other Minority Universities (OMU)	3.2	12.6	13.2
ISET Research Program Total	6.0	29.1	31.1

Goals

1. Achieve a broad-based, competitive aerospace research capability among the Nation's Minority Institutions (MI);
2. Foster new aerospace science and technology concepts;
3. Expand the Nation's base for aerospace research and development;
4. Develop mechanisms for increased participation by faculty and students in mainstream research; and
5. Increase the productivity of students (who are U.S. citizens and who have historically been underrepresented) with advanced degrees in NASA-related fields.

Content

ISET includes the University Research Center Program (URC) and the Institutional Research Awards (IRA). The URC Awards are collaborative programs conducted in cooperation with each Strategic Enterprise. These awards are designed to achieve a broad-based, competitive aerospace research capability among the nation's MI's that will: foster new aerospace science and technology concepts; expand the Nation's base for aerospace research and development; develop mechanisms for increased participation by faculty and students in mainstream research; and increase the productivity of underrepresented students with advanced degrees in NASA-related fields. The URC's have formed the National Alliance of NASA University Research Centers (NANURC) and the National Conference of the University Research Centers in order to enhance collaborations and explore avenues for increasing the number of advanced degrees being awarded to disadvantaged students.

Institutional Research Awards (IRA) improves academic, scientific and technology infrastructure and broadens the NASA-related science and technology base at MI's. The Enterprise NASA Research Announcement (NRA) for Research Opportunities in Space Science (ROSS) solicits proposals for basic investigations that seek to understand natural space phenomena across the full range of space science programs relevant to the four OSS science themes.

Major ISET Research Results in the Past Year

- Completed annual renewal for continuation of 14 competitively selected URC under Group I and Group II designation.
- Procured third-party assessment of the Group I URC's that recommend extension of successful initiatives at HBCU's.

Program Plans for FY 2003

- Continue funding 10 new University Research Centers started in FY02 as a result of the competitively selected institutions designated as Group III URC.
- Provide technical assistance to ensure development of Minority Institutions so that there is clear progress towards development of competitive capacity

Principal Investigator (PI) Program

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Historically Black Colleges and Universities (HBCU)	2.7	5.2	5.7
Other Minority Universities (OMU)	2.3	2.3	2.8
Principal Investigator Program Totals	5.0	7.5	8.5

Goal

Increase the participation of faculty and other professionals in conducting NASA research, research training and/or administration.

Content

The Faculty Awards for Research (FAR) provide faculty at MI's the opportunity to integrate the research and education components of their careers with the unique mission requirements of a specific NASA Center/JPL. The FAR program provides merit selection of proposals from tenured and tenure-track faculty to provide research support to enable them to demonstrate creativity, productivity, and future promise in the transition to achieving competitive awards in the Agency's mainstream research processes. FAR is implemented through a competitive peer review and merit selection process in collaboration with the NASA Centers/JPL.

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Program Plans for FY 2003

- Issue new solicitation for individual investigator research awards to meet the research agenda of NASA field installations.
- Develop a new solicitation for Phase II FAR awards to provide a pathway to building the human resources capability at MI’s.
- Issue new calls within NASA and MI for Engineers, Scientists, and Technologists participants for the NAFP.
- Develop a new announcement for Cohort 2 of the Louis Stokes Professional Leadership Program that will assist the HBCU’s and OMU’s in strengthening the delivery and management of NASA-sponsored scientific research and education.

Partnership Program

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Historically Black Colleges and Universities (HBCU)	10.9	12.9	11.2
Other Minority Universities (OMU)	5.2	3.6	2.2
Partnership Program Totals	16.1	16.5	13.4

Goal

To enhance academic infrastructure in specific NASA-related disciplines with a focus on interdisciplinary collaborations.

Content

Partnership Awards for the Integration of Research into MSET Undergraduate Education (PAIR) has an interdisciplinary focus that spans more than one MSET academic program, creating a collaborative effort among different academic departments. The enhanced collaboration among MSET academic departments strengthens the MSET baccalaureate degree-producing capacity of the MI's by building upon previous NASA funding. As a result, the outcomes of partnership awards are: (1) innovative interdisciplinary study among MSET academic programs that center on NASA-related course study, research, and technological applications, including collaborative efforts within MSET academic departments; (2) more competitive undergraduate U.S. students, underrepresented in MSET fields who, because of their research training and exposure to cutting-edge technologies, are better prepared to enter MSET graduate programs or MSET employment; (3) enhanced undergraduate courses and curricula including laboratory-based curricula that foster collaborative educational experiences between faculty members and students leading to institutional faculty development efforts; and (4) model HBCU's and OMU's that integrate NASA-related research into the appropriate areas of the undergraduate curriculum and expose more of the academic community to the Agency's cutting-edge technologies.

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- Established a partnership with the National Association for Equal Opportunity in Higher Education (NAFEO) to establish an Academy for Scientific Research and Educational Advancement in the NASA Ames Research Center Research Park to: 1) expand research collaborations between NASA and Research Park scientists both on-site and at the partnering institutions, especially in the areas of astrobiology/biotechnology, information technology and nanotechnology; 2) contribute with innovative novel projects designed to examine the new frontiers in space research; 3) focus on integrating faculty and students to current NASA projects and in encouraging them to pursue careers in fields related to NASA interests; and 4) establish a virtual community of faculty and students at HBCU's and OMU's dedicated to supporting NASA's scientific mission including a diverse scientific workforce.

Program Plans for FY 2003

- Continuation funding decisions for the multi-year awards selected under prior year NRA's.
- New NRA for Partnership Awards for the Integration of Research (PAIR) into MSET Undergraduate Education

Mathematics and Science Education (MSE) Awards

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Historically Black Colleges and Universities (HBCU)	14.7	14.4	14.9
Other Minority Universities (OMU)	14.1	17.2	14.2
Mathematics & Science Education Program Totals	28.8	31.6	29.1

Goals

1. Increase the participation and achievement of socially and economically disadvantaged and/or disabled students in MSET fields at all levels of education.
2. Contribute to the national education goals by integrating the contents from the NASA mission into the educational outreach projects at MI's.
3. Contributes to the increase in the number and the strengthening of the skills, knowledge, and interest of students and teachers in mathematics-, science-, engineering-, and technology-based academic programs.

Content

Undergraduate and Graduate Awards provide scholarships, fellowships, internships, and research opportunities in NASA-related fields, and other services to enhance retention and increase graduation rates. These awards contribute to the U.S. scientific and technical leadership by partnering with HBCU's and OMU's to meet the Agency's mission and human resource requirements. These awards encourage students to pursue scholarships in science, mathematics, engineering and technology through research-based academic programs. The ultimate result of such participation is an increased number of individuals from underrepresented groups in the nation's pool of graduate researchers.

Teacher Preparation and Enhancement Awards provide opportunities for MI's to develop diverse and exemplary research-based mathematics, science, technology and geography teacher education curricula that are integrated with content from NASA's mission. The awards will contribute to the participating states' efforts to increase the numbers and percentage of state-certified mathematics, science, or technology teachers employed in hard-to-staff elementary, middle, and secondary schools not normally served by NASA.

Pre-college Awards offer opportunities for MI's, in collaboration with NASA and local school districts, to provide informal educational opportunities that will enhance the numbers and percentage of students enrolled in mathematics and science college preparatory courses. As a result of participating in these awards, students will gain awareness of career opportunities in MSET fields, exposure to NASA's mission and scientific and technical personnel role models, and will enter college pursuing NASA-related career fields.

Major MSE Research Results in the Past Year

- Conducted an Expert Panel Evaluation of the Pre-college Achievement of Excellence (PACE) Program, which concluded that the contributions to an increase in the number of targeted students completing gateway classes were significant. Other recommendations included requiring baseline performance metrics from each PACE grantee
- The new PACE announcement for FY 2002 incorporates the reviewer's recommendations.
- Selection of five new Science Engineering Mathematics Aerospace Academy (SEMAA) sites competitively selected from the FY2001 NRA
- External evaluation of SEMAA validated the conceptual design and clarified appropriate outcome indicators of success.

Program Plans for FY 2003

- New NRA's for PACE
- New NRA's for SEMAA
- Continuation of multi-year awards for prior year grant awards selected under competitive NRA's

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

TWO APPROPRIATION BUDGET/MISSION SUPPORT

FISCAL YEAR 2003 ESTIMATES

GENERAL STATEMENT

In FY 2001, the Mission Support appropriation provided funding for mission support and includes: safety, mission assurance, engineering and advanced concepts activities supporting agency programs; salaries and related expenses in support of research in NASA field installations; design, repair, rehabilitation and modification of institutional facilities and construction of new institutional facilities; and other operations activities supporting conduct of agency programs.

Beginning in FY 2002, NASA implemented a two-appropriation budget (excluding the Inspector General account). The two-appropriation budget includes Human Space Flight (HSF) and Science, Aeronautics and Technology (SAT) and is NASA's first step at transitioning to a full cost budget. While full cost will ultimately integrate institutional and programmatic funds into a single budget, that integration is done in a step-wise manner, by providing for a mission support budget line under each Enterprise and eliminating the present mission support appropriation. This initial step will begin to recognize, budget, and track direct full time equivalent (FTE) people associated at the Enterprise level and then use this FTE data to distribute other-than-direct (OTD) institutional costs (Research and Program Management and non-programmatic Construction of Facilities) using the relative percentages of direct FTE's by Enterprise.

This means the distribution of the OTD resources takes advantage of a basic assumption, to be used prior to the existence of cost and service pools, that FTE's are a reasonable relative indicator at the Enterprise level of required facility and institutional capabilities. Taking this step will help program/project personnel and decision makers begin to understand the potential magnitude of institutional funds that are associated with each Enterprise in preparation for the day when full cost budgeting will distribute these funds most appropriately to the project level via the appropriate cost/service pools.

The Mission Support budget is shown for display purposes only. Beginning in FY 2002, there is no longer a Mission Support account. Institutional costs will be budgeted within HSF and SAT (as discussed above), and Safety, Mission Assurance and Engineering will be budgeted within the HSF account.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

TWO APPROPRIATION BUDGET/MISSION SUPPORT

FISCAL YEAR 2003 ESTIMATES
(IN MILLIONS OF REAL YEAR DOLLARS)

	BUDGET PLAN		
	FY 2001 OP PLAN REVSIED	FY 2002* INITIAL OP PLAN	FY 2003* PRES BUDGET
MISSION SUPPORT	**2,602.3**	**[2,864.9]**	**[2,953.9]**
SAFETY, MISSION ASSURANCE AND ENGINEERING	47.4	[47.6]	[47.6]
RESEARCH AND PROGRAM MANAGEMENT	2,276.4	[2,583.9]	[2,639.4]
CONSTRUCTION OF FACILITIES	278.5	[233.4]	[266.9]

**Beginning in FY 2002, SMA&E is included within the Human Space Flight Appropriation. Research and Program Management and Construction of facilities are included in the Institutional Support budgets in each of the five enterprises. FY 2002 and FY 2003 data is for comparison purposes only.*

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

TWO APPROPRIATION BUDGET/MISSION SUPPORT

REIMBURSABLE SUMMARY
(MILLIONS OF DOLLARS)

BUDGET PLAN

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
MISSION SUPPORT	**58.4**	**--**	**--**
*SAFETY, MISSION ASSURANCE AND ENGINEERING	0.5	--	--
**SPACE COMMUNICATIONS SERVICES	2.5	--	--
***RESEARCH AND PROGRAM MANAGEMENT	51.7	--	--
***CONSTRUCTION OF FACILITIES	3.7	--	--

**Beginning in FY 2002, Safety, Mission Assurance and Engineering (SMA&E) is included in the Human Space Flight appropriation*
***Beginning in FY 2002, Space Communications Services are included in the Space Communications and Data Systems budget of the Human Space Flight appropriation*
****Beginning in FY 2002, Research and Program Management and Construction of Facilities are included in the Investments and Support budget of the Human Space Flight appropriation, and in the Institutional Support budgets of each Enterprise within the Science, Aeronautics and Technology appropriation.*

TWO APPROPRIATION BUDGET/MISSION SUPPORT

FISCAL YEAR 2003 ESTIMATES

BUDGET SUMMARY

OFFICE OF SAFETY & MISSION ASSURANCE
OFFICE OF THE CHIEF ENGINEER
OFFICE OF THE CHIEF TECHNOLOGIST

SAFETY, MISSION ASSURANCE, ENGINEERING AND ADVANCED CONCEPTS

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN*	FY 2003 PRES BUDGET*
		(Millions of Dollars)	
Safety and Mission Assurance*	25.1	[28.5]	[28.5]
Engineering*	17.5	[19.1]	[19.1]
Advanced Concepts**	4.8	--	--
Total	47.4	[47.6]	[47.6]
Distribution of Program Amount by Installation			
Johnson Space Center	7.2	[7.2]	[8.7]
Kennedy Space Center	0.4	[0.7]	[0.7]
Marshall Space Flight Center	3.2	[3.1]	[3.6]
Stennis Space Center	0.1	[0.2]	[0.4]
Ames Flight Research Center	1.2	[0.6]	[1.0]
Dryden Research Center	0.2	[0.2]	[1.0]
Langley Research Center	5.9	[5.5]	[5.8]
Glenn Research Center	2.5	[2.5]	[2.1]
Goddard Space Flight Center	15.6	[12.2]	[12.6]
Jet Propulsion Laboratory	7.3	[7.7]	[7.3]
Headquarters	3.9	[7.7]	[4.4]
Total	47.4	[47.6]	[47.6]

Beginning in FY 2002, SMA&E is included in the Human Space Flight Appropriation. Funding is shown for display purposes only.
***Beginning in FY 2002, Advanced Concepts is funded in the SAT appropriation within the Aerospace Technology Program*

DESCRIPTION/JUSTIFICATION

The Safety, Mission Assurance, Engineering, and Advanced Concepts (SMAEAC) area is an investment to enable the safety and success of all NASA programs. The SMAEAC budget supports the activities of the Office of Safety and Mission Assurance (OSMA), the Office of the Chief Engineer (OCE), and the activities of the former Office of the Chief Technologist (OCT) that were assumed by the Office of Aerospace Technology (OAT) in FY 2000. These Offices advise the Administrator, oversee NASA programs, develop Agency-wide policies and standards, and support the technology requirements of NASA flight programs. Each area is discussed separately.

Safety and Mission Assurance (SMA) assures that sound and robust SMA strategies, processes, and tools are in place to enable safe and successful missions. It establishes strategies, policies, and standards, and assures that effective and efficient processes and tools are appropriately applied throughout the program life cycle. SMA analyzes, oversees, and independently assesses programs and flight and ground operations to assure that attention is placed on risk, missions are conducted safely, and there is a high probability of meeting Agency objectives. SMA funds research, development, pilot application, and evaluation of tools, techniques, and practices that advance NASA's capabilities in areas such as facility and operational safety, risk management, human reliability, software assurance, and risk analysis. Funding also develops SMA training courses.

The OCE oversees the conduct and improvement of NASA's engineering practice, manages the strategic crosscutting process to "Provide Aerospace Products and Capabilities" and independently evaluates ongoing programs, proposed concepts, and options for new programs. The OCE establishes policies, standards, guidance, and support for improving NASA engineering practices and technical capabilities, and manages the NASA Electronics Parts and Packaging Program, which supports evaluation and infusion of advanced electronic parts and packaging technology into NASA programs.

The Office of Aerospace Technology (OAT) is NASA's principal advocate for advanced technology. As such, the OAT advises the Administrator on technology matters and develops a NASA-wide investment strategy for innovative and advanced technology. The office leads the development of NASA-wide technology goals and objectives and oversees NASA technology policies, programs, processes, and capabilities. OAT also sponsors the NASA Institute for Advanced Concepts (NIAC), which addresses NASA strategic objectives requiring technology readiness ten to twenty years into the future.

PROGRAM STATUS/NOTIFICATIONS/PLANS THROUGH 2002

With the Mission Support appropriation now discontinued, the budget for these activities were dispersed beginning in FY 2002. Safety, Mission Assurance and Engineering (SMA&E) is now funded in the Human Space appropriation as a separate program while Advanced Concepts is now funded in the SAT appropriation under Aerospace Technology. Additional information on these projects can now be found in their respective sections.

FY 2003 ESTIMATES

RESEARCH AND PROGRAM MANAGEMENT

DESCRIPTION/ JUSTIFICATION

The civil service workforce is the underpinning for the successful accomplishment of the Nation's civil aeronautics and space programs. These are the people who plan the programs; conduct and oversee the research; select and monitor the contractors; manage the various research, development, and test activities; and oversee all of NASA's operations. A key dimension of the reinvention of NASA has been the restructuring of the civil service workforce to deliver a space and aeronautics program that is balanced, relevant, and at the forefront of technology development.

Primary goals:

- Acquire and maintain a civil service workforce reflecting the cultural diversity of the Nation,
- Provide a workforce sized and skilled consistent with accomplishing NASA's research, development, and operational missions with innovation, excellence, and efficiency.

The Research and Program Management (R&PM) program provides the salaries, other personnel and related costs, travel and the necessary support for all of NASA's administrative functions and other basic services in support of research and development activities at NASA installations.

- The salaries, benefits, and supporting costs of this workforce comprise approximately 78% of the requested funding.
- Administrative and other support is 20% of the requests.
- The remaining 2% of the request is required to fund travel necessary to manage NASA and its programs.

FTE levels that were included in Program Operations (which were mostly Center Management and Operations) in prior R&PM FTE allocations, are now included in Institutional Support in the Enterprise summaries for each Center.

The FY 2003 budget estimate of $2,639.4 million for Research and Program Management represents an increase of $55.5 million from the FY 2002 budget plan of $2,583.9 million. Of this total increase, Personnel and related costs increase by $119.3 million from FY 2002 to FY 2003. These increases fully fund the civil service workforce, the full year cost of the 2002 payraise, the payraise projected to be effective in January 2003, increased costs of health care and normal salary growth. Travel represents an increase of $4.5 million over the FY 2002 budget plan. $2.5 million of this increase is due to increased travel requirements in the Strategic Launch Initiative. Research Operations Support decreases by $68.3 million from the FY 2002 budget plan. This is due to the FY 02 budget being supplemented by $108.5 million due to the provision of the emergency response fund provided to enhance NASA's security and counter intelligence efforts. In summary, the FY 2003 budget requirement of $2,639.4 million will provide for 18,837 full-time equivalent civil service workyears including 18,264 full-time permanent civil service workyears to support the activities at nine NASA Installations and Headquarters. NASA plans to control personnel levels through full time permanent (FTP) civil servant workyears while continuing to track full-time equivalent workyears, as done in the past. This will allow NASA more flexibility in the use of non-permanent positions for short-term technical needs as well as co-op and intern programs.

The following describes, in detail, the cost elements within this program.

I. Personnel and Related Costs

A. Compensation and Benefits

1. Compensation

a. Permanent Positions: covers the salaries of the full-time permanent civil service workforce and is the largest portion of this functional category.

b. Other Than Full-Time Permanent Positions: includes the salaries of NASA's non-permanent workforce. Programs such as Presidential Management Interns, students participating in cooperative training, summer employment, youth opportunity, and temporary clerical support are covered in this category.

c. Reimbursable Detailees: In accordance with existing agreements, NASA reimburses the parent Federal organization for the salaries and related costs of persons detailed to NASA.

d. Overtime and Other Compensation: Overtime, holiday, post and night differential, and hazardous duty pay are included in this category. Also included are incentive awards for outstanding achievement and superior performance.

2. Benefits: In addition to compensation, NASA, as authorized and required by law, makes the employer's contribution to personnel benefits. These benefits include contributions to the Civil Service Retirement Fund, the Federal Employees Retirement System, employees' life and health insurance, payments to the Medicare fund for permanent employees, and social security contributions. Payments to the civil service retirement fund for re-employed annuitants and severance pay to former employees involuntarily separated through no fault of their own are also included.

B. Supporting Costs

1. Transfer of Personnel: Provides relocation costs required by law, such as the expenses of selling and buying a home, subsistence expenses, and the movement and storage of household goods.

2. Investigative/Other Services: The Office of Personnel Management is reimbursed for activities such as security investigations of new hires and revalidation of sensitive position clearances. In addition, this category pays for, recruitment advertising, and materials, personnel/workforce studies and Federal wage system surveys.

3. Personnel Training: Provided within the framework of the Government Employees Training Act of 1958. Part of the training costs is for courses offered by other Government agencies, and the remainder is for training through non-government sources.

II. Travel

A. Program Travel: The largest part of travel is for direction, coordination, and management of program activities including international programs and activities. The complexity of the programs and the geographical distribution of NASA Installations and contractors necessitate this category of travel. As projects reach the flight stage, support is required for pre launch activities including overseas travel to launch and tracking sites. The amount of travel required for flight projects is significant as it is directly related to the number of systems and subsystems, the number of design reviews, and the number and complexity of the launches and associated ground operations.

B. Scientific and Technical Development Travel: Permits employees engaged in research and development to participate in both Government sponsored and non-government sponsored activities. This participation allows personnel to benefit from exposure to technological advances, which arise outside NASA, as well as allowing personnel to present both accomplishments and problems to their associates and provides for the dissemination of technical results to the United States community.

C. Management and Operations Travel: Provides for the direction and coordination of general management matters and travel by officials to review the status of programs. It also includes travel by functional managers in such areas as personnel, financial management, and procurement. This category also includes the cost of travel of unpaid members of research advisory committees; and initial duty station, permanent change of assignment, and related travel expenses.

III. Research Operations Support

A. Facilities Services: Provides security, fire protection, and other custodial services. It also provides maintenance of roads and grounds and of all administrative buildings and facilities. Finally, it provides rental of administrative buildings and all utility costs of administrative buildings.

B. Technical Services: Provides the Administrative Automatic Data Processing capability that supports Accounting, Payroll, Budgeting, Procurement, and Personnel as well as all the other Administrative functions. It also funds the Graphics and Photographic support to these functions. Finally, it funds the Installation-wide safety and public information programs.

C. Management and Operations: Funds the telephone, mail, and logistics systems, the administrative equipment and supplies, and the transportation system including the general purpose motor pools and the program support aircraft. It also funds the basic medical and environmental health programs. Finally, it funds printing and reproduction and all other support, such as small contract and purchases for the Center Directors staff and the Administrative functions. Included in this area is funding for the System Management offices at all centers which provides support and independent evaluations of projects and programs.

SUMMARY OF BUDGET PLAN BY FUNCTION
(Millions of Dollars)

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
PERSONNEL AND RELATED COSTS	$1,792.7	$1,894.5	$2,013.8
TRAVEL	$53.1	$54.7	$59.2
RESEARCH OPERATIONS SUPPORT	$430.6	$634.7	$566.4
TOTAL PROGRAM PLAN	**$2,276.4**	**$2,583.9**	**$2,639.4**

Per the two-appropriation approach, the R&PM funds for FY 2002 and FY 2003, displayed here for information purposes only, are allocated in the HSF and SAT accounts against the appropriate Enterprises. This allocation is based on the distribution of the direct full time equivalent (FTE) people associated with each Enterprise, along with a share of other than direct R&PM funds allocated using the relative percentages of direct FTE's by Enterprises. These funds are identified within each Enterprise section under the title of "Institutional Support".

DETAIL OF BUDGET PLAN BY FUNCTION
(Millions of Dollars)

	FY 2001	FY 2002	FY 2003
I. Personnel and related costs	**$1,792.7**	**$1,894.5**	**$2,013.8**
A. Compensation and benefits	$1,731.9	$1,839.8	$1,951.1
1. Compensation	$1,431.2	$1,505.9	$1,596.6
2. Benefits	$300.7	$333.9	$354.5
B. Supporting costs	$60.8	$54.7	$62.7
1. Transfer of personnel	$8.6	$2.8	$3.1
2. Investigative services	$1.9	$1.6	$1.9
3. Personnel training	$50.3	$50.3	$57.7
II. Travel	**$53.1**	**$54.7**	**$59.2**
A. Program travel	$32.6	$33.0	$35.2
B. Scientific and technical development travel	$7.3	$7.0	$8.5
C. Management and operations travel	$13.2	$14.7	$15.5
III. Research operations support	**$430.6**	**$634.7**	**$566.4**
A. Facilities services	$120.2	$246.8	$182.7
B. Technical services	$162.8	$214.4	$218.2
C. Management and operations	$147.6	$173.5	$165.5
Total	**$2,276.4**	**$2,583.3**	**$2,639.4**

DISTRIBUTION OF BUDGET PLAN BY FUNCTION BY INSTALLATION
(Millions of Dollars)

FUNCTION	TOTAL NASA	JSC	KSC	MSFC	SSC	GSFC	ARC	DFRC	LARC	GRC	JPL	HQS
PERSONNEL AND RELATED COSTS												
FY 2001	1,792.7	312.8	169.4	252.5	24.3	304.6	157.1	57.7	212.2	176.2		125.9
FY 2002	1,894.5	326.9	175.6	263.3	25.1	319.4	163.2	57.3	219.5	183.4		160.8
FY 2003	2,013.8	344.4	186.5	286.4	26.2	333.5	176.0	59.8	231.5	192.2		177.3
TRAVEL												
FY 2001	53.1	8.4	5.8	7.8	0.8	7.7	3.8	1.5	5.5	3.8		8.0
FY 2002	54.7	8.9	5.6	6.4	0.8	7.6	3.8	1.5	5.1	4.0		11.0
FY 2003	59.2	8.9	5.6	6.3	0.7	7.7	4.7	1.8	6.1	4.7		12.7
RESEARCH OPERATIONS SUPPORT												
FY 2001	430.6	44.6	74.8	53.1	17.2	56.8	33.3	3.0	20.1	25.1		102.6
FY 2002	634.7	59.4	124.2	59.4	22.3	57.3	48.9	4.6	21.7	28.8	2.8	205.3
FY 2003	566.4	51.4	97.5	58.6	22.7	54.3	33.8	5.4	21.0	27.0	2.1	192.6
TOTAL												
FY 2001	2,276.4	365.8	250.0	313.4	42.3	369.1	194.2	62.2	237.8	205.1		236.5
FY 2002	2,583.9	395.2	305.4	329.1	48.2	384.3	215.9	63.4	246.3	216.2	2.8	377.1
FY 2003	2,639.4	404.7	289.6	351.3	49.6	395.5	214.5	67.0	258.6	223.9	2.1	382.6

SUMMARY OF BUDGET PLAN BY INSTALLATION
(Millions of Dollars)

	FY 2001	FY 2002	FY 2003
JOHNSON SPACE CENTER	$365.8	$395.2	$404.7
KENNEDY SPACE CENTER	$250.0	$305.4	$289.6
MARSHALL SPACE FLIGHT CENTER	$313.4	$329.1	$351.3
STENNIS SPACE CENTER	$42.3	$48.2	$49.6
AMES RESEARCH CENTER	$194.2	$215.9	$214.5
DRYDEN FLIGHT RESEARCH CENTER	$62.2	$63.4	$67.0
LANGLEY RESEARCH CENTER	$237.8	$246.3	$258.6
GLENN RESEARCH CENTER	$205.1	$216.2	$223.9
GODDARD SPACE FLIGHT CENTER	$369.1	$384.3	$395.5
JET PROPULSION LABORATORY	$0.0	$2.8	$2.1
HEADQUARTERS	$236.5	$377.1	$382.6
AGENCY TOTAL	$2,276.4	$2,583.9	$2,639.4

DISTRIBUTION OF FULL-TIME EQUIVALENT (FTE) WORKYEARS BY INSTALLATION

	FY 2001	FY 2002	FY 2003
JOHNSON SPACE CENTER	2,988	3,014	2,975
KENNEDY SPACE CENTER	1,831	1,852	1,870
MARSHALL SPACE FLIGHT CENTER	2,709	2,761	2,761
STENNIS SPACE CENTER	286	295	301
AMES RESEARCH CENTER	1,496	1,498	1,506
DRYDEN FLIGHT RESEARCH CENTER	635	600	595
LANGLEY RESEARCH CENTER	2,381	2,365	2,365
GLENN RESEARCH CENTER	1,945	1,923	1,924
GODDARD SPACE FLIGHT CENTER	3,228	3,317	3,323
HEADQUARTERS	1,011	1,167	1,217
TOTAL, FULL-TIME EQUIVALENTS	**18,510**	**18,792**	**18,837**

DISTRIBUTION OF FULL-TIME EQUIVALENT (FTE) WORKYEARS BY PROGRAM

	FY 2001	FY 2002	FY 2003
HUMAN EXPLORATION & DEVELOPMENT OF SPACE	**7,839**	**7,090**	**6,786**
International Space Station	2,565	1,793	1,607
Space Operations (SOMO)	358	381	267
Space Flight Operations (Space Shuttle)	1,934	1,986	1,920
Payload & ELV Support	287	256	243
Investment – HEDS	715	700	706
HEDS Mission Support	1,954	1,950	2,013
HEDS Reimbursable Activities	26	24	30
SPACE SCIENCE	**2,022**	**2,439**	**2,453**
Major Development Programs	289	271	228
Payloads Program	21	10	10
Explorer Program	160	118	93
Mars Exploration Program	80	75	76
Discovery Program	15	14	5
Operating Missions	68	92	77
Technology Program	317	487	567
Research Program	397	482	474
Space Science Mission Support	675	890	923
BIOLOGICAL & PHYSICAL RESEARCH	**427**	**1242**	**1273**
Biological & Physical Research	332	381	375
ISS Research Capabilities	0	649	650
B&PR Mission Support	95	212	248
EARTH SCIENCE	**1,913**	**1,747**	**1,848**
Earth Observing System Program	400	399	392
Earth Probes Program	122	134	125

DISTRIBUTION OF FULL-TIME EQUIVALENT (FTE) WORKYEARS BY PROGRAM

	FY 2001	FY 2002	FY 2003
Operating Missions	31	25	126
Research & Technology	609	548	548
Investment – ES	7	4	4
Earth Science Mission Support	679	570	590
ES Reimbursable Activities	65	67	63
AERO-SPACE TECHNOLOGY	**6,170**	**6,140**	**6,344**
Aero-Space Focused Programs	1,728	1,508	0
Aero-Space Base	2,333	2,774	0
Commercial Technology Program	200	196	250
Space Base Program	311	8	0
Aviation Safety	0	0	326
Vehicle Systems	0	0	1,908
Airspace Systems	0	0	206
2nd Generation RLV Focused	0	0	841
Space Transfer & Launch Tech	0	0	298
Computing Info & Communications Tech	0	0	501
Engineering For Complex Systems	0	0	36
Enabling Concepts & Technologies	0	0	243
Investment – AST	9	9	9
Aero-Space Technology Mission Support	1,589	1,645	1,726

DISTRIBUTION OF FULL-TIME EQUIVALENT (FTE) WORKYEARS BY PROGRAM

	FY 2001	FY 2002	FY 2003
SAFETY AND MISSION ASSURANCE	**97**	**92**	**91**
Safety And Mission Assurance	97	92	91
ACADEMIC PROGRAMS	**42**	**42**	**42**
Academic Programs	42	42	42
Total full-time equivalents (FTES)	**18,510**	**18,792**	**18,837**

RESEARCH AND PROGRAM MANAGEMENT

FISCAL YEAR 2003 ESTIMATES

LYNDON B. JOHNSON SPACE CENTER

ROLES AND MISSIONS

LEAD CENTER RESPONSIBILITIES:

International Space Station (ISS) - JSC technical responsibilities include development of a set of facilities and systems to conduct operations aboard the Space Station including on-orbit control of the Space Station. The Center provides institutional personnel as well as engineering and testbed support to the Space Station program. This includes test capabilities, the provision of Government Furnished Equipment, and engineering analysis support for the work of the prime contractor, its major subcontractors, and NASA system engineering and integration efforts.

Space Shuttle - JSC will provide development, integration, and operations support for the Mission Control Center (MCC), the Shuttle Mission Simulator (SMS), and other ground facilities needed for Space Shuttle Operations. JSC will provide Space Shuttle operational flight program management including system integration, crew equipment modification and processing, crew training, flight mission planning and operations, and procurement of Orbiter hardware.

Biomedical Research and Countermeasures/Advanced Human Support Technologies/Space Medicine - As part of these activities, JSC will develop, coordinate and implement research into human physiological changes associated with the space flight environment and develop effective countermeasures to ensure crew health and optimal performance during all phases of flight.

PERFORMING CENTER RESPONSIBILITIES:

Space Launch Initiative – JSC has established a Space Launch Initiative (SLI) Project Office to manage technology developments related to human space vehicles, including crew transfer vehicle, crew and cargo transfer vehicle, crew escape and survivability, mission planning and flight operations, and related activities. The Office will provide architectural definition, integrated assessments, technology development, advanced operations development, and integration of flight demonstrations. The Office will also coordinate and integrate JSC support to SLI technology projects undertaken by other NASA centers.

Payload and ELV Support - JSC will conduct concept studies and development on flight systems and options for human transportation. JSC provides support to payload operations and support equipment, and technology program support.

Space Communications and Data Systems - JSC provides the administration and management of the Consolidated Space Operations Contract (CSOC).

HEDS Investment Support – This activity supports the center's Engineering Technical Base and Advanced Project requirements. These requirements are largely engineering lab support activities that are tied to Space Station and Space Shuttle program needs.

Space Science – JSC is responsible for leadership in the field of astromaterials and operates NASA's astromaterial curatorial facility for extraterrestrial sample materials. The Center supports the Agency's Space Science goals through research, information dissemination, and interaction with the scientific community. This research includes planetary science, astrobiology, space debris, and sample material handling. The primary focus is on the composition, structures, and evolutionary histories of astromaterials to further our understanding of the solar system and aid in the planning for future missions.

Biological and Physical Research - The JSC has established a Program for the support of biotechnology applications in microgravity in order to study growth factors, medical chemo/immunotherapeutic techniques, and human tissue transplantation. The program will integrate life science flight experiments for Spacehab and the ISS, operate integrated payload systems, and train mission specialists in the science aspects of their missions.

Center Management and Operations - Provides management, administrative, and financial oversight of NASA programmatic elements under JSC cognizance. In addition, the Center provides for the operation of and maintenance of the institutional facilities, systems, and equipment. Coordinates Agency wide policy and the processing for all foreign travel. Also included in this area is the System Management office which provides support and independent evaluations of projects and programs.

DISTRIBUTION OF FULL-TIME EQUIVALENT (FTE) WORKYEARS BY PROGRAM
JOHNSON SPACE CENTER

	FY 2001	FY 2002	FY 2003
HUMAN EXPLORATION & DEVELOPMENT OF SPACE	**2,790**	**2,701**	**2,666**
International Space Station	1,136	1,091	1,027
Space Operations (SOMO)	46	44	44
Space Flight Operations (Space Shuttle)	760	756	734
Investment – HEDS	300	279	279
HEDS Mission Support	548	531	582
HEDS Database Adjustment	0	0	0
SPACE SCIENCE	**52**	**52**	**51**
Mars Exploration Program	7	2	2
Discovery Program	0	1	1
Operating Missions	1	0	0
Technology Program	16	13	13
Research Program	28	26	25
Space Science Mission Support	0	10	10
BIOLOGICAL & PHYSICAL RESEARCH	**98**	**205**	**202**
Biological & Physical Research	98	98	90
ISS Research Capabilities	0	67	69
B&PR Mission Support	0	40	43
AERO-SPACE TECHNOLOGY	**24**	**35**	**35**
Aero-Space Focused Programs	1	7	0
Aero-Space Base	5	4	0
Commercial Technology Program	18	17	17
2nd Generation RLV Focused	0	0	11
Aero-Space Technology Mission Support	0	7	7
SAFETY AND MISSION ASSURANCE	**14**	**13**	**13**
Safety And Mission Assurance	14	13	13
ACADEMIC PROGRAMS	**10**	**8**	**8**
Academic Programs	10	8	8
	2,988	**3,014**	**2,975**

RESEARCH AND PROGRAM MANAGEMENT

FISCAL YEAR 2003 ESTIMATES

JOHN F. KENNEDY SPACE CENTER

ROLES AND MISSIONS

LEAD CENTER RESPONSIBILITIES:

Payload Carriers and Support - KSC will provide technical expertise, facilities and capabilities to perform payload buildup, test and checkout, integration and servicing of multiple payloads; development, operation, logistics and maintenance of GSE; transportation of payloads and supporting equipment to the Space Shuttle; and integration and installation of the payloads into the Space Shuttle. The KSC develops, activates, operates, and maintains the Payload Carrier facility system, GSE, and processes to enable efficient launch site processing of carriers and payloads. The Center also provides pre- and post-flight support for life science flight experiments.

Expendable Launch Vehicle Launch Mission Support -KSC will provide government insight/oversight of all launch vehicle and payload processing and checkout activities for all NASA contracted expendable launch vehicle and upper stage launch services both at KSC and the Vandenburg Air Force Base.

PERFORMING CENTER RESPONSIBILITIES:

Space Station - The KSC provides launch site logistics support, re-supply, and customer utilization. The KSC serves as the primary agent for management and integration of ground processes for all U.S. launched International Space Station (ISS) elements from manufacture and assembly through verification and launch. The KSC develops and maintains ISS flight systems expertise to support the ISS on-orbit mission and retains technical and operational experience within NASA and KSC for ground processing and verification of space flight hardware for follow-on programs.

Space Shuttle - KSC will provide the technical expertise and services for Space Shuttle processing, launch and landing operations, and program integrated logistics. This includes Shuttle element processing; SRM/SRB element buildup; Shuttle element and payload integration; and operation and maintenance of the Shuttle processing, launch, and landing facilities, systems, associated technical infrastructure, and Ground Support Equipment (GSE).

Center Management and Operations - KSC will provide administrative and financial services in support of Center management and will provide for the operation and maintenance of the institutional facilities, systems, laboratories, testbeds, associated technical infrastructure, and equipment. Will serve as NASA's focal point for spaceport and range technology development efforts to provide advanced technologies, systems, and techniques increased in support of safety, security and reduce the cost of access to space. Coordinates the development of Agency policy and manages the NASA relocation contract. Also included in this area is the System Management office which provides support and independent evaluations of projects and programs.

DISTRIBUTION OF FULL-TIME EQUIVALENT (FTE) WORKYEARS BY PROGRAM
JOHN F. KENNEDY SPACE CENTER

	FY 2001	FY 2002	FY 2003
HUMAN EXPLORATION & DEVELOPMENT OF SPACE	**1,753**	**1,779**	**1,794**
International Space Station	332	341	340
Space Operations (SOMO)	1	7	15
Space Flight Operations (Space Shuttle)	774	815	788
Payload & ELV Support	220	220	220
Investment – HEDS	94	68	75
HEDS Mission Support	322	318	346
HEDS Database Adjustment	0	0	0
HEDS Reimbursable Activities	10	10	10
BIOLOGICAL & PHYSICAL RESEARCH	**16**	**20**	**21**
Biological & Physical Research	12	15	16
B&Pr Mission Support	4	5	5
AERO-SPACE TECHNOLOGY	**44**	**34**	**36**
Aero-Space Focused Programs	20	5	0
Commercial Technology Program	13	21	21
2nd Generation Rlv Focused	0	0	7
Aero-Space Technology Mission Support	11	8	8
SAFETY AND MISSION ASSURANCE	**7**	**7**	**7**
Safety and Mission Assurance	7	7	7
ACADEMIC PROGRAMS	**11**	**12**	**12**
Academic Programs	11	12	12
Total full-time equivalents (FTEs)	**1,831**	**1,852**	**1,870**

GEORGE C. MARSHALL SPACE FLIGHT CENTER

ROLES AND MISSIONS

LEAD CENTER RESPONSIBILITIES:

Space Launch Initiative (SLI) – The SLI is aimed at improving access to space for 21st century missions. The SLI projects represent a partnership that stretches across the country and throughout the Agency. As NASA's Center of Excellence for Space Propulsion, the 2nd Generation RLV Propulsion Office also is located at MSFC. Propulsion is the key ingredient for a safer, more reliable, and more cost-effective space transportation system. The Propulsion Office manages the development of all propulsion elements and coordinates its activities to assure synergy with current NASA, Department of Defense, and commercial RLV activities.

Space Transfer & Launch Technology (STLT) – STLT is focused on third generation reusable launch vehicle technologies that has as its primary focus three demonstrator programs. Two of the programs, Integrated Systems Testing of an Airbreathing Rocket (ISTAR), Revolutionary Turbine Accelerator (RTA) are ground demonstrators where the X-43-C is a flight demonstrator. Other technology projects, e.g. airframe and Propulsion Research & Technology, support the development of vision vehicle technologies in materials, airframe, and vehicle systems.

Biological and Physical Research - MSFC is responsible for implementing the Agency's microgravity initiatives through the Microgravity Research and Space Product Development programs. MSFC's efforts provide scientific and commercial researchers the unique opportunity to use the low gravity environment of space as a catalyst to generate new knowledge, products, and services that improve the quality of life on earth. MSFC is also responsible for implementing the Materials Science and Biotechnology Science disciplines and the Glovebox Program within the Microgravity Research Program.

Space Science - MSFC is responsible for managing the overall design, development, integration, test, and flight operations of the Gravity Probe–B (GP–B) flight experiment

PERFORMING CENTER RESPONSIBILITIES:

Space Shuttle – The Space Shuttle Projects Office (SSPO) manages the performance of MSFC and industry personnel and resources in the planning, design, engineering, integration, development, production, testing, upgrade, delivery and operations of the Space Shuttle Main Engines (SSME), External Tank (ET), Solid Rocket Booster (SRB), and the Reusable Solid Rocket Motor (RSRM), guiding effective implementation of safety, schedule, performance and cost goals. MSFC continues to streamline operations and implement upgrades to enhance safety, meet the manifest, improve mission supportability, and improve the system.

International Space Station (ISS) – MSFC plays a vital role in building, operating, and utilizing the ISS for NASA. Specifically, MSFC provides management oversight of Nodes 2 and 3, which will be provided by the Italian Space Agency and their contractor, Alenia. MSFC is responsible for the development of the regenerative life support systems for the ISS crew and the research animals. MSFC's Testing, Manufacturing and Support Team will provide technical expertise to ISS design and development teams. MSFC is also responsible for the management, integration and execution of payload operations and utilization activities on board the ISS.

Space Optics Manufacturing Technology - MSFC leads the Agency in the development of lightweight, large-aperture Space Optics Manufacturing Technology for use in achieving the mission goals of NASA's strategic enterprises.

Space Science Research - MSFC manages the Solar B and the GLAST Burst Monitor, and conducts fundamental research in six disciplines—cosmic-ray physics, gamma-ray astronomy, x-ray astronomy, solar physics, space plasma physics and astrobiology. MSFC manages the operation of the MSFC developed Chandra X-ray Observatory through the Operations Control Center and the Chandra X-ray Center at the Smithsonian Astrophysical Observatory in Cambridge, MA.

Earth Science Research - Through the Global Hydrology and Climate Center (GHCC), a joint venture with academia, MSFC engages in research, education, and the development of Earth science applications. The GHCC focuses on using advanced technology to observe and understand the global climate system and apply this knowledge to agriculture, urban planning, water resource management, and operational meteorology.

National Space Science and Technology Center (NSSTC) - The NSSTC, headquartered in Huntsville, Alabama, is a research and education institution that provides an environment for selected key scientific disciplines. It consists of researchers and resources from government, academia and industry collaborating in an environment that enables cutting edge basic and applied research and fosters education of the next generation of scientists and engineers. The NSSTC is a partnership between NASA and the State of Alabama through the Alabama Space Science & Technology Alliance (SSTA) to perform research meeting the nation's needs.

Center Management and Operations - MSFC provides administrative and financial services in support of Center management and provides for the operation and maintenance of the institutional facilities, systems and equipment. A broad range of personnel, facilities, and operational support services are required to support Agency functions assigned to MSFC. MSFC has responsibility for the following Agency support activities: Communications Architecture and Providing Agency WAN Services; NASA Automated Data Processing Consolidation Center; NASA Digital Television Transition; Sustaining Support for Agencywide Administrative Systems; NASA Integrated Service Network; NASA Technical Standards Program; NASA Acquisition Internet Service; NASA Operational Environment Team; National Center for Advanced Manufacturing; NASA Engineering Infrastructure; Earned-Value Management; Defense Contract Administrative Service Financial Management Support; Integrated Financial Management Program Core Financial Project; Integrated Financial Management Program

Integration Project and the Spacelink. Also included in this area is the System Management office which provides support and independent evaluations of projects and programs.

DISTRIBUTION OF FULL-TIME EQUIVALENT (FTE) WORKYEARS BY PROGRAM
GEORGE C. MARSHALL SPACE FLIGHT CENTER

	FY 2001	FY 2002	FY 2003
HUMAN EXPLORATION & DEVELOPMENT OF SPACE	**1,719**	**1,185**	**1,138**
International Space Station	704	243	190
Space Operations (SOMO)	11	12	12
Space Flight Operations (Space Shuttle)	383	393	376
Payload & ELV Support	20	10	13
Investment - HEDS	272	300	299
HEDS Mission Support	329	227	248
SPACE SCIENCE	**183**	**209**	**163**
Major Development Programs	23	30	16
Payloads Program	10	10	10
Operating Missions	2	2	2
Technology Program	47	38	49
Research Program	65	84	69
Space Science Mission Support	36	45	17
BIOLOGICAL & PHYSICAL RESEARCH	**92**	**539**	**503**
Biological & Physical Research	76	109	111
ISS Research Capabilities	0	344	314
B&PR Mission Support	16	86	78
EARTH SCIENCE	**48**	**49**	**48**
Earth Observing System Program	2	2	1
Research & Technology	38	39	39
Earth Science Mission Support	8	8	8
AERO-SPACE TECHNOLOGY	**644**	**756**	**886**
Aero-Space Focused Programs	368	465	0

DISTRIBUTION OF FULL-TIME EQUIVALENT (FTE) WORKYEARS BY PROGRAM
GEORGE C. MARSHALL SPACE FLIGHT CENTER (continued)

	FY 2001	FY 2002	FY 2003
Aero-Space Base	120	131	0
Commercial Technology Program	30	27	76
Space Base Program	17	8	0
Vehicle Systems	0	0	12
2nd Generation Rlv Focused	0	0	549
Space Transfer & Launch Tech	0	0	76
Computing Info & Communications Tech	0	0	3
Enabling Concepts & Technologies	0	0	28
Aero-Space Technology Mission Support	109	125	142
SAFETY AND MISSION ASSURANCE	**12**	**12**	**12**
Safety And Mission Assurance	12	12	12
ACADEMIC PROGRAMS	**11**	**11**	**11**
Academic Programs	11	11	11
Total full-time equivalents (FTES)	**2,709**	**2,761**	**2,761**

JOHN C. STENNIS SPACE CENTER

ROLES AND MISSIONS

LEAD CENTER RESPONSIBILITIES:

Rocket Propulsion Testing - As the Lead Center for Propulsion Testing, SSC operates, maintains, and manages a propulsion test capability that includes test facilities at JSC/WSTF, MSFC, and GRC/Plum Brook and related systems for development, certification, and acceptance of rocket propulsion systems and components. The Center provides, maintains, and manages the facilities and the related capabilities required for the continued development and acceptance testing of the Space Shuttle Main Engines. SSC also maintains and supports the Center's technical core laboratory and operations to enable SSC to conduct advanced propulsion test technology research and development for government and commercial propulsion programs.

Earth Science - Through the Remote Sensing Applications Program, SSC enhances U.S. economic competitiveness via commercial partnership programs that apply remote sensing technologies in business applications and reduce new product development costs. As part of the Research and Analysis – Applications Program, SSC conducts fundamental and applied research, which increases our understanding of environmental systems sciences, with emphasis on coastal research of both land and oceans. Starting in FY02, Commercial Remoter Sensing was absorbed into other areas within Applications.

PERFORMING CENTER RESPONSIBILITIES:

Aerospace Technology - Through the Technology Transfer and Small Business Innovative Research programs, SSC broadens and accelerates the development of spin-off technologies derived from national investments in aerospace research. SSC also supports the development of new and innovative propulsion technologies through the Advanced Space Transportation Program that supports the Agency goal of reducing the cost of access to space. Included in this effort is the propulsion test technology research for the Space Launch Initiative.

Center Management and Operations - SSC provides administrative and financial services in support of Center management and provides for the operation and maintenance of the institutional facilities, systems, and equipment. The Center provides, operates, maintains, and manages the institutional base and laboratories required to support NASA programs, Commercial programs, and other Federal and State agencies and organizations resident at the SSC. Also included in this area is the System Management office which provides support and independent evaluations of projects and programs.

DISTRIBUTION OF FULL-TIME EQUIVALENT (FTE) WORKYEARS BY PROGRAM
STENNIS SPACE CENTER

	FY 2001	FY 2002	FY 2003
HUMAN EXPLORATION & DEVELOPMENT OF SPACE	**126**	**148**	**153**
Space Flight Operations (Space Shuttle)	11	13	13
Investment – HEDS	49	53	53
HEDS Mission Support	50	68	67
HEDS Database Adjustment	0	0	0
HEDS Reimbursable Activities	16	14	20
EARTH SCIENCE	**48**	**45**	**56**
Research & Technology	26	26	33
Earth Science Mission Support	22	19	23
AERO-SPACE TECHNOLOGY	**111**	**101**	**91**
Aero-Space Focused Programs	44	37	0
Aero-Space Base	14	14	0
Commercial Technology Program	5	5	5
2nd Generation Rlv Focused	0	0	47
Aero-Space Technology Mission Support	48	45	39
SAFETY AND MISSION ASSURANCE	**1**	**1**	**1**
Safety And Mission Assurance	1	1	1
Total full-time equivalents (FTES)	**286**	**295**	**301**

RESEARCH AND PROGRAM MANAGEMENT

FISCAL YEAR 2003 ESTIMATES

GODDARD SPACE FLIGHT CENTER

ROLES AND MISSIONS

LEAD CENTER RESPONSIBILITIES:

Space Science - GSFC is the Lead Center for two of the four science themes in the Space Science Enterprise: Sun-Earth Connections and Structure & Evolution of the Universe. The objectives of Sun-Earth Connections are to seek a scientific understanding of the why Sun varies and to determine how solar variability affects life and society. Structure & Evolution of the Universe is comprised of three fundamental scientific quests: explaining the structure of the universe and forecasting our cosmic destiny, exploring cycles of matter and energy in the evolving universe, and examining the ultimate limits of gravity and energy in the universe. In support of these objectives, GSFC manages many currently operating missions, such as the Hubble Space Telescope, the Microwave Anisotropy Probe, and the Thermosphere-Ionosphere-Mesosphere-Energetics and Dynamics mission. GSFC also manages a large number of missions in development, including all missions in the Explorers program, missions in the Living With a Star program, as well as several major strategic missions, such as the Next Generation Space Telescope. GSFC also conducts world-class space science research in such areas as astrophysics, solar physics, high-energy astronomy (x-ray and gamma ray), optical astronomy, microwave/infrared astronomy, and radio astronomy. Other activities include managing the NASA's sounding rocket program and scientific balloon research program.

Earth Science – GSFC is the Lead Center for the Earth Science Enterprise. In this role, GSFC is responsible for the management of the Earth Observing System (EOS) program, operation of orbiting Earth observing spacecraft, and development of emerging technologies in support of future Earth observing missions. The EOS program is the centerpiece of NASA's Earth Science Enterprise. The EOS is comprised of integrated scientific investigation activities whose primary objective is to record global change and to observe regional-to-global processes. The EOS will document global change over a 15-year period to provide long-term, consistent data sets for use in modeling and understanding global processes. This process and modeling research effort will provide the basis for establishing predictive global change models for policy makers and scientists.

GSFC manages Earth Explorers and New Millennium flight projects; and manages, on a reimbursable basis, the acquisition of meteorological observing spacecraft for the National Oceanic and Atmospheric Administration (NOAA). Conducts science correlation measurements from balloons, sounding rockets, aircraft, and ground installations.

GSFC is the Lead Center for Earth Science technology development activities. Examples of these technologies include advanced techniques to accelerate data processing for the Earth Observing system, development of unique coatings, detector materials and electronics, and state of the art optics for future Earth orbiting missions.

GSFC is the Lead Center for the Independent Verification & Validation (IV&V) Facility in Fairmont, West Virginia. The IV&V Facility is responsible for providing independent assessments of project software and for the management of all software IV&V efforts within the Agency.

PERFORMING CENTER RESPONSIBILITIES:

Space Shuttle/Payload and ELV Support - GSFC manages flights of the Hitchhiker, a reusable carrier system that provides increased flight opportunities with reduced lead-time while maximizing Space Shuttle load factors and minimizing space flight costs. GSFC also manages and coordinates the Agency's Get Away Special (GAS) program.

Space Science - GSFC is a Performing Center for two of the four science themes in the Space Science Enterprise: the Astronomical Search for Origins and Solar System Exploration. In addition to managing two key missions in the Origins theme (the Hubble Space Telescope and the Next Generation Space Telescope), GSFC develops science instruments and technologies targeted at improving instruments, on-board spacecraft systems, and subsystems. GSFC has also conducted scientific research in support of the Origins program, planetary exploration, and investigations into other bodies in the Solar System

Earth Science – As an integral partner in the Agency's High Performance Computing and Communications (HPCC) program, GSFC leads an effort to enhance the infusion of HPCC technologies into the Earth community through the provision of advanced computer architectures and communication technologies.

Aerospace Technology - The Wallops Flight Facility provides institutional and technical support to Langley Research Center, other NASA Centers, and commercial users who conduct flight studies of new approach and landing procedures using the latest in guidance equipment and techniques, pilot information displays, human factors data, and terminal area navigation. Promotes private sector investment in space-based technologies through the transfer of technologies that derive from NASA's programs and activities.

Space Communications and Data Systems- Research and technology involves the investigation and development of advanced systems and techniques for spacecraft communications and tracking, command and control, and data acquisition and processing. The primary objectives are to apply technology and develop advanced capabilities to meet the tracking and data processing requirements of new missions and to improve the cost effectiveness and reliability of flight mission support.

GSFC manages a number of critical program elements, including operation of the Tracking and Data Relay Satellite System (TDRSS); the development of the replenishment TDRSS spacecraft; mission control, data processing, and orbit/attitude computation support; operating the Space Tracking and Data Network (STDN), the NASA Communications (NASCOM) Network, and the Aeronautics, Balloons and Sounding Rocket Program.

The NASCOM Network links the stations of the Deep Space Network (DSN), STDN, TDRSS, and other tracking and data acquisition elements with control centers and data processing and computation centers.

Center Management and Operations - Provides administrative and financial services in support of Center management and provides for the operation and maintenance of the institutional facilities, systems, and equipment. Also included in this area is the System Management office which provides support and independent evaluations of projects and programs.

DISTRIBUTION OF FULL-TIME EQUIVALENT (FTE) WORKYEARS BY PROGRAM
GODDARD SPACE FLIGHT CENTER

	FY 2001	FY 2002	FY 2003
HUMAN EXPLORATION & DEVELOPMENT OF SPACE	**438**	**440**	**313**
International Space Station	2	0	0
Space Operations (SOMO)	229	253	146
Payload & ELV Support	47	26	10
HEDS Mission Support	160	161	157
SPACE SCIENCE	**1,357**	**1,673**	**1,718**
Major Development Programs	212	188	166
Payloads Program	11	0	0
Explorer Program	159	114	89
Mars Exploration Program	1	0	0
Discovery Program	9	9	0
Operating Missions	65	90	75
Technology Program	222	357	420
Research Program	238	305	312
Space Science Mission Support	440	610	656
EARTH SCIENCE	**1,301**	**1,089**	**1,168**
Earth Observing System Program	345	333	331
Earth Probes Program	91	74	64
Operating Missions	25	22	123
Research & Technology	290	245	236
Investment – ES	7	4	4
Earth Science Mission Support	478	344	347
ES Reimbursable Activities	65	67	63

DISTRIBUTION OF FULL-TIME EQUIVALENT (FTE) WORKYEARS BY PROGRAM
GODDARD SPACE FLIGHT CENTER (continued)

	FY 2001	FY 2002	FY 2003
AERO-SPACE TECHNOLOGY	**112**	**97**	**107**
Aero-Space Base	5	10	0
Commercial Technology Program	43	49	53
Space Base Program	20	0	0
Computing Info & Communications Tech	0	0	4
Engineering For Complex Systems	0	0	7
Aero-Space Technology Mission Support	44	38	43
SAFETY AND MISSION ASSURANCE	**16**	**14**	**13**
Safety And Mission Assurance	16	14	13
ACADEMIC PROGRAMS	**4**	**4**	**4**
Academic Programs	4	4	4
Total full-time equivalents (FTES)	**3,228**	**3,317**	**3,323**

RESEARCH AND PROGRAM MANAGEMENT

FISCAL YEAR 2003 ESTIMATES

AMES RESEARCH CENTER

ROLES AND MISSIONS

LEAD CENTER RESPONSIBILITIES:

Center of Excellence for Information Technology - Provides Agency-wide leadership and strategically maintains or increases the Agency's preeminent position in Information technology by serving as the NASA Center of Excellence for Information Technology.

Aerospace Technology

- Airspace Systems (AS) - Ames Research Center (ARC) is responsible for developing technology to increase the safety and capacity of the national and international airspace for: (1) the modernization and improvement in the air-traffic management system; (2) pioneering the development and validation of advanced technology concepts, methods, and procedures, and for transferring them to the user and regulatory communities to enable major increases in safe aircraft operations; and (3) the introduction of new vehicle classes that can reduce airport congestion and expand the use of presently under utilized airspace and airports. To support these goals, ARC conducts research in aerospace operations automation technologies and modeling and provides high-fidelity flight simulations with an emphasis on enhancing National Airspace capacity and safety.

- Computing, Information and Communications Technology (CICT) - ARC is the lead for integrative research in information technology, biotechnology and nanotechnology towards applications in NASA's missions. Provides leadership for high end computing and networking within the Agency. ARC technical responsibilities include the development and demonstration of revolutionary computing, information and communications technologies. Specifically, ARC is responsible for the technical leadership and implementation of research efforts in such areas as advanced computing and networking, information environments, autonomy, human-centered systems, intelligent data understanding and fundamental information technologies, including high-confidence systems and bio-nanotechnology. Also provides key research personnel to support the integration and infusion of these technologies into NASA aerospace, space science, Earth Science and Human Space Flight missions. Provides key personnel and institutional support for the management of the overall CICT Program, and three of the four major projects within CICT (Computing, Networking, and Information Systems Project, Intelligent Systems Project and the Information Technology Strategic Research Project).

- Engineering for Complex Systems (ECS) - ECS addresses issues identified in multiple agency reports (NIAT, SIAT, mishap reports, etc.) to enable successful complex systems (hardware, software, people) across engineering activities performed throughout the agency and in private industry. ARC conducts research and technology development that supports life cycle risk management and the associated knowledge management systems. Key areas of focus are engineering design, software resiliency, human and organizational risk, and an integrated system risk perspective, with strong application of knowledge engineering and model-based reasoning technologies as an enabling vehicle.

Space Science - ARC has the Agency lead role in Astrobiology (the study of life in the universe), which focuses on the origin, adaptation, and destiny of life in the universe. Research includes advanced laboratory and computation facilities for astrochemistry; planetary protection; planetary atmosphere modeling, including relationships to the atmosphere of the Earth; the formation of stars and planetary systems; and an infrared technology program to investigate the nature and evolution of astronomical systems. Research and development in advanced information technologies, conducted by various NASA/university teams, are directed toward significantly increasing the efficiency of the Stratospheric Observatory for Infrared Astronomy (SOFIA) as it becomes operational. ARC is the lead Center for information technology efforts in the cross-enterprise spacecraft technology program.

Biological and Physical Research - ARC has the Agency lead roles in the Fundamental Biology program and the Biomolecular Systems Research program. These synergistic programs examine the adaptation of life forms to reduced gravity and the biotechnology which supports this scientific pursuit. Research continues into the effects of gravity on living systems using spaceflight experiments, ground simulation, and hypergravity facilities to understand how gravity affects the development, structure, and functions of living systems. Development continues on the Space Station Biological Research Project, the key life science facility aboard the International Space Station.

PERFORMING CENTER RESPONSIBILITIES:

Aerospace Technology

- Conducts aerospace vehicle research and technology development associated with autonomy and integrated vehicle health management. Conducts research on advanced thermal protection systems and performs arcjet testing to meet national needs for access to space and planetary exploration.

- Performs lead project responsibility for the Aviation Safety Program (AvSP) in the areas of Aviation System Monitoring and Modeling (ASMM) and System Wide Accident Prevention (SWAP). ARC manages technology and human factors research related to monitoring the National Airspace System (NAS) and modeling of the effectiveness of candidate safety technology interventions for reductions in the rate of aviation incidents and accidents. In addition, ARC will direct development of human behavioral models appropriate to the aviation context, and advances in aircraft maintenance and pilot/mechanic training. ARC will provide technology development assessments, resources management, and integration of ARC research activities with program flight demonstrations.

Space Science – Research and development in advanced information technologies are directed toward significantly increasing the efficiency of SOFIA as it becomes operational. ARC is the lead Center for information technology efforts in the cross-enterprise spacecraft technology program.

Biological and Physical Research - Also studies options for preventing problems in crew health and psychophysiology during and after extended spaceflight. ARC has a primary focus on advanced physical/chemical technologies for life support, including research into all aspects of regenerative life support. Research is conducted in the areas of ecosystems and health monitoring.

Earth Science - Builds instruments and computer models for the measurement and analysis of atmospheric constituents and properties from aircraft platform are being developed. Performs applied research and development to enhance the use of remote and in-situ sensing technology for Earth resources applications continues. Provides information systems and high end computing support for Earth Sciences knowledge acquisition.

Center Management and Operations - Provides management, administrative and financial oversight of NASA programmatic elements under ARC cognizance. Provides for the safe and effective operation and maintenance of supporting facilities, systems, and equipment. Serves as the Principal Center for the Agency in the following areas: information technology security, human resources operations, and directives management. Also included in this area is the System Management office that provides support and independent evaluations of projects and programs.

DISTRIBUTION OF FULL-TIME EQUIVALENT (FTE) WORKYEARS BY PROGRAM
AMES RESEARCH CENTER

	FY 2001	FY 2002	FY 2003
HUMAN EXPLORATION & DEVELOPMENT OF SPACE	**110**	**32**	**2**
International Space Station	80	0	0
HEDS Mission Support	30	32	2
SPACE SCIENCE	**206**	**219**	**218**
Major Development Programs	53	52	45
Mars Exploration Program	18	23	22
Technology Program	15	20	25
Research Program	65	64	65
Space Science Mission Support	55	60	61
BIOLOGICAL & PHYSICAL RESEARCH	**72**	**159**	**193**
Biological & Physical Research	53	55	54
ISS Research Capabilities	0	83	84
B&PR Mission Support	19	21	55
EARTH SCIENCE	**82**	**86**	**86**
Earth Observing System Program	7	7	7
Research & Technology	53	55	55
Earth Science Mission Support	22	24	24
AERO-SPACE TECHNOLOGY	**1,021**	**998**	**1,003**
Aero-Space Focused Programs	262	199	0
Aero-Space Base	425	518	0
Commercial Technology Program	3	7	7
Space Base Program	33	0	0
Aviation Safety	0	0	25
Vehicle Systems	0	0	103
Airspace Systems	0	0	122

DISTRIBUTION OF FULL-TIME EQUIVALENT (FTE) WORKYEARS BY PROGRAM
AMES RESEARCH CENTER (continued)

	FY 2001	FY 2002	FY 2003
2nd Generation RLV Focused	0	0	32
Space Transfer & Launch Tech	0	0	31
Computing Info & Communications Tech	0	0	385
Engineering For Complex Systems	0	0	19
Aero-Space Technology Mission Support	298	274	279
SAFETY AND MISSION ASSURANCE	**1**	**0**	**0**
Safety And Mission Assurance	1	0	0
ACADEMIC PROGRAMS	**4**	**4**	**4**
Academic Programs	4	4	4
Total full-time equivalents (FTEs)	**1,496**	**1,498**	**1,506**

RESEARCH AND PROGRAM MANAGEMENT

FISCAL YEAR 2003 ESTIMATES

DRYDEN FLIGHT RESEARCH CENTER

CENTER ROLES AND MISSIONS

PERFORMING CENTER RESPONSIBILITIES:

Vehicle Systems Program- Aerospace Flight Research and Advanced Vehicle Concepts

DFRC develops, manages, and maintains facilities and test bed aircraft to support safe, timely, and cost effective NASA flight research with piloted and unpiloted research aircraft and to support industry, university, and other government agency flight programs.

DFRC pioneers the identification, development, verification, transfer, and application of high-payoff aeronautical technologies. The program matures promising new aeronautics technologies into practical, ready-for-application technologies. Demonstration in the "real world" flight environment, integrated with other technologies in a practical package is critical to the transfer of these promising technologies into use in future aircraft and atmospheric-capable spacecraft. These activities have a large emphasis in closing the gap on experimental aircraft. Experimental aircraft provide a mechanism to validate design tools and new technology. Early development and validation of new concepts can be evaluated in a realistic environment, which allows lower cost developments and more rapid transfer of technology to allow low-cost space access.

Fiscal Year 2003 promises to be a productive year of flight research. In ERAST, the Flight Research program will demonstrate the Helios vehicle for long duration flight in FY03. F-15B flight testbed activities this year may include: Laminar Flow, Space-based Telemetry And Range Safety (STARS), Nielsen Phase II SBIR, and the F-5 Shaped Boom Demonstration. In pursuit of efficiency and affordability an F-18 testbed aircraft will demonstrate Active Aeroelastic Wing (AAW) technology.

Advanced Vehicle Concepts activities at DFRC will focus on the following specific activities: Intelligent Flight Control System (IFCS) Generation II flight testing on the F-15 flight test vehicle. The C-17 Research Flight Computing System (REFLCS) flight validation activities will begin during this year. The REFLCS will provide an unparalleled in-flight research capability. With follow on IFCS flight test activities using the REFLCS. The X-43 Hyper-X project is supporting the development of the second vehicle for flight test in early FY03.

Other experiments and technology developments within the program are concerned with validating new designs and design tools. As new designs are developed and matured, a mechanism is needed to validate those designs and the tools used to design the systems. The results generate and gather the information necessary to validate both the designs and the tools used for the designs. Often, these activities generate basic data to build new tools for more efficient design cycles.

The DFRC Western Aeronautical Test Range (WATR) provides communications, tracking, data acquisition, and mission control for a wide variety of aeronautic and aerospace vehicles. Customers of the WATR include other NASA Centers, other federal agencies and the aerospace industry. The test range was extended to the West Coast to support the X-43 launch over the Pacific Ocean. The WATR provides the range safety ground station to ensure public safety during flight of unpiloted vehicles.
International Space Station—X-38/Crew Return Vehicle – DFRC support of the space station program includes the conduct of technology development and flight test of the X-38 prototype emergency Crew Return Vehicle (ACRV) and provides on-orbit tracking and communications through the WATR.

Space Shuttle Program--Space Shuttle Ground Ops and Space Communications – DFRC serves as an alternate landing site and provides operational and technical support for the conduct of Space Shuttle missions. Other support includes on-orbit tracking and communications (WATR).

Earth Science – DFRC conducts flight operations in support of Airborne Science Missions for data collection and observations.

The NASA DC-8 Airborne Laboratory Program at NASA/Dryden Flight Research Center operates a DC-8-72 aircraft to acquire data for airborne science research. The platform aircraft provides for a wide variety of experiments, collecting data in support of scientific projects, to serve the world scientific community. Included in this community are NASA, other federal, state, academic, and foreign investigators. Data gathered at flight altitude and by remote sensing from the DC-8 have been used in many studies. Scientific investigators use the aircraft for earth, atmospheric and celestial observations. Research includes development of new sensors, and methodology for conducting such observations. Data from operational sensors as well as newly developed instruments are used in applications programs examining subjects such as ozone depletion, tropical rain forest destruction, tropical disease vectors, wildfire investigations and geologic remote sensing.

The ER-2 is a reconnaissance platform. These high-altitude aircraft are used as platforms for investigations that cannot be accomplished by sensor platforms of the private sector. The ER-2, flying at the edge of space, can scan shorelines, measure water levels, help fight forest fires, profile the atmosphere, assess flood damage, and sample the stratosphere.

Center Management and Operations - Provides administrative services in support of Center management and provides for the operation and maintenance of the institutional facilities, systems, and equipment. Also included in this area is the System Management office that provides support and independent evaluations of projects and programs.

DISTRIBUTION OF FULL-TIME EQUIVALENT (FTE) WORKYEARS BY PROGRAM
DRYDEN FLIGHT RESEARCH CENTER

	FY 2001	FY 2002	FY 2003
HUMAN EXPLORATION & DEVELOPMENT OF SPACE	**129**	**28**	**8**
International Space Station	77	0	0
Space Operations (SOMO)	15	15	0
Space Flight Operations (Space Shuttle)	3	6	6
HEDS Mission Support	34	7	2
EARTH SCIENCE	**43**	**45**	**46**
Research & Technology	29	35	35
Earth Science Mission Support	14	10	11
AERO-SPACE TECHNOLOGY	**460**	**524**	**538**
Aero-Space Focused Programs	137	14	0
Aero-Space Base	210	378	0
Commercial Technology Program	3	2	3
Aviation Safety	0	0	6
Vehicle Systems	0	0	356
2nd Generation RLV Focused	0	0	12
Space Transfer & Launch Tech	0	0	20
Engineering For Complex Systems	0	0	5
Aero-Space Technology Mission Support	110	130	136
SAFETY AND MISSION ASSURANCE	**1**	**1**	**1**
Safety And Mission Assurance	1	1	1
ACADEMIC PROGRAMS	**2**	**2**	**2**
Academic Programs	2	2	2
Total full-time equivalents (FTEs)	**635**	**600**	**595**

RESEARCH AND PROGRAM MANAGEMENT

FISCAL YEAR 2003 ESTIMATE

LANGLEY RESEARCH CENTER

ROLES AND MISSIONS

LEAD CENTER RESPONSIBILITIES:

Aerospace Technology

- Aviation Safety - The NASA Aviation Safety Program was created in 1997. The program's goal is to develop and demonstrate technologies that contribute to a reduction in the aviation fatal accident rate by a factor of 5 by year 2007 and by a factor of 10 by year 2022. This ambitious program is a partnership between NASA, the Federal Aviation Administration (FAA), the aviation industry and the Department of Defense (DoD). The safety program emphasizes not only accident reduction, but also a decrease in injuries when accidents do occur. The program includes research to reduce human-error-caused accidents and incidents, to predict and prevent mechanical and software malfunctions, and to eliminate accidents involving hazardous weather and controlled flight into terrain. The program also uses information technology to build a safer aviation system to support pilots and air traffic controllers. The FAA will help define requirements and actions to enact many of the safety standards. The DoD is expected to share in technology development as well as apply safety advances to military aircraft.

Earth Science - Performs an Agency-designated Atmospheric Science mission role in support of the Earth Science Enterprise in the NASA Strategic Plan. As Lead Center for Focused Atmospheric Science Missions, conducts a world-class peer reviewed and selected atmospheric science program in support of national goals in preserving the environment and in fundamental science. Specific discipline areas of expertise are Earth radiation research, particularly the role of clouds in the Earth's energy budget; middle and upper atmospheric research; and troposhperic research. Performs innovative scientific research to advance the knowledge of atmospheric radiative, chemical, and dynamic processes for understanding global change; develop innovative passive and active sensor systems concepts for atmospheric science measurements. Conducts a technology development program that develops advanced laser and LIDAR technologies for Earth science missions; advanced passive remote sensing technologies;. Develops advanced ultra-lightweight and adaptive materials, structural systems technologies, and analytical tools for significantly reducing the end-to-end cost and increasing the performance of earth observation space instruments and systems. Conducts an Application and Educational Outreach program that utilizes scientific data for non-scientific applications and in support of science and math education. Serves as a Primary Data Analysis and Archival Center (DAAC) for Earth Radiation and Atmospheric Chemistry for the Earth Observing System.

Center of Excellence for Structures & Materials - Provides Agency-wide leadership and strategically maintains or increases the Agency's preeminent position in structures and materials by serving as the NASA Center of Excellence for Structures and Materials.

Systems Analysis/Independent Program Evaluation and Assessment - Serves as the Agency lead Center for systems analysis and the conduct of independent evaluation, assessment, and cost estimation of Agency programs. Maintains, as a Center core competency, appropriate expertise and analysis tools to support the Agency's Strategic Enterprises in the definition and development of advanced systems concepts to achieve NASA's goals. Utilizes core systems analysis capabilities (supplemented with expertise from other centers as appropriate) to support the Office of the Administrator by conducting independent assessments of advanced concepts and proposed new systems to validate conceptual level designs prior to Agency commitment to major developmental funding. Provides Agency-wide independent cost estimates and analysis for programs and projects. Supports the Administrator's Program Management Council (PMC) in the organization, administration, and technical support of PMC review process

PERFORMING CENTER RESPONSIBILITIES:

Aerospace Technology

- Vehicle Systems - Langley Research Center (LaRC) conducts advanced research in fundamental airframe systems technologies including: aerodynamics; high-speed, highly maneuverable aircraft; hypersonic propulsion; guidance and controls; acoustics; and structures and materials. Develops a technology base for improving transport, fighter, general aviation, and commuter aircraft. Conducts an aeronautical research and technology program to study current and future technology requirements and to demonstrate technology applications. Conducts theoretical and experimental research in fluid and flight mechanics to determine aerodynamic flows and complex aircraft motions. Develop a new vehicle research thrust to explore advanced vehicle concepts and revolutionary new technologies to enable the development of advanced 21st Century Air Vehicles. LaRC conducts research to develop new technologies such as advanced aeroelastically tailored materials, new structural concepts, embedded sensors, intelligent systems, and microactuators. Employ advanced analysis methods to combine these new technologies to develop innovative new airframe systems with improved safety, reduced emissions and noise, and reduced cost per seat mile for commercial transport and general aviation aircraft.

- Airspace Systems - Employ advanced analysis methods to combine these new technologies to develop innovative new airframe systems with increased capacity. Conducts control and guidance research programs to advance technology in aircraft guidance and navigation, aircraft control systems, cockpit systems integration and interfacing techniques, and performance validation and verification methods. For the Small Aircraft Transportation Systems (SATS), the focus of this effort is the development of three airborne capabilities: (1) higher volume operations at non-towered, non-radar small airports, (2) lower landing minimums at minimally equipped landing facilities, and (3) flight systems for reduced pilot/system error.

- Space Launch Initiative - LaRC is the lead performing Center for the development and demonstration of technologies for advanced airframe design and integration methods to improve airframe reliability and reduce design cycle time; aerodynamics and aerothermodynamics assessment which yields higher fidelity information and supports reduced design cycle time; and robust, low cost, low maintenance structures, materials, tanks, Thermal Protection System (TPS) and integrated thermal structures.

- Space Transfer & Launch Technology (STLT) - Conducts aeronautics and space research and technology development for airframe systems to advance space transportation systems, including hypersonic aircraft and space access vehicles using airbreathing and rocket propulsion. Conducts research to develop airframe technologies and capabilities for next generation reusable launch vehicles and to develop aeroassist technologies and capabilities to enable safer and more affordable spacecraft. Specific technology discipline areas of expertise are aerodynamics, aerothermodynamics, structures, materials, hypersonic propulsion, guidance and controls, and systems analysis. Conducts long-range studies directed at defining the technology requirements for advanced transportation systems and missions. Develops technology options for realization of practical hypersonic and transatmospheric flight.

Space Sciences – Conducts studies and selected technology development for future planetary atmospheric flight vehicles including aeroshells, airplanes, gliders, etc, and continues to provide analysis of spacecraft aerodynamics, aerothermodynamics, and flight dynamics for spacecraft entering planetary atmospheres (including Earth) in support of both spacecraft design and flight operations. Conducts a technology development program for advanced ultra-lightweight and adaptive materials, structural systems technologies, and analytical tools for significantly reducing the end-to-end cost and increasing the performance of space science instruments and systems. Develops active and passive sensor technologies and concepts for application in planetary atmospheric studies. Selectively develops laser, LIDAR, and passive sensor technologies and perform research for planetary studies in areas which are related to our Earth Science role. Supports the solicitation and selection process of the Office of Space Science's (OSS) Discovery, Explorer, and Solar Terrestrial Probes Programs; conduct reviews of candidate and selected missions and independent assessments of on-going space science missions to help ensure that OSS criteria for high quality science return within cost and schedule constrains are met. Also is responsible for the design and development of atmospheric entry vehicle technologies for ongoing robotic exploration programs.

Human Exploration and Development of Space - Supports the Human Exploration and Development of Space through systems analyses of future human space exploration missions, assessments of the proper balance between human and robotic exploration, evaluations of shuttle safety and performance improvements, and development of tools and analytical methodologies in support of the space station.

Biological and Physical Research - Conducts space radiation exposure studies and develops/upgrades analysis tools in support of current and future human space efforts for a more accurate assessment of astronaut radiation exposures. Develops and tests new materials to minimize astronaut radiation exposure by improving body-shielding factors.

Center Management and Operations - Provides management, administrative and financial oversight of NASA programmatic elements under LaRC cognizance. Provides for the safe and effective operation and maintenance of supporting facilities, systems, and equipment. Serves as the Principal Center for the Agency in the following areas: integrated financial management (travel management), information technology business case review, Scientific and Technical Information Program, government travel charge card program, excess equipment screening, and the Academy of Program/Project Leadership. Also included in this area is the System Management office which provides support and independent evaluations of projects and programs. Also included in this area is the System Management office which provides support and independent evaluations of projects and programs.

DISTRIBUTION OF FULL-TIME EQUIVALENT (FTE) WORKYEARS BY PROGRAM
LANGLEY RESEARCH CENTER

	FY 2001	FY 2002	FY 2003
HUMAN EXPLORATION & DEVELOPEMENT OF SCIENCE	**34**	**43**	**15**
International Space Station	21	28	0
HEDS Mission Support	13	15	15
SPACE SCIENCE	**86**	**94**	**98**
Major Development Programs	1	1	1
Explorer Program	1	4	4
Mars Exploration Program	54	50	52
Discovery Program	6	4	4
Technology Program	5	14	15
Research Program	1	3	3
Space Science Mission Support	18	18	19
BIOLOGICAL & PHYSICAL RESEARCH	**0**	**0**	**28**
ISS Research Capability	0	0	28
EARTH SCIENCE	**299**	**328**	**328**
Earth Observing System Program	46	57	53
Earth Probes Program	31	60	61
Operating Missions	6	3	3
Research & Technology	170	144	146
Earth Science Mission Support	46	64	65
AERO-SPACE TECHNOLOGY	**1,930**	**1,868**	**1,864**
Aero-Space Focused Programs	535	474	0
Aero-Space Base	927	985	0
Commercial Technology Program	61	44	44
Space Base Program	63	0	0

DISTRIBUTION OF FULL-TIME EQUIVALENT (FTE) WORKYEARS BY PROGRAM
LANGLEY RESEARCH CENER (continued)

	FY 2001	FY 2002	FY 2003
Aviation Safety	0	0	204
Vehicle Systems	0	0	827
Airspace Systems	0	0	72
2nd Generation RLV Focused	0	0	153
Space Transfer & Launch Tech	0	0	88
Computing Info & Communications Tech	0	0	19
Engineering For Complex Systems	0	0	5
Enabling Concepts & Technologies	0	0	82
Aero-Space Technology Mission Support	344	365	370
SAFETY AND MISSION ASSURANCE	**32**	**31**	**31**
Safety And Mission Assurance	32	31	31
ACADEMIC PROGRAMS	**0**	**1**	**1**
Academic Programs	0	1	1
Total full-time equivalents (FTEs)	**2,381**	**2,365**	**2,365**

GLENN RESEARCH CENTER at LEWIS FIELD

ROLES AND MISSIONS

PERFORMING CENTER RESPONSIBILITIES

Vehicle Systems Program - Aerospace Propulsion and Power Project - The Aerospace Propulsion and Power Base R&T Project provides a foundation for the broad range of high-risk, high pay-off technologies needed for a steady influx of concepts available for use by the U.S. aerospace industry through the future years. It supports the Enterprise goals by providing a foundation to enable the following:

- The development of advanced technology concepts and methodologies for future application by industry;
- The advancement of high-risk technologies to a maturity level such that further research and development can be conducted by programs focused on selected national needs;
- A quick response to critical safety, security and other issues; and
- World-class aeropropulsion facilities and expert consultation for industry during their product development.

  The Aerospace Propulsion and Power Base R&T project spans subsonic, supersonic, hypersonic, general aviation, high performance aircraft, and access-to-space propulsion systems through research in combustion, turbomachinery, materials and structures, computational fluid dynamics, instrumentation and controls, aerospace power technology, interdisciplinary technologies, and aircraft icing. In addition, GRC provides enabling technologies for space initiatives and Advanced Space Transportation. The enabling technologies span the areas of power systems, on-board propulsion systems, air breathing propulsion, rocket components and integrated vehicle monitoring systems.

Vehicle Systems Program - Ultra-Efficient Engine Technology Project - Another Lead-Center project, Ultra-Efficient Engine Technology, is planned and designed to develop high-payoff, high-risk technologies to enable the next breakthroughs in propulsion systems to spawn a new generation of high performance, operationally efficient and economical, reliable and environmentally compatible U.S. aircraft. The breakthrough technologies are focused on propulsion component and high temperature engine materials development and demonstrations enabling future commercial and military propulsion systems which are greatly simplified, achieve higher performance, and have potential for much reduced environmental impact with a broad range of aircraft application.

Enabling Concepts and Technologies Program - Space Power and Electric Propulsion - Glenn is a world leader in research and development of ion propulsion and aerospace power systems. The mission of the Glenn Research Center Power and Electrical Propulsion effort is to advance the state of technology from the lowest technology level to the highest readiness level needed for NASA missions and commercialization. The transition to higher technology readiness levels (TRL) will continue to be accomplished by a combination of in-house design, development, test and evaluation in cooperation with other NASA Centers, other government agencies, universities, small and large business, and industry. The Power activity includes technologies, such as advanced solar cells and arrays, energy storage systems (including batteries, fuel cells, and flywheels), thermal energy storage/conversion, and power management and distribution (PMAD). Solar and nuclear electric propulsion activities include electrostatic ion, Hall effect, and pulsed plasma thrusters.

Nuclear Power Program – The Glenn Research Center provides leadership and management of this Program, as well as makes significant technology advancements, in the areas of advanced nuclear power and propulsion capabilities to enable future complex interplanetary science missions for the Agency. Some of the specific technologies being developed include advanced radioisotope power conversion devices, Brayton energy conversion, power management and distribution (PMAD), advanced electrostatic ion and Hall effect propulsion systems, and advanced heat rejection technologies.

Microgravity Research - The Glenn Research Center (GRC) provides leadership and management of the fluid physics, combustion science, and the microgravity environment disciplines of NASA's Microgravity Science Program. Sponsors and conducts ground-based scientific studies that may lead to experiments in space. GRC has a substantial effort in the design, buildup, testing, integration, and telescience operations of hardware for experiments to be conducted aboard the Space Shuttle and the utilization of the Space Station for scientific missions.

International Space Station - GRC support to the space station program includes technical and management support in the areas of power and on-board propulsion components and system, engineering and analysis, technical expertise, and testing for components and systems. This includes use of facilities and testbeds and construction of flight hardware as required.

Mission Communications Services - GRC develops and demonstrates communications and networks technologies in relevant environments to enhance the performance of existing mission services or enable new services. The Center identifies and infuses new capabilities at currently used frequencies and at higher frequencies (Ka-band and above) into the next generation of spacecraft and communications satellites, to enable seamless interoperability between NASA assets and commercial space and ground networks. The Center also ensures timely and high quality availability of radio frequency spectrum to enable the realization of NASA goals.

Center Management and Operations - Provides administrative and financial services in support of Center Management and provides for the operation and maintenance of the institutional facilities, systems, and equipment. Also included in this area is the System Management office that provides support and independent evaluations of projects and programs. Also included in this area is the System Management office that provides support and independent evaluations of projects and programs.

DISTRIBUTION OF FULL-TIME EQUIVALENT (FTE) WORKYEARS BY PROGRAM
GLENN RESEARCH CENTER at LEWIS FIELD

	FY 2001	FY 2002	FY 2003
HUMAN EXPLORATION & DEVELOPMENT OF SPACE	**321**	**217**	**176**
International Space Station	213	90	50
Space Operations (SOMO)	56	50	50
Space Flight Operations (Space Shuttle)	3	3	3
HEDS Mission Support	49	74	73
SPACE SCIENCE	**15**	**57**	**57**
Technology Program	12	45	45
Space Science Mission Support	3	12	12
BIOLOGICAL & PHYSICAL RESEARCH	**118**	**285**	**285**
Biological & Physical Research	93	104	104
ISS Research Capabilities	0	155	155
B&PR Mission Support	25	26	26
EARTH SCIENCE	**3**	**4**	**4**
Research & Technology	3	4	4
AERO-SPACE TECHNOLOGY	**1,475**	**1,347**	**1,389**
Aero-Space Focused Programs	361	307	0
Aero-Space Base	627	734	0
Commercial Technology Program	24	24	24
Space Base Program	178	0	0
Aviation Safety	0	0	91
Vehicle Systems	0	0	610
Airspace Systems	0	0	12
2nd Generation RLV Focused	0	0	30
Space Transfer & Launch Tech	0	0	83
Computing Info & Communications Tech	0	0	90
Enabling Concepts & Technologies	0	0	133
Investment – AST	9	9	9
Aero-Space Technology Mission Support	276	273	307
SAFETY AND MISSION ASSURANCE	**13**	**13**	**13**
Safety And Mission Assurance	13	13	13
Total full-time equivalents (FTEs)	**1,945**	**1,923**	**1,924**

RESEARCH AND PROGRAM MANAGEMENT

FISCAL YEAR 2003 ESTIMATES

NASA HEADQUARTERS

ROLES AND MISSIONS

MISSION - Plan and provide executive direction for the implementation of U. S. space exploration, space science, Earth science, aeronautics, and technology programs. This includes corporate policy development, program formulation, resource allocations, program performance assessment, long-term institutional investments, and external advocacy for all of NASA.

MAJOR CORPORATE ROLES - The broad framework for program formulation will be conducted through five Strategic Enterprises:

- Human Exploration and Development of Space
- Earth Science
- Aerospace Technology
- Biological and Physical Research
- Space Science

Consistent with the NASA strategic plan, the Strategic Enterprises develop program goals and objectives to meet the needs of external customers within the policy priorities of the Administration and Congress.

Corporate-level enabling processes and staff functions will provide crosscutting interfaces required to support the Strategic Enterprises in:

- Legislative Affairs
- Budget And Financial Management
- Human Resources
- Legal Affairs
- International Affairs
- Information Systems And Technology
- Safety And Mission Quality
- Security Management and Safeguards
- Public Affairs
- Equal Opportunity Programs
- Education
- Procurement
- Management Systems And Facilities
- Small Business
- Advisory Committees

These functions are distributed under Institutional Support across the different Enterprises.

DISTRIBUTION OF FULL-TIME EQUIVALENT (FTE) WORKYEARS BY PROGRAM
NASA HEADQUARTERS

	FY 2001	FY 2002	FY 2003
HUMAN EXPLORATION & DEVELOPMENT OF SPACE	**419**	**517**	**521**
HEDS Mission Support	419	517	521
SPACE SCIENCE	**123**	**135**	**148**
Space Science Mission Support	123	135	148
B&PR MISSION SUPPORT	**31**	**34**	**41**
B&PR Mission Support	31	34	41
EARTH SCIENCE	**89**	**101**	**112**
Earth Science Mission Support	89	101	112
AERO-SPACE TECHNOLOGY	**349**	**380**	**395**
Aero-Space Technology Mission Support	349	380	395
Total full-time equivalents (FTEs)	**1011**	**1167**	**1217**

The allocation of FTEs for Mission Support at Headquarters is determined by a formula based on the proportion of total civil service FTEs associated with each Enterprise across all NASA Centers. The numbers above do not reflect the number of direct FTEs at NASA Headquarters in each of the Enterprise offices since the function of HQ personnel is considered to be "corporate" in nature, supporting the entire Agency. The derivation for these FTEs is similarly used to distribute the cost of the NASA Headquarters civil servants to the Enterprises.

DETAIL OF PERMANENT POSITIONS

	FY 2001	FY 2002	FY 2003
Executive level II	1	1	1
Executive level III		1	1
Executive level IV	0	1	1
Subtotal	**1**	**3**	**3**
ES-6	36	39	44
ES-5	64	90	95
ES-4	124	146	151
ES-3	60	75	80
ES-2	40	75	65
ES-1	53	78	68
Subtotal	**377**	**503**	**503**
CA	1	1	1
SL/ST	67	67	67
GS-15	2,654	2,590	2,594
GS-14	3,900	3,813	3,809
GS-13	5,507	5,625	5,640
GS-12	1,854	1,821	1,836
GS-11	1,455	1,438	1,435
GS-10	187	217	217
GS-9	537	575	585
GS-8	282	298	298
GS-7	644	635	635
GS-6	360	422	422
GS-5	61	89	79
GS-4	23	32	32
GS-3	10	2	2
GS-2	3	0	0
Subtotal	**17,545**	**17,625**	**17,652**

DETAIL OF PERMANENT POSITIONS (continued)

	FY 2001	FY 2002	FY 2003
Special ungraded positions established by NASA Administrator (NEX)	16	48	48
Ungraded positions - Wage Grade	58	58	58
Total permanent positions	**17,997**	**18,237**	**18,264**
Unfilled positions, EOY	0	0	0
Total, permanent employment, EOY	**17,997**	**18,237**	**18,264**

PERSONNEL SUMMARY

	FY 2001	FY 2002	FY 2003
Average GS/GM grade	12.61	12.55	12.55
Average ES salary	$130,344	$135,036	$138,547
Average GS/GM salary	$71,992	$75,304	$77,262
Average salary of special ungraded positions established by NASA Administrator	$101,086	$105,736	$108,485
Average salary of ungraded positions	$46,555	$48,697	$49,963

CENTER LOCATIONS AND CAPITAL INVESTMENT

JOHNSON SPACE CENTER - The Lyndon B. Johnson Space Center is located 20 miles southeast of Houston, Texas. NASA owns 1,581 acres of land at the Houston site and uses another 60,552 at the White Sands Test Facility, Las Cruces, New Mexico. The total capital investment including land, buildings, structures and facilities, equipment, and other fixed assets was $2,548,687,000 as of September 30, 2001.

KENNEDY SPACE CENTER - The Kennedy Space Center is located 50 miles east of Orlando, Florida. NASA owns 82,943 acres and uses launch facilities at Cape Canaveral Air Station and Vandenberg Air Force Base. The total capital investment including land, buildings, structures and facilities, equipment, and other fixed assets was $1,770,633,000 as of September 30, 2001.

MARSHALL SPACE FLIGHT CENTER - The Marshall Space Flight Center is located within the U.S. Army's Redstone Arsenal at Huntsville, Alabama. MSFC also manages operation at the Michoud Assembly 15 miles east of New Orleans, Louisiana and the Slidell Computer Complex in Slidell, Louisiana. The total capital investment including land, buildings, structures and facilities, equipment, and other fixed assets was $3,365,674,000 as of September 30, 2001.

STENNIS SPACE CENTER - The Stennis Space Center is located approximately 50 miles northeast of New Orleans, Louisiana. NASA owns 20,663 acres and has easements covering an additional 118,284 acres. The total capital investment including land, buildings, structures and facilities, equipment, and other fixed assets was $484,856,000 as of September 30, 2001.

GODDARD SPACE FLIGHT CENTER - The Goddard Space Flight Center is located 15 miles northeast of Washington, D.C. at Greenbelt, Maryland. NASA owns 1,121 acres at this location and an additional 6,176 acres at the Wallops Flight Facility in Wallops Island, Virginia. The total capital investment including land, buildings, structures and facilities, equipment, and other fixed assets at both locations was $1,876,282,000 as of September 30, 2001.

AMES RESEARCH CENTER - The Ames Research Center is located south of San Francisco on Moffett Field, California. NASA owns 447.5 acres at the Moffett Field location. The total capital investment including land, buildings, structures and facilities, equipment, and other fixed assets at both locations was $1,043,942,000 as of September 30, 2001.

DRYDEN FLIGHT RESEARCH CENTER - The Dryden Flight Research Center is 65 air miles northeast of Los Angeles. Dryden is located at the north end of Edwards Air Force Base on 838 acres of land under a permit from the Air Force. The total capital investment at Dryden, including fixed assets in progress and contractor-held facilities at various locations, as of September 30, 2001 was $621,907,000.

LANGLEY RESEARCH CENTER - The Langley Research Center is adjacent to Langley Air Force Base which is located between Williamsburg and Norfolk at Hampton, Virginia. NASA owns 788 acres and has access to 3,276 acres. The total capital investment including land, buildings, structures and facilities, equipment, and other fixed assets was $938,505,000 as of September 30, 2001.

GLENN RESEARCH CENTER - The Lewis Research Center occupies two sites; the main site is in Cleveland, Ohio, adjacent to Cleveland-Hopkins Airport; the second site is the Plum Brook Station located south of Sandusky, Ohio, and 50 miles west of Cleveland. NASA owns 6,805 acres and leases an additional 14 acres at the Cleveland location. The total capital investment including land, buildings, structures and facilities, equipment, and other fixed assets at both locations was $656,134,000 as September 30, 2001.

<u>NASA HEADQUARTERS</u> - NASA Headquarters is located at Two Independence Square, 300 E St. SW, Washington, D.C. and occupies other buildings in the District of Columbia, Maryland, and Virginia. These are leased facilities.

CONSTRUCTION OF FACILITIES

FISCAL YEAR 2003 ESTIMATES

BUDGET SUMMARY

OFFICE OF MANAGEMENT SYSTEMS

SUMMARY OF RESOURCES BY APPROPRIATION

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET	Page Number
	(Millions of Dollars)			
Direct Programs:	50.9	121.9	60.1	
Human Space Flight Programs	16.3	46.5	18.2	CoF-7
Science, Aeronautics and Technology Programs	34.6	75.4	41.9	CoF-11
Institutional Support:	278.5	233.4	266.9	CoF-17
Institutional Support – Human Space Flight	118.9	77.7	74.9	
Institutional Support – Science, Aeronautics and Technology	159.6	155.7	192.0	
Total	329.4	355.3	327.0	

**Beginning in FY 2002, Institutional Support Construction of Facilities previously contained within the Mission Support account was allocated to the Human Space Flight (HSF) and the Science, Aeronautics and Technology (SAT) accounts based on the number for full time equivalent personnel within each Enterprise.*

GOALS

The goal of the Construction of Facilities (CoF) program is to ensure that the facilities critical to achieving NASA's space and aeronautics programs are constructed and continue to function effectively, efficiently, and safely, and that NASA installations conform to requirements and initiatives for the protection of the environment and human health.

CONTENT

NASA facilities are critical to the shuttle, sustaining payload and launch operations, and for providing critical national aeronautical and aerospace testing capabilities, which support NASA, military and private industry users. NASA has conducted a thorough review of its facilities infrastructure finding that the deteriorating plant condition warrants an increased repair and renovation rate to avoid safety hazards to personnel, facilities, and mission; and that some dilapidated facilities need to be replaced. Facility revitalization is needed to maintain a facility infrastructure that is safe and capable of supporting NASA's missions. The Budget supports facilities funding to address these needs.

The Institutional Support Construction of Facilities (CoF) budget line item funds projects required for components of NASA's basic infrastructure and institutional facilities. Almost all of these projects are capital repair. Also included are funds for the design of facilities projects, advanced planning related to future facilities needs, and facilities-related sustaining engineering support. Beginning in FY 2002, the funding contained within Mission Support was allocated to the Human Space Flight (HSF) and Science, Aeronautics and Technology (SAT) accounts based on the number for full time equivalent personnel within each Enterprise. Funding for construction projects required for specific HSF or SAT programs/projects is included in the appropriate budget line item. Descriptions and cost estimates are shown as part of the Construction of Facilities program to provide a complete picture of NASA's budget requirement for facilities.

The institutional facility projects requested for FY 2003 continue the vital rehabilitation, modification, and repair of facilities to renew and help preserve and enhance the capabilities and usefulness of existing facilities and ensure the safe, economical, and efficient use of the NASA physical plant. They repair and modernize deteriorating and obsolete building and utility systems that have reached or exceeded their normal design life, are no longer operating effectively or efficiently, and cannot be economically maintained. These systems include mechanical, structural, cooling, steam, electrical distribution, sewer, and storm drainage. Some projects replace substandard facilities in cases where it is more economical to demolish and rebuild than it is to restore. In selected cases, additional square footage may be built when there are compelling reasons to support new or specialized technical and/or institutional requirements of a nature that cannot be provided by using existing facilities. Projects with estimated costs greater than $1.5 million are budgeted as discrete projects while projects greater than $0.5 million but not over $1.5 million are included as Minor Revitalization and Construction projects. Should residual resources become available from these projects, they will be used for urgently needed facility revitalization requirements. Congress will be notified before work is initiated for any such project that exceeds $1.5 million. Funds requested for Facility Planning and Design cover advance planning and design requirements for potential future projects, preparation of facility project design drawings and bid specifications, master planning, facilities studies, and engineering reports and studies. Also included are critical functional leadership activities directed at increasing the rate of return of constrained Agency resources while keeping the facility infrastructure safe, reliable, and available.

Institutional Support also includes the Environmental Compliance and Restoration (ECR) Program, which is critical to ensuring that statutory and regulatory environmental requirements and standards are met. NASA's environmental strategy demonstrates our commitment to protect the environment and provides for the protection and safety of human health. Focusing and directing our leadership and efforts into the principal areas of environmental compliance, remediation, restoration and conservation, and prevention achieve this commitment. The requested funds cover environmental activities required for compliance with environmental statutory and regulatory requirements and standards, orders, regulatory and cooperative agreements and support of environmental program initiatives, including the decommissioning of the Plum Brook Reactor.

CONSTRUCTION OF FACILITIES

FISCAL YEAR 2003 ESTIMATES

SUMMARY OF BUDGET PLAN BY APPROPRIATION AND PROJECT

PROJECT AND INSTALLATION	FY 2001	FY 2002	FY 2003	Page Number
		(Millions of Dollars)		
HUMAN SPACE FLIGHT PROGRAMS	16.3	46.5	18.2	CoF-7
INTERNATIONAL SPACE STATION	0.3	5.0	---	
Modify ISS Software Development Integration Laboratory (JSC)	---	5.0	---	
Facility Planning and Design	0.3	---	---	
SPACE SHUTTLE	15.6	39.5	15.0	
Replace Cell "E" Air Handling Units, Building 110 (MAF)	---	---	1.7	CoF-8
Replace Chilled Water, Steam, and Condensate Systems (110, 114) (MAF)	---	1.9	2.0	CoF-9
Replace Paint Spray Facility, Building 103 (MAF)	---	---	2.0	CoF-10
Repair Crane Hoist Trolley Motor Drive, Rotating Payload Servicing Facility (KSC)	---	1.6	---	
Repairs to the Vehicle Assembly Building (KSC)	---	25.0	*	
Restore Low Voltage Power System, Pad B (KSC)	---	2.0	---	
Repair and Modernize A-Complex (SSC)	---	3.0		
Contractor Claim on Replace Components Refurbishment Laboratory (KSC)	0.1	---	---	
Repair and Upgrade Substations 20A/20B (MAF)	1.8	---	---	
Minor Revitalization of Facilities at Various Locations Not in excess of $1.5 million per project	10.4	4.5	7.8	CoF-34
Facility Planning and Design	3.3	1.5	1.5	
PAYLOAD AND ELV SUPPORT	0.4	2.0	3.2	
Minor Revitalization of Facilities, not in excess of $1.5M	---	1.9	3.0	CoF-34
Facility Planning and Design	0.4	0.1	0.2	

*NASA's FY 2003 Budget request includes $61 million for Space Shuttle infrastructure revitalization budgeted under the Program Integration line of the Space Shuttle budget. FY 2003 funding for the VAB and other significant Shuttle infrastructure revitalization projects will be based on an assessment scheduled for completion in the latter half of FY 2002.

CONSTRUCTION OF FACILITIES

FISCAL YEAR 2003 ESTIMATES

SUMMARY OF BUDGET PLAN BY APPROPRIATION AND PROJECT

PROJECT AND INSTALLATION	FY 2001	FY 2002	FY 2003	Page Number
		(Millions of Dollars)		
SCIENCE, AERONAUTICS, AND TECHNOLOGY PROGRAMS	34.6	75.4	41.9	CoF-11
SPACE SCIENCE	7.2	43.6	21.7	
Construct Flight Projects Center (JPL)	---	12.4	16.5	CoF-12
Safety Renovations, Buildings 2 and 26 (GSFC)	---	1.7	---	
Construct 34-Meter Beam Waveguide Antenna, Madrid, Spain (JPL)	5.0	7.0	---	
Construct Propulsion Research Laboratory (MSFC)	---	22.0	---	
Construct Optical Interferometry Development Laboratory (JPL)	0.5	---	---	
Facility Planning and Design	1.7	0.5	5.2	
BIOLOGICAL AND PHYSICAL RESEARCH	11.6	9.8	2.8	
Construct Booster Applications Facility, Brookhaven National Laboratory	11.6	9.8	2.8	CoF-13
EARTH SCIENCE	---	2.5	3.4	
Construct Flight Projects Center (JPL)	---	2.5	3.4	CoF-12
AEROSPACE TECHNOLOGY	15.3	19.5	14.0	
Modify Cell W-2 for Dual-Spool Turbine Research, ERB (GRC)	---	---	10.0	CoF-15
Construct Rocket-Based Combined Cycle (RBCC) Test Facility (SSC)	10.0	8.0	4.0	CoF-16
Construct Visitor Center (LaRC)	---	1.5	---	
Construct Addition to Main Administration Building (SSC)	---	3.5	---	
Construct Propulsion Test Operations Facility (SSC)		1.5	---	
Upgrade E-Complex Test Capabilities (SSC)	---	5.0	---	
Replace Fan Blades, National Full-scale Aerodynamic Complex (ARC)	0.6	---	---	
Construction of Dry Room, Space Power Research Facility (GRC)	0.7			
Construct Propulsion Research Laboratory (MSFC)	2.0			
Facility Planning and Design	2.0	---	---	
SPACE OPERATIONS	0.5	---	---	
Facility Planning and Design	0.5	---	---	

CONSTRUCTION OF FACILITIES

FISCAL YEAR 2003 ESTIMATES

SUMMARY OF BUDGET PLAN BY APPROPRIATION AND PROJECT

PROJECT AND INSTALLATION	FY 2001	FY 2002	FY 2003	Page Number
		(Millions of Dollars)		
INSTITUTIONAL SUPPORT PROJECTS				CoF-17
Repair Roofs and Masonry, Various Buildings (GRC)	---	---	1.8	CoF-19
Repair Sanitary Sewer System (GRC)	4.4	3.9	1.6	CoF-20
Upgrade 150 PSIG Combustion Air System, ERB (GRC)	---	---	3.5	CoF-21
Realign Soil Conservation Service Road, Greenbelt (GSFC)	---	---	4.4	CoF-22
Repair Site Steam Distribution System (GSFC)	4.0	4.0	2.3	CoF-23
Relocate and Revitalize High Efficiency Antenna, DSS-65, Madrid Spain (JPL)	---	---	2.0	CoF-24
Construct Operations Support Building II, LC-39 Area (KSC)	13.0	12.8	5.6	CoF-25
Replace Air Handling Units, Headquarters Building (KSC)	---	---	2.0	CoF-26
Repairs to Air Conditioning Systems, Various Facilities (LaRC)	---	3.3	3.7	CoF-27
Upgrade Hangar Fire Suppression System, B1244 (LaRC)	---	---	2.8	CoF-28
Construct Replacement Office Building, 4600 Area (MSFC)	---	---	7.3	CoF-29
Replace Roof, External Tank Manufacturing Building (MAF)	---	12.0	11.0	CoF-30
Replace Site-Wide High Voltage Oil Switches (MAF)	---	---	2.8	CoF-32
Repairs to Airfield (WFF)	---	---	2.0	CoF-33
Construct Child Care Facility (ARC)	1.4	1.1	---	
Restore Electrical Distribution System (ARC)	8.7	8.9	---	
Rehabilitate and Modify Central Emergency Generator System (DFRC)	---	3.0	---	
Restore Parkway Bridge (GSFC)	---	2.9	---	
Connect Madrid Deep Space Complex to Commercial Power (JPL)	---	2.8	---	
Rehabilitate Aircraft Hangar, Ellington Field (JSC)	---	3.2	---	
Construct Operations Support Building, Pad A (KSC)	---	4.7	---	
Construct Replacement Air Traffic Control Tower, Shuttle Landing Facility (KSC)	---	2.0	---	
Rehabilitate Atmospheric Sciences Building, 1250 (LaRC)	---	2.4	---	
Replace Heater, 20-inch Mach 6 CF4 Tunnel (LaRC)	---	3.5	---	
Rehabilitate Interior, Office and Laboratory Building (MSFC)	---	1.8	---	
Rehabilitate and Modify Productivity Enhancement Complex (MSFC)	---	3.6	---	
Rehabilitate Precision Cleaning Facility (MSFC)	---	2.1	---	
Repair and Upgrade Substations 31, 32, and 33 (MAF)	---	2.4	---	

CONSTRUCTION OF FACILITIES

FISCAL YEAR 2003 ESTIMATES

SUMMARY OF BUDGET PLAN BY APPROPRIATION AND PROJECT

PROJECT AND INSTALLATION	FY 2001	FY 2002	FY 2003	Page Number
		(Millions of Dollars)		
INSTITUTIONAL SUPPORT PROJECTS (Continued)				
Provide 34.5kV Alternate Feed to Substation G (GRC)	4.5	---	---	
Rehabilitate Distributed Control System (GRC)	3.0	---	---	
Restore Chilled Water Distribution System (GSFC)	5.0	---	---	
Replace Chillers, Space Flight Operations Facility (JPL)	1.7	---	---	
Upgrade 34M Beam Waveguide Antenna Subnet for KA-Band, Network (JPL)	1.9	---	---	
Rehabilitate Electrical Distribution System, 200 Area, WSTF (JSC)	2.5	---	---	
Construct Operations Support Building, Hypergol Maintenance Facility (KSC)	2.3	---	---	
Construct Operations Support Building, Pad B (KSC)	4.0	---	---	
Repairs to Primary Electrical Power System, (KSC)	3.5	---	---	
Repairs to Electrical Systems, East and West Areas (LaRC)	9.0	---	---	
Repair and Modernize Fluid Dynamics Vacuum Pump Facility (MSFC)	2.6	---	---	
Replace Roof, Building 4705 (MSFC)	1.4	---	---	
Replace Mechanical Equipment and Roof, Building 350 (MAF)	5.4	---	---	
Construct Propulsion Test Operations Facility (SSC)	10.5	---	---	
Upgrade E-Complex Test Capabilities (SSC)	17.9	---	---	
Repair Storm Drainage System (WFF)	2.7	---	---	
Minor Revitalization and Construction of Facilities at Various Locations, Not in excess of $1.5 million per project	109.3	80.3	91.9	CoF-34
Facility Planning and Design	15.7	15.7	17.2	CoF-40
Environmental Compliance and Restoration	44.1	57.0	105.0	CoF-43
Total - Institutional Support CoF	278.5	233.4	266.9	

CONSTRUCTION OF FACILITIES

FISCAL YEAR 2003 ESTIMATES

SUMMARY

HUMAN SPACE FLIGHT PROGRAMS

	FY 2003 PRES BUDGET (Millions)	Page Number
Space Shuttle:		
Replace Cell "E" Air Handling Units, Building 110/130 (MAF)	1.7	CoF-8
Replace Chilled Water, Steam, and Condensate Systems (110, 114) (MAF)	2.0	CoF-9
Replace Paint Spray Facility, Building 103 (MAF)	2.0	CoF-10
Minor Revitalization of Facilities at Various Locations, Not in excess of $1.5 million per project	7.8	CoF-34
Facility Planning and Design	1.5	
Payload and ELV Support:		
Minor Revitalization of Facilities at Various Locations, Not in excess of $1.5 million per project	3.0	CoF-34
Facility Planning and Design	0.2	
Total Human Space Flight	18.2	

PROJECT TITLE: Replace Cell E Air Handling Units 1 and 2, Buildings 110/130
COGNIZANT ENTERPRISE: Human Exploration & Development of Space

INSTALLATION: Michoud Assembly Facility
LOCATION: New Orleans, Orleans Parish, LA

FY 2003 COST ESTIMATE (Millions of Dollars): 1.7

PRIOR YEARS FUNDING:	0.1
Construction	---
Facility Planning and Design	0.1

PROJECT DESCRIPTION:

This project provides for the replacement of two air-handling units located in Building 130 that are critical to External Tank (ET) production. The two air-handling units support the internal and external tank drying systems of Cell E in the Vertical Assembly Building (110). The project also provides for the installation of a new platform north of the Cell E control room, and for modifications to the mechanical components such as ductwork, steam, condensate, chilled water piping, electrical power and instrumentation.

PROJECT JUSTIFICATION:

Cell E is one of six cells located in the Vertical Assembly Building. The cleaning operations of the ET liquid oxygen (LO2) tank, both internal and external, and the liquid hydrogen (LH2) tank, internal only, are done at this location. Critical elements to cleaning operations within Cell E are the drying and tank purging features. Air Handling Unit No. 2 supports drying subsequent to internal washing of flight hardware cleaned in Cell E. This unit also provides an air purge to the LO2/LH2 tank during tank entry. Air Handling Unit No. 1 supports external drying after external washing of the LO2/LH2 tank.

The two air-handling units being replaced were installed as part of the Cell E Tank Drying System in 1987. These units provide an increased drying capacity, thereby reducing production-processing time. However, the chilled water coil casings and the absolute filter housings are corroding. The pans for the units are rusted and deteriorated. In addition, problems such as the lack of accessibility to the flow vane actuator and the accumulation of trash in the air duct are maintenance concerns. This project will replace the units in kind, thereby satisfying existing requirements for LOX/LH2 cleanliness, temperature, airflow rate, dew point, etc. The new units and associated ductwork will be designed with consideration for the corrosive chemicals that are used during the cleaning processes, in particular, the internal process.

IMPACT OF DELAY

These units have been in continuous operation since 1987 and are extensively deteriorated resulting in loss of efficiency. The housings are corroding allowing air to bypass the coils, the absolute filter housings are deteriorating, the drip pans are rusted out, and there are recurring motor/fan alignment and bearing problems. Continued degradation of these units and associated components could impact ET production schedules.

PROJECT TITLE: Replace Chilled Water, Steam, and Condensate Systems (110/114) INSTALLATION: Michoud Assembly Facility
COGNIZANT ENTERPRISE: Human Exploration & Development of Space LOCATION: New Orleans, Orleans Parish, LA

FY 2003 COST ESTIMATE (Millions of Dollars):	2.0	PRIOR YEARS FUNDING:	2.2
		Construction	1.9
		Facility Planning and Design	0.3

PROJECT DESCRIPTION:
This project replaces and reconfigures chilled water, steam and condensate systems to meet current and future equipment requirements. New chilled water supply and return piping will be routed from the mechanical equipment room to the south side of the Vertical Assembly Building (VAB) and to the Building 130 chilled water pumps supporting Cell E. New steam and condensate piping will be routed from the 190 Tank Farm area to the south side of the VAB equipment and receiver stations. The project will also provide for the replacement of condensate receiver stations, shut-off valves, strainers, and control valves.

PROJECT JUSTIFICATION:
External Tank (ET) production demands for chilled water, steam, and condensate changed substantially from 1963 (original installation was for production of the Apollo Saturn S1-C booster program). The inability to supply adequate chilled water to reach required temperature/humidity thresholds during an ET production process is a continuing problem which occurs during the hot and humid months of the year. It then becomes necessary to wait hours or days for the ambient conditions to moderate so ET processing activities can proceed in the cells. Chilled water, steam, and condensate return systems are crucial for the continuation of ET operations within the VAB. Chilled water is provided to the air handling units for the dehumidification inside the cells (requires 17%-18% relative humidity for spray operations). Steam/condensate is provided to the air handling units for heating inside the cells (requires 90°± 10° F cell environment and 196° supply temperature for tank heating).

The Vertical Assembly Building (VAB) chiller provides chilled water to the Building 110 heating, ventilation, and air-conditioning (HVAC) systems for the critical cooling and dehumidification parameters within the production cell systems. The HVAC systems use steam/condensate systems this heating means to condition the air entering critical cell environments and also prepare the surface temperature of the ET for foam application. The VAB steam condensate system has also deteriorated, causing back-ups, leakage, and reduced condensate feedwater for the boilers. Building 110 is the Vertical Assembly Building used for major assembly, Thermal Protection System ablator application, testing, and cleaning of the LH2 and LO2 tanks. Both the chilled water system and the steam/condensate systems were originally installed in 1963, making the majority of the systems almost 40 years old. The chilled water system capacity is unable to meet present year-round demands due to limitations imposed by existing piping system resistance and internal pipe corrosion. Current capacity delays ET production processing due to inability to meet stringent environmental parameters. The chiller supplying chilled water to Building 110 operates at full capacity during the summer in an attempt to maintain designed parameters in all critical cell environments.

IMPACT OF DELAY:
Continued degradation of system components and prolonged loss of chilled water, steam, or condensate would impact ET production activities and impact critical ET schedules. Also, delays in ET processing result from increased waiting times required to meet critical temperature and humidity requirements for spray operations in the cells.

PROJECT TITLE: Replace Paint Spray Facility, Building 103
COGNIZANT ENTERPRISE: Human Exploration & Development of Space

INSTALLATION: Michoud Assembly Facility
LOCATION: New Orleans, Orleans Parish, LA

FY 2003 COST ESTIMATE (Millions of Dollars): 2.0

PRIOR YEARS FUNDING:	0.2
Construction	---
Facility Planning and Design	0.2

PROJECT DESCRIPTION:
This project provides for the replacement of a paint spray facility and its associated components with an efficient state-of-the-art unit. The paint spray facility is located in the External Tank Manufacturing Building (103).

PROJECT JUSTIFICATION:
The paint spray facility to be replaced was installed in 1960. At MAF there are three areas where epoxy primer is applied to components of the External Tank. Cells K and P are where large amounts of the primer are applied to the LOX and LH2 tanks. The third area is the paint spray facility located east of the Chemical Clean Line Facility, Building 103. Smaller amounts of primer are used in this paint spray facility for flight hardware applications such as feed lines, cross beams and manhole covers.

The Paint Spray Facility, because of obsolescence, is the source of approximately 16 pounds per year of chromium emissions, which are about 67% of the actual chromium emissions from MAF. (Twenty-five pounds per year of chromium is MAF's regulatory threshold). Other major deficiencies identified by maintenance personnel are as follows: the facility lacks adequate air supply, doors are no longer sealed, outside air is sucked into the booth through cracks in the exterior wall, and the facility lacks temperature and humidity controls (temperature window is 65-90 degrees F, and relative humidity must be less than 70%). The facility does not meet humidity requirements at least 20% of the time; this is more prevalent during the warmer months resulting in a loss of productivity.

IMPACT OF DELAY
Replacement of the Paint Spray Facility is urgent. Chromium emissions resulting from major system deficiencies are fast approaching the maximum emission rate allowed by law.

CONSTRUCTION OF FACILITIES

FISCAL YEAR 2003 ESTIMATES

SUMMARY

SCIENCE, AERONAUTICS, AND TECHNOLOGY PROGRAMS

	FY 2003 PRES BUDGET (in millions)	Page Number
Space Science		
Construct Flight Projects Center (JPL)	16.5	CoF-12
Facility Planning and Design	5.2	
Biological and Physical Research		
Construct Booster Applications Facility, Brookhaven National Laboratory, Phase 4	2.8	CoF-13
EARTH SCIENCE		
Construct Flight Projects Center (JPL)	3.4	CoF-12
AEROSPACE TECHNOLOGY		
Modify Cell W-2 for Dual-Spool Turbine Research, ERB (GRC)	10.0	CoF-15
Construct Rocket-Based Combined Cycle (RBCC) Test Facility (SSC)	4.0	CoF-16
Total Science, Aeronautics, and Technology	41.9	

PROJECT TITLE: Construct Flight Projects Center, Phase 2
COGNIZANT ENTERPRISE: Space Science

INSTALLATION: Jet Propulsion Laboratory
LOCATION: La-Canada-Flintridge, Los Angeles County, CA

FY 2003 COST ESTIMATE (Millions of Dollars)	19.9*
Project Elements:	
Sitework	1.5
Structural	2.0
Architectural	6.0
Mechanical	6.4
Electrical	4.0

PRIOR YEARS FUNDING:	15.6
Construction	14.8
Facility Planning and Design	0.8

*FY 2003 funding includes $16.5 million included within Space Science and $3.4M included within Earth Science.

PROJECT DESCRIPTION:
The scope of this project was revised at no increase to the cost in order to incorporate the results of studies and preliminary design, and a scope increase was noted in the NASA FY 2002 Initial Operating Plan. The changes include an increase in gross square meters (GSM) of the building from 12,000 to approximately 17,800, a decrease in offices from 800 to approximately 700 and the incorporation of a project review center for approximately 400 people. The building will be located on the southeast corner of Surveyor and Mariner Roads and will also contain conference rooms, and support facilities. A structural steel framework will support concrete over steel deck floor and roof slabs. The building exterior will be a high performance glass and aluminum curtain wall system with a single ply membrane roof. Heating, ventilating, and air-conditioning (HVAC) and electrical equipment will be modern high efficiency units in fully integrated, digitally controlled systems. Forty-four wooden trailers (2,100 GSM) and six 1940s vintage buildings (4,000 GSM) will be demolished. The Design-Build procurement methodology will be used for this project. The total estimated construction cost for phases 1 and 2 is $35 million.

PROJECT JUSTIFICATION:
The new building will make optimal use of scarce building sites at JPL, ease the over crowded conditions at the Oak Grove campus, and allow demolition of substandard trailers and buildings that are costly to operate and maintain. Missions can be accomplished more effectively, efficiently, and safely while improving employee morale. Expensive off-site leased space will be vacated and the need for additional off-site leases will be avoided. This helps meet NASA's objective to minimize off-site leases. Annual costs of $4-5 million for modular units and off-site leases will be avoided.

IMPACT OF DELAY:
Employees would continue to work in substandard trailers and buildings that are very costly to operate and maintain. Personnel would continue to occupy increasingly expensive off-site leased space, with additional leased space required. Employee effectiveness, efficiency, and moral would continue to be at risk.

PROJECT TITLE: Construct Booster Applications Facility, Phase 6
COGNIZANT ENTERPRISE: Biological and Physical Research

INSTALLATION: Brookhaven National Laboratory
LOCATION: Long Island, NY

FY 2003 COST ESTIMATE (Millions of Dollars):	2.8	PRIOR YEARS FUNDING:	31.2
		Construction	31.2

PROJECT DESCRIPTION:
This project constructs a Booster Applications Facility (BAF) adjacent to the existing Brookhaven National Laboratory (BNL) Alternating Gradient Synchrotron (AGS) Booster. Conventional construction includes site clearing and preparation; new roads and parking areas; booster wall penetration; tunnel construction with access/egress corridors at both ends of the tunnel; and construction of two pre-engineered metal buildings, one for protecting power supplies and switchgear, and the other to provide laboratory workspace. The project modifies the AGS Booster to accommodate installation of hardware required to perform slow extraction. Booster modifications include relocation of the beam dump and a wall current monitor; installation of new septum magnets; provision of new power supplies; rewiring for higher currents; and reconfiguration of existing vacuum chambers. The project constructs a 63-meter Beam Transport System (BTS) in the new tunnel capable of providing a 20-degree bend (to eliminate direct line-of-sight) between the booster ring and the target area, and capable of distributing the beam over a 15-centimeter x 15-centimeter target area. The BTS consists of a 10-centimeter diameter vacuum pipe with a thin window in front of the target and a fast-closing valve to protect the booster vacuum from a window break; magnetic elements to transport and shape the beam on target; a cooling system using low conductivity water; and cable trays and cabling for direct current (DC) power and controls. The project includes all distributed systems, central services, and process controls required for operation of the BAF, including a relay-based personnel access control system that permits entrance to radiation areas only when safe to do so. The project upgrades one of the two existing BNL Tandem accelerators to 16 megavolts and modifies it to enable concurrent use by AGS and BAF. The project provides for outfitting of the experimental areas of research in biological systems, including dosimeters, computer systems, and other electronic equipment. Project provides for all supporting infrastructure and utilities. This is the sixth increment of this $34 million project.

PROJECT JUSTIFICATION:
The BAF will provide a ground-based facility in which to conduct important research aimed at understanding and assessing health risks and developing effective countermeasures against galactic cosmic radiation. Such a capability does not currently exist. The BAF will provide the capability to simulate all major ion components and energies of the galactic cosmic rays and solar proton events. Once the BAF becomes operational, BNL will provide NASA access to more than 2,000 beam-hours-per-year in order to meet all of the goals of NASA's Strategic Radiation Health Plan for Space Radiation Health Research.

The BAF will benefit the International Space Station (ISS) by providing a ground-based facility for meeting operational, scientific, and technology goals in radiation protection. The BAF will provide a capability for accurate calibration of radiation detectors used to monitor crewmember exposures on ISS and verify doses as regulated by OSHA. It will also provide a facility for developing shielding augmentation for ISS, which would increase astronaut safety and extend crew stays. The BAF will enable critical research and measurements for assessing health risks from heavy-ions that comprise up to 50 percent of the biological dose on ISS. Acquiring this scientific knowledge will allow NASA to maximize crew stay times and reduce costs from excessive crew changes.

The National Research Council and the National Council of Radiation Protections and Measurements in independent reviews have informed NASA that the scientific basis to estimate risk from galactic cosmic radiation during long-term space flight does not exist. The BAF will benefit long-duration missions by providing a unique ground-based facility in which to conduct critical research to obtain knowledge of potential health effects and for he development of ground analogs, biological countermeasures, and radiation shielding strategies.

<u>IMPACT OF DELAY</u>:
Delaying this project would greatly impact NASA's ability to pursue vital research on space radiation effects required to enable development of maximum-exposure guidelines and of radiation countermeasures such as shielding. NASA's ability to safety carry out extended crew stays at the ISS and other potential future long-duration space flights would be severely curtailed. Delay of this project would also delay our ability to calibrate radiation detectors without which NASA cannot accurately monitor ISS crewmembers' exposure to radiation. These impacts will translate into increased ISS operations cost due to more frequent crew changes, and increased risk to astronauts due to limited knowledge of space radiation effects.

PROJECT TITLE: Modify Cell W-2 for Dual-Spool Turbine Tech, ERB (23)		INSTALLATION: Glenn Research Center	
COGNIZANT ENTERPRISE: Aerospace Technology		LOCATION: Cleveland, OH	
FY 2003 COST ESTIMATE (Millions of Dollars)	10.0	PRIOR YEARS FUNDING:	2.3
Project Elements:		Preliminary Engineering Report	0.3
Combustion Air & Exhaust Subsystems	2.7	Facility Planning and Design	2.0
Power Absorption Subsystem	2.3		
Manifolds, Support Structure & Bearing Cartridges	1.5		
Misc. Support Systems	1.2		
Electrical & Control Subsystems	1.1		
Structural Modifications	1.2		

PROJECT DESCRIPTION:

This project provides for the modifications to Cell W-2 of the Engine Research Building (ERB) No. 23. These modifications will provide a Dual Spool Turbine Facility (DSTF) for continuous flow testing of highly loaded, closely coupled turbine systems. Existing Glenn Central Systems such as the 150 psig Combustion Air System and the Altitude Exhaust System will be modified as part of this project. Combustion Air will be heated to 1000 °F using a new non-vitiated air heater system. A custom-designed inlet air manifold will introduce uniform heater air into the inlet of the test section. Custom-designed bearing cartridges will accommodate a wide size and weight range of high-pressure (HP) and low-pressure (LP) turbine rotors. Turbine power absorption will be accomplished using two new synchronous generators controlled by the Glenn Variable Frequency System. A new exhaust manifold will be used to collect the primary and cooling air flows from the test section outlet. All exhaust will be ported to the Glenn Altitude Exhaust System. Facility health monitoring and control will be accomplished using Programmable Logic Controllers (PLCs) mounted in an existing control room.

PROJECT JUSTIFICATION:

In the search for ultra-efficient gas turbine engines, one of the major areas of potential improvement is the reduction of size and number of turbine stages. One promising technique to accomplish this is to rely on a single high-work, high-pressure turbine close-coupled to a counter-rotating low-pressure turbine. The operating envelope of the DSTF will accommodate a wide range of commercial and military applications with high- pressure turbine sections up to 46 inches in diameter and low-pressure turbine sections up to 70 inches in diameter. There is very limited experimental capability in the U.S. to test and measure the details of the complex flow interactions in such turbine systems. The DSTF will provide this capability. The large scale and high expansion ratio aspects designed into the DSTF will allow for accurate computer code validation and support the robust requirements of the Ultra Efficient Engine Technology (UEET) Program.

IMPACT OF DELAY:

Delay in building the DSTF will jeopardize the attainment of UEET Level 1 milestones. Also, two new dual-spool test facilities are known to exist in Europe. Consequently, delay in building the DSTF will delay U.S. engine companies in the development of ultra-efficient engine technology.

PROJECT TITLE: Construct Rocket Based Combined Cycle (RBCC) Test Facility, Phase 4 INSTALLATION: Stennis Space Center
COGNIZANT ENTERPRISE: Aerospace Technology LOCATION: Bay St. Louis, MS

FY 2003 COST ESTIMATE (Millions of Dollars)	4.0	PRIOR YEARS FUNDING:	22.0
Project Elements:		Construction	21.0
Controls, Instrumentations and Activation	4.0	Facility Planning and Design	1.0

PROJECT DESCRIPTION:
This project provides for the design and construction of a “free jet” facility to test up to a 50k-thrust rocket engine with a maximum of Mach 0.75 air supply system. Construction will include the sitework, test cell structure, a structure for a Test Control Center (TCC), offices, and a high-bay area for engine preparation and storage. The project will also include installation of gas and cryogenic storage and transfer systems. Project provides for supporting infrastructure and utilities. This is the fourth and final increment of this $26 million project.

PROJECT JUSTIFICATION:
The potential benefits of Rocket Based Combined Cycle (RBCC) engines over traditional rocket propulsion have been considered for many years. The primary benefit is the improvement in payload mass fraction resulting in less cost per pound to orbit. RBCC technologies must be matured and the maturing process will require ground testing due to the complex interactions of chemical kinetics, fluid mechanics and compressible flow effects that occur in RBCC engines.

The RBCC Program requires testing of a rocket engine and possible engine clusters to simulate flight conditions at subsonic conditions. This testing is critical to the engine prototype development and future production testing of the engine. A testing facility is required for sea level testing, sea level freejet testing to a Mach 0.75 and altitude testing. No facility is currently available for testing criteria for this type of technology. A Government owned facility will provide control of facility availability, control of test readiness on a day to day basis, and enhanced understanding of the interactions between facility and test article (engine) including air heating and storage systems, thrust measurement systems, and controls and data acquisition systems. The RBCC propulsion test facility will have high productivity goals. Initial estimates are 10 tests per month.

IMPACT OF DELAY:
A delay of this project would prevent the technologies to be developed in accordance with the NASA Strategic Plan within the Aerospace Technology goal to revolutionize space launch capabilities reducing payload cost to low-cost orbit by an order of magnitude during the period of 2003-2009.

CONSTRUCTION OF FACILITIES

FISCAL YEAR 2003 ESTIMATES

SUMMARY OF INSTITUTIONAL SUPPORT RESOURCES REQUIREMENTS

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET	Page Number
Discrete Projects	109.4	80.4	52.8	CoF-18
Minor Revitalization and Construction	109.3	80.3	91.9	CoF-34
Facility Planning and Design	15.7	15.7	17.2	CoF-40
Environmental Compliance and Restoration	44.1	57.0	105.0	CoF-43
TOTAL	278.5	233.4	266.9	
Distribution of Program Amount by Installation				
Johnson Space Center	35.8	20.6	21.8	
Kennedy Space Center	48.4	33.4	30.5	
Marshall Space Flight Center	32.9	34.6	35.5	
Stennis Space Center	42.0	10.9	10.9	
Ames Research Center	21.1	21.1	11.6	
Dryden Flight Research Center	5.3	8.5	5.1	
Glenn Research Center	30.5	31.0	85.9	
Langley Research Center	17.8	20.6	17.9	
Goddard Space Flight Center	23.4	23.7	20.0	
Jet Propulsion Laboratory	17.3	24.1	22.5	
Headquarters	4.0	4.9	5.2	
TOTAL	278.5	233.4	266.9	

CONSTRUCTION OF FACILITIES

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SUMMARY

INSTITUTIONAL SUPPORT

	FY 2003 PRES BUDGET (Millions)	Page Number
Institutional Support Discrete Projects:		
Repair Roofs and Masonry, Various Buildings (GRC)	1.8	CoF-19
Repair Sanitary Sewer System (GRC)	1.6	CoF-20
Upgrade 150 PSIG Combustion Air System, ERB (GRC)	3.5	CoF-21
Realign Soil Conservation Service Road, Greenbelt (GSFC)	4.4	CoF-22
Repair Site Steam Distribution System (GSFC)	2.3	CoF-23
Relocate and Revitalize High Efficiency Antenna, DSS-65, Madrid Spain (JPL)	2.0	CoF-24
Construct Operations Support Building II, LC-39 Area (KSC)	5.6	CoF-25
Replace Air-Handling Units, Headquarters Building (KSC)	2.0	CoF-26
Repairs to Air Conditioning Systems, Various Facilities (LaRC)	3.7	CoF-27
Upgrade Hangar Fire Suppression System, B1244 (LaRC)	2.8	CoF-28
Construct Replacement Office Building, 4600 Area (MSFC)	7.3	CoF-29
Replace Roof, External Tank Manufacturing Building (MAF)	11.0	CoF-30
Replace Site-Wide High Voltage Oil Switches (MAF)	2.8	CoF-32
Repairs to Airfield (WFF)	2.0	CoF-33
Total Discrete Projects	52.8	

PROJECT TITLE: Repair Roofs and Masonry, Various Buildings
COGNIZANT ENTERPRISE: Aerospace Technology

INSTALLATION: Glenn Research Center
LOCATION: Cleveland, OH

FY 2003 COST ESTIMATE (Millions of Dollars)	1.8	PRIOR YEARS FUNDING:	0.2
		Facility Planning and Design	0.2

PROJECT DESCRIPTION:

This project is the first of three phases to repair and/or replace deteriorated and damaged roofing systems on various existing buildings throughout the Center. Roofing membranes, insulation, flashing, pitch pockets, roof curbs, and walk pads that are judged to be defective will be removed and replaced with new material. Sealing joints with weatherproof materials will repair existing building parapet walls and copingstones. The estimated cost of construction for all three phases is $8.2 million dollars.

PROJECT JUSTIFICATION:

The repair and/or replacement of deteriorated roofing systems will reduce damage to interior spaces of buildings. Water damage has caused financial loss attributed to replacement of computer equipment, wind tunnel systems, research, laboratory equipment, furniture, interior building finishes, and the disruption of employee work areas. Unchecked water penetration into perimeter masonry walls has caused considerable damage to buildings due to annual freeze/thaw cycles, typical in the Northeast Ohio area. Present roofing systems, which are severely damaged, require an increasingly large amount of annual budget funding for maintenance.

IMPACT OF DELAY:

Failure to replace roofing systems could result in risk to personnel safety, and potentially extensive and costly damage to wind tunnel systems, research, and building systems. The annual budget will continue to be used to repair roof leaks, parapet walls, and displace employees from their work areas.

PROJECT TITLE: Repair Sanitary Sewer System, Phase 5
COGNIZANT ENTERPRISE: Aerospace Technology

INSTALLATION: Glenn Research Center
LOCATION: Cleveland, OH

FY 2003 COST ESTIMATE (Millions of Dollars)	1.6	PRIOR YEARS FUNDING:	10.8
		Construction	10.1
		Facility Planning and Design	0.7

PROJECT DESCRIPTION:
This project is the fifth of five phases to repair the aging sanitary sewer system. The scope includes replacing sewer mains, eliminating cross connections between the sanitary and storm water systems, and repair/installing oil-water separators. It also includes excavation, backfill, and pavement repair necessary to replace sewer lines and manholes. It will improve the hydraulics of the system, greatly reduce maintenance and operating costs, and eliminate noncompliance discharges to the storm outfalls.

PROJECT JUSTIFICATION:
The existing sanitary sewer system is more than fifty years old and is in poor condition. This project will reduce treatment and maintenance costs associated with operating the aging sanitary sewer system and eliminate nonconformance discharges to storm outfalls. This project will reduce maintenance costs by reducing the need for emergency repairs on broken lines. It will reduce treatment costs by reducing inflow and infiltration into the sanitary sewer. In addition, it will eliminate noncompliance discharges to storm sewer outfalls caused by broken sanitary lines and cross connections to comply with National Pollution Discharge Elimination Systems permits.

IMPACT OF DELAY:
Without the project, avoidable and costly treatment of storm water discharged through the sanitary sewer system would continue. In addition, continued breaks and blockages in sewer lines are increasingly more likely to occur, requiring costly emergency repairs. Continued noncompliance notices could result in increased inspections, increased monitoring, and fines by the Ohio EPA.

PROJECT TITLE: Upgrade 150 PSIG Combustion Air System, ERB
COGNIZANT ENTERPRISE: Aerospace Technology

INSTALLATION: Glenn Research Center
LOCATION: Cleveland, OH

FY 2003 COST ESTIMATE (Millions of Dollars)	3.5	PRIOR YEARS FUNDING:	0.2
		Construction	
		Facility Planning and Design	0.2

PROJECT DESCRIPTION:
This project provides for the installation of a 150-psig compressor at 38 pounds/second in the Engine Research Building (64). The scope includes the fabrication and installation of a 150-psig compressor and associated air and cooling water piping, electric power, and controls.

PROJECT JUSTIFICATION:
Anticipated high-pressure air demand exceeds the current system capacity. The recent addition of the Advanced Subsonic Combustor Rig (ASCR) compressor (1250 psig) in the Engine Research Building (ERB) and the projected future usage are limited by the 150-psig stage mass flow rate. When capacity is exceeded, large compressors located in the Central Air Equipment Building (64) are required to operate at low capacity. It is inefficient and expensive to use these compressors for this requirement. This situation also results in a loss or delay of research at some facilities due to scheduling conflicts and increased utility costs. Other test facilities such as Test Cells (CE-5, CE-9, & C-22) and the 9x15 wind tunnel cannot run when the ASCR is running.

IMPACT OF DELAY:
The existing compressors require major inspections every four years. Unscheduled maintenance shutdowns will increase resulting in increasing delays to research. Scheduling conflicts will continue as the demand for high-pressure air increases.

PROJECT TITLE: Realign Soil Conservation Service Road
COGNIZANT ENTERPRISE: Office of Mission of Planet Earth

INSTALLATION: Goddard Space Flight Center
LOCATION: Greenbelt, MD

FY 2003 COST ESTIMATE (Millions of Dollars)	4.4	PRIOR YEARS FUNDING:	0.4
		Facility Planning and Design	0.4

PROJECT DESCRIPTION:
The project will reroute non-NASA traffic, currently along Soil Conservation Road, around a consolidated center perimeter. Work includes constructing new roadways and parking areas, upgrading existing roadways, realigning security fence perimeters, constructing new and temporary gates. Ancillary work includes site demolition, grading and landscaping, traffic controls, signage, lighting, utility modifications, and environmental remediation.

PROJECT JUSTIFICATION:
Currently, Soil Conservation Service (SCS) road cuts the Center in half. This causes security concerns and problems by denying the Center a contiguous secure campus. Additionally, the splitting of the Center by the road results in pedestrian and vehicular safety concerns and problems. The project will also enable the realization of a number of key goals contained in the Goddard Space Flight Center (GSFC) Master Plan. First, it will facilitate the creation of a single, safer security perimeter. Relocating the road is a part of consolidating major functional activities at GSFC, in turn helping to improve facilities efficiencies. The site area currently occupied by the Soil Conservation Service road will provide building sites for new, highly quality facilities such as the future Space Science building, which addresses critical quality problems for one of GSFC's Core Competencies. In addition, existing buildings that are freed up by shifting existing organizations will allow for the creation of a Partnering and Outreach Zone.

IMPACT OF DELAY:
Delay will perpetuate current safety, quality, unified campus, and efficiency problems. In particular, delaying this project would cause a commensurate postponement in satisfying critical facilities requirements for the Space Sciences Directorate, a GSFC Core Competency. Addressing many of these problems may require interim facilities fixes at substantial cost to the CoF program. Further, projected operational cost savings would be postponed.

PROJECT TITLE: Repair Site Steam Distribution System, Phase 5
COGNIZANT ENTERPRISE: Earth Science

INSTALLATION: Goddard Space Flight Center
LOCATION: Greenbelt, MD

FY 2003 COST ESTIMATE (Millions of Dollars)	2.3

PRIOR YEARS FUNDING:	13.9
Construction	12.9
Facility Planning and Design	1.0

PROJECT DESCRIPTION:
This project comprises the fifth phase of a multi-year program to rehabilitate the site steam distribution system. It includes completion of the loop providing redundant steam to the East Campus, the replacement of three lines supplying steam to individual buildings, and completion of the west campus loop. Construction includes replacement of the steam and condensate lines, upgrading steam manholes, all site work required to install the new lines, and removal of the existing lines when feasible. This is the last phase for this work.

PROJECT JUSTIFICATION:
The central steam distribution system was originally installed in the early 1960s and is at the end of its useful life. The piping is experiencing frequent leaks and failures due to deterioration. Lack of redundancy and risk of pipe failure threaten the supply of steam to critical buildings. The degradation of the system poses possible safety risks to operations and maintenance workers. This project is a part of the on-going restoration program, which will improve system efficiency, reduce maintenance cost and restore reliability.

IMPACT OF DELAY:
A major failure could occur in the campus-wide steam distribution system, resulting in the loss of steam supply to several buildings. That may seriously impact the operations in those buildings. The delay will also increase the operation and maintenance costs to keep the remaining deteriorated portions of the system operational.

PROJECT TITLE: Relocate and Revitalize High Efficiency Antenna DSS-65
COGNIZANT ENTERPRISE: Space Science

INSTALLATION: JPL Deep Space Network
LOCATION: Madrid DSCC, Madrid, Spain

FY 2003 COST ESTIMATE (Millions of Dollars)	2.0	PRIOR YEARS FUNDING:	0.2
		Facility Planning and Design	0.2

PROJECT DESCRIPTION:
This project will construct a new foundation for the DSS-65 antenna at the Madrid Deep Space Communications Complex (MDSCC), located near Madrid, Spain. Following this construction, the antenna will be partially disassembled and subsequently moved from its current location to its new foundation and reassembled. The new foundation will likely be located within 100 meters of the current antenna location. Various mechanical components that have been damaged as a result of previous foundation displacement will be replaced. These include the azimuth track assembly and the antenna azimuth wheel assemblies.

PROJECT JUSTIFICATION:
DSS-65 is an operational 34-meter High Efficiency (HEF) Antenna of the Deep Space Network (DSN). DSS-65 construction was completed in 1986 and the antenna began to track spacecraft that same year. In 1994, evidence of structural problems on the antenna began to appear. Subsequent analysis of the soil conditions determined that the antenna foundation was constructed upon weak rock and without a footing, causing the movement of the foundation. Several efforts over the years have been employed to stop the movement of the antenna foundation. However, none of the efforts undertaken have proven adequate. Consequently, detailed engineering studies of the problem have determined that it is best to move the antenna, rather than attempting to stabilize the current foundation in place or building the new foundation in the current antenna location. This implementation will also result in less antenna downtime, as the antenna will be able to remain operational during the new foundation construction phase.

IMPACT OF DELAY:
The DSS-65 foundation will continue its differential movement move. As the foundation moves, the integrity of the antenna structure will become increasingly compromised. The deterioration in the antenna structure will result in significant antenna downtime that will affect tracking of spacecraft.

PROJECT TITLE: Construct Operations Support Building II, LC-39 Area, Phase 3
COGNIZANT ENTERPRISE: Office of Space Flight

INSTALLATION: Kennedy Space Center
LOCATION: Brevard County, Merritt Island, FL

FY 2003 COST ESTIMATE (Millions of Dollars):	5.6
Project Element:	
Architectural and Structural	2.6
Mechanical	1.5
Electrical	1.5

PRIOR YEARS FUNDING:	28.2
Construction	25.8
Facility Planning and Design	2.4

PROJECT DESCRIPTION:
This project provides for the construction of a second Operations Support Building in the LC-39 Vehicle Assembly Building (VAB) area. The complex will be approximately 200,000 square feet and accommodate approximately 1,000 workers. The complex will support operational areas and consist of offices, training rooms, computer rooms, multi-media conference rooms, Mission Conference Center with observation deck, technical libraries, Exchange store, snack bar, storage, miscellaneous support areas and parking. Facility systems to be included are heating, ventilation, and air conditioning (HVAC); electrical power; natural gas; water; sewage; fire detection and protection; and paging and area warning systems. The project will also upgrade the existing central utilities and control systems in order to support the new complex. This is the third and final increment of this $31.4M project. Non-construction funding in the amount of $14 million will be budgeted to provide for systems furniture, communication systems, computer equipment, and other such outfitting and activation costs.

PROJECT JUSTIFICATION:
A critical need exists to eliminate 280 trailer equivalents of dilapidated substandard housing affecting the safety, morale and welfare of approximately 700 Shuttle processing workers, transient Launch fallback personnel, and personnel who attend training. This project allows consolidation of fragmented programs affecting approximately 300 workers currently scattered across the Center supporting LC-39 operations and Spaceport Technology Center strategies. Additional substandard housing will be eliminated when vacated permanent housing currently being used by the fragmented programs is backfilled. KSC's heavy salt corrosive environment has aggressively attacked and severely corroded the existing 20-year-old portable office trailers and modified railroad boxcars. These units have mold and indoor air quality problems; rotting and termite infested siding and floor substructures; roof and siding that leak; plumbing that does not drain properly; tripping hazards, such as uneven floors and exterior stairs that are wobbly and unstable; and numerous other code violations. Trailers and modular housing have 24 times more environmental health complaints than comparable permanent facilities. This contributes to intensive and unscheduled maintenance having excessive costs; highly inefficient and costly energy consumption; and working environments that barely meet minimum safety and health standards.

IMPACT OF DELAY:
People would continue to work in deteriorated, grossly substandard conditions, which adversely affects morale and productivity, and could potentially affect their health and safety. Maintenance would continue to cost approximately $1.3 million/year more than for conventional permanent facilities and 47% more energy would continue to be consumed. Productivity would continue at lower levels also because people working on the same program are not in close proximity and have to travel greater distances.

PROJECT TITLE: Replace Air-Handling Units, Headquarters Building
COGNIZANT ENTERPRISE: Human Exploration & Development of Space

INSTALLATION: Kennedy Space Center
LOCATION: Brevard County, Merritt Island, FL

FY 2003 COST ESTIMATE (Millions of Dollars): 2.0

PRIOR YEARS FUNDING:	0.2
Facility Planning and Design	0.2

PROJECT DESCRIPTION:
This project provides for the replacement of seven 35-year-old air-handling units in the west end (Wings E and F) of the KSC Headquarters Building (M6-399), and includes the installation of direct digital controls compatible with the Industrial Area Chiller Plant's utility control system for efficiency and energy conservation purposes. An outdoor air intake system will be installed to provide dehumidification and building pressurization to address Health and Safety problems within the building. Heat load calculations and a test and balance of the system will be performed to ensure all areas are adequately covered. This project is the first of three phases to replace all the air-handling units and associated controls, and the air distribution system ductwork serving this facility. Estimated total construction cost is $6 million. Non-construction funds in the amount of $100,000 per phase will be budgeted separately to fund the temporary relocation of ~170 occupants per wing and for activation.

PROJECT JUSTIFICATION:
The 35-year-old air-handling units and associated ductwork in the KSC Headquarters Building have exceeded their life span by fifteen years. The units and the ductwork are structurally deteriorated, energy inefficient, and difficult and costly to maintain. Their deterioration, in conjunction with an inadequate design for the humid climate, makes it difficult to provide adequate cooling and ventilation inside the facility. Indoor air quality problems prevail, putting at risk the health and safety of building occupants. Workers Compensation claims have already been filed and the potential for OSHA complaints and lawsuits exists. This project will bring the KSC Headquarters Building into compliance with the ASHRAE Indoor Air Quality Standards for Hot and Humid Climates, the Environmental Protection Agency (EPA) Guidelines for Building Air Quality, and the Executive Order on Energy Efficiency and Water Conservation at Federal Facilities. Modern air-handling units and accessible ductwork will improve maintainability, improve indoor air quality, and enhance energy management.

IMPACT OF DELAY
Delay of this project will continue to expose occupants to prevailing indoor air quality problems, which impacts the morale and productivity of the workforce. The potential will continue to exist for additional Workers Compensation claims. The facility will also continue to experience high energy and maintenance costs wasting valuable operations and maintenance resources.

PROJECT TITLE: Repairs to Air Conditioning Systems, Various Facilities
COGNIZANT ENTERPRISE: Aerospace Technology

INSTALLATION: Langley Research Center
LOCATION: Hampton, VA

FY 2003 COST ESTIMATE (Millions of Dollars)	3.7	PRIOR YEARS FUNDING:	0.4
Project Elements:		Facility Planning and Design	0.4
Building 1230 (East Wing):	2.3		
Building 1236:	1.4		

PROJECT DESCRIPTION:
The project provides new terminal induction units with four pipe fan coil units and a primary/secondary pumping system for Building 1230. The existing steam absorption chiller will be utilized for chilled water and a new steam to hot water converter will provide the heating. A separate outside unit with a total enthalpy wheel will be installed to provide the proper amount of preconditioned ventilation air to each of the fan coil units. A new variable air volume (VAV) system comprised of a VAV terminal units with a hot water reheat coil will be utilized in building 1236. A new central air handler with a variable frequency drive will provide conditioned air to the VAV units. A new air-cooled packaged chiller will be installed in the courtyard area to provide chilled water and a new steam to hot water converter will provide the heating. A separate outside air unit with a total energy enthalpy wheel will be installed to provide ventilation to the individual rooms. A direct digital control system for both buildings will allow control and monitoring from Building 1215. Additional work to the buildings includes the remediation of asbestos from the mechanical systems, interior partitions, and building finishes. Life safety improvements will include the installation of a complete wet pipe sprinkler system, improvements to the fire alarm system, upgrades to the smoke detectors, and improvements of the integrity of fire rated paths of egress. Electrical work will include installation of required power connections to all new equipment and replacement of obsolete distribution panels. A redesigned lighting layout and the replacement of inefficient lamps and fixtures will improve lighting levels and require less maintenance and energy to operate.

PROJECT JUSTIFICATION:
These air conditioning units have reached the end of their useful lives. The equipment is old, unreliable, and incapable of performing under stress, such as maintaining consistent temperature levels in the summertime. The number of service calls is increasing and maintenance costs are high. The majority of this equipment was identified for replacement by the Facility Assessment Review conducted in 1993.

IMPACT OF DELAY:
The air conditioning and fume hood systems are critical to the safety and operations in these facilities. Failures of this equipment affects performance and making emergency repairs is expensive and causes significant disruptions. These air conditioning units must be repaired and replaced in a timely manner.

PROJECT TITLE: Upgrade Hangar Fire Suppression System (1244)
COGNIZANT ENTERPRISE: Aerospace Technology

INSTALLATION: Langley Research Center
LOCATION: Hampton, VA

FY 2003 COST ESTIMATE (Millions of Dollars)	2.8
Project Elements:	
Architectural & Structural	1.3
Mechanical	1.3
Controls & Electrical	0.2

PRIOR YEARS FUNDING:	0.1
Facility Planning and Design	0.1

PROJECT DESCRIPTION:
Provide an Aqueous Film Forming Foam (AFFF)-water deluge system(s) and supplemental protection systems designed and tested per National Fire Protection Association (NFPA) 16 and NFPA 11 or 11A respectively. Provide a new fire detection system compatible with the Center wide system per NFPA 72. Provide supplemental under-wing foam/water systems to cover the specified floor areas beneath the aircraft to be protected. Fire control is to be achieved in 30 seconds and extinguished within 60 seconds. The primary aircraft of concern is the Boeing 757. The existing hose stations provided within the hangar are designed for water application only. These stations will be upgraded to meet NFPA requirements.

PROJECT JUSTIFICATION:
The existing water-deluge system does not provide satisfactory protection per Section 3-1.1 of NFPA 409 and Chapter 7 of NASA Standard 8719.11 - NASA Safety Standard For Fire Protection. Supplemental protection systems, such as under wing foam nozzles are required for Hangar areas housing aircraft having wing areas in excess of 3,000 sq. ft. per Section 3-3.1 of NFPA 409.

IMPACT OF DELAY:
Delay could lead to loss of buildings, aircraft and equipment, as well as potential loss of life in the event of an aircraft fire.

PROJECT TITLE: Construct Replacement Office Building, 4600 Area
COGNIZANT ENTERPRISE: Human Exploration & Development of Space

INSTALLATION: Marshall Space Flight Center
LOCATION: Huntsville, AL

FY 2003 COST ESTIMATE (Millions of Dollars):	7.3
Project Element:	
Site Utilities	4.3
Civil/Structural	1.6
Architectural/Mechanical/Electrical	1.4

PRIOR YEARS FUNDING:	2.4
Facility Planning and Design	2.4

PROJECT DESCRIPTION:
This project replaces about 130,000 SF of mostly 1940's vintage office buildings scattered throughout the 4600 and 4700 area with a five-story office building of approximately 120,000 square feet that will accommodate about 500 people. Existing facilities are in an extreme state of disrepair and cannot be economically rehabilitated. Site utilities will include basic electrical, potable water, sanitary sewer, chilled water, communications, and storm drainage. Utility runs to the site will be sized to facilitate future construction of additional replacement office buildings over the next several years. Mechanical systems will provide climate control, potable water, sanitary sewer, chilled water, and sprinkler systems. Climate controls will be connected to the existing center-wide utility control system. The building will house a special conferencing facility and the basement will be designed to serve double-duty as a shelter for personnel during severe weather (i.e. tornadoes). Two roads will be improved to provide ease of access to the facility. The new facility will have asphalt-paved surface parking with hard surface access (such as concrete pavers) around the building. Landscaping is included. This project will be funded in two increments ($7.3M in FY03/$16.7M in FY04). Estimated total construction cost is $24 million. About $5 million in non-construction funds are also being budgeted separately for the activation and outfitting costs associated with this project.

PROJECT JUSTIFICATION:
All building systems and components of the facilities to be replaced are in need of major repairs and upgrading. This finding was supported by a recent 100% Facilities Condition Assessment Study. These buildings greatly contribute to the Center's maintenance backlog – the structures have been patched, pieced, minimally modified with utilities and communications to support projects and manage space shortages, and will be demolished once they are vacated. The new building will provide more efficient utilization of space than the buildings it will replace. It will consolidate dislocated staff in a productive, healthy and efficient working environment. And it will significantly reduce costs associated with energy usage and facility maintenance and repair. This project has a discounted payback period of six years.

IMPACT OF DELAY
These buildings are very costly to operate and maintain and are high energy-consumers. Delay of this project would force the accomplishment of some uneconomical major repairs that could be avoided if the buildings are vacated soon. Continued use of the existing facilities will also result in further degradation of employee morale and productivity, and will delay the energy savings and productivity improvements that can be gained over the life of the new building.

PROJECT TITLE: Replace Roof, External Tank Manufacturing Building, Phase 2
COGNIZANT ENTERPRISE: Human Exploration & Development of Space

INSTALLATION: Michoud Assembly Facility
LOCATION: New Orleans, Orleans Parish, LA

FY 2003 COST ESTIMATE (Millions of Dollars):	11.0
Project Element:	
Site Preparation and Demolition	1.8
Precast Concrete Panels/Moisture Control	0.7
Lightweight Purlins/Fasteners	0.3
Roof Deck Insulation/Foamglass	1.9
Built-up Roofing	1.8
Reflective Coating	1.1
Membrane Roofing	2.5
Miscellaneous/Equipment Rental/Piping/Lightning Protection	0.9

PRIOR YEARS FUNDING:	12.4
Construction	12.4
Facility Planning and Design	0.4

PROJECT DESCRIPTION:
This project is the second and final phase to replace Building 103 roofing system (1,679,200 square feet) and roof drainage piping. Components of the roofing system to be replaced include deteriorated timber purlins (replaced using light gauge steel); damaged concrete planks; base sheet; 4-ply built-up felt system; glaze coat and reflective topcoat. Repairing the roof drainage piping involves removing/replacing downspouts, as well as using lining material to repair a portion of the downspouts that are inaccessible. The horizontal run-outs that connect the downspouts to roof drains will also be replaced. Cast iron/galvanized pipe will be replaced with PVC or fiberglass pipe to ensure reliability.

PROJECT JUSTIFICATION:
Building 103, the “External Tank Manufacturing Building,” was constructed in 1943. It is primarily used for Shuttle External Tank assembly (chemical cleaning, component cleaning, component painting, harness fabrication, heat treating, machining, riveting, tube fabrication, and welding) and new business (X33, RLV, and NCAM). Building 103 has a roof area of approximately 40 acres. An in-house study completed in September 1998 found the roof to be deteriorated beyond the capabilities of a major maintenance restoration project. Roof leaks that can cause damage to production equipment and flight hardware and injury to personnel if not addressed are occuring throughout various areas of the building. Surface deficiencies and a high moisture content were also found.

Building 103 also has approximately 100 downspouts for draining rainwater from the roof. The fire water system and air handling units also drain into the downspouts. The downspouts penetrate the floor slab and tie into the main storm drainage pipes that run to the Borrow Canal. During severe rainfall, storm water is forced out of faulty joints and runs out onto the factory floor and utility trenches. This creates hazardous conditions to personnel. Temporary repairs are made on damaged downspouts to stop leaks. Approximately 40% of the downspouts are not accessible because electrical panels or other equipment block access to them. Horizontal run-outs connect the downspouts to the roof drains. There are three different types of run-outs: cast iron, galvanized, and fiberglass. The majority of leaks in Building 103 stem from the horizontal run-outs. Cracks form on the top of the cast iron pipe making them unnoticeable until rainwater leaks. Holes form around the galvanized pipe and allow rain to infiltrate the building. Several repairs are made on these run-outs during periods of severe weather.

IMPACT OF DELAY

Failure to replace roofing system will result in risk to personnel safety, and potentially extensive and costly damage to flight hardware and production equipment. As the downspouts, horizontal run-outs and 4-ply roof continue to deteriorate, more leaks will occur.

PROJECT TITLE: Replace Site-wide High Voltage Oil Switches
COGNIZANT ENTERPRISE: Human Exploration & Development of Space

INSTALLATION: Michoud Assembly Facility
LOCATION: New Orleans, Orleans Parish, LA

FY 2003 COST ESTIMATE (Millions of Dollars): 2.8

PRIOR YEARS FUNDING:	0.1
Facility Planning and Design	0.1

PROJECT DESCRIPTION:
This project provides for the replacement of approximately 48 high-voltage oil switches site-wide at the Michoud Assembly Facility. The 13,800-volt electrical distribution switches supply electrical power to every building on site. This project will reconfigure the respective areas to accept replacement switches, redistribute loads to isolate switches, remove and install switches, and re-terminate 13.8 kV feeders consistent with the replacement configuration.

PROJECT JUSTIFICATION:
Major suppliers have indicated that replacement parts for these switches will no longer be provided because of system safety and reliability. Companies have also reported explosions attributed to these oil switches, and maintenance personnel at MAF have been forced to utilize non-standard replacement parts to repair them. The replacement parts carry no certification of reliability or switch congruence from the manufacturers. Many of the switches contain fuses that are no longer available, and should a fault occur that causes these fuses to expire, the electrical load would be de-energized for an extended time resulting in the disruption of operations. Manufacturer recommends replacement with sulfur hexaflouride or vacuum technology type switches.

IMPACT OF DELAY
Many of the switches contain fuses that are no longer available. Not replacing the oil switches and fuses would result in continued forced utilization of non-standard replacement parts and continued use of replacement parts carrying no certification of reliability, and safety risk to personnel in the event of a switch explosion.

PROJECT TITLE: Repairs To Airfield
COGNIZANT ENTERPRISE: Aerospace Technology

INSTALLATION: Wallops Flight Facility
LOCATION: Accomack County, VA

FY 2003 COST ESTIMATE (Millions of Dollars)	2.0	PRIOR YEARS FUNDING:	0.2
		Facility Planning and Design	0.2

PROJECT DESCRIPTION:
Repair of six sections of Runway 4-22, one section of the high-speed taxiway, and two sections of runway approaches to 4-22 by milling approximately 70,400 square meters of existing pavement and resurfacing with 2.5" of asphalt concrete; sealing of longitudinal and transverse cracking in 10 sections, approximately 88,200 square meters of Runway 4-22; and applying herbicide and crack fill/sealant on the Runway 4-22 overrun.

PROJECT JUSTIFICATION:
Cracks have developed in these paved surfaces with missing sections, or deteriorated joint sealant. If not addressed, the deterioration will continue, with cracks becoming wider and deeper, leading to spalling of surfaces at section corners, Foreign Object Debris (FOD) will result from the spalling, and block cracking. Swelling and block cracking may result in areas with an irregular surface. These conditions would present a hazard to aircraft. Continued deterioration would require more extensive repair efforts than the above-mentioned milling and resurfacing, at a much greater expense.

IMPACT OF DELAY:
If this project is not implemented runway will continue to crack and deteriorate, damage will reach the underlying pavement layers and base materials, resulting in extensive and costly future repairs to restore the runway to a safe operating conditions. Postponement will also result in increased number and severity of failures. Risk of Aircraft engine, structural, and tire damage due to Foreign Objects will continue and increase.

PROJECT TITLE: Minor Revitalization & Construction of Facilities, Not in Excess of $1.5 million Per Project
COGNIZANT Office: Office of Management Systems LOCATION: Various

	Institutional Support	Human Space Flight Programs
FY 2003 COST ESTIMATE (Millions of Dollars)	91.9	10.8
Location:		
Ames Research Center	9.3	
Dryden Flight Research Center	4.2	
Glenn Research Center	10.7	
Goddard Space Flight Center	8.5	
Jet Propulsion Laboratory	12.2	
Johnson Space Center	12.9	
Kennedy Space Center	11.9	9.4
Langley Research Center	9.4	
Marshall Space Flight Center	3.5	
Stennis Space Center	9.3	1.4

PROGRAM DESCRIPTION:
Proposed projects for FY 2003 are identified under "MINOR PROJECT COST ESTIMATE". They include Institutional Support projects totaling $91.9 million for components of the basic infrastructure and institutional facilities, and $10.4 million to accomplish specific Human Space Flight projects. The $10.4 million is included in the appropriate budget line items of the Human Space Flight appropriation. The cost estimates are shown here to provide a complete picture of NASA's minor program budget requirement for facilities.

These resources provide for revitalization and construction of facilities at NASA field installations and Government-owned industrial plants supporting NASA activities. The request includes facility revitalization and construction needs for FY 2003 that are greater than $500 Millions but not in excess of $1.5 million per project. Revitalization projects provide for the repair, modernization, and/or upgrade of facilities and collateral equipment. Repair and modernization projects restore facilities and components thereof, including collateral equipment, to a condition substantially equivalent to their originally intended and designed capability. Repair and modernization work includes the substantially equivalent replacement of utility systems and collateral equipment necessitated by incipient or actual breakdown. It also includes major preventive measures that are normally accomplished on a cyclic schedule, and those quickly needed out of cycle based on adverse condition information revealed during predictive testing and inspection efforts. Upgrade projects may include not only some restoration of current functional capability, but also enhancement of the condition of a facility so that it can more effectively accomplish its designated purpose or increase its functional capability. Occasionally minor facility construction projects will be required to provide for either the construction of small new facilities or additions to existing facilities. The facilities being revitalized or constructed in this program are expected to remain active in the long term and are consistent with current and anticipated Agency roles and missions. Annual funding will be required for continuing minor revitalization and construction needs.

This program includes revitalization and construction projects estimated to cost more than $500 Millions per project. Projects $500 Millions and less in magnitude are normally accomplished by routine day-to-day facility maintenance and repair activities provided for in Research Operations Support and direct program operating budgets. Projects estimated to cost more than $1.5 million are included as separate discrete projects in the budget request.

PROGRAM JUSTIFICATION:
NASA is experiencing “block obsolescence” because 90% of the agency’s facilities have been in use for over 25 years. Repair costs for mechanical and electrical systems in a typical building are almost three times higher after system operations exceed 15-20 years than they are during the initial years. Many electrical and mechanical components reach the end of their serviceable or economic life at the 20-year point and should be replaced. Continued piecemeal repair of these components is more costly in the long run than replacement or closure at the end of the economic life of the original components.

The NASA physical plant has a capital investment of over $6 billion with a current replacement value of more than $19 billion. A continuing program of revitalization of these facilities is required to accomplish the following:

a. Protect the capital investment in critical facilities by minimizing the cumulative effects of wear and deterioration.
b. Ensure that critical facilities are continuously available and that they operate at peak efficiency.
c. Improve the capabilities and usefulness of critical facilities and thereby mitigate the effects of obsolescence.
d. Provide a better and safer environment for all personnel.
e. Reduce current operating costs and avoid significantly greater future repair costs.

New construction will primarily replace substandard facilities in cases where it is more economical to demolish and rebuild than it is to restore. Included are projects that replace old and dilapidated trailers and other modular facilities that do not meet current occupational health and safety standards, and which no longer satisfy user functional requirements. In selected cases, additional square footage may be built when there are compelling reasons to support specialized requirements of a nature that cannot be provided for using existing facilities. Included in this latter category are technical, programmatic, and institutional projects that are essential to the accomplishment of an installation’s mission objectives.

MINOR PROJECT COST ESTIMATE (Millions of Dollars):
The projects that comprise this request are of the highest priority based on relative urgency and expected return on investment. Deferral of this mission-essential work would adversely impact the availability of critical facilities and program schedules. The titles of the projects are designed to identify the primary intent of each project and may not always capture the entire scope or description of each project. Also, during the year, some rearrangement of priorities may be necessary which may force a change in some of the items to be accomplished. Any such changes, however, will be accomplished within total the resources available.

HUMAN SPACE FLIGHT PROGRAMS, $10.8 million

A. Kennedy Space Center (KSC), $9.4 million for the following:
1. Revitalize Cable Plant, Vandenberg Launch Site, Space Launch Complex-2 (ELV)
2. Consolidate Shop Facilities, Vandenberg Launch Site, Space Launch Complex-2 (ELV)
3. Modify Multi-Payload Processing Facility for Hazardous Capability, Building M7-1104 (PLC)
4. Restore Low Voltage Power System, LC-39A, Phase 3 (Space Shuttle)
5. Restore Low Voltage Power System, LC-39B, Phase 3 (Space Shuttle)
6. Replace 15KV Feeders, Shuttle Landing Facility Area (Space Shuttle)
7. Replace 15KV Feeder 609, N & K Electrical Power Distribution Line (Space Shuttle)
8. Replace Roof and Roof-Top Air-Handling Units, Building L6-247 (Space Shuttle)

B. Stennis Space Center (SSC), $1.4 million for the following:
1. Repair and Modernize Space Shuttle Main Engine A-2 Test Stand, Phase 4 (Space Shuttle)

INSTITUTIONAL SUPPORT: $91.9 million

A. Ames Research Center (ARC), $9.3 million for the following:
1. Replace Fire Pump, N221
2. Replace Fire Suppression & Alarm Systems, 245 & 215
3. Rehabilitate Fire Exits in N240 and Safety Upgrades, Various Buildings
4. Rehabilitate Fire Protection System and Modify for Americans with Disabilities Act, N19
5. Rehabilitate Arc-Jet Cooling System, N234, Phase III
6. Repair 11FT Turning Vanes, Set 1&2, N227A
7. Replace Main Drive Heat Exchangers, Unitary Plan Wind Tunnel, N227
8. Replace Chiller, N233
9. Rehabilitate and Modify 5-Megawatt Arc-Jet Heater, Developmental Arc-Jet Facility

B. Dryden Flight Research Center (DFRC), $4.2 million for the following:
1. Repair Roofs, Various Buildings
2. Install Aqueous Film Forming Foam Fire Suppression, B1623
3. Rehabilitate Sewer System
4. Construct Central HVAC Plant, Research Engineering Support Facility Area

C. <u>Glenn Research Center (GRC), $10.7 million for the following:</u>

1. Replace K1 & K2 Switchgear and Reinsulate Cables
2. Rehabilitate Special Projects Lab, Phase 1 (24)
3. Repair Water Systems, Plum Brook (PBS)
4. Construct Addition for ADA Modifications, Engineering & Supply Building (21) & Cafeteria (15)0
5. Rehabilitate & Modify Research Projects Building (100)
6. Rehabilitate & Modify Material Processing Building, Phase 3 (105)
7. Rehabilitate Electric Propulsion Laboratory (301)
8. Replace Inlet Guide Vanes, Icing Research Tunnel (11)
9. Replace CE-5B Pre-Heaters, Engine Research Building (5)
10. Upgrade Variable Frequency System (23)
11. Upgrade Heated Tube Facility, Cell 103 (51)

D. <u>Goddard Space Flight Center (GSFC), $8.5 million for the following:</u>

1. Repair Storm Drains, Phase VI, Wallops Flight Facility (WFF)
2. Repair Roofs, Greenbelt Various Buildings.
3. Repair Roofs (WFF)
4. Revitalization of Communications Ductbank, Phase III (WFF)
5. Rehabilitate Operations & Maintenance Facilities, Building F-16 (WFF)
6. Modifications to E-Complex, Phase II (WFF)
7. Modifications to HVAC, Building F-10 (WFF)
8. Repair Fire Protection & Domestic Water
9. Rehabilitate HVAC Building 23, Phase IV
10. Construct Auditorium/Conference/Training Facility (WFF)

E. <u>Jet Propulsion Laboratory (JPL), $12.2 million for the following:</u>

1. Modifications for Extreme Environment Biology & Geology Lab, Building 244
2. Revitalize Inflatable Structures/Solar Sail Development Facility, Building 299
3. Revitalize 34 Meter High Efficiency Antenna, DSS-45
4. Construct Monolithic Microwave Integrated Circuit (MMIC) Assembly & Testing Facility
5. Modify Hydraulic System for Hydrostatic Bearing, 70-Meter Antenna, DSS-14
6. Construct Addition to Building 126
7. Upgrade 2.4 KV Utilities
8. Upgrade Electrical Bank 25
9. Replace Roofs, Various Buildings
10. Fire Protection Upgrades, Phase 2, (Goldstone, CA)
11. Modify South Security Gate

F. <u>Johnson Space Center (JSC), $12.9 million for the following:</u>

1. Rehabilitate Electrical Utilization System, 300 Area, White Sands Test Facility (WSTF)
2. Rehabilitate Electrical Utilization System, 400 Area (WSTF)
3. Repair Mechanical System for Indoor Air Quality, Building 4 North
4. Upgrade Radio Telecommunications Facility
5. Rehabilitate Electrical Distribution System, Energy System Test Area
6. Rehabilitate Support Facilities, Buildings 270 and 276, Ellington Field
7. Rehabilitate Direct Current Power Supply Systems, Propulsion Areas (WSTF)
8. Upgrade Electrical Substation, Building 5
9. Replace Roofs, Buildings 16, 29, 38, 41
10. Replace Roof, Second TDRSS Ground Terminal (WSTF)
11. Rehabilitate Aircraft Hangar, Building 990, Ellington Field

G. <u>Kennedy Space Center (KSC), $11.9 million for the following:</u>

1. Upgrade Central Station Fire Monitoring System, Various Locations
2. Replace Airfield Lighting System, Shuttle Landing Facility
3. Upgrade Facilities For Disabled Access, Various Locations
4. Replace Medium And Low Voltage Power Systems, Shuttle Landing Facility
5. Repair Bridge Neoprene Bearing Pads, Industrial Area
6. Replace Secondary Distribution Switch Gear and Panels, Hangar "S"
7. Modify Platform Hoist Control Circuit, VAB, High Bays 1 and 2
8. Repair South Elevation Wall, O&C Building
9. Repair NASA Causeway East
10. Repair Roads And Paved Areas, LC-39 Area
11. Safety Modifications To Critical Lifting Devices, Phase 1
12. Construct Replacement Training Facility

H. Langley Research Center (LaRC), $9.4 million for the following:
   1. Construct Model Prep/Storage & Data Processing Rooms, Experimental Test Range, B1299F
   2. Modify Vacuum System, Hypersonic Facility Complex
   3. Modify Reclaimer System, 20-Inch Mach 6 CF4 Tunnel, B1275
   4. Replace Electrical Substations, B1247F
   5. Automation Modifications to 31 Inch M 10 Tunnel, B1251A
   6. Construct Addition to the Child Development Center, B1231
   7. Demolition of Abandoned Facilities, Various Locations

I. Marshall Space Flight Center (MSFC), $3.5 million for the following:
   1. Demolish Unsafe Facilities
   2. Rehabilitate Bridge Cranes, Various Facilities, Phase 1
   3. Replace Sprinkler Heads, Various Facilities
   4. Replace Emergency Power Systems, Buildings 103 and 207, Michoud Assembly Facility

J. Stennis Space Center (SSC), $9.3 million for the following:
   1. Repair and Modify HVAC System, Environmental Laboratory [B1105], Phase 3
   2. Repair and Modernize Fire Alarm Systems, Various Facilities, Phase 3
   3. Repairs to Facility Operations Building [B4010]
   4. Repair and Modernize HVAC, 8100 Complex, Phase 1
   5. Repair to Potable Water System
   6. Repair and Modify Secondary Power Systems, Phase 4
   7. Repair and Modernize 13.8 kV Unit Substation Transformers
   8. Repair Roads and Paved Areas
   9. Expand Energy Management Control System, Phase1

PROJECT TITLE: Facility Planning and Design (FP&D)
COGNIZANT OFFICE: Office of Management Systems LOCATION: Various

FY 2003 COST ESTIMATE (Millions of Dollars)	17.2
Project Elements:	
Master Planning	1.0
Sustaining Engineering Support	1.2
Project Planning and Design Activities	15.0

These funds are required to provide for advance planning and design activities; special engineering studies; facility engineering research; preliminary engineering efforts required to initiate design-build projects; preparation of final designs, construction plans, specifications, and associated cost estimates; and participation in facilities-related professional engineering associations and organizations as follows:

A. Master Planning, $1.0 million:
The NASA field installation master plans need to be periodically updated. The master plans are essential as reference documents for land use planning, identification of physical relationships of facilities, and proper orientation and arrangement of facilities. The updates reflect as-built condition of facilities and utility systems with emphasis on changes caused by recent facility construction and modifications.

B. Sustaining Engineering Support, $1.2 million:
Provisions for facility studies and specific engineering support continue in importance as evidenced in recent years. These efforts are important due to changing trends in construction equipment, materials, and fuels; the operation and maintenance costs for the physical plant; and energy conservation and efficiency. The following items are included:

1. Value Engineering, and Design and Construction Management Studies

Provides for critically important studies to improve the quality and cost effectiveness of NASA's facility components and construction practices, and to ensure that developing technology and industry best practices are incorporated into the agency's construction program. Also provides services necessary to predict and validate facility costs to aid in resources planning and studies to assess design and construction functional management.

2. Facility Operation and Maintenance Studies

Provides for studies and engineering support, where not otherwise provided for, at NASA field installations relative to functional management of maintenance, automated maintenance management systems, and facilities condition assessments. Included in this activity are field surveys to be conducted at selected NASA field installations to evaluate the effectiveness and efficiency of the operations and maintenance management activities, and to identify possible improvements in productivity.

3. Facilities Utilization Analyses

Provides for the analyses of agency-wide facilities utilization data covering (1) office and other types of building space; (2) designated major technical facilities; and (3) special studies comparing the utilization of technical facilities which are similar in type or capability, such as wind tunnels. Such analyses provide for (1) insights into and development of better methods of identifying underutilized facilities; (2) improved techniques to quantify level of facilities use; (3) actions to improve facilities utilization; and (4) recommendations regarding consolidation/closure of Agency facilities.

4. Facilities Management Systems

Provides for continued engineering support for the technical updating of NASA's master text construction specifications to reflect the use of new materials, state-of-the-art construction techniques and current references to building codes and safety standards. Also provides engineering support for the Major Facilities Inventory, the Real Property Database and the Facilities Utilization Database systems.

5. Capital Leveraging Research Activities

Provides for modest participation in facilities related professional engineering associations, institutes, and organizations established to bring together major facility owners, contractors, and academia in proven research and study efforts to improve the quality and cost effectiveness of facilities engineering management practices for member organizations. Such organizations include, but are not limited to the Federal Facilities Council of the National Research Council, Construction Industry Institute, Fully Integrated and Automated Technology Consortium, and National Institute of Building Sciences. This also provides for independent research activities to address facility problems unique to NASA.

C. <u>Project Planning and Design Activities: $15.0 million:</u>

These resources provide for project planning and design activities associated with Mission Support construction projects. Project planning and design activities for construction projects required to conduct specific Human Space Flight or Science, Aeronautics, and Technology programs or projects are included in the appropriate budget line item.

1. Preliminary Engineering, $1.0 million:

This estimate provides for preparation of Preliminary Engineering Reports (PERs), investigations, project studies and other pre-project planning activities related to proposed facility projects. These reports are required to permit the early and timely development of the most suitable project to meet the stated programmatic and functional needs. Reports provide basic data, cost estimates and schedules relating to future budgetary proposals.

2. Related Special Engineering Support, $1.5 million:

This estimate provides for investigations and project studies related to proposed facility projects to be included in the subsequent Construction of Facilities programs. Such studies involve documentation and validation of 'as-built' conditions, survey/study of present condition of such items as roofing and cooling towers, utility plant condition and operational modes, and other similar field investigations and studies. These studies are required to support long-term project development strategies, and project specific designs, cost estimates, and schedules.

3. Design, $12.5 million:

The amount requested will provide for the preparation of designs, plans, drawings, and specifications necessary for the accomplishment of construction projects. Also provides technical and engineering support analyses, designs, and reviews required to verify, confirm and ensure suitability of construction designs within the project cost estimates. This work is associated with construction proposed for the FY 2005 program and with changes to projects proposed for the FY 2004 program. The goal is to obtain better facilities, faster and at a lower cost.

PROJECT TITLE: Environmental Compliance and Restoration Program
COGNIZANT OFFICE: Office of Management Systems, Environmental Management Division LOCATION: Various Locations

FY 2003 Cost Estimate (Millions of Dollars)	105.0
Location:	
Ames Research Center	0.6
Dryden Flight Research Center	0.6
Glenn Research Center	66.6
Goddard Space Flight Center	0.7
Jet Propulsion Laboratory	6.9
Johnson Space Center	1.2
Kennedy Space Center	9.0
Langley Research Center	0.1
Marshall Space Flight Center	6.7
Michoud Assembly Facility	1.8
Stennis Space Center	0.9
Wallops Flight Facility	0.7
White Sands Test Flight Facility	5.3
Headquarters	3.9

PROGRAM DESCRIPTION:
The Program provides for environmental activities necessary for compliance with environmental requirements including environmental program initiatives. Proposed environmental activities for FY 2003 are identified below under “ENVIRONMENTAL ACTIVITIES COST ESTIMATE” title. The Program includes activities necessary for NASA to comply with environmental statutory and regulatory requirements and standards, orders, regulatory and cooperative agreements, and support of environmental program initiatives. The Program focuses our efforts in the principal areas of environmental compliance, remediation, conservation, pollution prevention and closures. Within this framework, compliance with environmental requirements is performed, while simultaneously remediating previously contaminated sites, performing environmental closures, and promoting the identification of pollution prevention and conservation activities. Program activities include projects, studies, assessments, investigations, plans, designs, related engineering, program support, and sampling, monitoring, and operation of remedial treatment processes and sites as part of the remediation and cleanup measures. These activities will be performed at NASA installations, NASA-owned industrial plants supporting NASA activities, and other current or former NASA sites where NASA operations have contributed to environmental problems and NASA is obligated to contribute to cleanup costs. In addition, these resources will be used to provide for activities including regulatory agency oversight costs, to acquire land if necessary to implement environmental compliance and restoration measures, and to perform studies, assessments and other activities in support of functional leadership initiatives related to the environmental program.

PROGRAM JUSTIFICATION:

The Program represents this year's request on a phased approach in relation to the total Agency requirements for environmental remediation measures that must be implemented within the next several years, as well as for needed requirements for other environmental compliance measures and initiatives. The Program includes activities necessary for compliance with environmental statutory and regulatory requirements and standards, orders, regulatory and cooperative agreements, and support of environmental program initiatives. Based on relative urgency and potential health hazards and safety, these activities are the highest priority requirements currently planned for accomplishment in FY 2003. Deferral of these necessary compliance and remedial measures would preclude NASA from complying with environmental requirements and regulatory agreements, and could jeopardize NASA operations. As studies, assessments, investigations, plans, regulatory approvals, and designs progress and as new discoveries or regulatory requirements change, it is expected that priorities may change and revisions to these activities may be necessary.

The broad environmental categories summarizing the efforts proposed to be undertaken with the identified estimated costs are listed below. Remediation activities include one or more phases of a site cleanup program from site identification to final closeout, including but not limited to site assessments, site investigations, interim cleanup actions, testing and evaluation, remedial treatment systems and processes operation, sampling and monitoring, and other activities associated with CERCLA/RCRA cleanup requirements.

a. Environmental Remediation Activities and Initiatives --- Remediation (e.g. CERCLA, RCRA) . . . . $ 35.2
b. Closure (Decommissioning of Plum Brook Reactor --- Atomic Energy Act). . . . . $ 64.0
c. Other Environmental Compliance Requirements and Initiatives ---
Compliance, Restoration, Prevention, Closures (e.g. CAA, CWA, RCRA, ESA, PPA). . . . . $ 5.8

CERCLA = Comprehensive Environmental Response, Compensation and Liability Act
RCRA = Resource Conservation and Recovery Act
CAA = Clean Air Act
CWA = Clean Water Act
ESA = Endangered Species Act
PPA = Pollution Prevention Act

ENVIRONMENTAL ACTIVITIES COST ESTIMATE: $105.0 million, as follows:

A. Ames Flight Research Center (ARC), $0.6 million

B. Dryden Flight Research Center (DFRC), $0.6 million

C. Glenn Research Center (GRC), $66.4 million* for the following:
1. Remediation of Contaminated Areas
1. Plum Brook Reactor Decommissioning Activities*
2. Sewage Treatment Plant Decommissioning and Reconnection at Plum Brook

*detailed estimate for Plum Brook Reactor Decommissioning activities totals $64.0M and is provided in the following section.

D. Goddard Space Flight Center (GSFC), $0.5 million

E. Jet Propulsion Laboratory (JPL), $6.7 million for the following:
1. Cleanup of Arroyo Saco Groundwater Contamination
2. Pasadena and Lincoln Avenue Agreements

F. Johnson Space Center (JSC), $0.8 million for the following:
1. Tier III NOx Controls for Engines and Boilers
2. Construction of Stormwater Sampling Stations

G. Kennedy Space Center (KSC), $3.7 million for the following:
1. Remediation at Fuel Storage Area #1 (CCAS)
2. Various Interim Measures, Various Locations (KSC and CCAS)
3. Remediation at the Hydrocarbon Burn Facility
4. GSA Reclamation yard Remediation
3. Wilson Corners Groundwater Treatment, Phase 3

H. Langley Research Center (LaRC), $0.1 million

I. Marshall Space Flight Center (MSFC), $5.9 million for the following:
1. CERCLA Investigation and Cleanup
2. RCRA Investigation and Cleanup, Santa Susana Field Laboratory
3. Groundwater Investigation and Cleanup, Santa Susana Field Laboratory

J. Michoud Assembly Facility (MAF), $1.8 million for the following:

1. Remediation Activities, Various Locations

K. Wallops Flight Facility (WFF), $0.2 million for the following

L. White Sands Test Facility (WSTF), $5.3 million for the following:

1. Groundwater Contamination Assessment and Remediation

M. Other (various locations), $13.1 million for the following:

Studies, Assessments, and Investigations; Plans; Designs; Sampling, Monitoring and Operation of Remedial Treatment Systems; Related Engineering and Program Support

PROJECT TITLE: Plum Brook Reactor Decommissioning
COGNIZANT OFFICE: Office of Management Systems

INSTALLATION: Glenn Research Center
LOCATION: Plum Brook Station Sandusky, OH

FY 2003 COST ESTIMATE (Millions of Dollars):	64.0
Project Elements:	
Decommissioning, Decontamination activities	12.2
Demolition, De-watering and Disposal activities	38.4
Environmental, Safety & Health monitoring, Construction & Project Management, Community Relations, Institutional & Technical Support	13.4

PRIOR YEARS FUNDING*:	29.0
FY 1998 - FY 2002:	
Pre-decommissioning work	8.8
Plans, studies and samplings	4.2
Decommissioning activities	16.0

PROJECT DESCRIPTION:

This project decommissions and demolishes the nuclear test reactor located in Plum Brook Station in Sandusky, Ohio. The reactor has been in standby mode since 1975. Work towards decommissioning began with the Nuclear Regulatory Commission required Decommissioning Plan in 1999. The decommissioning work will be performed in a phased approach and is expected to end in 2006. The actual completion date will depend on what is found as the decommissioning and demolition work evolves. In 2003, the primary work to be performed will be the demolition and disposal of the mockup reactor, hot cells, reactor fan and pump houses, and hot and cold retention areas. Ancillary de-watering activities necessary to maintain worksite integrity will also commence. Other activities continuing in 2003 include community relations; environmental, safety and health support; and asbestos abatement. The cost to complete all decommissioning work (recorded as a liability on NASA's Fiscal Year 2001 financial statements) is currently estimated at $152 million.

PROJECT JUSTIFICATION:

The Nuclear Regulatory Commission (NRC) is the regulatory agency requiring NASA to decommission the Plum Brook Reactor. NRC issues licenses for nuclear reactors. In 1998, the NRC, through the Plum Brook Station reactor licensing process, directed NASA to decommission the reactor by 2007. This research reactor has been without nuclear fuel and in mothball status since 1975. Decommissioning activities are required by NRC regulations under 10 CFR 20.82 (b) and 10 CFR 50 and require NASA to totally demolish the structure and transport all debris to regulated disposal facilities.

IMPACT OF DELAY:

With external containment breached and the reactor internals exposed, this project is at a critical juncture. Delay could eliminate or severely limit NASA's ability to dispose of radioactive waste in the only facility regulated to receive such waste. Without that disposal option, long-term on-site radioactive containment structures would have to be built and radiation-monitoring systems devised to meet NRC requirements until an alternative disposal site could be found. NASA would be faced with the interim costs for these measures and would still be required to ultimately decommission and dispose of the reactor site in accordance with NRV regulations. The NRC has notified the American public of the decommissioning, and the Ohio delegation and Sandusky Ohio community have been directly contacted with the projects overarching goals, objectives, and target end dates. Delay of this project would prevent NASA from honoring theses commitments, jeopardize NASA's credibility with the community, and significantly inflate the total cost to taxpayers.

INSPECTOR GENERAL

FISCAL YEAR 2003 ESTIMATES

BUDGET SUMMARY

OFFICE OF INSPECTOR GENERAL

SUMMARY OF RESOURCES REQUIREMENTS

	FY 2001 OP PLAN REVISED	FY 2002 INITIAL OP PLAN	FY 2003 PRES BUDGET
		(Millions of Dollars)	
Personnel & related costs	21.0	21.8	22.7
Travel	1.2	1.2	1.2
Operation of installation	0.7	0.7	0.7
Total	22.9	23.7	24.6
Distribution of Program Amount by Installation			
Headquarters	22.9	23.7	24.6
Total	22.9	23.7	24.6

INTRODUCTION

The NASA Office of Inspector General (OIG) budget request for Fiscal Year 2003 is $24.6 million.

- 92.3 percent of the proposed budget is dedicated to personnel and related costs, including salaries, benefits, monetary awards, worker's compensation and training, as well as the Government's contributions for Social Security, Medicare, health and life insurance, Government contributions for employee accounts, the required 25 percent availability pay for criminal investigators, and supporting personnel costs, such as moving expenses.
- 4.8 percent of the proposed budget is dedicated to travel, including the cost of transportation, per diem at current rates, and related expenses of OIG auditors, investigators, inspectors, and supporting personnel in conducting OIG audits, investigations, inspections, evaluations, and other studies. The OIG staff is located at 14 offices in or near NASA installations.
- 2.9 percent of the proposed budget is dedicated to equipment, including government vehicles, special equipment for criminal

investigators, and information technology equipment unique to the OIG.

The OIG continues to streamline activities to increase its ability to meet its objectives. Administrative overhead positions have been converted to program assistants and to analysts responsible for assisting on audits, investigations, and inspections. Personnel and management analyst positions have been matrixed to support direct mission activities. The OIG continues to simplify communications and reporting channels, and improve computer and telecommunications capacities to further increase the staff's capabilities and efficiency. Finally, the OIG has outsourced reviews of the Agency's annual financial statements to independent auditors, freeing its financial auditors to concentrate on audits of programs and projects, accounting controls, information systems, and performance measurements.

This request represents the OIG resources needed at NASA Headquarters and field offices to fulfill the OIG mission. Recognizing the demands of the numerous audits, investigations, inspections, assessments, and other activities it conducts, the OIG continuously adjusts its priorities. In this way, it maintains a balanced coverage of NASA's programs and operations, it promptly evaluates and investigates critical and sensitive matters, and it ensures that all OIG customers receive timely, accurate, and complete responses. In FY 03, the OIG will continue to focus attention on and recommend improvements to NASA's high-risk areas, material weaknesses, and areas of significant concern. The OIG will continue to work to improve the scope, timeliness, and thoroughness of its oversight of NASA programs and operations; identify preventive measures; and enhance its capabilities to assist NASA management to efficiently and effectively achieve program and project goals and objectives.

OBJECTIVES

At the requested funding level, the OIG will work to:

- Prevent and detect crime, fraud, waste, abuse, and mismanagement.
- Promote economy, effectiveness, and efficiency within the Agency and across the Government.
- Keep the Administrator and the Congress fully and currently informed of problems in Agency programs and operations.
- Provide the Agency and the Government with timely, accurate, and independent information and useful recommendations relating to Agency programs and operations.
- Provide timely and valuable input regarding existing and proposed legislation and regulations relating to Agency programs and operations.
- Help NASA to improve the security of its information technology systems and bring to justice those that illegally access or otherwise harm those systems (including those who conduct cyber espionage or cyber terrorism).
- Recommend improvements to systems and processes, or disciplinary actions where appropriate, in response to allegations of non-criminal misconduct by Agency employees.

As NASA continues to establish new priorities and modify its programs and operations, the OIG regularly reevaluates its resource allocations to concentrate staff resources on those programs, processes, and operations identified as the most critical and vulnerable to crime, fraud, waste, and abuse. Identifying these vulnerable areas will require continued cooperation with NASA management and Congress.

STATUS

Criminal Investigations

The OIG Office of Criminal Investigations (OCI) identifies, investigates, and refers for prosecution cases of crime, waste, fraud, and abuse in NASA programs and operations. The OIG's Federal law enforcement officers investigate false claims, false statements, conspiracy, theft, mail fraud, and violations of Federal laws, such as the Procurement Integrity Act and the Anti-Kickback Act. Through its investigations, the OCI also seeks to prevent and deter crime at NASA. In the past 2 years, OCI recovered $7.5 million for the Government in civil recoveries and criminal fines and penalties--more than $100,000 per Special Agent per year. In FY 01, the OCI opened 188 new cases, many of which are highly complex and will require months, or even years, to complete. At the end of FY 01, the OCI was investigating 269 active criminal cases.

The FY 03 investigative staffing level will require the effective management of a complex workload of investigative criminal and civil fraud matters. OCI investigators have been freed to work more serious criminal cases by referring non-criminal administrative cases to other organizations. OCI refers the most serious administrative matters to the OIG Office of Inspections and Administrative Investigations (I&A) for review. More routine administrative matters are referred to NASA management for their resolution (with the requirement that OIG be advised of the action taken). By referring matters to Agency managers and the I&A staff to resolve, the OIG has been able to apply increased investigative resources to address the more serious allegations. OCI has also increased efficiency by using leads generated by OIG audits to target programs identified as highly vulnerable to fraud.

Computer and Technology Crimes Investigations

Computer crimes at NASA have a negative impact on the Agency's mission, image, and bottom line. The NASA OIG formed the Computer and Technology Crimes Office (CTCO) and the Technical Services Office (TSO) to bring to justice those who illegally access or otherwise harm the Agency's information technology (IT) systems

- CTCO performs criminal and cyber-counterintelligence investigations in response to attacks against NASA's information systems networks, computer communication systems, and advanced technology programs. CTCO also investigates criminal misuse of NASA computers.
- TSO performs forensic analysis of computer media in support of criminal and cyber-counterintelligence investigations and is a leader in the development of law enforcement hardware and software.

The President's Council on Integrity and Efficiency, the Department of Justice, and individual United States Attorney's Offices have recognized the OIG's computer crimes investigations units for excellence. These units' unique ability to investigate and create countermeasures to IT exploitations will help deter and detect future exploits, thereby protecting NASA's technology and assets.

Both CTCO and TSO:

- Increasingly provide support to the OIG Office of Criminal Investigations on complex cases involving computer technology (e.g., where key information for a case resides on a suspect's computer) or in cases where the computer was used as a means of carrying out the crime (e.g., wire fraud or monetary extortion).
- Participate in Federal task forces, provide expert technical assistance to other federal agencies, and train law enforcement

personnel in advanced computer-related crime fighting techniques.

- Work cooperatively with NASA, notifying NASA management of incidents that may pose a threat to human safety or critical missions, and investigating potential criminal incidents forwarded by the Center IT Security Managers.
- Participate in joint task forces with federal (including the Secret Service and the Federal Bureau of Investigation), state, and local law enforcement officials.
- Serve as NASA's focal point for referrals to the Department of Justice and other external law enforcement organizations of all violations of Federal criminal and civil statutes related to computer system intrusions or criminal misuse of computers at NASA, including counterintelligence-related crimes.
- Provide investigative and analytical support the Federal Bureau of Investigation-sponsored National Infrastructure Protection Center and coordinate counterintelligence matters with the Central Intelligence Agency and the National Security Agency.

The OIG computer crimes units have solved cases involving extortion of NASA and contractor personnel, loss of communications services costing hundreds of thousands of dollars per intrusion to repair, and the use of NASA-funded networks to further criminal enterprises including the compromise of advanced technologies and industrial espionage. The number of new cases opened has increased from 30 in FY 1998 to 150 (not including assistance on fraud cases) in FY 2001.

Inspections and Administrative Investigations
The Office of Inspections and Administrative Investigations (I&A) utilizes an interdisciplinary staff to provide independent and objective inspections and assessments of the effectiveness, efficiency, and economy of NASA programs and operations, and conduct administrative (non-criminal) investigations. Inspections, assessments, and other reviews are conducted to support: management's interests and concerns in achieving NASA's programmatic objectives more efficiently and effectively; issues of Congressional concern; matters of high Agency vulnerability; and administrative inquiries related to unethical and improper conduct, waste and mismanagement. Inspection activities provide timely feedback to program managers and, in some instances, provide a foundation for audits or criminal investigations.

The I&A staff consists of a small core of analysts with expertise in a variety of fields, including procurement, communications security, management analysis, safety, and aerospace technology. I&A staff frequently support other OIG divisions by providing expertise and technical support. OIG resources have increasingly been focused on I&A to enable the conduct of complex inspections that can only be pursued by a team with expertise in a number of areas (e.g., safety, procurement).

Audits
The Office of Audits (OA) conducts independent, objective audits and reviews of NASA and NASA contractor programs and projects, to improve NASA operations. The OA conducts a broad range of professional audit and advisory services, comments on NASA policies, and is responsible for oversight of audits performed under contract or by other Federal agencies. The OA helps NASA accomplish its objectives by bringing a systematic, disciplined approach to evaluate and improve the economy, efficiency and effectiveness of NASA operations and by deterring fraud, crime, waste, and abuse.

The OA uses a formal, comprehensive (yet flexible) process to identify, review, prioritize, and select which NASA programs and processes to audit. Audit topics are derived from: (1) monitoring NASA's evolving initiatives in downsizing, re-engineering, commercialization, and privatization to determine vulnerabilities and opportunities for efficiencies; (2) addressing issues required by laws and internal regulations; and (3) reviewing the top management challenges provided by the OIG each year to the Congress and the Agency.

In addition to standard audits, the OA has taken the lead in two Government-wide initiatives. The OA initiated, developed, and hosted three joint conferences of the President's Council on Integrity and Efficiency and the Executive Council on Integrity and Efficiency (PCIE/ECIE)—the organizations representing all the Federal Offices of Inspector General—on the Government Information Security Reform Act (GISRA). The conferences focused on GISRA requirements, review approach and methods, and NASA OIG GISRA planning and experiences. The NASA OIG also led a PCIE/ECIE initiative to review the Federal Government's implementation of PDD-63 "Critical Infrastructure Protection." On September 12, 2001, NASA Inspector General Roberta Gross testified on this effort before the Senate Governmental Affairs Committee on "How Safe Is Our Critical Infrastructure?" OIG staff members received the PCIE *Award for Excellence* for their leadership in this activity.

SCHEDULES & OUTPUTS

WORKLOAD	FY 2001	FY 2002	FY 2003
Office Staff Ceiling			
Full-Time Equivalents	201	213	213
Investigations			
Cases pending beginning of year	246	269	286
Opened during the year	188	225	243
Closed during the year	165	208	223
Cases pending end of year	269	286	306
Computer Crimes			
Cases pending beginning of year	51	74	90
Opened during year	150	120	100
Closed during year	127	104	110
Cases pending end of year	74	90	80
Audits			
Audits pending beginning of year	37	35	42
Opened during year	53	62	62
Closed during year	55	55	55
Audits pending end of year	35	42	49
Inspections and Administrative Investigations (I&A)			
I&A Administrative Investigations* pending beginning of year	95	153	123
Opened during year	127	130	140
Closed during year	128	160	150
I&A Administrative Investigations pending end of year	153	123	113
I&A Inspections and Assessments** pending beginning of year	16	22	27
Opened during year	35	40	45
Closed during year	29	35	40
I&A Inspections and Assessments pending end of year	22	27	32

*Includes activities investigated by I&A staff, referrals to NASA management, and referrals to other organizations.
**Includes inspection and assessment reports, special studies, responses to congressional inquiries, and management alerts.

BASIS OF FY 2003 FUNDING REQUIREMENT

PERSONNEL AND RELATED COSTS

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Compensation and Benefits	**20.6**	**21.6**	**22.5**
Compensation	16.6	17.4	18.2
(Full-time Permanent)	16.5	17.4	18.2
(Other than full-time permanent)	0.1	--	--
(Overtime & other compensation)	--	--	--
Benefits	4.0	4.2	4.3
Supporting Costs	**0.4**	**0.2**	**0.2**
Transfer of personnel	0.2	0.1	0.1
Personnel training	0.2	0.1	0.1
OPM Services	--	--	--
Total	**21.0**	**21.8**	**22.7**

TRAVEL

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Travel	1.2	1.2	1.2

Travel funding is required to carry out audit, investigation, inspection, and management duties. The OIG's budget allows for increases in per diem, airline costs, and workloads. The OIG anticipates increased travel by its IT audit, IT inspection, and computer crimes teams. Also, in order to respond to NASA's changing priorities (and implementation of its centers of excellence and commercialization efforts), increased travel funds will be required to deploy staff located at field offices remote from the site where audit and investigation activities occur.

OPERATION OF INSTALLATION

	FY 2001	FY 2002	FY 2003
		(Millions of Dollars)	
Operation of Installation	0.7	0.7	0.7

Operation of Installation provides a broad range of services and equipment in support of the Office of Inspector General's activities. The estimates provide for all equipment, including purchase, maintenance, programming and operations of unique information technology (IT) equipment. Also provided in this category are miscellaneous expenses for GSA cars, the Inspector General's confidential fund, miscellaneous contracts, and supplies not provided by NASA. NASA generally provides common services items such as office space, communications, supplies, and printing and reproduction at no charge to the Office of the Inspector General.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROPOSED APPROPRIATION LANGUAGE

OFFICE OF INSPECTOR GENERAL

For necessary expenses of the Office of Inspector General in carrying out the Inspector General Act of 1978, as amended, [*23,700,000], 24,600,000* (*Departments of Veterans Affairs and Housing and Urban Development, and Independent Agencies Appropriations Act, 2001.)*

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CHANGES FROM FY 2002 BUDGET ESTIMATE TO FY 2002 CURRENT ESTIMATE

SUMMARY	NASA Request	Appropriation Changes*	NASA Changes	Emergency Supplemental**	Initial Op Plan
HUMAN SPACE FLIGHT	7,296.0	-383.6	-158.3	76.0	6,830.1
INTERNATIONAL SPACE STATION	2,087.4	-359.6	-6.1		1,721.7
SPACE SHUTTLE	3,283.8	-5.0	-6.0		3,272.8
PAYLOAD & ELV SUPPORT	91.3				91.3
HEDS INVESTMENTS & SUPPORT	1,303.5	-19.0	-146.0	76.0	1,214.5
SPACE OPERATIONS (SOMO)	482.2				482.2
SAFETY, MISSION ASSURANCE & ENG'G	47.8		-0.2		47.6
SCIENCE, AERONAUTICS & TECH	7,191.7	665.4	158.2	32.5	8,047.9
SPACE SCIENCE	2,786.4	62.6	10.7	7.4	2,867.1
BIOLOGICAL & PHYSICAL RESEARCH	360.9	357.5	97.2	4.5	820.0
EARTH SCIENCE	1,515.0	62.1	44.1	4.5	1,625.7
AEROSPACE TECHNOLOGY	2,375.7	109.6	6.3	16.1	2,507.7
ACADEMIC PROGRAMS	153.7	73.6			227.3
INSPECTOR GENERAL	23.7				23.7
TOTAL NASA	**14,511.4**	**281.8**	**0.0**	**108.5**	**14,901.7**

*Reflects appropriations levels included for NASA in the FY 2002 VA-HUD-Independent Agencies Appropriations Act (P.L. 107-73) and direction included in the Conference Report (House Report 107-282) accompanying H.R 2620.

**Reflects appropriations levels included for NASA as part of the FY 2002 Defense Appropriations Act (P.L. 107-117) and direction included in the Conference Report (House Report 107-350) accompanying H.R. 3338.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CHANGES FROM FY 2002 BUDGET ESTIMATE TO FY 2002 CURRENT ESTIMATE

PROGRAM DETAIL	NASA Request	Appropriation Changes*	NASA Changes	Emergency Supplemental**	Initial Op Plan
HUMAN SPACE FLIGHT	**7,296.0**	**-383.6**	**-158.3**	**76.0**	**6,830.1**
International Space Station	**2,087.4**	**-359.6**	**-6.1**		**1,721.7**
Vehicle	399.1	-30.0			369.1
Operations Capability	1,394.7	-76.0	-6.1		1,312.6
Research	283.6				0.0
Crew Return Vehicle	10.0	30.0			40.0
Space Shuttle	**3,283.8**	**-5.0**	**-6.0**		**3,272.8**
Flight Hardware	2,067.2	-30.0	-9.1		2,028.1
Ground Operations	604.1		6.8		610.9
Flight Operations	271.0		-33.0		238.0
Program Integration	341.5	25.0	29.3		395.8
Payload & ELV Support	**91.3**				**91.3**
Payload Carriers & Support	57.0				57.0
ELV Mission Support	34.3				34.3
HEDS Investments & Support	**1,303.5**	**-19.0**	**-146.0**	**76.0**	**1,214.5**
Investments	122.0	-19.0			103.0
Rocket Propulsion Testing	27.8				27.8
Engineering & Technical Base (ETB)	75.2				75.2
HEDS Technology/Commercialization (HTC)	19.0	-19.0			
Institutional Support	1,181.5		-146.0	76.0	1,111.5
SPACE OPERATIONS (SOMO)	**482.2**				**482.2**
TDRS Replenishment	125.5		-8.0		117.5
SOMO Services Upgrades	62.4		-37.0		25.4
Operations	258.9		59.9		318.8
SOMO Technology Activities	35.4		-14.9		20.5

PROGRAM DETAIL (continued)	NASA Request	Appropriation Changes*	NASA Changes	Emergency Supplemental**	Initial Op Plan
SAFETY, MISSION ASSURANCE & ENG'G	**47.8**		**-0.2**		**47.6**
Safety and Mission Assurance	28.7		-0.2		28.5
Engineering	19.1				19.1
SCIENCE, AERONAUTICS & TECH	**7,191.7**	**665.4**	**158.2**	**32.5**	**8,047.9**
SPACE SCIENCE	**2,786.4**	**62.6**	**10.7**	**7.4**	**2,867.1**
Major Development Programs	414.6		32.3		446.9
GP-B	40.2		5.9		46.1
HST	161.8		10.2		172.0
SOFIA	37.0		1.0		38.0
SIRTF	105.9		7.1		113.0
STEREO	50.3		2.6		52.9
GLAST	19.4		1.3		20.7
Payloads Program	44.8		2.7		47.5
Explorer Program	155.0		-29.8		125.2
Mars Surveyor Program	430.9		-16.2		414.7
Discovery Program	217.1		-2.5		214.6
Operating Missions	105.3		69.5		174.8
Technology Programs	478.8	56.0	-72.3		462.5
Research Programs	606.5	6.6	11.2		624.3
Institutional Support	333.4		15.9	7.4	356.7

PROGRAM DETAIL (continued)	NASA Request	Appropriation Changes*	NASA Changes	Emergency Supplemental**	Initial Op Plan
BIOLOGICAL & PHYSICAL RESEARCH	**360.9**	**357.5**	**97.2**	**4.5**	**820.0**
ISS Flight Research Capabilities	0.0	338.6	32.7	0.0	371.3
BPR Research & Technology	291.3	18.9	-32.3		277.9
Advanced Human Support Technology	31.1	1.0	-5.8		26.3
Biomedical Research & Countermeasures	66.8	10.7	-8.1		69.4
Fundamental Space Biology	39.2	0.4	-4.3		35.3
Physical Sciences Research	130.1	1.8	-11.8		120.0
Space Product Development	14.5	5.0	-2.8		16.8
Health Research	9.4		-3.3		6.1
Mission Integration	0.2				0.2
Agency Health & Medical Care			3.9		3.9
Institutional Support	69.6		96.8	4.5	170.9
EARTH SCIENCE	**1,515.0**	**62.1**	**44.1**	**4.5**	**1,625.7**
Earth Observing System Program	371.9	-17.2	30.7		385.4
Terra Project	2.4				2.4
Aqua Project	14.5		30.6		45.1
Aura Project	80.6		-10.2		70.4
Special Spacecraft Projects	56.4		14.6		71.0
EOS Follow-on Projects	129.6	-17.2	-2.8		109.6
Algorithm Development	83.4				83.4
QuikSCAT Project	3.3		-1.5		1.8
LANDSAT Project	1.7				1.7
EOSDIS Project	252.7	36.0	4.3		293.0

PROGRAM DETAIL (continued)	NASA Request	Appropriation Changes*	NASA Changes	Emergency Supplemental**	Initial Op Plan
Earth Explorers	84.5	1.0	-11.3		74.2
TOMS Project					
Earth Sys Science Pathfinders	84.0		-13.1		70.9
Experiments of Opportunity	0.5		1.8		2.3
Triana Project		1.0			1.0
Operating Missions	52.3				47.6
UARS Operating Mission	4.0		-4.7		2.9
TOPEX Operating Mission	6.6		-1.1		6.6
TOMS Operating Mission	6.5		0.1		5.0
TRMM Operating Mission	15.6		-1.5		13.8
Earth Sciences Minor Missions	19.6		-1.8		19.3
Research & Technology	516.6		-21.8		537.2
Research & Analysis - Science	357.4	5.0	-21.8		340.6
Mission Science Teams - Research	94.6				94.6
Airborne Science & Applications	23.0				23.0
Uncrewed Aerial Vehicles (UAV)	4.0				4.0
Research And Analysis	167.9	5.0	-16.8		156.1
Information Systems	13.6				13.6
EOS Science	54.3		-5.0		49.3
Applications, Education And Outreach	63.2	31.6			94.8
R&A - Applications	45.7	31.6			77.3
Education	16.5				16.5
Outreach	1.0				1.0
Technology Infusion (New Millennium)	96.0	5.8			101.8
Technology Infusion	74.2	5.8			80.0
High Performance Computing & Communications	21.8				21.8
Institutional Support	237.0		46.9	4.5	288.4

PROGRAM DETAIL (continued)	NASA Request	Appropriation Changes*	NASA Changes	Emergency Supplemental**	Initial Op Plan
AEROSPACE TECHNOLOGY	**2,375.7**	**109.6**	**6.3**	**16.1**	**2,507.7**
Aerospace Focused Program	720.6	12.3			732.9
Aviation System Capacity (ASC)	100.6	-6.2			94.4
Aviation Safety Technology	70.0	16.0			86.0
Ultra-Efficient Engine Technology (UEET)	40.0	10.0			50.0
Small Aircraft Transportation System (SATS)	15.0	0.5			15.5
Quiet Aircraft Technology	20.0				20.0
2nd Generation RLV (includes X-37/Pathfinder)	475.0	-8.0			467.0
Aerospace Base	637.0	71.8	-0.0		721.2
Commercial Technology Programs	146.9	13.1	3.8		163.8
Institutional Support	871.2		2.5	16.1	889.8
ACADEMIC PROGRAMS	**153.7**	**73.6**			**227.3**
Education	71.6	71.0			142.6
Minority University Research & Education	82.1	2.6			84.7
INSPECTOR GENERAL	**23.7**				**23.7**
TOTAL NASA	**14,511.4**	**281.8**		**108.5**	**14,901.7**

*Reflects appropriations levels included for NASA in the FY 2002 VA-HUD-Independent Agencies Appropriations Act (P.L. 107-73) and direction included in the Conference Report (House Report 107-282) accompanying H.R 2620.

**Reflects appropriations levels included for NASA as part of the FY 2002 Defense Appropriations Act and direction included in the Conference Report (House Report 107-350) accompanying H.R. 3338.

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SPECIAL ISSUES

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 2003 ESTIMATES

SUMMARY OF CONSULTING SERVICES

NASA uses paid experts and consultants to provide advice and expert input in addition to or beyond that available from its in-house civil service workforce. Management controls are established which assure that before entering into a consultant services arrangement with an individual that there is ample justification presented and that the action is approved at top management levels.

NASA also uses experts and consultants to provide expert advice and input on the selection of experiments for future space missions. The use of these experts and consultants, in addition to NASA civil service personnel, provides the agency with an independent view that assures the selection of experiments likely to have the greatest scientific merit. Other individuals are used to provide independent looks at technical and functional problems in order to provide top management the widest possible range of views before making major decisions.

	FY 2001	FY 2002	FY 2003
Number of Non-Paid Experts and Consultants	394	350	350
Number of Paid Experts and Consultants	59	60	60
Annual FTE Usage	3	3	3
Salaries	233,000	244,000	250,000
Total Salary and Benefits Costs	252,805	264,434	271,309
Travel Costs	532,826	559,467	587,441
Total Costs	785,631	823,901	858,750

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 2003 BUDGET ESTIMATES

FULL FUNDING FOR FEDERAL RETIREE COSTS
(IN MILLIONS OF REAL YEAR DOLLARS)

The Administration has proposed legislation (Budgeting and Managing for Results: Full Funding for Federal Retiree Costs Act of 2001) to require agencies, beginning in FY 2003, to pay the full Government share of the accruing cost of retirement for current CSRS, CIA and Foreign Service employees, the Coast Guard, Public Health Service, and NOAA Commissioned Corps. The legislation also requires agencies to pay the full accruing cost of post-retirement health benefits for current civilian employees and the post-retirement health costs of all retirees (and their dependents/survivors) of the Uniformed Services (DoD, Coast Guard, Public Health Service, and NOAA Commissioned Corps).

	FY 2001	FY 2002	FY 2003
HUMAN SPACE FLIGHT	[45.0]	[43.0]	42.0
SCIENCE, AERONAUTICS AND TECHNOLOGY	[58.0]	[67.0]	74.0
INSPECTOR GENERAL	[1.0]	[1.0]	1.0
TOTAL	[104.0]	[111.0]	117.0

A distribution by enterprise and revised agency totals are shown on the next page.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
FISCAL YEAR 2003 ESTIMATES
(IN MILLIONS OF REAL YEAR DOLLAR)
FEDERAL RETIREES COST DISTRIBUTED BY ENTERPRISE

For Display Purposes Only

	FY 2001	FY 2002 EXCLUDES EMERGENCY RESPONSE FUNDS	FY 2002 INCLUDES EMERGENCY RESPONSE FUNDS	FY 2003
HUMAN SPACE FLIGHT	**7,198.5**	**6,797.1**	**6,873.1**	**6,172.9**
INTERNATIONAL SPACE STATION	2,127.8	1,721.7	1,721.7	1,492.1
SPACE SHUTTLE	3,118.8	3,272.8	3,272.8	3,208.0
PAYLOAD & ELV SUPPORT	90.0	91.3	91.3	87.5
HEDS INVESTMENTS AND SUPPORT	1,292.8	1,181.5	1,257.5	1,220.2
SPACE COMMUNICATIONS & DATA SYSTEMS	521.7	482.2	482.2	117.5
SAFETY, MISSION ASSURANCE & ENGINEERING	47.4	47.6	47.6	47.6
SCIENCE, AERONAUTICS & TECHNOLOGY	**7,134.5**	**8,082.3**	**8,114.8**	**8,918.5**
SPACE SCIENCE	2,617.6	2,872.7	2,880.1	3,428.3
BIOLOGICAL & PHYSICAL RESEARCH	365.2	823.5	828.0	851.3
EARTH SCIENCE	1,771.2	1,631.2	1,635.7	1,639.4
AEROSPACE TECHNOLOGY	2,247.8	2,527.6	2,543.7	2,855.6
ACADEMIC PROGRAMS	132.7	227.3	227.3	143.7
INSPECTOR GENERAL	**23.9**	**24.7**	**24.7**	**25.6**
SUBTOTAL AGENCY	**14,357.2**	**14,904.2**	**15,012.7**	**15,117.0**
EMERGENCY RESPONSE FUND		**108.5**		
TOTAL AGENCY		**15,012.7**		

*FY 2001 restructured to reflect new FY 2002 Two Appropriation Structure

LYNDON B. JOHNSON SPACE CENTER
(JSC)

FTE Summary

	FY 01	FY 02	FY 03
TOTAL	2988	3014	2975

OFFICE OF THE DIRECTOR
FTE*:
FY 01: 24
FY 02: 18
FY 03: 18

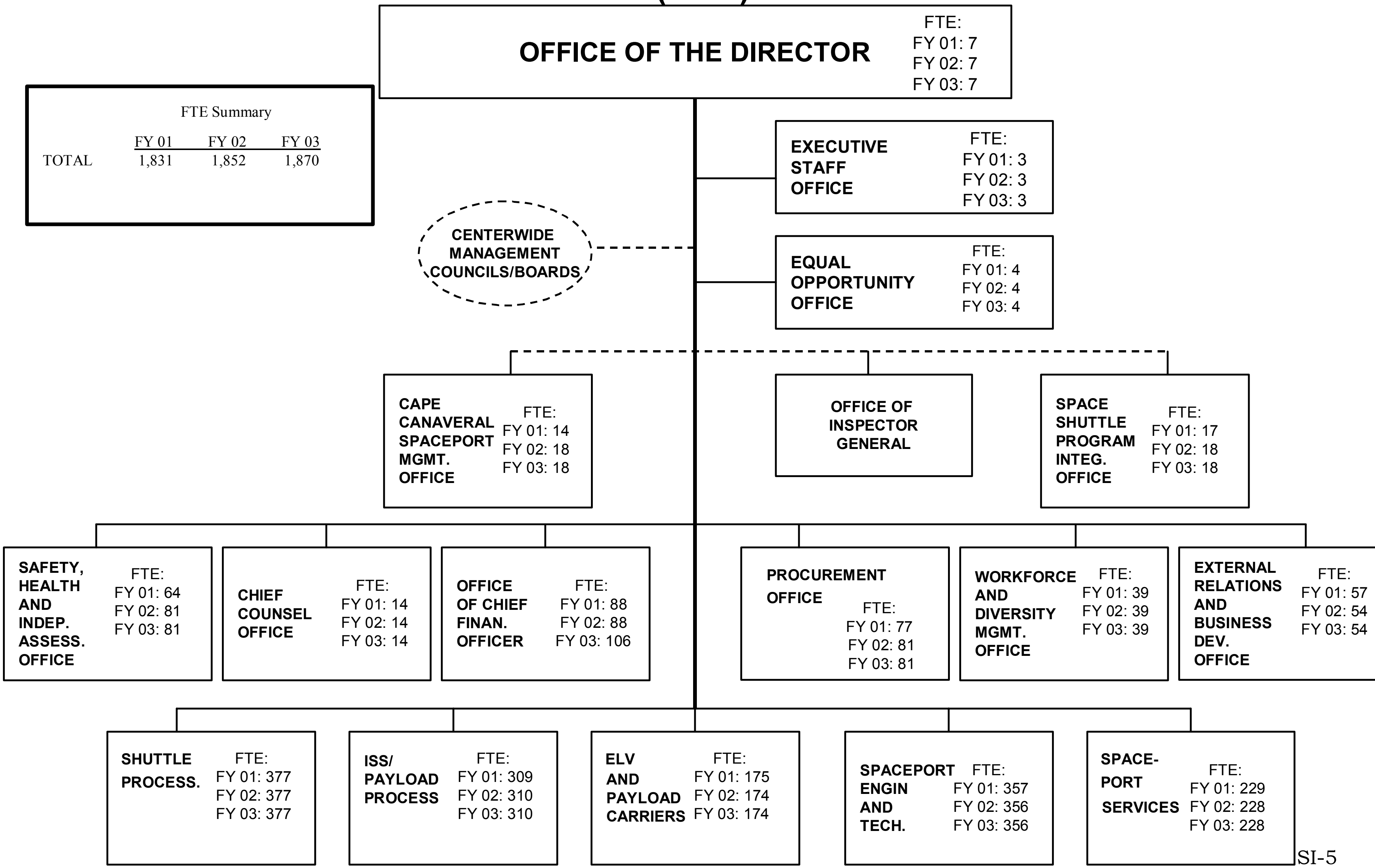
*Director's Office FTE count includes 6 FTE's in the Systems Management Office, which is not shown on this org chart FY 01 through FY03.

Office	FTE FY 01	FTE FY 02	FTE FY 03
HUMAN RESRCS OFFICE	59	58	57
EQUAL OPPOR. PRGRMS OFFICE	5	5	5
LEGAL OFFICE	12	12	12
PUBLIC AFFAIRS OFFICE	22	28	28
ISO 9000 OFFICE	6	6	6
OFFICE OF THE CHIEF INFOR. OFFICER	16	16	16
SAFETY, RELBLTY & QUALITY ASSURANCE OFFICE	128	136	129
OFFICE OF THE CHIEF FINANCIAL OFFICER	178	182	219
TECH. TRANSFER & COMM. OFFICE	12	13	13
SPACE STATION PRGRM OFFICE	273	286	286
SPACE SHUTTLE PRGRM OFFICE	140	145	145
SPACE OPS MGMT OFFICE	23	23	16
EVA PROJECT OFFICE	26	27	27
MISSION OPERATIONS DIRECTORATE	465	461	455
BUSINESS MANAGEMENT DIRECTORATE	128	136	136
INFORMATION SYSTEMS DIRECTORATE	86	86	86
CENTER OPERATIONS DIRECTORATE	124	125	120
ENGINEERING DIRECTORATE	841	828	790
SPACE & LIFE SCIENCES DIRECTORATE	186	190	190
FLIGHT CREW OPERATIONS DIRECTORATE	186	185	173
WHITE SANDS TEST FACILITY	48	48	48

JOHN F. KENNEDY SPACE CENTER
(KSC)

FTE Summary

	FY 01	FY 02	FY 03
TOTAL	1,831	1,852	1,870



MARSHALL SPACE FLIGHT CENTER
(MSFC)

FTE Summary

	FY 01	FY 02	FY 03
TOTAL	2709	2,761	2,761

OFFICE OF THE DIRECTOR
FTE:
FY 01: 13
FY 02: 13
FY 03: 13

SAFETY & MISSION ASSURANCE OFFICE
FTE:
FY 01: 100
FY 02: 114
FY 03: 114

PROCUREMENT OFFICE
FTE:
FY 01: 130
FY 02: 138
FY 03: 138

OFFICE OF CHIEF COUNSEL
FTE:
FY 01: 13
FY 02: 15
FY 03: 15

OFFICE OF CHIEF FINANCIAL OFFICER
FTE:
FY 01: 132
FY 02: 133
FY 03: 165

INSPECTOR GENERAL FIELD OFFICE

EQUAL OPPORTUNITY OFFICE
FTE:
FY 01: 6
FY 02: 6
FY 03: 6

SPACE SHUTTLE PROJECTS OFFICE
FTE:
FY 01: 146
FY 02: 130
FY 03: 130

SYSTEMS MANAGEMENT OFFICE
FTE:
FY 01: 26
FY 02: 26
FY 03: 26

SPACE TRANSPORTATION DIRECTORATE*
FTE:
FY 01: 335
FY 02: 415
FY 03: 415

SPACE LAUNCH INITIATIVE
FTE:
FY 01: 152
FY 02: 171
FY 03: 171

SCIENCE DIRECTORATE
FTE:
FY 01: 347
FY 02: 322
FY 03: 300

ENGINEERING DIRECTORATE
FTE:
FY 01: 729
FY 02: 650
FY 03: 650

CUSTOMER AND EMPLOYEE RELATIONS DIRECTORATE
FTE:
FY 01: 107
FY 02: 119
FY 03: 119

FLIGHT PROJECTS DIRECTORATE
FTE:
FY 01: 280
FY 02: 297
FY 03: 284

CENTER OPERATIONS DIRECTORATE
FTE:
FY 01: 193
FY 02: 212
FY 03: 215

JOHN C. STENNIS SPACE CENTER
(SSC)

	FTE Summary		
	FY 01	FY 02	FY 03
TOTAL	286	295	301

OFFICE OF THE DIRECTOR
FTE:
FY 01: 6
FY 02: 6
FY 03: 6

OFFICE OF EQUAL OPPORTUNITY
FTE:
FY 01: 1
FY 02: 1
FY 03: 1

OFFICE OF THE CHIEF COUNSEL
FTE:
FY 01: 4
FY 02: 4
FY 03: 4

OFFICE OF HUMAN RESOURCES
FTE:
FY 01: 10
FY 02: 9
FY 03: 9

OFFICE OF THE CHIEF FINANCIAL OFFICER
FTE:
FY 01: 27
FY 02: 26
FY 03: 27

OFFICE OF PUBLIC AFFAIRS
FTE:
FY 01: 5
FY 02: 6
FY 03: 6

OFFICE OF EDUCATION
FTE:
FY 01: 8
FY 02: 8
FY 03: 8

OFFICE OF PROCURE-MENT
FTE:
FY 01: 19
FY 02: 18
FY 03: 18

OFFICE OF SAFETY AND MISSION ASSURANCE
FTE:
FY 01: 17
FY 02: 19
FY 03: 19

OFFICE OF TECH TRANSFER
FTE:
FY 01: 4
FY 02: 4
FY 03: 4

PROPULSION TEST DIRECTORATE
FTE:
FY 01: 100
FY 02: 103
FY 03: 104

EARTH SCIENCE APPLICATIONS DIRECTORATE
FTE:
FY 01: 26
FY 02: 28
FY 03: 30

CENTER OPERATIONS AND SUPPORT DIRECTORATE
FTE:
FY 01: 59
FY 02: 63
FY 03: 65

AMES RESEARCH CENTER
(ARC)

FTE Summary	FY 01	FY 02	FY 03
TOTAL	1,496	1,498	1,506

OFFICE OF THE DIRECTOR
FY 01: 21
FY 02 21
FY 03: 21

ARMY AEROFLIGHT-DYNAMICS DIRECTORATE
FY 01: 3
FY 02: 3
FY 03: 3

OFFICE OF THECHIEF FINANCIAL OFFICER
FY 01: 63
FY 02: 66
FY 03: 69

SAFETY, ENVIRON. & MISSION ASSURANCE OFFICE
FY 01: 35
FY 02: 37
FY 03: 37

OFFICE OF THE CHIEF COUNSEL
FY 01: 10
FY 02: 10
FY 03: 10

COMMERCIAL TECHNOLOGY OFFICE
FY 01: 15
FY 02: 15
FY 03: 15

EXTERNAL AFFAIRS OFFICE
FY 01: 29
FY 02: 29
FY 03: 29

EQUAL OPPORTUNITY PROGRAMS OFFICE
FY 01: 4
FY 02: 4
FY 03: 4

AERO-SPACE DIRECT.
FY 01: 290
FY 02: 268
FY 03: 268

INFOR. SCI. & TECH. DIRECT.
FY 01: 266
FY 02: 268
FY 03: 270

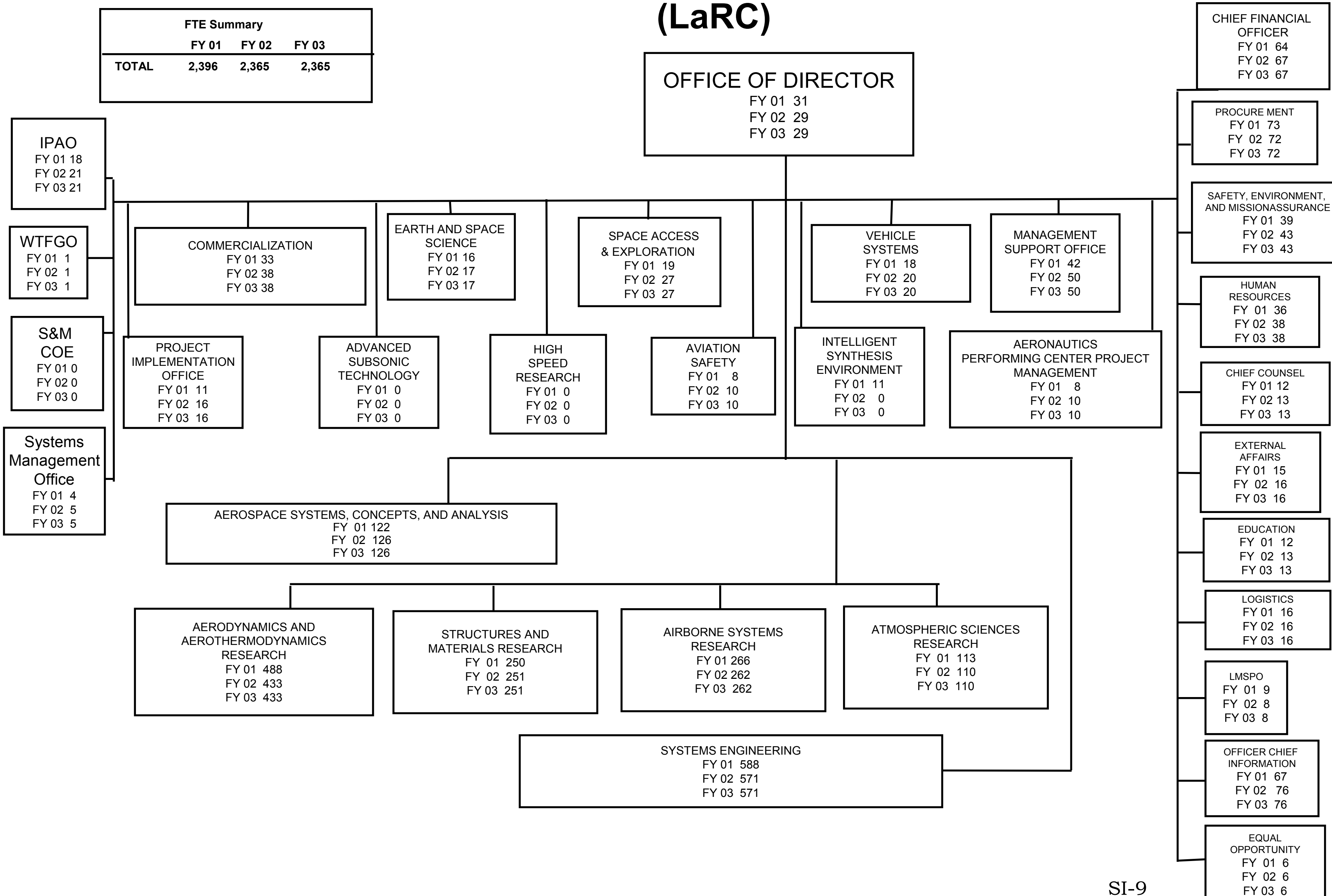
ASTRO. & SPACE RES. DIRECT.
FY 01 272
FY 02 291
FY 03: 294

RES. & DEVELOP. SERVICES DIRECT.
FY 01: 250
FY 02: 248
FY 03: 248

CENTER OPS. DIRECT.
FY 01: 238
FY 02: 238
FY 03: 238

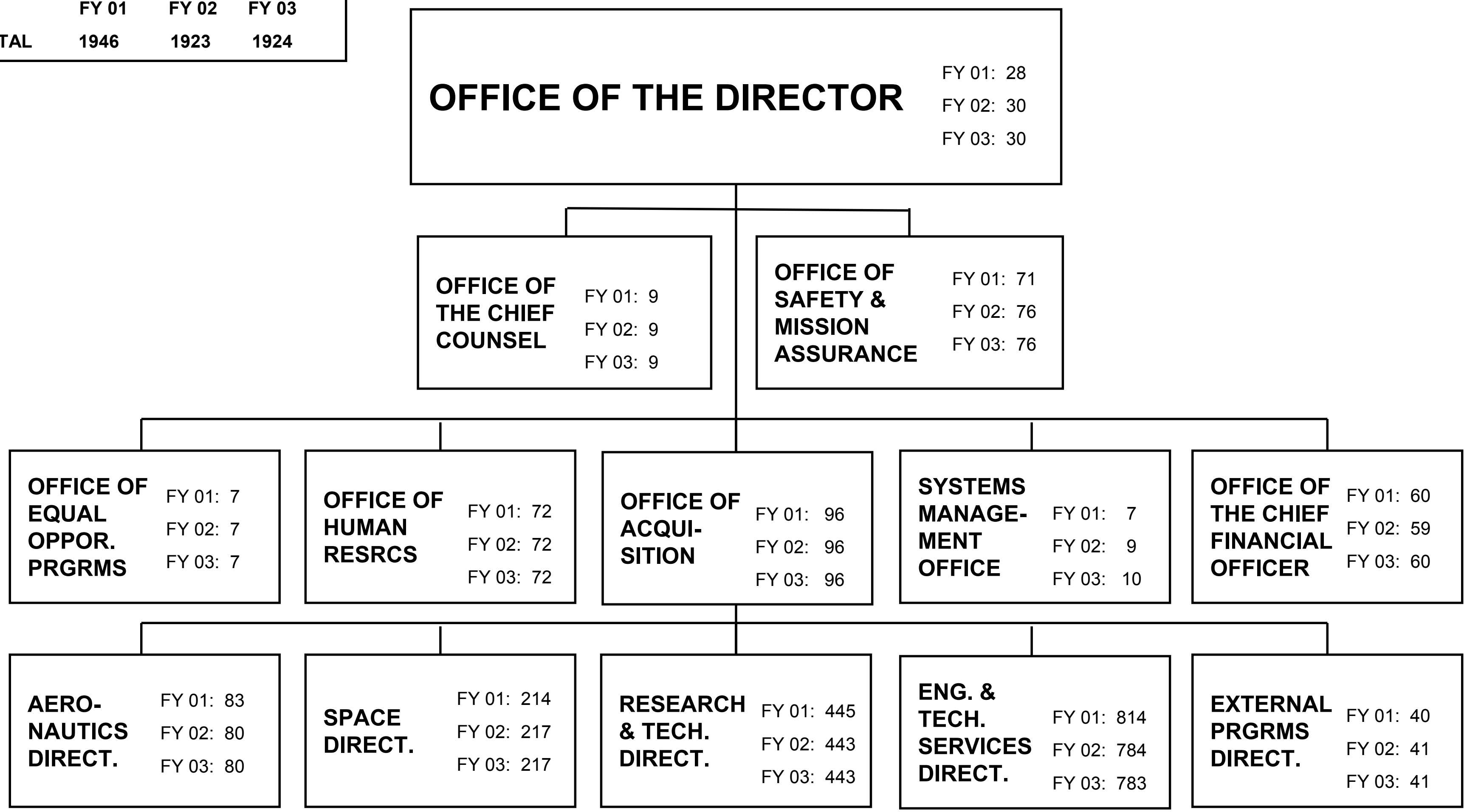
LANGLEY RESEARCH CENTER
(LaRC)

FTE Summary	FY 01	FY 02	FY 03
TOTAL	2,396	2,365	2,365



JOHN H. GLENN RESEARCH CENTER at LEWIS FIELD
(GRC)

FTE Summary			
	FY 01	FY 02	FY 03
TOTAL	1946	1923	1924



DRYDEN FLIGHT RESEARCH CENTER
(DFRC)

12/13/01

FTE Summary

	FY 01	FY 02	FY03
TOTAL	634	600	595

OFFICE OF THE DIRECTOR
FY 01: 18
FY 02: 18
FY 03: 17

Office	FY 01	FY 02	FY 03
EQUAL OPPORTUNITY OFFICE	4	3	3
HUMAN RESOURCES MGMT & DEVEL. OFFICE	35	19	18
PUBLIC AFFAIRS, COMM., & ED. OFFICE	10	10	9
SECURITY OFFICE	6	7	7
ACQUISITION MGMT OFFICE	21	18	18
OFFICE OF SAFETY & MISSION ASSURANCE	20	23	23
OFFICE OF THE CHIEF FINANCIAL OFFICER	41	38	38
OFFICE OF THE CHIEF COUNSEL	4	4	4
AIR-BORNE SCIENCES DIRECT.	12	14	14
RES. FACIL. DIRECT.	127	121	120
RES. ENG. DIRECT.	149	147	147
FLIGHT OPS. DIRECT.	155	148	147
AERO-SPACE PROJECTS DIRECT.	32	30	30

GODDARD SPACE FLIGHT CENTER
(GSFC)

FTE Summary			
	FY 01	FY 02	FY 03
TOTAL	3,228	3,317	3,323

- **Office Of The Director** — FTE: FY 01: 22; FY 02: 22; FY 03: 22
  - **Office of Equal Opportunity Programs** — FTE: FY 01: 6; FY 02: 6; FY 03: 6
  - **Office Of Public Affairs** — FTE: FY 01: 29; FY 02: 29; FY 03: 29
  - **Office Of The Chief Counsel** — FTE: FY 01: 11; FY 02: 11; FY 03: 11
  - **Office Of University Programs** — FTE: FY 01: 2; FY 02: 2; FY 03: 2
  - **Inspector General Field Office**
  - **Office Of Human Resources** — FTE: FY 01: 75; FY 02: 71; FY 03: 71
  - **Office Of The Chief Financial Officer** — FTE: FY 01: 95; FY 02: 94; FY 03: 93
  - **Office Of Sys. Safety & Mission Assurance** — FTE: FY 01: 86; FY 02: 104; FY 03: 112
  - **Mgmt. Operations Direct.** — FTE: FY 01: 554; FY 02: 573; FY 03: 575
  - **Applied Eng. & Tech. Direct.** — FTE: FY 01: 1168; FY 02: 1169; FY 03: 1185
  - **Sys. Tech. & Adv. Concepts Direct.** — FTE: FY 01: 206; FY 02: 253; FY 03: 224
  - **Flight Programs & Projects Direct.** — FTE: FY 01: 323; FY 02: 299; FY 03: 300
  - **Space Sciences Direct.** — FTE: FY 01: 238; FY 02: 247; FY 03: 248
  - **Suborbital & Special Orb. Projects Direct.** — FTE: FY 01: 85; FY 02: 94; FY 03: 100
  - **Earth Sciences Direct.** — FTE: FY 01: 328; FY 02: 343; FY 03: 345

Headquarters

FTE Summary	FY 01	FY 02	FY 03
TOTAL	1011	1167	1217

Office	FTE: FY 01	FTE: FY 02	FTE: FY 03
OFFICE OF THE ADMINISTRATOR	40	42	43
INSPECTOR GENERAL (W)	201	213	213

AEROSPACE SAFETY ADVISORY PANEL

NASA ADVISORY COUNCIL

FUNCTIONAL OFFICES

Office	FTE: FY 01	FTE: FY 02	FTE: FY 03
CHIEF FINANCIAL OFFICER (B)	57	70	77
GENERAL COUNSEL (G)	40	41	41
EQUAL OPPORTUNITY PROGRAMS (E)	29	30	31
EXTERNAL RELATIONS (I)	68	69	70
SECURITY MANAGEMENT AND SAFEGUARDS (X)	9	19	20
LEGISLATIVE AFFAIRS (L)	22	25	28
HUMAN RESOURCES AND EDUCATION (F)	59	69	71
PROCUREMENT (H) (Includes Agency Procurement Interns)	54	75	75
PUBLIC AFFAIRS (P)	44	49	49
MANAGEMENT SYSTEMS AND FACILITIES (J)	58	65	67
SAFETY AND MISSION ASSUR. (Q)	42	44	46
HEADQUARTERS OPERATIONS (C) (Includes Students, Temps, Interns for all HQ)	109	157	157
SMALL AND DISADVANTAGED BUSINESS UTILIZATION (K)	8	8	8

PROGRAM OFFICES

Office	FTE: FY 01	FTE: FY 02	FTE: FY 03
EARTH SCIENCE (Y)*	66	72	77
SPACE FLIGHT (M)	82	88	94
Biological & Physical Research (U)	52	59	66
SPACE SCIENCE (S) (Includes NMO @ JPL)	112	118	124
AERO-SPACE TECHNOLOGY (R)	60	67	73

OBJECT CLASSIFICATION (FY 2003 CONGRESSIONAL BUDGET)
(MILLIONS OF DOLLARS)
PO/CENTER: NASA TOTAL
TOTAL SAT & HSF

		FY 2001	FY 2002	FY 2003
	DIRECT OBLIGATIONS			
11	PERSONNEL COMPENSATION	1,409.7	1,505.9	1,596.6
12	PERSONNEL BENEFITS (CIVIL + PCS)	312.9	334.0	354.5
13	BENEFITS TO FORMER PERSONNEL	2.1	0.1	0.2
21	TRAVEL & TRANSP OF PERSONS	53.1	54.7	59.2
22	TRANSPORTATION OF THINGS	4.1	2.6	2.9
25	OTHER SERVICES	494.5	686.6	626.0
25	OTHER SERVICES (sal/bene + tvl)	63.9	51.9	59.6
25	OTHER SERVICES (ROS)*	430.6	634.7	566.4
	Emergency Response Fund (non-add)		(108.5)	(40.0)
		2,276.4	**2,583.9**	**2,639.4**

	FY 2002	FY 2003
SAT	1,572.3	1,645.7
HSF	1,011.6	993.7
TOTAL	**2,583.9**	**2,639.4**

*For this exercise, ROS funding has been included in OC25 only   Note: totals may not add due to rounding
Funding for Retirees Cost Not Inlcuded
The Object Class Structure is a 4-digit field established to classify financial transactions by object class code for accoun
and budgeting purposes. The first 2 digits will uniformy identify the classifications prescribed by the Office of Managem
and Budget (OMB). See OMB Circular A-12 for detailed explanation of the individual object classes.

OBJECT CLASSIFICATION (FY 2003 CONGRESSIONAL BUDGET)
(MILLIONS OF DOLLARS)
PO/CENTER: JOHNSON
TOTAL SAT & HSF

		FY 2001	FY 2002	FY 2003
	DIRECT OBLIGATIONS			
11	PERSONNEL COMPENSATION	250.0	267.8	279.8
12	PERSONNEL BENEFITS (CIVIL + PCS)	53.6	54.8	59.2
13	BENEFITS TO FORMER PERSONNEL	0.1	0.0	0.0
21	TRAVEL & TRANSP OF PERSONS	8.4	8.9	8.9
22	TRANSPORTATION OF THINGS	1.1	0.3	0.3
25	OTHER SERVICES	52.5	63.4	56.5
25	OTHER SERVICES (sal/bene + tvl)	7.9	4.0	5.1
25	OTHER SERVICES (ros)*	44.6	59.4	51.4
	Emergency Response Fund (non-add)		(13.3)	(4.7)
		365.8	**395.2**	**404.7**

	FY 2002	FY 2003
SAT	38.0	38.3
HSF	357.2	366.4
TOTAL	**395.2**	**404.7**

*For this exercise, ROS funding has been included in OC25 only
Note: totals may not add due to rounding

OBJECT CLASSIFICATION (FY 2003 CONGRESSIONAL BUDGET)
(MILLIONS OF DOLLARS)
PO/CENTER: KENNEDY
TOTAL SAT & HSF

		FY 2001	FY 2002	FY 2003
	DIRECT OBLIGATIONS			
11	PERSONNEL COMPENSATION	131.4	139.4	148.5
12	PERSONNEL BENEFITS (CIVIL + PCS)	33.8	33.1	35.6
13	BENEFITS TO FORMER PERSONNEL	0.1	0.0	0.0
21	TRAVEL & TRANSP OF PERSONS	5.8	5.6	5.6
22	TRANSPORTATION OF THINGS	0.4	0.3	0.3
25	OTHER SERVICES	78.5	127.1	99.7
25	OTHER SERVICES (sal/bene + tvl)	3.7	2.9	2.2
25	OTHER SERVICES (ros)*	74.8	124.2	97.5
	Emergency Response Fund (non-add)		(50.1)	(16.0)
		250.0	**305.4**	**289.6**

	FY 2002	FY 2003
SAT	8.9	9.5
HSF	296.5	280.1
TOTAL	**305.4**	**289.6**

*For this exercise, ROS funding has been included in OC25 only
Note: totals may not add due to rounding

OBJECT CLASSIFICATION (FY 2003 CONGRESSIONAL BUDGET)
(MILLIONS OF DOLLARS)
PO/CENTER: MARSHALL
TOTAL SAT & HSF

		FY 2001	FY 2002	FY 2003
	DIRECT OBLIGATIONS			
11	PERSONNEL COMPENSATION	197.0	211.3	227.9
12	PERSONNEL BENEFITS (CIVIL + PCS)	46.7	50.0	53.9
13	BENEFITS TO FORMER PERSONNEL	0.0	0.0	0.0
21	TRAVEL & TRANSP OF PERSONS	7.8	6.4	6.3
22	TRANSPORTATION OF THINGS	0.7	0.0	0.6
25	OTHER SERVICES	61.2	61.4	62.6
25	OTHER SERVICES (sal/bene + tvl)	8.1	2.0	4.0
25	OTHER SERVICES (ros)*	53.1	59.4	58.6
	Emergency Response Fund (non-add)		(3.9)	(2.3)
		313.4	**329.1**	**351.3**

SAT	186.6	200.2
HSF	142.5	151.1
TOTAL	**329.1**	**351.3**

*For this exercise, ROS funding has been included in OC25 only
Note: totals may not add due to rounding

OBJECT CLASSIFICATION (FY 2003 CONGRESSIONAL BUDGET)
(MILLIONS OF DOLLARS)
PO/CENTER: STENNIS
TOTAL SAT & HSF

		FY 2001	FY 2002	FY 2003
	DIRECT OBLIGATIONS			
11	PERSONNEL COMPENSATION	18.3	20.1	20.8
12	PERSONNEL BENEFITS (CIVIL + PCS)	4.9	4.6	4.9
13	BENEFITS TO FORMER PERSONNEL	0.0	0.0	0.0
21	TRAVEL & TRANSP OF PERSONS	0.8	0.8	0.7
22	TRANSPORTATION OF THINGS	0.3	0.1	0.1
25	OTHER SERVICES	18.1	22.7	23.1
25	OTHER SERVICES (sal/bene + tvl)	0.9	0.4	0.4
25	OTHER SERVICES (ros)*	17.2	22.3	22.7
	Emergency Response Fund (non-add)		(1.6)	(1.7)
		42.3	**48.2**	**49.6**

	FY 2002	FY 2003
SAT	24.2	25.2
HSF	24.0	24.4
TOTAL	**48.2**	**49.6**

*For this exercise, ROS funding has been included in OC25 only
Note: totals may not add due to rounding

OBJECT CLASSIFICATION (FY 2003 CONGRESSIONAL BUDGET)
(MILLIONS OF DOLLARS)
PO/CENTER: AMES
TOTAL SAT & HSF

		FY 2001	FY 2002	FY 2003
	DIRECT OBLIGATIONS			
11	PERSONNEL COMPENSATION	126.6	132.0	141.1
12	PERSONNEL BENEFITS (CIVIL + PCS)	27.0	29.7	32.8
13	BENEFITS TO FORMER PERSONNEL	0.1	0.0	0.0
21	TRAVEL & TRANSP OF PERSONS	3.8	3.8	4.7
22	TRANSPORTATION OF THINGS	0.0	0.3	0.2
25	OTHER SERVICES	36.7	50.2	35.7
25	OTHER SERVICES (sal/bene + tvl)	3.4	1.3	1.9
25	OTHER SERVICES (ros)*	33.3	48.9	33.8
	Emergency Response Fund (non-add)		(18.9)	(3.3)
		194.2	**215.9**	**214.5**

	FY 2002	FY 2003
SAT	207.6	212.2
HSF	8.3	2.3
TOTAL	**215.9**	**214.5**

*For this exercise, ROS funding has been included in OC25 only
Note: totals may not add due to rounding

OBJECT CLASSIFICATION (FY 2003 CONGRESSIONAL BUDGET)
(MILLIONS OF DOLLARS)
PO/CENTER: LANGLEY
TOTAL SAT & HSF

		FY 2001	FY 2002	FY 2003
	DIRECT OBLIGATIONS			
11	PERSONNEL COMPENSATION	169.1	176.9	186.8
12	PERSONNEL BENEFITS (CIVIL + PCS)	36.2	39.2	41.7
13	BENEFITS TO FORMER PERSONNEL	1.1	0.0	0.0
21	TRAVEL & TRANSP OF PERSONS	5.5	5.1	6.1
22	TRANSPORTATION OF THINGS	0.3	0.3	0.3
25	OTHER SERVICES	25.5	24.9	23.7
25	OTHER SERVICES (sal/bene + tvl)	5.4	3.2	2.7
25	OTHER SERVICES (ros)*	20.1	21.7	21.0
	Emergency Response Fund (non-add)		(1.2)	(1.4)
		237.8	**246.3**	**258.6**

SAT	241.1	253.1
HSF	5.2	5.5
TOTAL	**246.3**	**258.6**

*For this exercise, ROS funding has been included in OC25 only
Note: totals may not add due to rounding

OBJECT CLASSIFICATION (FY 2003 CONGRESSIONAL BUDGET)
(MILLIONS OF DOLLARS)
PO/CENTER: GLENN
TOTAL SAT & HSF

		FY 2001	FY 2002	FY 2003
	DIRECT OBLIGATIONS			
11	PERSONNEL COMPENSATION	140.5	145.8	154.0
12	PERSONNEL BENEFITS (CIVIL + PCS)	30.4	32.8	34.7
13	BENEFITS TO FORMER PERSONNEL	0.2	0.0	0.0
21	TRAVEL & TRANSP OF PERSONS	3.9	4.0	4.7
22	TRANSPORTATION OF THINGS	0.0	0.2	0.2
25	OTHER SERVICES	30.1	33.4	30.3
25	OTHER SERVICES (sal/bene + tvl)	5.0	4.6	3.3
25	OTHER SERVICES (ros)*	25.1	28.8	27.0
	Emergency Response Fund (non-add)		(1.7)	(1.8)
		205.1	**216.2**	**223.9**

	FY 2002	FY 2003
SAT	203.3	212.1
HSF	12.9	11.8
TOTAL	**216.2**	**223.9**

*For this exercise, ROS funding has been included in OC25 only
Note: totals may not add due to rounding

OBJECT CLASSIFICATION (FY 2003 CONGRESSIONAL BUDGET)
(MILLIONS OF DOLLARS)
PO/CENTER: DRYDEN
TOTAL SAT & HSF

		FY 2001	FY 2002	FY 2003
	DIRECT OBLIGATIONS			
11	PERSONNEL COMPENSATION	45.7	45.5	47.7
12	PERSONNEL BENEFITS (CIVIL + PCS)	10.2	10.6	10.9
13	BENEFITS TO FORMER PERSONNEL	0.0	0.0	0.0
21	TRAVEL & TRANSP OF PERSONS	1.5	1.5	1.8
22	TRANSPORTATION OF THINGS	0.1	0.1	0.2
25	OTHER SERVICES	4.7	5.7	6.3
25	OTHER SERVICES (sal/bene + tvl)	1.7	1.1	0.9
25	OTHER SERVICES (ros)*	3.0	4.6	5.4
	Emergency Response Fund (non-add)		(1.5)	(1.7)
		62.2	**63.4**	**67.0**

SAT	60.3	63.6
HSF	3.4	3.4
TOTAL	**63.7**	**67.0**

*For this exercise, ROS funding has been included in OC25 only

Note: tota

OBJECT CLASSIFICATION (FY 2003 CONGRESSIONAL BUDGET)
(MILLIONS OF DOLLARS)
PO/CENTER: GODDARD
TOTAL SAT & HSF

		FY 2001	FY 2002	FY 2003
	DIRECT OBLIGATIONS			
11	PERSONNEL COMPENSATION	242.6	257.2	269.7
12	PERSONNEL BENEFITS (CIVIL + PCS)	52.3	55.7	57.6
13	BENEFITS TO FORMER PERSONNEL	0.4	0.0	0.0
21	TRAVEL & TRANSP OF PERSONS	7.7	7.6	7.7
22	TRANSPORTATION OF THINGS	0.8	0.8	0.6
25	OTHER SERVICES	65.2	63.1	60.0
25	OTHER SERVICES (sal/bene + tvl)	8.4	5.8	5.7
25	OTHER SERVICES (ros)*	56.8	57.3	54.3
	Emergency Response Fund (non-add)		(2.1)	(2.5)
		369.1	**384.4**	**395.6**

	FY 2002	FY 2003
SAT	333.3	352.3
HSF	51.1	43.3
TOTAL	**384.4**	**395.6**

*For this exercise, ROS funding has been included in OC25 only
Note: totals may not add due to rounding

OBJECT CLASSIFICATION (FY 2003 CONGRESSIONAL BUDGET)
(MILLIONS OF DOLLARS)
PO/CENTER: HEADQUARTERS
TOTAL SAT & HSF

(includes ROS funding to JPL)

		FY 2001	FY 2002	FY 2003
	DIRECT OBLIGATIONS			
11	PERSONNEL COMPENSATION	88.4	110.2	120.4
12	PERSONNEL BENEFITS (CIVIL + PCS)	17.8	23.5	23.3
13	BENEFITS TO FORMER PERSONNEL	0.1	0.1	0.2
21	TRAVEL & TRANSP OF PERSONS	8.0	11.1	12.7
22	TRANSPORTATION OF THINGS	0.3	0.3	0.1
25	OTHER SERVICES	121.8	234.7	228.1
25	OTHER SERVICES (sal/bene + tvl)	19.2	26.6	33.4
25	OTHER SERVICES (ros)*	102.6	208.1	194.7
	Emergency Response Fund (non-add)		(11.4)	(4.6)
		236.5	**379.9**	**384.8**

	FY 2002	FY 2003
SAT	269.3	279.3
HSF	110.6	105.5
TOTAL	**379.9**	**384.8**

*For this exercise, ROS funding has been included in OC25 only

TABLE OF CONTENTS

FY 2003 PERFORMANCE PLAN

FY 2003 Performance Plan

Background and Introduction

The Government Performance and Results Act

The Government Performance and Results Act (GPRA) was passed by Congress and signed by the President in 1993. GPRA was enacted to improve the efficiency of all Federal agencies, with the following specific goals:

Improve Federal program management, effectiveness, and public accountability
Improve Congressional decision making on where to commit the Nation's financial and human resources
Improve citizen confidence in Government performance

GPRA directs Executive Branch agencies to develop a customer-focused strategic plan that aligns activities with concrete missions and goals. The Act directs agencies to manage and measure results to justify Congressional appropriations and authorizations. One hundred and eighty days after the completion of the fiscal year, agencies report on the degree of success in achieving the goals and performance measures defined in the strategic and performance plans. NASA's third Annual Performance Report will be furnished to the Congress in March 2002, covering performance in FY 2001.

NASA's Strategic Management System

Processes within NASA's Strategic Management System provide the information and results for GPRA's planning and reporting requirements. This system is defined in the NASA Strategic Management Handbook (NASA Procedures and Guidelines 1000.2, February 2000). Strategic Management Elements are depicted in the handbook (Figure 1-2) illustrating the hierarchy of documentation for the Strategic Management System (Agency--Enterprise--Centers--Program/Project--Employees).

The NASA Strategic Plan (NASA Policy Directive 1000.1b) defines the vision, mission, and fundamental questions of science and research that provide the foundation of the Agency's goals. The Plan describes five Strategic Enterprises that manage the programs and activities to implement our mission, answer fundamental questions, and provide service to identified customers. These Strategic Enterprises are the: *Space Science Enterprise, Earth Science Enterprise, Human Exploration and Development of Space Enterprise, Biological and Physical Research Enterprise and Aerospace Technology Enterprise*. The support systems for the Strategic Enterprises, defined as Crosscutting Processes, are: *Manage Strategically, Provide Aerospace Products and Capabilities, Communicate Knowledge and Generate Knowledge*. Interested readers may access NASA's Strategic Plan at the following website: http://www.hq.nasa.gov/office/codez/new/

The FY 2003 Performance Plan reflects the recent Strategic Plan. In the NASA Strategic Plan, the vision and mission statements of the Agency are articulated. We reprint them here for the convenience of the reader.

NASA Vision Statement

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.

NASA Mission Statement

- **To advance and communicate scientific knowledge and understanding of the 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 space technologies.**

Outcomes of NASA's Activities

Government investment decisions on funding for space and aeronautics research and technology cannot be made knowing in advance the full benefits ("outcomes") that will accrue from making the investments. Nor can the exact timetable be known as to when these benefits will be realized. However, we can identify how the outcomes of NASA's activities contribute significantly to the achievement of America's goals in five key areas:

Economic growth and security – NASA conducts aeronautics and space research and develops technology in partnership with industry, academia, and other federal agencies to keep America capable and competitive.

Increased understanding of science and technology – NASA communicates widely the content, relevancy, and excitement of our mission and discoveries to inspire and increase the understanding and the broad application of science and technology.

Protection of the Earth's Environment – NASA studies the Earth as a planet and as a system to understand global climate change, enabling the world to address environmental issues.

Educational Excellence – NASA involves the educational community in our endeavors to inspire America's students, create learning opportunities, and enlighten inquisitive minds.

Peaceful Exploration and Discovery – NASA explores the Universe to enrich human life by stimulating intellectual curiosity, opening new worlds of opportunity, and uniting nations of the world in this quest.

Annual performance goals (APGs) supporting the first three outcomes can be found in all of the Enterprises and Crosscutting Processes. APGs supporting the preservation of the environment can be found in the Earth Science Enterprise.

NASA's Fiscal Year 2003 Budget

The NASA FY 2003 budget request to OMB supports the President's commitment to support NASA's space and aeronautics program. This budget supports NASA's near-term priorities to fly the Space Shuttle safely and build the International Space Station. NASA's longer-term investments in America's future—developing more affordable, reliable means of access to space and conducting cutting-edge scientific and technological research – are also supported.

The successful execution of NASA's strategic goals and objectives is contingent on receipt of the requested appropriations, as well as the provision of funds, materials, or services which have been committed to the cooperative agreements or partnerships that are referenced in this document. The parties to these agreements include: foreign governments, other Federal Agencies or Departments, and commercial entities.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
FISCAL YEAR 2003 ESTIMATES
(IN MILLIONS OF REAL YEAR DOLLARS)
FEDERAL RETIREES COST DISTRIBUTED BY ENTERPRISE

For Display Purposes Only

	FY 2001	FY 2002 EXCLUDES EMERGENCY RESPONSE FUNDS	FY 2002 INCLUDES EMERGENCY RESPONSE FUNDS	FY 2003
HUMAN SPACE FLIGHT	**7,198.5**	**6,797.1**	**6,873.1**	**6,172.9**
INTERNATIONAL SPACE STATION	2,127.8	1,721.7	1,721.7	1,492.1
SPACE SHUTTLE	3,118.8	3,272.8	3,272.8	3,208.0
PAYLOAD & ELV SUPPORT	90.0	91.3	91.3	87.5
HEDS INVESTMENTS AND SUPPORT	1,292.8	1,181.5	1,257.5	1,220.2
SPACE COMMUNICATIONS & DATA SYSTEMS	521.7	482.2	482.2	117.5
SAFETY, MISSION ASSURANCE & ENGINEERING	47.4	47.6	47.6	47.6
SCIENCE, AERONAUTICS & TECHNOLOGY	**7,134.5**	**8,082.3**	**8,114.8**	**8,918.5**
SPACE SCIENCE	2,617.6	2,872.7	2,880.1	3,428.3
BIOLOGICAL & PHYSICAL RESEARCH	365.2	823.5	828.0	851.3
EARTH SCIENCE	1,771.2	1,631.2	1,635.7	1,639.4
AEROSPACE TECHNOLOGY	2,247.8	2,527.6	2,543.7	2,855.6
ACADEMIC PROGRAMS	132.7	227.3	227.3	143.7
INSPECTOR GENERAL	**23.9**	**24.7**	**24.7**	**25.6**
SUBTOTAL AGENCY	**14,357.2**	**14,904.2**	**15,012.7**	**15,117.0**
EMERGENCY RESPONSE FUND		**108.5**		
TOTAL AGENCY		**15,012.7**		

*FY 2001 restructured to reflect new FY 2002 Two Appropriation Structure

Fiscal Year 2003 Estimates
(In millions of Dollars)

	FY 1999	FY 2000	*FY 2001	FY 2002[1]	FY2003
NASA Total Including Federal Retirees Cost			[14,357]	[15,013]	15,117
NASA Total Excluding Federal Retirees Cost	13,653	13,602	14,253	14,902	15,000
SPACE SCIENCE	2,119	2,194	2,321	2,867	3,414
EARTH SCIENCE	1,414	1,443	1,485	1,626	1,628
HUMAN EXPLORATION AND DEVELOPMENT OF SPACE**	6,345	6,302	5,973	6,830	6,131
AEROSPACE TECHNOLOGY	1,339	1,125	1,404	2,508	2,816
BIOLOGICAL & PHYSICAL RESEARCH***			313	820	842
R&PM/CoF/OIG/ACADEMIC PROGRAMS	2,436	2,538			
OIG/ACADEMIC PROGRAMS				251	169
FEDERAL RETIREES COST			[104]	[111]	117
CIVIL SERVICE FTEs******	18,469	18,375	18,711	19,005	19,050

*Reflects 9/28/01 Operating Plan

** Includes Human Space Flight, Biological & Physical Research, Mission Communications and Space Communications Services, Space Operations, and Safety, Mission Assurance & Engineering.
***Beginning in FY 2001, Biological & Physical Research is a separate Enterprise.
**** FTE's reflect total Agency including Office of Inspector General (OIG).
[1]Includes $108M for Emergency Response Fund

The mission support line in the preceding table (FY 1999 – 2001) provides funding for mission support and includes: safety, mission assurance, engineering and advanced concepts activities supporting agency programs; salaries and related expenses in support of research in NASA field installations; design, repair, rehabilitation and modification of institutional facilities and construction of new institutional facilities; and other operations activities supporting conduct of agency programs such as the OIG and Academic Programs.

NASA is making progress towards full cost management. Beginning in FY 2002, NASA is implementing a two-appropriation budget (excluding the Inspector General account). The two-appropriation budget includes Human Space Flight (HSF) and Science, Aeronautics and Technology (SAT). The budget for Mission Support and other select elements have been allocated against the Enterprises contained in the two-appropriation budget that began in FY 2002.

For informational purposes, the Enterprise sections of this plan will display: 1) Enterprise FY funding levels for FY 1999-2003 and, 2) Civil Service staffing levels assigned to each Enterprise.

Additional detail on the means and strategies for accomplishing these performance targets is included in the budget narrative sections of this document. The NASA FY 2003 Budget will be available through the NASA homepage at the following internet address: http://ifmp.nasa.gov/codeb/budget2003/

NASA's Performance Plan

The performance plan describes performance measures for program activities requested in the FY 2003 budget. FY 2003 Performance goals and objectives are defined for NASA's Strategic Enterprises and for Crosscutting Processes in the NASA Strategic Plan (NPD 1000.1b).

The FY 2003 Plan provides information on how NASA plans to verify and validate performance data. Enterprises/Crosscutting Processes also include a description of the individual means that they will use to verify and validate measured values in performance reporting. These added features are provided to communicate various approaches used in the verification and validation of performance data and to support the credibility of reported performance.

Strategic goals and objectives are provided along with annual performance goals and indicators in the introductory section for each Enterprise and Crosscutting Process. The annual performance goals and indicators used in performance tracking are integrated with the strategic goals and objectives to provide a better linkage between the Strategic Plan and the Performance Plan. This format provides greater performance context and eliminates the necessity for a separate performance table to demonstrate the linkage between the Strategic Plan and the Annual Performance Plan that was a duplicative effort.

Generate Knowledge, a crosscutting process, is central to NASA's mission and is the primary means through which we seek the answers to our fundamental questions. Based on a NASA Advisory Council recommendation, Generate Knowledge was not included in the FY 2002 Performance Plan. The NAC's recommendation was based on the potential duplication of science research metrics across the Enterprises. As a result, NASA has been exploring alternative ways to effectively communicate this performance. Beginning with FY 03, an alternative method for reporting Generate Knowledge, in lieu of using performance metrics, will be provided in the Agency Performance Report. Based on the input provided by the Committee on Science, Engineering, and Public Policy (COSEPUP) report titled *Implementing the Government Performance and Results Act for Research* (2000), NASA will take a new approach to reporting the knowledge generated by the Agency's funded research. The NASA Research Results report will be an annual compilation of research highlights and most important discoveries made possible by the Generate Knowledge process via NASA funding. This report will augment the enterprise metrics that are detailed in the Agency Performance Plan. This report will not measure performance, but will describe research products resulting from NASA investments.

In accordance with OMB Circular A-ll requirements, annual performance goals for FY 1999-2003 are displayed by Enterprise/Crosscutting Process. Multi-year formats help to demonstrate cumulative progress towards achievement of strategic goals and objectives. Each annual performance goal also has an associated color assessment to facilitate trend analysis.

The following color key is used to assess performance:

Blue: Significantly exceeded performance
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 within the next fiscal year

Each Enterprise or Crosscutting Process section continues to include a budget link table that recaps the relationship of budget account and annual performance goals. To facilitate configuration management, control numbers have been assigned to all performance targets. The numbering sequences may not be contiguous, as targets may have been dropped out as the formulation process progressed.

The Performance Evaluation Process

NASA uses a process of extensive internal and external reviews to evaluate our progress against established plans. Enterprises and functional managers conduct reviews on a periodic basis. There are regular reviews for functional management activities, such as procurement, finance, facilities, personnel, and information resources management. There are also programmatic reviews of science, engineering, and technology plans and performance. The NASA Inspector General conducts independent reviews and provides recommendations for corrective actions.

NASA has established management councils, as described in the NASA Strategic Management Handbook, which conduct internal oversight reviews. Throughout the year, Program Management Councils (PMCs) at Headquarters and the Centers assess program schedules, cost, and technical performance against established programmatic commitments. The Senior Management Council (SMC) brings together both Headquarters and Field Installation Directors to conduct assessment reviews twice a year of the progress being made in meeting the Enterprise and Crosscutting Process performance targets.
NASA's extant management review processes provide appropriate forums for internal reporting and reviewing of project and program performance data. The recent streamlining of agency processes provides confidence that new data collection and oversight processes need not be created for compliance with GPRA. Our mission oriented organizational structure and established management processes are well suited to assessment of this type of performance evaluation.

There are also significant external review processes in place. The external reviews typically begin with the peer review processes in which NASA uses panels of outside scientific experts to ensure that science research proposals are selected strictly on the merits of the planned research. This process takes into account past performance for selection and/or continued funding.
NASA requests assistance from other federal agencies to provide expert advice and council. In some cases, the organizations are advisory bodies of experts from the public and private sectors that work with NASA to establish priorities in particular scientific disciplines. For example, NASA has requested that its senior advisory body, the NASA Advisory Council (NAC), independently review NASA's annual performance. Since FY 1999, the NAC has reviewed reported performance and provided a qualitative assessment of the Agency's progress that is included in the Agency Performance Report. In other cases, reviews are conducted by organizations such as the NASA Advisory Council, the Aerospace Safety Advisory Panel, and the National Academy of Sciences, which share responsibility for oversight of the Agency.

Additionally, the General Accounting Office reviews both the Performance Plan and Performance Report in their annual report "Status of Plans for Achieving Key Outcomes and Addressing Major Management Challenges."

The use of these external reviews allows NASA to receive a report card on whether we are making the anticipated progress towards accomplishing the priorities established by the Administration, the Congress, and our advisory bodies. When necessary, these external assessments result in the revision of either implementation plans or strategic plans.

The GPRA Performance Evaluation and Report Process

For the purposes of the GPRA performance reporting process, NASA uses advisory committees as the critical input when assessing performance. These committees provide inputs on NASA's Strategic Plan, individual Enterprise Strategic Plans, and budgetary priorities. NASA furnishes program performance status information, and in turn, the committees render advice and council. NASA uses this process to generate an independent "scorecard" report on our annual performance.
NASA has historically been one of the most open federal agencies in terms of performance measurements. Public attention is drawn quickly to program successes, and particularly to program failures. Press conferences on scientific results and program technical status are commonplace. The technical measurement of program progress is a management imperative due to the heavy emphasis on development programs, and within the programs, the specific projects. Flight programs such as the International Space Station compile thousands of technical performance metrics, schedule milestones, and cost performance data.

However, the GPRA requires a heavier focus on outcome metrics rather than NASA's ubiquitous input and output metrics. Like other federal agencies engaged in science and technology, NASA has difficulty in quantifying outcomes and, especially, relating current outcomes to current fiscal expenditures. This is appropriate since NASA's development programs are multi-year in character. In some cases, past expenditures began more than a decade ago. For example, the Hubble Space Telescope that entered into development in the mid-1970's. More recently, NASA has focused on programs and projects with much shorter development periods, on the order of 3-5 years. Yet, the science outcomes are dependent on scientists analyzing the information gathered in the years after launch. Therefore, in measuring the incremental annual performance of a multi-year research or development activity, where an outcome is not realized for several years, output metrics are the most appropriate way to measure the progress towards the achievement of strategic goals and objectives.

The stated objectives of programs within NASA's Enterprises are long-term in character. Annual performance evaluations assess whether appropriate progress is being made in obtaining the scientific or technical data that was believed necessary to achieve these objectives at the time they were developed. By obtaining such information, NASA provides the outputs necessary to achieve outcomes such as answering scientific questions or implementing new aerospace technologies. However, in many cases, NASA cannot guarantee that such outcomes will be achieved since other factors outside NASA's direct control (like breakthroughs in scientific understanding or private sector investments in technology) may be required to achieve a given outcome.

It is particularly important in our view to avoid evaluating actual output performance in R&D organizations solely by counting the number of planned events for the year with the number that actually occurred. The "beancount" approach is more appropriate to a known manufacturing environment. In the high-performance, high-risk R&D environment that characterizes NASA's programs, it is inadvisable to incentivize on-time performance at the expense of safety, budget, quality, high performance and appropriate risk-taking.

NASA has worked hard to maintain the highest emphasis on safety; this value applies not only to safety of personnel but also to preservation of high value facilities, equipment, experimental hardware, and related capabilities. Quality goes hand-in-hand with safety, but extends well beyond it. For example, taking credit for completing a critical design review (CDR) for a spacecraft is only appropriate when the CDR process has been thorough, complete, and meets performance standards. Great care must be taken that quality does not suffer when contract fee incentives call for a milestone payment upon completion of the CDR. Other examples abound, and give rise to our constant vigilance to avoid rushing to launch in order to achieve a given date.

It is possible, of course, to emphasize safety and quality and achieve little of lasting significance or have the achievement take an inordinate amount of time. Building spacecraft that do not test new designs, but rely only on proven designs, is appropriate for operational, mission agencies or commercial entities. It is not the appropriate role for an R&D agency like NASA. Conducting basic and applied research involves experimentation. When exploring new methods and new technologies in these high-performance ventures, it is acceptable to take risks, to push the envelope, and to fail. The tolerance of failure puts NASA and other R&D agencies into a different category than other federal agencies involved in the delivery of services to the public. Note, however, that this does not translate into an acceptance of failures that result from taking an inappropriate level of risk. The level of appropriate risk is tailored to the environment. The distinction is critical, particularly in high-value, high-cost environments, such as human space flight, the maintenance of the Hubble Space Telescope, and the launch of research spacecraft. The risk of failure in those venues is limited by all practicable means.

Thus, output measures are best used in suitable context. For these reasons, NASA management encourages Space Shuttle program managers to set aside metrics dealing with launches planned vs. launches achieved during a given fiscal year. If by waiting, one less launch is achieved than planned, but the result is better safety or quality or enables improved performance or reduces risk, then the latter result is what NASA wants to incentivize.

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 for 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 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 an audit of the FY 2000 Performance Report, GAO stated that NASA's validation and verification reporting efforts provided greater confidence that results were credible. Specific documentation of achievement was provided for each annual performance goal. This effort will continue as demonstrated by individual enterprise/crosscut verification and validation efforts summarized in the Plan and verification/validation/data source information by APG reported in the Report. 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 was identified in the data sources section of each target's performance. With regards 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 NAC evaluates annual performance for both the Enterprises and the Crosscutting Processes, assessing both actual performance and progress towards strategic goal and objective achievement. 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.

Space Science

FY 2003 Performance Plan

Mission

The mission of NASA's Space Science Enterprise is to seek the answers to three fundamental questions:

- How did the Universe begin and evolve?
- How did we get here?
- Are we alone?

While these appear to be fairly straightforward questions, their answers have eluded humankind throughout the course of history.

Perhaps for the first time since humans began pondering the cosmos and our place in it, scientists stand poised to make the breakthrough discoveries that are necessary to answer these questions. With each space science mission NASA launches to study the planets, the stars, and other celestial phenomena comes new and profound scientific discovery. Discoveries made in recent years by NASA's space science missions are rewriting textbooks and fundamentally challenging long-standing scientific thought. Space science images of our Universe – beautiful, mysterious, and even volatile – have captured the fascination of not only the science community, but of the general public worldwide. In the last year, space science images graced the covers of dozens of popular magazines and newspapers.

Enterprise Resource Requirements

The budget to support the accomplishment of Space Science goals, including the President's FY 2002 and FY 2003 requests, is as follows:

	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
NOA $M	**$2,119**	**$2,194**	**$2,321**	**$2,867**	**$3,414**
CS FTEs	**1,846**	**2,362**	**2,064**	**2,481**	**2,453**

The structure of the Space Science Performance Plan is aligned with that of the Space Science Strategic Plan. However, in addition to considering strategic significance, an important factor in the formulation of the Performance Plan is adequate coverage of the Space Science budget. The Performance Plan contains twelve annual performance goals. Nine (75%) of these goals support Strategic Plan science objectives, and involve programs that comprise approximately 73% of the Space Science budget. The other three annual performance goals support the technology and education Strategic Plan objectives, and account for the remainder of Space Science funding.

Implementation Strategy

The Space Science Enterprise Performance Plan is aligned directly with the Space Science Strategic Plan. The Strategic Plan is based on science goals and objectives with research and flight programs structured to implement these goals. The Performance Plan then measures the Enterprise's annual performance progress towards the achievement of the science goals and objectives contained in the Strategic Plan.

The Space Science Enterprise continues to use scientific merit as the primary criterion for program planning and resource commitment. Projects are not approved for implementation until a clear technology path to successful implementation is demonstrated. New technologies are applied aggressively, within the constraints of prudent stewardship of public investment.

Active participation of the research community outside NASA in planning, flight programs, research investigations, and peer review is viewed as critical to the success of the Space Science Enterprise. Collaborative efforts with other Federal agencies, such as the National Science Foundation, Department of Defense and Department of Energy, as well as with international partners, play a key role in carrying out space science research. Finally, a fundamental consideration in planning and conducting all Space Science programs is the recognition that the national investment in space science is a public trust. The Space Science Enterprise places a very high priority on sharing the results and excitement of our programs through the formal education system and public engagement. Knowledge and discoveries will be shared with the public to enhance science, mathematics, and technology education and increase the scientific and technological literacy of all Americans.

FY 2003 Performance Metrics

Strategic Plan Goal:

***Science:* Chart the evolution of the Universe, from origins to destiny, and understand its galaxies, stars, planets, and life.**

Public Benefit: Perhaps for the first time since humans began pondering the cosmos and our place in it, scientists stand poised to make the breakthrough discoveries that are necessary to answer three fundamental questions:

- How did the Universe begin and evolve?
- How did we get here?

– Are we alone?

With each space science mission NASA launches to study the planets, the stars, and other celestial phenomena comes new and profound scientific discovery.

Objective: Understand the structure of the Universe, from its earliest beginnings to its ultimate fate.

Public Benefit: One of the great quests since ancient philosophers first pondered the sky has been to understand where humanity fits within the Cosmos: What is the age of the Universe? How did it begin and how will it end? What are its primary constituents and how do they interact? NASA's pursuits in the research focus areas are intended to answer these questions.

APG 3S1: Earn external review rating of "green," on average, on making progress in the following research focus areas:

- Identify dark matter [the matter in the universe that can be inferred but not directly seen using today's astronomical techniques] and learn how it shapes galaxies and systems of galaxies.
- Determine the size, shape, age, and energy content of the Universe.

<u>Indicators</u>

- Demonstrate significant progress toward the goal, as determined by external expert review.
- Obtain expected data from at least 80% of operating missions supporting this goal (as identified and documented at the beginning of the fiscal year).

Objective: Explore the ultimate limits of gravity and energy in the Universe.

Public Benefit: Astronomical observations show that energy, not matter, dominated the early universe. The evolution of the Universe from the energetic chaos of the Big Bang, a universe dominated by energy, to one filled with galaxies, stars, and planets, depends on the behavior of matter, energy, and forces (the laws of nature) under conditions that can never be duplicated or tested on Earth. Using the Universe as a laboratory of extreme environments will give us insight into the fundamental processes of nature and may reveal "new physics" and new phenomena that cannot be discovered in any Earthbound laboratory.

APG 3S2: Earn external review rating of "green," on average, on making progress in the following research focus areas:

- Discover the sources of gamma ray bursts and high energy cosmic rays [two phenomena that astronomers believe are created are the most energetic events in the universe].
- Test the general theory of relativity near black holes and in the early universe, and search for new physical laws, using the universe as a laboratory.
- Reveal the nature of cosmic jets and relativistic flows. [Understand the physical mechanisms that can accelerate matter to near the speed of light, as observed in cosmic jets and other relativistic flows.]

<u>Indicators</u>

- Demonstrate significant progress toward the goal, as determined by external expert review.
- Obtain expected data from at least 80% of operating missions supporting this goal (as identified and documented at beginning of fiscal year).

Objective: Learn how galaxies, stars, and planets form, interact, and evolve.

Public Benefit: Life on Earth is the product of a complex sequence of events, which are not fully understood at present. This sequence begins with the birth of the galaxies and continues through the creation of heavy elements inside stars and the birth of stars and other planetary systems. To understand how life arose on Earth, and perhaps elsewhere, a complete understanding of the entire "thread of life" in the Cosmos is necessary.

APG 3S3: Earn external review rating of “green” on average, on making progress in the following research focus areas:

- Observe the formation of galaxies and determine the role of gravity in this process.
- Establish how the evolution of a galaxy and the lifecycle of stars influence the chemical composition of material available for making stars, planets, and living organisms.
- Observe the formation of planetary systems [outside our solar system] and characterize their properties.
- Use the exotic space environments within our Solar System as natural science laboratories and cross the outer boundary of the Solar System to explore the nearby environment of our galaxy. [This will advance our knowledge of the composition of material between stars from which stars and planets are formed.]

<u>Indicators</u>

- Demonstrate significant progress toward the goal, as determined by external expert review.
- Obtain expected data from at least 80% of operating missions supporting this goal (as identified and documented at beginning of fiscal year).

Objective: Look for signs of life in other planetary systems.

Public Benefit: "Are we alone?" is one of the most profound questions that humanity can ask, and its answer will affect almost every aspect of how humans view themselves and their place in the Universe.

APG 3S4: Earn external review rating of “green” on average, on making progress in the following research focus areas:

- Discover planetary systems of other stars [beyond our solar system] and their physical [and chemical] characteristics.
- Search for worlds that could or do harbor life.

<u>Indicators</u>

- Demonstrate significant progress toward the goal, as determined by external expert review.
- Obtain expected data from at least 80% of operating missions supporting this goal (as identified and documented at beginning of fiscal year).

Objective: Understand the formation and evolution of the Solar System and the Earth within it.

Public Benefit: Research shows that the Earth and all of the other bodies in the Solar System formed at about the same time from a common disk of gas and dust that surrounded the Sun. While these bodies share some similarities, there are striking differences among them. A fundamental goal of the NASA Space Science Enterprise is to understand the physical conditions and processes that led to those differences. What do these differences imply about the response of Earth’s environment to natural and manmade influences? What do they imply about the likelihood of Earth-like planets, potential habitats for life, circling other stars?

APG 3S5: Earn external review rating of "green," on average, on making progress in the following research focus areas:

- Inventory and characterize the remnants of the original material from which the Solar System formed.
- Learn why the planets in our Solar System are so different from each other.
- Learn how the Solar System evolves.

<u>Indicators</u>

- Demonstrate significant progress toward the goal, as determined by external expert review.
- Obtain expected data from at least 80% of operating missions supporting this goal (as identified and documented at beginning of fiscal year).

Objective: Probe the origin and evolution of life on Earth, and determine if life exists elsewhere in our Solar System.

Public Benefit: The interactions between a changing Earth, its space environment, and the origin and evolution of life are not completely known. However, what we do learn will further the understanding of the organizing principles of life and its origin and thereby guide our search for extraterrestrial life.

APG 3S6: Earn external review rating of "green," on average, on making progress in the following research focus areas:

- Investigate the origin and early evolution of life on Earth, and explore the limits of life in terrestrial environments that might provide analogues for conditions on other worlds.
- Determine the general principles governing the organization of matter into living systems and the conditions required for the emergence and maintenance of life
- Chart the distribution of life-sustaining environments within our Solar System, and search for evidence of past and present life.
- Identify plausible signatures of life on other worlds.

<u>Indicators</u>

- Demonstrate significant progress toward the goal, as determined by external expert review.
- Obtain expected data from at least 80% of operating missions supporting this goal (as identified and documented at beginning of fiscal year).

Objective: Understand our changing Sun and its effects throughout the Solar System.

Public Benefit: Short-term changes in the Sun's output affect life and society by causing "space weather," which can affect space assets vital to the national economy (communications, military, and weather satellites), short wave radio communications, electric power grids, and astronauts. Long-term changes in the Sun's output are also a natural drivers of global climate change and appear to have affected Earth's climate in the past.

APG 3S7: Earn external review rating of "green," on average, on making progress in the following research focus areas:

- Understand the origins of long- and short-term solar variability.
- Understand the effects of solar variability on the solar atmosphere and heliosphere.

- Understand the space environment of Earth and other planets.

  Indicators
  - Demonstrate significant progress toward the goal, as determined by external expert review.
  - Obtain expected data from at least 80% of operating missions supporting this goal (as identified and documented at beginning of fiscal year).

Objective: Chart our destiny in the Solar System.

Public Benefit: The course of life on Earth has been profoundly altered by impacts of asteroids and comets. It is widely accepted that a major impact 65 million years ago led to the extinction of dinosaurs and cleared the way for the rise of mammals. Impacts did not end in prehistoric times. In 1908, a fragment of a comet or asteroid leveled hundreds of square miles of forest in the remote Siberian region of Tunguska; had the object fallen about four hours later, it would have annihilated the city of St. Petersburg.

It is estimated that there are between 700 and 1,000 objects whose orbits cross Earth's that are large enough to cause global catastrophe if they were to strike Earth. (These are known as Near Earth Objects, or NEOs.) NASA Space Science supports the search for such NEOs. By identifying those objects that actually have a potential to collide with Earth, we expect to have decades of advance warning in which to take countermeasures, if necessary.

APG 3S8: Earn external review rating of "green," on average, on making progress in the following research focus areas:

- Understand forces and processes, such as impacts, that affect habitability of Earth.
- Develop the capability to predict space weather.
- Find extraterrestrial resources and assess the suitability of Solar System locales for future human exploration.

  Indicators
  - Demonstrate significant progress toward the goal, as determined by external expert review.
  - Obtain expected data from at least 80% of operating missions supporting this goal as identified and documented at beginning of fiscal year.

Support of Strategic Plan Science Objectives (1-8); Development/ Near-Term Future Investments

Public Benefit: NASA has been chartered by the American people to undertake challenging scientific explorations of our Solar System and the Universe beyond by building and launching missions that will achieve ambitious scientific goals. Missions in development have moved beyond study and preliminary design, and into detailed design and fabrication. Once launched and operational, the images and data they provide will advance our understanding of our Solar System and the Universe in which we live.

APG 3S9: Earn external review rating of "green" on making progress in the following area:

- Design, develop, and launch projects to support future research in pursuit of Strategic Plan science objectives.

  Indicator

  Meet no fewer than 75% of the development performance objectives for "major programs/projects," and complete a majority of performance objectives for "other projects."

Major Programs/Projects:

- Hubble Space Telescope (HST) Development: Complete thermal vacuum test of the Cosmic Origins Spectrograph (COS).
- Stratospheric Observatory for Infrared Astronomy (SOFIA) Development: Complete the SOFIA aircraft fuselage structural modification.
- Gravity Probe-B (GP-B) Development: Successful launch and check-out.
- Mars Exploration Rover '03 Development: Successful launch and check-out.
- Mars Reconnaissance Orbiter '05 Development: Conduct Critical Design Review (CDR).
- Stereo Mission Development: Conduct Critical Design Review (CDR).
- Gamma-ray Large Area Space Telescope (GLAST) Development: Conduct Large Area Telescope (LAT) Critical Design Review (CDR).
- Mercury Surface, Space Environment, Geochemistry and Ranging (MESSENGER) Development: Begin spacecraft integration and test.

Other Projects:

- Swift Development: Complete instrument payload module and spacecraft integration.
- Full-sky Astrometric Mapping Explorer (FAME) Development: Begin spacecraft integration.
- Coupled Ion-Neutral Dynamics Investigations (CINDI) Development: Complete payload module.
- Deep Impact Development: Conduct Integration and Test (I&T) Readiness Review.
- Solar-B Development: Conduct the Pre-Environmental Review for the X-ray Telescope (XRT) Instrument.
- Planck Development: Complete the Cryocooler Qualification Model.
- Herschel Development: Complete Spectral and Photometric Imaging Receiver (SPIRE) Qualification Model Detectors.

Strategic Plan Goal:
Technology/Long-Term Future Investments: **Develop new technologies to enable innovative and less expensive research and flight missions.**

Objectives: Acquire new technical approaches and capabilities.
Apply and transfer technology.

Public Benefit: NASA must be a prudent steward of the taxpayers' money by investing in essential technologies that are clearly relevant to future missions. This important principle includes consideration of the possibilities for commercialization, as well as options for using key technologies for multiple missions.

APG 3S10: Earn external review rating of "green" on making progress in the following technology development area:

- Focus (advance) technology development on a well-defined set of performance requirements covering the needs of near-term to mid-term strategic plan missions.

Indicator

Meet no fewer than 66% of the performance objectives for technology development.

- Next Generation Space Telescope (NGST): Complete and document final analysis of Advanced Mirror System Demonstrator (AMSD) technology program.
- StarLight: Conduct System Preliminary Design Review.
- Europa Orbiter: Complete Phase 1 X-2000 hardware.
- In-Space Propulsion: Select Phase II award(s) for electric propulsion technology development.
- Future Mars Exploration: Begin Phase A studies for Mars 2007 missions.
- Future Solar Terrestrial Probes: Award Magnetospheric MultiScale (MMS) instrument contract.
- Living With a Star: Complete the Initial Confirmation Review (Phase A to Phase B transition) for the Solar Dynamics Observatory (SDO).
- Constellation-X: Complete and test the Spectroscopy X-ray Telescope (SXT) Optics Engineering Unit.
- Laser Interferometer Space Antenna (LISA): Begin Phase A studies.

Objectives: Validate new technologies in space.
Apply and transfer technology.

Public Benefit: Careful stewardship of public money requires that challenging new technologies be evaluated via cost-effective demonstration and precursor missions so that NASA's most ambitious research facilities can be reliably developed using proven technologies.

APG 3S11: Earn external review rating of “green” on making progress in the following technology validation area:

- Formulate and implement cost-effective space demonstrations of selected technologies on suitable carriers.

Indicator

Meet no fewer than 66% of the performance objectives for flight validation.

- Flight Validation/New Millennium Program: Conduct Space Technology 6 (ST-6) Critical Design Review (CDR).
- Flight Validation/New Millennium Program: Conduct Space Technology 7 (ST-7) Confirmation Review.
- Flight Validation/New Millennium Program: Complete Space Technology 8 (ST-8) Initial Confirmation (Phase B Downselect).

Strategic Plan Goal:
***Education and Public Outreach:* Share the excitement and knowledge generated by scientific discovery and improve science education.**

Objectives: Share the excitement of space science discoveries with the public.
Enhance the quality of science, mathematics, and technology education, particularly at the pre-college level.
Help create our 21st Century scientific and technical workforce.

Public Benefit: Space Science Enterprise education and public outreach goals center on sharing the results of our missions and research programs with wide audiences and using space science discoveries as vehicles to improve teaching and learning at all levels. This is a deliberate expansion of the traditional role of the Enterprise in supporting graduate and postgraduate professional education, a central element of meeting our responsibility to help create the scientific workforce of the future. Our commitment to education includes a special emphasis on pre-college education and on increasing the general public's understanding and appreciation of science, mathematics, and technology.

APG 3S12: Earn external review rating of "green," on average, on making progress in the following focus areas:

- Incorporate a substantial, funded education and outreach program into every space science flight mission and research program.
- Increase the fraction of the space science community that contributes to a broad public understanding of science and is directly involved in education at the pre-college level.
- Establish strong and lasting partnerships between the space science and education communities.
- Develop a national network to identify high-leverage education and outreach opportunities and to support long-term partnerships.
- Provide ready access to the products of space science education and outreach programs.
- Promote the participation of underserved and underutilized groups in the space science program by providing new opportunities for minorities and minority universities to compete for and participate in space science missions, research, and education programs.
- Develop tools for evaluating the quality and impact of space science education and outreach programs.

  Indicator

  Meet no fewer than six (75%) of the eight performance objectives for education and public outreach (E/PO).

  - Ensure that every stand-alone mission approved for development start in FY 2003 has a funded E/PO program (and preliminary E/PO plan) in place at the start of development, with a definitive E/PO plan prepared by its Critical Design Review (CDR). For cases in which E/PO is planned and implemented at the Program level (with individual missions contributing to the overall program), have a long-term program E/PO plan prepared by the end of FY 2003.
  - Increase the number of space scientists directly participating in E/PO activities by 5% over the baseline established by the E/PO Annual Report published in FY 2002.
  - Plan and/or implement Enterprise-supported E/PO activities taking place in at least forty-five states.
  - Ensure that at least thirteen Enterprise-sponsored, favorably peer-reviewed, research, mission development or operations, or education projects are underway in Historically Black Colleges and Universities, Hispanic Serving Institutions, and Tribal Colleges, with at least three being underway in an institution of each type.
  - Provide exhibits, materials, workshops, and personnel at a minimum of five national and seven regional education and outreach conferences.
  - Have at least eight Enterprise-sponsored exhibits or planetarium shows on display or on tour at major science museums or planetariums across the country.
  - Develop a comprehensive plan for the reproduction and distribution of educational products. During FY 2003, focus on defining and implementing the mechanisms for the dissemination of audiovisual and CD-based products.

- Complete a major external review of the accomplishments of the Space Science E/PO efforts over the past five years, and initiate a comprehensive study directed towards collecting evidence concerning the E/PO program's effectiveness and educational impact. Use the results of both studies to guide adjustments in program direction and content.

VERIFICATION AND VALIDATION

Internal Assessment and Verification

The Space Science program consists of numerous diverse components, and each component's performance must be assessed in an appropriate way. For some program elements, such as mission and technology development, achievement of major milestones serves as the mechanism for assessing performance. For missions in an operational phase, performance is gauged in terms of operating efficiency or major data sets returned. In each of these cases, performance data is retrieved from normal project management reporting during the course of the fiscal year, and is verified and validated by the cognizant Program Executive or Program Scientist. This performance data is also monitored and regularly reviewed at the Enterprise level to ensure that performance is accurately reported.

External Assessment and Verification

For basic research programs, evaluation must include consideration of important contextual factors such as: the relative value of the research objectives; progress toward those objectives; productivity by prevailing research community standards; and impact on related research funded or performed by other agencies. Measures such as number of grants or scientists supported, publication counts, or research citations are not able to capture these important aspects of the evaluation requirement. The best way to assess research programs has been demonstrated to be an external peer review approach. The Enterprise will employ this mechanism to qualitatively assess the progress of its programs in basic research and data analysis against Enterprise strategic plan science goals and objectives. The reviews will determine whether outcomes of these programs are fully effective, are not as strong as desired but have returned results of significant value, or are not scientifically or technologically competitive. The review process will also identify those programs that have produced important unexpected results or have contributed to an unanticipated degree to other research.

External Assessment

At the conclusion of the verification process, the performance results will be assessed by the NASA Advisory Council.

PERFORMANCE-RELATED REVIEWS

In FY 2003, the Enterprise will continue to operate under its established project management review structure, and will continue rigorous peer review of research programs.

The annual review of Enterprise education and public outreach (E&PO) activities and accomplishments will be conducted, with results published. In addition, a major external review of the accomplishments of E&PO efforts over the past five years will be completed, and a second comprehensive study, directed towards collecting evidence concerning the E/PO program's effectiveness and educational impact, will be initiated. The results of both studies will be used to guide adjustments in program direction and content.

FY 2003 MULTI-YEAR PERFORMANCE TREND

SPACE SCIENCE

Strategic Objective: Solve mysteries of the universe.

	FY99	FY00	FY01
Annual Performance Goal and APG #	Successfully launch seven spacecraft, within 10% of budget, on average. #9S1		
APG Assessment	Blue		

	FY02	FY03	FY04
Annual Performance Goal and APG #			
APG Assessment			

	FY99	FY00	FY01
Annual Performance Goal and APG #	Measure the Hubble constant within an accuracy of about 10 percent, as compared to previous measurements that differ among themselves by a factor of two. (R&A) #9S2		
APG Assessment	Green		

	FY02	FY03	FY04
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #	Record 25 images and spectra at a resolution of better than an arcsecond, five to ten times sharper than images gathered earlier by the Einstein Observatory. (CXO) #9S3	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. #OS1	
APG Assessment	Green	Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #	Record data on approximately 12 compact stellar objects with a sensitivity 50 times greater than the Einstein Observatory. (CXO) #9S4		
APG Assessment	Green		

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #	Observe physical phenomena 25,000 times closer to the event horizon of black holes than permitted with optical wavelength measurements. (RXTE) #9S5	The baseline RXTE mission ended in 1997; the target for FY00 is to operate at least three of the five 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. #OS2	
APG Assessment	Green	Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		Complete final integration and test of the Gravity Probe-B science payload with the spacecraft in August 2000. #OS3	
APG Assessment		Yellow	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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% during FY00 operations before they are interrupted for the third servicing mission, presently scheduled for May 2000. #OS4	
APG Assessment		Yellow	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS43	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		Deliver the 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. #OS5	
APG Assessment		Yellow	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		Prepare the INTEGRAL Science Data Center (ISDC) for data archiving and prepare instrument analysis software for the spectrometer on INTEGRAL (SPI) instrument within 10% of estimated cost. #OS6	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		Assemble and successfully test the breadboard cooler for ESA's Planck mission in April 2000. #OS7	
APG Assessment		Yellow	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS8	
APG Assessment		Yellow	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		Begin system-level environmental testing of the MAP spacecraft during July 2000. #OS9	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		The baseline mission of the CGRO ended in 1996; the target for FY00 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%. #OS11	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		The 3-year 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. #OS12	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		The prime mission of SAMPEX ended in 1995; the FY00 target is to obtain at least 60% data coverage from at least three of SAMPEX's four instruments. #OS15	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS14	
APG Assessment		Red	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		Complete the NGST Developmental Cryogenic Active Telescope Testbed (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. #OS53	
APG Assessment		Red	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS62	
APG Assessment		Yellow	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS63	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS65	
APG Assessment		Red	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS66	
APG Assessment		Red	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #			Successfully develop and launch no fewer than three of four planned missions within 10% of budget and schedule. Missions are: GALEX, MAP, GP-B, and CATSAT. (Indicators have also been established for other missions in development.) (#1S1)
APG Assessment			

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #			Obtain expected scientific data from at least 80% of operating missions. Missions are: HST, CXO, XTE, ACE, FUSE, SWAS, and, if successfully launched, GALEX, and GP-B. (#1S2)
APG Assessment			

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #			Perform innovative scientific research and technology development by meeting technology development objectives for major projects, by achieving mission success in astronomy rocket and balloon flights, and by making satisfactory research progress in related Research and Analysis (R&A) and Data Analysis (DA) programs. Meet no fewer than 66% of the performance objectives for the following technology and research programs: NGST, Herschel (FIRST), GLAST, Sounding Rockets, Balloons, and R&A. Achieve a "fully effective" (green) overall science achievement rating from the Space Science external advisory committee. (#1S3)
APG Assessment			

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

<u>Strategic Objective</u>: Understand the structure of the Universe, from its earliest beginnings to its ultimate fate.

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #			
APG Assessment			

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #	Earn external review rating of "green," on average, on making progress in the following research focus areas: • Identify dark matter and learn how it shapes galaxies and systems of galaxies. • Determine the size, shape, age, and energy content of the universe. (#2S1)	Earn external review rating of "green," on average, on making progress in the following research focus areas: • Identify dark matter and learn how it shapes galaxies and systems of galaxies. • Determine the size, shape, age, and energy content of the universe. (#3S1)	
APG Assessment			

<u>Strategic Objective</u>: Explore the ultimate limits of gravity and energy in the Universe.

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #			
APG Assessment			

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #	Earn external review rating of "green," on average, on making progress in the following research focus areas: • Discover the sources of gamma ray bursts and high energy cosmic rays. • Test the general theory of relativity near black holes and in the early universe, and search for new physical laws, using the universe as a laboratory. • Reveal the nature of cosmic jets and relativistic flows. (#2S2)	Earn external review rating of "green," on average, on making progress in the following research focus areas: • Discover the sources of gamma ray bursts and high energy cosmic rays [two phenomena that astronomers believe are created are the most energetic events in the universe]. • Test the general theory of relativity near black holes and in the early universe, and search for new physical laws, using the universe as a laboratory. • Reveal the nature of cosmic jets and relativistic flows. [Understand the physical mechanisms that can accelerate matter to near the speed of light, as observed in cosmic jets and other relativistic flows.] (#3S2)	
APG Assessment			

Strategic Objective: Learn how galaxies, stars, and planets form, interact, and evolve.

	FY99	FY00	FY01
Annual Performance Goal and APG #			
APG Assessment			

	FY02	FY03	FY04
Annual Performance Goal and APG #	Earn external review rating of "green," on average, on making progress in the following research focus areas: • Observe the formation of galaxies and determine the role of gravity in this process. • Establish how the evolution of a galaxy and the life cycle of stars influence the chemical composition of material available for making stars, planets, and living organisms. • Observe the formation of planetary systems and characterize their properties. • Use the exotic space environments within our Solar System as natural science laboratories and cross the outer boundary of the Solar System to explore the nearby environment of our galaxy. (#2S3)	Earn external review rating of "green," on average, on making progress in the following research focus areas: • Observe the formation of galaxies and determine the role of gravity in this process. • Establish how the evolution of a galaxy and the life cycle of stars influence the chemical composition of material available for making stars, planets, and living organisms. • Observe the formation of planetary systems [outside our solar system] and characterize their properties. • Use the exotic space environments within our Solar System as natural science laboratories and cross the outer boundary of the Solar System to explore the nearby environment of our galaxy. [This will advance our knowledge of the composition of material between stars from which stars and planets are formed.] (#3S3)	
APG Assessment			

Strategic Objective: **Explore the solar system.**

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #	Orbit Eros closer than 50 kilometers, 20-30 times closer than previous asteroid flybys. (NEAR) #9S6	NEAR will successfully orbit 433 Eros and meet primary scientific objectives while not exceeding projected mission cost by more than 10%. #OS16	
APG Assessment	Yellow	Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #	Measure the shape of Eros to an accuracy of 1 kilometer or better, about 10 times better than previous measurements, and measure the asteroid's mass to an accuracy of 20 percent. (NEAR) #9S7		
APG Assessment	Green		

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #	Complete the first direct compositional measurements of an asteroid. (NEAR) #9S8		
APG Assessment	Yellow		

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #	Map the 75 to 80 percent of the Moon's surface not accessible during the Apollo missions conducted from 1969 to 1972. (Lunar Prospector) #9S9		
APG Assessment	Green		

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #	Provide definitive measurements of the weak lunar magnetic field. (Lunar Prospector) #9S10		
APG Assessment	Green		

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #	Provide data with spatial resolution five times better than were collected from the Yohkoh Soft X-ray Telescope. (TRACE) #9S11 *Note: In performance plans prior to FY02, the "Explore the Solar System" objective included missions to increase our understanding of the Sun and its effects on the Earth.*	Collect pixel-limited images in all Transition Region and Coronal Explorer (TRACE) wavelength bands, operating 24-hour schedules for sustained periods over eight months. #OS17 *Note: In performance plans prior to FY02, the "Explore the Solar System" objective included missions to increase our understanding of the Sun and its effects on the Earth.*	
APG Assessment	Green	Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS29	
APG Assessment		Yellow	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS30	
APG Assessment		Yellow	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS20	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		The TIMED mission will be delivered on time for a planned May 2000 launch, within 10% of the planned development budget. #OS18 *Note: In performance plans prior to FY02, the "Explore the Solar System" objective included missions to increase our understanding of the Sun and its effects on the Earth.*	
APG Assessment		Yellow	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS19 *Note: In performance plans prior to FY02, the "Explore the Solar System" objective included missions to increase our understanding of the Sun and its effects on the Earth.*	
APG Assessment		Yellow	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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 FY00, activate and verify the wideband data and U.S. subcomponents after launch. #OS21 *Note: In performance plans prior to FY02, the "Explore the Solar System" objective included missions to increase our understanding of the Sun and its effects on the Earth.*	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		HESSI will be delivered in time for a planned July 2000 launch, within 10% of the planned development budget. #OS22 *Note: In performance plans prior to FY02, the "Explore the Solar System" objective included missions to increase our understanding of the Sun and its effects on the Earth.*	
APG Assessment		Yellow	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS23 *Note: In performance plans prior to FY02, the "Explore the Solar System" objective included missions to increase our understanding of the Sun and its effects on the Earth.*	
APG Assessment		Yellow	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS25 *Note: In performance plans prior to FY02, the "Explore the Solar System" objective included missions to increase our understanding of the Sun and its effects on the Earth.*	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		IMAGE will be delivered on time for a planned February 2000 launch and within 10% of the planned development budget. #OS26 *Note: In performance plans prior to FY02, the "Explore the Solar System" objective included missions to increase our understanding of the Sun and its effects on the Earth.*	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		If launched, IMAGE will acquire critical measurements at minute time scales, returning 85% real-time coverage of Earth's magnetospheric changes. #OS27 *Note: In performance plans prior to FY02, the "Explore the Solar System" objective included missions to increase our understanding of the Sun and its effects on the Earth.*	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	FY00	FY01
Annual Performance Goal and APG #		Select two Small Explorer (SMEX) missions and release a University Explorer (UNEX) Announcement of Opportunity (AO). #OS28 *Note: In performance plans prior to FY02, the "Explore the Solar System" objective included missions to increase our understanding of the Sun and its effects on the Earth.*	
APG Assessment		Red	

	FY02	FY03	FY04
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS24 *Note: In performance plans prior to FY02, the "Explore the Solar System" objective included missions to increase our understanding of the Sun and its effects on the Earth.*	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		Complete Genesis spacecraft assembly and start functional testing in November 1999. #OS31	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		Release an AO for the next Discovery mission. #OS32	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS42	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	FY00	FY01
Annual Performance Goal and APG #		The baseline Galileo mission ended in 1997; the target for FY00 is to recover at least 90% of playback data from at least one Galileo flyby of Io. #OS45	
APG Assessment		Blue	

	FY02	FY03	FY04
Annual Performance Goal and APG #			
APG Assessment			

	FY99	FY00	FY01
Annual Performance Goal and APG #		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% of the available science data and relaying to Earth 70% of the data transmitted at adequate signal levels by the Mars Polar Lander (MPL). #OS40	
APG Assessment		Red	

	FY02	FY03	FY04
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS41	
APG Assessment		Red	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		The Mars Global Surveyor (MGS) will acquire 70% of science data available, conduct at least two five-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. #OS46 *(Also shown below, under "Mars, the Moon, and small bodies.")*	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		Collect 85% of data acquired from the International Solar-Terrestrial Physics Program (ISTP) spacecraft and successfully execute the WIND trajectory plan. #OS33 *Note: In performance plans prior to FY02, the "Explore the Solar System" objective included missions to increase our understanding of the Sun and its effects on the Earth.*	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS34	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		Capture at least 90% of available Ulysses science data. These will be the only data observed from outside-of-the-ecliptic plane. #OS35 *Note: In performance plans prior to FY02, the "Explore the Solar System" objective included missions to increase our understanding of the Sun and its effects on the Earth.*	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS36 *Note: In performance plans prior to FY02, the "Explore the Solar System" objective included missions to increase our understanding of the Sun and its effects on the Earth.*	
APG Assessment		Yellow	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		Stardust: Continue spacecraft cruise operations without major anomalies and perform interstellar dust collection for at least 36 days. #OS37	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS38 *Note: In performance plans prior to FY02, the "Explore the Solar System" objective included missions to increase our understanding of the Sun and its effects on the Earth.*	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		Collect and process data from the Interplanetary Monitoring Platform (IMP-8, launched in 1973), making data from at least six instruments available within 15 months and the magnetic field and plasma data available within 2 months. #OS39 *Note: In performance plans prior to FY02, the "Explore the Solar System" objective included missions to increase our understanding of the Sun and its effects on the Earth.*	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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 three days for 90% of the year. #OS48 *Note: In performance plans prior to FY02, the "Explore the Solar System" objective includes missions to increase our understanding of the Sun and its effects on the Earth.*	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		Complete the system CDR for the New Millennium Deep Space-4 (Champollion) project before the end of FY00, including successful completion of the avionics subsystem CDR and the mechanical subsystem CDR. #OS47	
APG Assessment		Red	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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: 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. #OS58	
APG Assessment		Red	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		Complete and deliver for testing Solar-B's four Electrical Engineering Models in September 2000. #OS60 *Note: In performance plans prior to FY02, the "Explore the Solar System" objective included missions to increase our understanding of the Sun and its effects on the Earth.*	
APG Assessment		Yellow	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS61 *Note: In performance plans prior to FY02, the "Explore the Solar System" objective included missions to increase our understanding of the Sun and its effects on the Earth.*	
APG Assessment		Yellow	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS64	
APG Assessment		Red	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS70	
APG Assessment		Red	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #			Successfully develop and launch no fewer than one of two missions within 10% of budget and schedule. Missions are: Mars Odyssey ('01 Orbiter) and Genesis. (Indicators have also been established for other projects in development.) (#1S4)
APG Assessment			

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #			Obtain expected scientific data from at least 80% of operating missions. Missions are: Cassini, Voyager, Ulysses, SAMPEX, FAST, TRACE, Stardust, Mars Global Surveyor, and ISTP spacecraft; also, if successfully launched, TIMED, HESSI, IMAGE, Genesis, and Mars Odyssey ('01 Orbiter). (#1S5) *Note: In performance plans prior to FY02, the "Explore the Solar System" objective included missions to increase our understanding of the Sun and its effects on the Earth.*
APG Assessment			

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #			Perform innovative scientific research and technology development by meeting technology development objectives for major projects, by achieving mission success in space physics rocket and balloon flights, and by making satisfactory research progress in related R&A and DA programs. Meet no fewer than 66% of the performance objectives for the following technology and research programs: Solar-B, STEREO, Solar Probe, Future Solar Terrestrial Probes, Future Deep Space Technology, CISM, X2000, Sounding Rockets, and Balloons. Achieve a "fully effective" (green) overall science achievement rating from the Space Science external advisory committee. (#1S6) *Note: In performance plans prior to FY02, the "Explore the Solar System" objective included missions to increase our understanding of the Sun and its effects on the Earth.*
APG Assessment			

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

<u>Strategic Objective</u>: Understand the formation and evolution of the Solar System and the Earth within it.

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #			
APG Assessment			

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #	Earn external review rating of “green,” on average, on making progress in the following research focus areas: • Inventory and characterize the remnants of the original material from which the Solar System formed. • Learn why the planets in our Solar System are so different from each other. • Learn how the Solar System evolves. (#2S5)	Earn external review rating of “green,” on average, on making progress in the following research focus areas: • Inventory and characterize the remnants of the original material from which the Solar System formed. • Learn why the planets in our Solar System are so different from each other. • Learn how the Solar System evolves. (#3S5)	
APG Assessment			

Strategic Objective: **Probe the evolution of life on Earth, and determine if life exists elsewhere in our Solar System.**

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #			
APG Assessment			

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #	Earn external review rating of "green," on average, on making progress in the following research focus areas: • Investigate the origin and early evolution of life on Earth, and explore the limits of life in terrestrial environments that might provide analogues for conditions on other worlds. • Determine the general principles governing the organization of matter into living systems and the conditions required for the emergence and maintenance of life • Chart the distribution of life-sustaining environments within our Solar System, and search for evidence of past and present life. • Identify plausible signatures of life on other worlds. (#2S6)	Earn external review rating of "green," on average, on making progress in the following research focus areas: • Investigate the origin and early evolution of life on Earth, and explore the limits of life in terrestrial environments that might provide analogues for conditions on other worlds. • Determine the general principles governing the organization of matter into living systems and the conditions required for the emergence and maintenance of life • Chart the distribution of life-sustaining environments within our Solar System, and search for evidence of past and present life. • Identify plausible signatures of life on other worlds. (#3S6)	
APG Assessment			

Strategic Objective: Understand our changing Sun and its effects throughout the Solar System.

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #			
APG Assessment			

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #	Earn external review rating of "green," on average, on making progress in the following research focus areas: • Understand the origins of long- and short-term solar variability. • Understand the effects of solar variability on the solar atmosphere and heliosphere. • Understand the space environment of Earth and other planets. (#2S7)	Earn external review rating of "green," on average, on making progress in the following research focus areas: • Understand the origins of long- and short-term solar variability. • Understand the effects of solar variability on the solar atmosphere and heliosphere. • Understand the space environment of Earth and other planets. (#3S7)	
APG Assessment			

<u>Strategic Objective</u>: Chart our destiny in the Solar System.

	<u>FY99</u>	**<u>FY00</u>**	**<u>FY01</u>**
Annual Performance Goal and APG #			
APG Assessment			

	<u>FY02</u>	**<u>FY03</u>**	**<u>FY04</u>**
Annual Performance Goal and APG #	Earn external review rating of "green," on average, on making progress in the following research focus areas: • Understand forces and processes, such as impacts, that affect habitability of Earth. • Develop the capability to predict space weather. • Find extraterrestrial resources and assess the suitability of Solar System locales for future human exploration. (#2S8)	Earn external review rating of "green," on average, on making progress in the following research focus areas: • Understand forces and processes, such as impacts, that affect habitability of Earth. • Develop the capability to predict space weather. • Find extraterrestrial resources and assess the suitability of Solar System locales for future human exploration. (#3S8)	
APG Assessment			

<u>Strategic Objective</u>: Discover planets around other stars.

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #	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) #9S12	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. #OS55	
APG Assessment	Green	Yellow	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	FY00	FY01
Annual Performance Goal and APG #		The Space Interferometry Mission (SIM) System Testbed (STB) will demonstrate, in May 2000, that an rms optical path difference can be controlled at 1.5 nanometers, operating in an emulated on-orbit mode. #OS52	
APG Assessment		Green	

	FY02	FY03	FY04
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS54	
APG Assessment		Red	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #			Perform innovative scientific research and technology development by meeting interferometry technology development objectives and by making satisfactory research progress in related R&A programs. Meet no fewer than 66% of the performance objectives for SIM, TPF, ST-3, Keck, and R&A. Achieve a "fully effective" (green) overall science achievement rating from the Space Science external advisory committee. (#1S7)
APG Assessment			

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

Strategic Objective: **Look for signs of life in other planetary systems.**

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #			
APG Assessment			

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #	Earn external review rating of "green," on average, on making progress in the following research focus areas: • Discover planetary systems of other stars and their physical characteristics. • Search for worlds that could or do harbor life. (#2S4)	Earn external review rating of "green," on average, on making progress in the following research focus areas: • Discover planetary systems of other stars and their physical characteristics. • Search for worlds that could or do harbor life. (#3S4)	
APG Assessment			

Strategic Objective: Search for life beyond Earth.

	FY99	FY00	FY01
Annual Performance Goal and APG #	Successfully complete and receive scientific data from at least 8 of 10 planned data-taking encounters with Europa. #9S13 (Galileo)		
APG Assessment	Green	Blue	

	FY02	FY03	FY04
Annual Performance Goal and APG #			
APG Assessment			

	FY99	FY00	FY01
Annual Performance Goal and APG #	Bring the total mapping coverage to about 1 percent of the surface at about 30-meter resolution, and multispectral coverage distributed over 50 percent of the surface at lower resolution. #9S14 (Galileo coverage of Jupiter's moon Europa)		
APG Assessment	Green		

	FY02	FY03	FY04
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #	Initiate Institute operations by linking up to 8 institutions and engaging approximately 50 investigators. #9S17 (Astrobiology Institute)		
APG Assessment	Green		

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS56	
APG Assessment		Red	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #			Perform innovative scientific research and technology development by meeting technology development objectives and by making satisfactory research progress in the related R&A program, including the Astrobiology program. Meet no fewer than two of the three performance objectives for Europa Orbiter, Astrobiology, and R&A. Achieve a "fully effective" (green) overall science achievement rating from the Space Science external advisory committee. (#1S8)
APG Assessment			

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #			Advance the search for life beyond Earth by successfully launching a Mars mission, by obtaining data from operational spacecraft, and by performing innovative technology development. Meet no fewer than two of the three performance objectives for Mars Odyssey ('01 Orbiter), Mars Global Surveyor, and Terrestrial Planet Finder. (#1S14)
APG Assessment			

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

Strategic Objective: **Investigate the composition, evolution, and resources on Mars, the Moon, and small bodies.**

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #	Achieve the final science orbit. #9S15 (Mars Global Surveyor)		
APG Assessment	Green		

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #	Measure the topography with 10-meter precision, about 100 times more accurate than previous measurements. #9S19 (Mars Global Surveyor)		
APG Assessment	Blue		

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #	Provide high-resolution 1.5-meter imaging data, 10 times more detailed than the best imaging from the 1976 Viking mission. #9S20 (Mars Global Surveyor)		
APG Assessment	Green		

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #	Provide the first thermal infrared spectrometry of the planet. #9S21 (Mars Global Surveyor)		
APG Assessment	Green		

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	FY00	FY01
Annual Performance Goal and APG #			Investigate the composition, evolution, and resources of Mars, the Moon, and small bodies by successfully launching a Mars mission, by obtaining data from operational spacecraft, and by making satisfactory progress in related R&A and DA programs. Meet no fewer than 75% of the performance objectives for Mars Odyssey ('01 Orbiter), CONTOUR, Mars Global Surveyor, and R&A. Achieve a "fully effective" (green) overall science achievement rating from the Space Science external advisory committee. (#1S10)
APG Assessment			

	FY02	FY03	FY04
Annual Performance Goal and APG #			
APG Assessment			

<u>Strategic Objective</u>: Improve the reliability of space weather forecasting.

	<u>FY99</u>	**<u>FY00</u>**	**<u>FY01</u>**
Annual Performance Goal and APG #	Achieve complete coverage (maximum and minimum) of the solar cycle, an increase from 35 percent. #9S22 (Space Physics fleet of spacecraft)	*(Refer to Space Physics spacecraft targets under "Explore the Solar System." These include SAMPEX, TRACE, TIMED, HESSI, TWINS, IMAGE, Yohkoh, ISTP, WIND, Ulysses, Voyager, FAST, IMP-8, ACE, Solar-B, and STEREO.)*	
APG Assessment	Green		

	<u>FY02</u>	**<u>FY03</u>**	**<u>FY04</u>**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #			Develop the knowledge to improve the reliability of space weather forecasting by obtaining scientific data from three of five missions and by making satisfactory progress in related areas in R&A and DA programs. Meet no fewer than 75% of the performance objectives for R&A, ACE, SAMPEX, TRACE, ISTP, and, if successfully launched, HESSI. Achieve a "fully effective" (green) overall science achievement rating from the Space Science external advisory committee. (#1S11)
APG Assessment			

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #			Further understanding of basic natural processes and the effects of solar variability on humans and technology. Meet no fewer than two of the three performance objectives for: Strategic Plan Development, Solar Dynamics Observatory, and Research and Data Analysis. Achieve a "fully effective' (green) overall science achievement rating from the Space Science external advisory committee. (#1S13)
APG Assessment			

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

Strategic Objective: Develop innovative technologies for Enterprise missions and external customers.

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #	Demonstrate an improvement in measurement precision for optical path lengths in laser light to the 100-picometer (million-millionths of a meter) range. #9S24 (Micro-Arcsecond Metrology Testbed)		
APG Assessment	Yellow		

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #	Demonstrate an advanced robotic manipulator with an order of magnitude performance improvement compared to the manipulator used on Viking in 1976. #9S25 (Robotic Manipulator, Mars Polar Lander)		
APG Assessment	Green		

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS49	
APG Assessment		Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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 testbed, with the applications' sustained performance degraded by no more than 25% at fault rates characteristic of deep space and low-Earth orbit. #OS50	
APG Assessment		Yellow	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #		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. #OS57	
APG Assessment		Red	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

<u>Strategic Objective:</u> Develop new technologies needed to carry out innovative and less costly mission and research concepts.

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #			Plan, develop, and validate new technologies needed to enable future research and flight missions by achieving performance objectives in the space science core technology programs and by making progress as planned in the Flight Validation program. Meet no fewer than 66% of the performance objectives for Information Systems, High Performance Computing, Explorer Program Technology, and Flight Validation. (#1S12)
APG Assessment			

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

Strategic Objective: **Acquire new technical approaches and capabilities. Validate new spacecraft capabilities in space. Apply and transfer technology.**

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #			
APG Assessment			

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #	Earn external review rating of "green" on making progress in the following technology development area: • Focus technology development on a well-defined set of performance requirements covering the needs of near-term to mid-term strategic plan missions. (#2S10)	Earn external review rating of "green" on making progress in the following technology development area: • Focus (advance) technology development on a well-defined set of performance requirements covering the needs of near-term to mid-term strategic plan missions. (#3S10)	
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #			
APG Assessment			

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #	Earn external review rating of "green" on making progress in the following technology validation area: • Formulate and implement cost-effective space demonstrations of selected technologies on suitable carriers. (#2S11)	Earn external review rating of "green" on making progress in the following technology validation area: • Formulate and implement cost-effective space demonstrations of selected technologies on suitable carriers. (#3S11)	
APG Assessment			

<u>Strategic Objective:</u> Incorporate education and enhanced public understanding of science as integral components of space science missions and research.

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #	Account for 4 percent of the 150 “most important science stories” in the annual review by *Science News*. #9S26		
APG Assessment	Green		

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #	Account for no less than 25 percent of total contributions to the college textbook *Astronomy: From the Earth to the Universe*. #9S27		
APG Assessment	Green		

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #	Each new Space Science Enterprise mission initiated in FY 1999 will have a funded education and outreach program. #9S28		
APG Assessment	Green		

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #	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. #9S29	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 outreach program. (2) By the end of FY00, 10% of all Space Science research grants will have an associated education and outreach program under way. (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, 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. #OS67	
APG Assessment	Green	Green	

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

Strategic Objective: **Make education and enhanced public understanding of science an integral part of our missions and research.**

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #			Continue and expand the integration of education and enhanced public understanding of science with Enterprise research and flight mission programs. Meet no fewer than 75% of the eight performance objectives for education and public outreach. (#1S9)
APG Assessment			

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #			
APG Assessment			

Strategic Objective: **Share the excitement of space science discoveries with the public. Enhance the quality of science, mathematics, and technology education, particularly at the pre-college level. Help create our 21st Century scientific and technical workforce.**

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #			
APG Assessment			

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #	Earn external review rating of "green," on average, on making progress in the following focus areas: • Incorporate a substantial, funded education and outreach program into every space science flight mission and research program. • Increase the fraction of the space science community that contributes to a broad public understanding of science and is directly involved in education at the pre-college level. • Establish strong and lasting partnerships between the space science and education communities. • Develop a national network to identify high-leverage education and outreach opportunities and to support long-term partnerships. • Provide ready access to the products of space science education and outreach programs. • Promote the participation of underserved and underutilized groups in the space science program by providing new opportunities for minorities and minority universities to compete for and participate in space science missions, research, and education programs. • Develop tools for evaluating the quality and impact of space science education and outreach programs. (#2S12)	Earn external review rating of "green," on average, on making progress in the following focus areas: • Incorporate a substantial, funded education and outreach program into every space science flight mission and research program. • Increase the fraction of the space science community that contributes to a broad public understanding of science and is directly involved in education at the pre-college level. • Establish strong and lasting partnerships between the space science and education communities. • Develop a national network to identify high-leverage education and outreach opportunities and to support long-term partnerships. • Provide ready access to the products of space science education and outreach programs. • Promote the participation of underserved and underutilized groups in the space science program by providing new opportunities for minorities and minority universities to compete for and participate in space science missions, research, and education programs. • Develop tools for evaluating the quality and impact of space science education and outreach programs. (#3S12)	
APG Assessment			

Strategic Objective: Multi-theme / support all objectives.

	FY99	FY00	FY01
Annual Performance Goal and APG #		Conduct research and analysis. #OS68	
APG Assessment		Green	

	FY02	FY03	FY04
Annual Performance Goal and APG #			
APG Assessment			

	FY99	FY00	FY01
Annual Performance Goal and APG #		Conduct data analysis. #OS69	
APG Assessment		Green	

	FY02	FY03	FY04
Annual Performance Goal and APG #			
APG Assessment			

Strategic Objective: **Support of Strategic Plan Science Objectives*; Development/ Near-Term Future Investments**

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG #			
APG Assessment			

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG #	Earn external review rating of “green” on making progress in the following area: • Design, develop, and launch projects to support future research in pursuit of Strategic Plan science objectives. (#2S9)	Earn external review rating of “green” on making progress in the following area: • Design, develop, and launch projects to support future research in pursuit of Strategic Plan science objectives. (#3S9) (The Strategic Plan science objectives are detailed in Annual Performance Goals 3S1 through 3S9.)	
APG Assessment			

**Supports Strategic Plan Science Objectives:*

Understand the structure of the Universe, from its earliest beginnings to its ultimate fate.
Explore the ultimate limits of gravity and energy in the Universe.
Learn how galaxies, stars, and planets form, interact, and evolve.
Look for signs of life in other planetary systems.
Understand the formation and evolution of the Solar System and the Earth within it.
Probe the origin and evolution of life on Earth, and determine if life exists elsewhere in our Solar System.
Understand our changing Sun and its effects throughout the Solar System.
Chart our destiny in the Solar System.

Space Science Enterprise **FY 2003 Budget Link Table**	**Budget Category**	HST Development	GP-B	SOFIA	STEREO	GLAST	Payloads	Explorers	Discovery	Mars Exploration	Operating Missions	Technology Program	Research Program
Annual Performance Goal & APG #													
Earn external review rating of “green,” on average, on making progress in the following research focus areas: (1) Identify dark matter and learn how it shapes galaxies and systems of galaxies. (2) Determine the size, shape, age, and energy content of the universe. APG #3S1											X		X
Earn external review rating of “green,” on average, on making progress in the following research focus areas: (1) Discover the sources of gamma ray bursts and high energy cosmic rays. (2) Test the general theory of relativity near black holes and in the early universe, and search for new physical laws using the universe as a laboratory. (3) Reveal the nature of cosmic jets and relativistic flows. APG #3S2											X		X
Earn external review rating of “green,” on average, on making progress in the following research focus areas: (1) Observe the formation of galaxies and determine the role of gravity in this process. (2) Establish how the evolution of a galaxy and the life cycle of stars influence the chemical composition of material available for making stars, planets, and living organisms. (3) Observe the formation of planetary systems [outside our solar system] and characterize their properties. (4) Use the exotic space environments within our Solar System as natural science laboratories and cross the outer boundary of the Solar System to explore the nearby environment of our galaxy. APG #3S3											X		X
Earn external review rating of “green,” on average, on making progress in the following research focus areas: (1) Discover planetary systems [beyond our solar system] of other stars and their physical characteristics. (2) Search for worlds that could or do harbor life. APG #3S4											X		X

Space Science Enterprise FY 2003 Budget Link Table	**Budget Category**	HST Development	GP-B	SOFIA	STEREO	GLAST	Payloads	Explorers	Discovery	Mars Exploration	Operating Missions	Technology Program	Research Program
Earn external review rating of “green,” on average, on making progress in the following research focus areas: (1) Inventory and characterize the remnants of the original material from which the Solar System formed. (2) Learn why the planets in our Solar System are so different from each other. (3) Learn how the Solar System evolves. APG #3S5											X		X
Earn external review rating of “green,” on average, on making progress in the following research focus areas: (1) Investigate the origin and early evolution of life on Earth, and explore the limits of life in terrestrial environments that might provide analogues for conditions on other worlds. (2) Determine the general principles governing the organization of matter into living systems and the conditions required for the emergence and maintenance of life. (3) Chart the distribution of life-sustaining environments within our Solar System, and search for evidence of past and present life. (4) Identify plausible signatures of life on other worlds. APG #3S6											X		X
Earn external review rating of “green,” on average, on making progress in the following research focus areas: (1) Understand the origins of long- and short-term solar variability. (2) Understand the effects of solar variability on the solar atmosphere and heliosphere. (3) Understand the space environment of Earth and other planets. APG #3S7											X		X
Earn external review rating of “green,” on average, on making progress in the following research focus areas: (1) Understand forces and processes, such as impacts, that affect habitability of Earth. (2) Develop the capability to predict space weather. (3) Find extraterrestrial resources and assess the suitability of Solar System locales for future human exploration. APG #3S8											X		X
Earn external review rating of “green” on making progress in the following area: Design, develop, and launch projects to support future research in pursuit of Strategic Plan science objectives. APG #3S9		X	X	X	X	X	X	X	X	X			

Space Science Enterprise FY 2003 Budget Link Table	**Budget Category**	HST Development	GP-B	SOFIA	STEREO	GLAST	Payloads	Explorers	Discovery	Mars Exploration	Operating Missions	Technology Program	Research Program
Earn external review rating of “green” on making progress in the following technology development area: Focus (advance) technology development on a well-defined set of performance requirements covering the needs of near-term to mid-term strategic plan missions. APG #3S10												X	
Earn external review rating of “green” on making progress in the following technology validation area: Formulate and implement cost-effective space demonstrations of selected technologies on suitable carriers. APG #3S11												X	
Earn external review rating of “green,” on average, on making progress in the following focus areas: (1) Incorporate a substantial, funded education and outreach program into every space science flight mission and research program. (2) Increase the fraction of the space science community that contributes to a broad public understanding of science and is directly involved in education at the pre-college level. (3) Establish strong and lasting partnerships between the space science and education communities. (4) Develop a national network to identify high-leverage education and outreach opportunities and to support long-term partnerships. (5) Provide ready access to the products of space science education and outreach programs. (6) Promote the participation of underserved and underutilized groups in the space science program by providing new opportunities for minorities and minority universities to compete for and participate in space science missions, research, and education programs. (7) Develop tools for evaluating the quality and impact of space science education and outreach programs. APG #3S12		X	X	X	X	X	X	X	X	X	X	X	X

Earth Science
FY 2003 Performance Plan

Prologue

The mission of NASA's Earth Science Enterprise (ESE) is to develop a scientific understanding of the Earth system and its response to natural and human-induced changes to enable improved prediction of climate, weather, and natural hazards for present and future generations. NASA brings to this endeavor the vantage point of space, allowing global views of Earth system change. NASA is a provider of objective scientific information, via observation, research, modeling, and applications demonstration, for use by decision-makers in both the public and private sectors. NASA has been studying the Earth from space since inception as an agency. These efforts have led to current and future generations of national weather satellites, and the first series of comprehensive Earth Observing System (EOS) satellites that will concurrently observe for the first time the major interactions of the land, oceans, atmosphere, ice, and life that comprise the Earth system.

We know that natural and human-induced changes are acting on the Earth system. Natural forces include, but are not limited to, variation in the Sun's energy output, and volcanic eruptions, which spew dust into the atmosphere and scatter incoming sunlight. Human forces include deforestation, carbon emission from burning of fossil fuels, methane and soil dust production from agriculture, and ozone depletion by various industrial chemicals. Internal climate factors such as atmospheric water vapor and clouds also introduce feedbacks that serve to either dampen or enhance the strength of climate forcing. We also know the climate system exhibits considerable variability in time and space, i.e., both short and long term changes and regionally specific impacts.

NASA introduced the concept of Earth System Science to promote total understanding of how Earth's atmosphere, biosphere, oceans, and continents shape Earth's climate and its variations. Researchers have constructed computer models to simulate the Earth system, and to explore the possible outcomes of potential changes they introduce in the models. This way of looking at the Earth as a system is a powerful means of understanding changes we see around us. That has two implications for Earth Science. First, we need to ***characterize*** (that is, identify and measure) the forces acting on the Earth system and its responses. Second, we have to ***understand*** the sources of Earth's internal variability: the complex interplay among atmosphere, oceans, continents, and life that comprise the system.

Earth system changes are global phenomena. Yet the system comprises many micro-scale processes and the most significant manifestations are regional. Thus, studying such changes requires a global view at regionally discerning resolutions. This is where NASA comes in, bringing the unique capability to study planet Earth from the vantage point of space. By combining observations, research and modeling, we create a capability to ***predict*** Earth system change to help our partners produce better forecasts of change.

To ***characterize*** the forces acting on the Earth system and its responses, ***understand*** the source of internal variability and ***predict*** Earth system change, NASA must observe the Earth, conduct research and analysis of the data, model the data and synthesize the information into new knowledge. Where we are on this knowledge "life cycle" determines the strategy for our investment decisions.

Implementation Strategy

The baseline ESE program is pursuing a targeted research program, focused on a set of specific science questions that can be addressed effectively with NASA's capabilities. ESE formulates comprehensive research strategies that can lead to definitive scientific answers and to effective applications for the nation.

The key Earth Science research topics sponsored by NASA fall largely into three categories: forcings, responses, and the processes that link the two and provide feedback mechanisms. This conceptual approach applies in essence to all research areas of NASA's Earth Science program, although it is particularly relevant to the problem of climate change, a major Earth Science-related challenge facing our nation and the rest of the world. The ESE has articulated an overarching question and a set of strategic science questions which its observational programs, research and analysis, modeling, and advanced technology activities are directed at answering.

How is the Earth system changing, and what are the consequences for life on Earth?

How is the global Earth system changing?

What are the primary causes of change in the Earth system?

How does the Earth system respond to natural and human-induced changes?

What are the consequences of changes in the Earth system for human civilization?

How can we predict future changes in the Earth system?

In this and subsequent Performance Plans, NASA's annual results in Earth Science will be measured in terms of progress made toward answering these questions. Accordingly, the assessment of performance against the first strategic goal is structured in the form of key questions whose answers are provided by the ongoing mission of NASA's Earth Science program. While these questions will be answered over a period greater than a single year, the general nature of activities in FY 2003 continues to focus on completion of the first EOS satellite series and characterization of the forces acting on the Earth system and its responses. For subsequent plans starting in FY 2004, the Enterprise is developing a set of detailed roadmaps which define the program elements required to achieve answers to these questions and the timing of their achievability. These multiyear roadmaps will then form the basis for future annual performance plans and provide further insight into the ESE longer-term research outcomes.

Research conducted by NASA, within the scope of scientific questions and issues outlined in the ESE Research Strategy, normally follows a well tested process leading from a Principal Investigator (PI) led research activity through periodic publication of interim and final results in the peer reviewed literature, culminating in improved knowledge and/or new technology that can be applied to practical applications involving the solution of contemporary environmental problems of national importance. This process is reflected in our Research Strategy and, as appropriate, in our performance indicators.

The Global Climate Change Act of 1990 specifically highlights the importance of results that apply to the areas of energy and community growth. Given this focus and ESE activities and results in Earth science research and related remote sensing technology development, ESE has recognized the potential to provide socioeconomic benefits in the areas of applying weather forecast optimization to more efficient energy management and to applications in aviation. For example, *USA Today* has noted that the annual cost of electricity could decrease by at least $1B if the accuracy of 30-hour weather forecasts improved 1 degree Fahrenheit. Moreover, the projected annual savings of operating aircraft using NASA developed advanced Synthetic Vision Systems at just 10 airports in the U.S. in one year is estimated to be over $2B. Through existing and planned projects such as Geostationary Imaging Fourier Transform Spectrometer (GIFTS), Shuttle Radar Topography Mission (SRTM), and Earth Observing-1 (EO-1) and our work in atmospheric modeling, climate prediction modeling, topography, and land use/land cover, the ESE will contribute to the potential for such socioeconomic realization in this decade. Earth Science is science in the national interest. NASA is pleased to play a leadership role in exploring and understanding the Earth. This ESE Performance Plan describes our planned accomplishments toward this great scientific endeavor with tangible societal benefits in FY 2003. These planned accomplishments, while important and useful in their own right, are essential stepping-stones on the path to answering the ESE science questions over the next decade.

Characterization of FY 2002 VS FY 2003 Performance Plans

The FY 2003 plan structure, as outlined with its strategic goals and objectives, remains the same as that in the FY 2002 plan. The indicators of progress are the only elements that have changed. This year, we have only developed detailed indicators for one-third of our basic research portfolio. However a qualitative assessment will be provided on progress made in every science question in the FY 2003 report. In future years, we will assess progress against the road maps we are developing for our entire research portfolio.

NASA Earth Science Enterprise Roadmap

	Through 2002 Characterize the Earth System	2003-2010 Understand the Earth System	2010-2025 and Beyond Predict Changes in the Earth System

Science

Objectives

- Understand Earth system variability
- Identify & measure primary causes of change
- Determine how the Earth system responds
- Identify the consequences for civilization
- Predict future Earth system changes

Through 2002

- Establish a benchmark for global rainfall
- Estimate uptake of atmospheric CO2 from global measurements of the terrestrial biosphere
- Provide precise global measurements of atmospheric temperature and humidity
- Make global measurements of cloud properties to determine Earth's response to solar radiation
- Measure global ocean winds and topography to improve accuracy and length of weather prediction and drive models of ocean impacts on climate change
- Produce 3-D maps of the entire inhabited surface of the Earth

2003-2010

- Achieve a quantitative understanding of the global fresh water cycle
- Quantify with a "high" or "moderate" degree of confidence all the principal Earth system forcing and response factors
- Quantify the variation and trends in terrestrial and marine ecosystems; estimate carbon stocks in forests and oceans globally
- Assess impacts of climate change on global ecosystems using interactive ecosystem-climate models
- Assimilate ocean winds, topography, & surface temperature, tropospheric winds, and precipitation into climate and weather forecasting models

2010-2025 and Beyond

Demonstrate capability for:

- 10 year climate forecasts
- 12 month rain rate
- 7 day forecast of pollution alerts
- 60 day volcanic eruption prediction
- 15-20 month El Nino forecasts
- 5 day hurricane track forecast
- 1-5 year earthquake forecast (experimental)
- Assess sea-level rise and effects
- Predict regional impacts of decadal climate change

Applications / Education

Objectives

- Demonstrate scientific & technical capabilities into practical tools for public & private sector decisions
- Stimulate public understanding of Earth science and encourage careers in science & technology

Through 2002

- Demonstrate applications of geospatial data to agriculture, forestry, urban & transportation planning, etc.
- Expand use of commercial systems in collecting Earth system science data
- Collaborate with educators to develop new curricula support materials using Earth science data and discoveries

2003-2010

- Enable 7-10 day weather and seasonal precipitation prediction capability; enable broad use of data in precision agriculture
- Enable an effective mix of private, government, & international data sources and users
- Incorporate Earth System Science into education curricula at the K-14 and university levels

2010-2025 and Beyond

- Conduct research to enable 10-14 day weather and annual precipitation prediction capability
- Enable wide spread commercial supply and use of global environmental data; integration of environmental information and economic decision-making
- Produce the next generation of Earth System Scientists

Technology

Objectives

- Develop advanced technologies for Earth observation
- Develop advanced information technologies for Earth science data
- Partner with others for Earth system monitoring & prediction

Through 2002

- Implement satellite formation flying to improve science return; New Millennium Program to space- validate revolutionary technologies
- Explore new instrument concepts for next decade missions
- Employ high-performance computing to address Earth system modeling challenges
- Collaborate with operational agencies in mission planning, development & utilization

2003-2010

- Develop and implement autonomous satellite control
- Demonstrate a new generation of small, highly capable active, passive and in situ instruments
- Employ distributed computing & data mining techniques for Earth system modeling
- Transition advanced instruments for systematic measurements to operational systems
- Develop high data rate communications and on-board data processing & storage

2010-2025 and Beyond

- Deploy cooperative satellite constellations and intelligent sensor webs
- Design instruments for new scientific challenges; deploy advanced instruments to migrate selected observations from LEO & GEO to L1 and L2
- Develop a collaborative synthetic environment to facilitate understanding and enable remote use of models and results
- Collaborate in an international global observing and information system; improve operational systems with new technology

Figure 1. Strategic Roadmap for the Earth Science Enterprise

Resource Requirements:

	FY 1999*	FY 2000*	FY 2001*	FY 2002	FY 2003
$ in M	1,414	1,443	1,485	1,626	1,628
Civil Service FTE	1,365	1,907	1,913	1,747	1,848

* Two-appropriation structure starts in FY 2002.

FY 2003 Performance Measures

Enterprise Mission: Develop a scientific understanding of the Earth system and its response to natural and human-induced changes to enable improved prediction of climate, weather, and natural hazards for present and future generations.

NASA’s ESE is dedicated to understanding the total Earth system and the effects of natural and human-induced changes on the global environment. The vantage point of space provides information about Earth's land, atmosphere, ice, oceans, and biota that is obtainable in no other way. Programs of the ESE study the interactions among these components to advance the new discipline of Earth System Science. Our research results contribute to the development of sound environmental policy and economic investment decisions**.**

NASA's ESE also develops innovative technologies and applications of remote sensing for solving practical societal problems in agriculture and food production, natural hazard mitigation, water resources, regional planning, and national resource management in partnership with other Federal agencies, with industry, and with state and local governments. Earth Science discoveries are shared with the public to enhance science, mathematics, and technology education and increase the scientific and technological literacy of all Americans. ESE combines the excitement of scientific discovery with the reward of practical contribution to the sustainability of planet Earth.

Strategic Goal: Observe, understand, and model the Earth system to learn how it is changing, and the consequence for life on Earth.

NASA's Earth observing and research program elements are the principal means by which global-scale questions about our home planet are posed and answered. These elements identify the variability in the Earth system, the forces responsible for change, responses of the Earth system to changes, and the consequences and predictability of future change. Nations and industries make billions of dollars worth of investment decisions yearly that will be better informed by the information and understanding we provide.

Objective: Discern and describe how the global Earth system is changing.

Annual Performance Goal (3Y1). Increase understanding of global precipitation, evaporation and how the cycling of water through the Earth system is changing.

It is important to establish a baseline for determining the existence or absence of significant trends in the water cycle, and the extent to which observed changes match predictions. Acceleration of the global water cycle could result in intensification and/or redistribution of rainfall patterns, severe storm frequency, droughts and glacial melting. Understanding of the water cycle enables prediction of freshwater availability.

The last set of indicators and associated progress was presented in the FY 2002 performance plan. We did not develop specific indicators for FY 2003. An assessment of progress toward answering this question will be published in the FY 2003 report.

Annual Performance Goal (3Y2). Increase understanding of global ocean circulation and how it varies on interannual, decadal, and longer time scales.

Establishing the basis for variations in the temperature and circulation of the upper ocean can be used to help assess any changes that may be affecting the Earth's weather and climate, including EL Niño phenomena.

<u>Performance Indicator</u>: Update the record of trends in sea ice duration, concentration and extent to span the period from 1979-2000. Current records extend to 1996.

<u>Performance Indicator</u>: Initiate production of sub-monthly analysis from a data-assimilating global ocean model, using NASA and other agency satellite and *in situ* observations, to evaluate ocean circulation changes such as those associated with EL Niño. This work is done in the context of the Global Ocean Data Assimilation Experiment. [http://www.ecco.ucsd.edu/]

Annual Performance Goal (3Y3). Increase understanding of global ecosystems change.

The activity establishes the basis for short-term, seasonal, and inter-annual variability of ecosystems. It also provides a baseline against which to evaluate future change. Measurements of seasonal, annual, and inter-annual changes in ecosystems are used to estimate productivity in agriculture, forestry, fisheries, and Earth's unmanaged lands and oceans.

The last set of indicators and associated progress was presented in the FY 2002 performance plan. We did not develop specific indicators for FY 2003. An assessment of progress toward answering this question will be published in the FY 2003 report.

Annual Performance Goal (3Y4). Increase understanding of stratospheric ozone changes, as the abundance of ozone-destroying chemicals decreases and new substitutes increases by meeting 2 of 2 performance indicators.

Reduction in atmospheric ozone amounts leads to an increased flux of ultraviolet radiation at the Earth's surface, with harmful effects on plant and animal life including human health. Understanding and possibly mitigating this process is a key ESE concern.

> Performance Indicator: Provide continuity of calibrated data sets from ground-based, suborbital, and space-based instruments for determining long term trends in the total column and profile abundances of stratospheric ozone with sufficient precision to enable the later assessment of expected ozone recovery.

> Performance Indicator: Characterize the inter-annual variability and possible long-term evolution of stratospheric aerosols (characteristics and profile abundances) and of the vertical profiles of methane, water vapor, and temperature to assist in the interpretation of observed ozone changes and chemistry-climate interactions. This requires a combination of data records from ground-based, airborne, balloon-borne, and space-based measurements.

Annual Performance Goal (3Y5). Increase understanding of change occurring in the mass of the Earth's ice cover by meeting at least 3 of 4 performance indicators.

Sea level is estimated to have been rising by as much as 2 mm/year over the last century. Possible contributions to this change include thermal expansion of the oceans and the loss of ice from glaciers and the large ice sheets. Of these, the large ice sheets present the greatest uncertainty in terms of their contribution to sea level rise and also represent the greatest potential threat to the coastal ecosystems and infrastructure. It is therefore important to establish whether Polar Regions are in the process of losing mass and contributing to the current observed sea level rise.

> Performance Indicator: Convert remotely sensed observations of Greenland ice sheet surface melting to estimates of ice mass loss in order to quantify how much ice is lost to melting, and its variability from year to year.

> Performance Indicator: Produce the first high-resolution (~10-15m) synthetic aperture radar "mini-mosaics" for key coastal regions in Antarctica to be used as a baseline for comparison to past and present high-resolution imagery.

> Performance Indicator: Use initial ICESat elevation data in Greenland and Antarctica to determine a baseline elevation for regions measured.

Performance Indicator: Perform initial assessment of the extent to which sea ice thickness can be determined using ICESat.

Annual Performance Goal (3Y6). Increase understanding of the motions of the Earth, the Earth's interior, and what information can be inferred about the Earth's internal processes.

Motions of the Earth's Interior are the forcings, which drive earthquakes, volcanoes, and build our mountains and valleys. Knowledge, which has been building over the past decades, has led to a quantum leap in our understanding of how our planet has evolved. Through this new knowledge has come a better understanding of natural hazards and natural resource assessment. Technological by-products include better navigation (including civilian Global Positioning System (GPS), the tracking of ocean height variability, and the attendant visualization of EL Niño and related phenomena to name just a few of many applications.

The last set of indicators and associated progress was presented in the FY 2002 performance plan. We did not develop specific indicators for FY 2003. Progress toward answering this question will be published in the FY 2003 report.

Objective: Identify and measure the primary causes of change (forcings) in the Earth system.

Annual Performance Goal (3Y7). Increase understanding of trends in atmospheric constituents and solar radiation and the role they play in driving global climate by meeting at least 4 of 5 performance indicators.

Solar radiation is the primary external force acting on Earth's climate. Atmospheric constituents, clouds, and aerosols drive the climate system; changes in their concentration/distribution will contribute to climate change through a variety of processes.

Performance Indicator: Continue and extend the current 23-year record of concentration measurements (and associated standards development) of anthropogenic and naturally occurring halogen-containing chemicals and other chemically active and greenhouse gases to provide for an understanding of future changes in ozone and climate forcing.

Performance Indicator: Characterize global sources of carbon monoxide using data assimilation techniques to combine carbon monoxide measurements from Measurements of Pollution in the Troposphere (MOPITT) with chemical transport models.

Performance Indicator: Use the comprehensive multi-instrument integrated data set for studying the sources/sinks and distribution of tropospheric aerosols over land, based on data from the Total Ozone Mapping Spectrometer (TOMS), Moderate Resolution Imaging Spectro Radiometer (MODIS), and Multi-angle Imaging Spectroradiometer (MISR) instruments to support evaluation of the impact on climate forcing of natural and anthropogenic aerosols in the atmosphere.

Performance Indicator: Combine multiple instrument data sets on the total solar irradiance (i.e. the total solar radiation per unit of Earth surface) and the solar ultraviolet (UV) flux (i.e. the UV component of total solar irradiance) over a full solar cycle in order to explore correlations between solar variation and climate without resorting to solar proxies (i.e. indirect measures of solar variability).

Performance Indicator: Reduce uncertainty (i.e. error) in the retrievals (calculation) of upper troposphere / lower stratosphere water vapor abundances (from microwave soundings) by 10 – 30% through improved laboratory spectroscopic measurements of the water vapor continuum.

Annual Performance Goal (3Y8). Increase understanding about the changes in global land cover and land use and their causes.

Change in land cover and land use is the dominant present-day forcing of change in terrestrial and coastal ecosystems and constitutes our largest uncertainty in the global carbon budget. Understanding the human and biophysical factors that cause land cover and land use change will be essential for assessing consequences for food production, natural resources availability, and resource management as well as for predicting future global changes.

The last set of indicators and associated progress was presented in the FY 2002 performance plan. We did not develop specific indicators for FY 2003. Progress toward answering this question will be published in the FY 2003 report.

Annual Performance Goal (3Y9). Increase understanding of the Earth's surface and how it is transformed and how such information can be used to predict future changes.

This effort is leading to a better understanding of natural events/processes that transform or change the topographic surface of the Earth, and the impact of such changes on human activities. Progress toward answering this question will lead to a better understanding of the risk of natural hazards and societies vulnerability to natural disasters. By products of these activities include better topographic maps of the Earth surface. These are important to many endeavors such as airplane landing and routing, watershed assessment, and roadway planning. Risk assessment for natural hazards such as flooding, earthquakes, landslides, and volcanoes is becoming increasingly important as societal resources are developed and concentrated in vulnerable areas.

The last set of indicators and associated progress was presented in the FY 2002 performance plan. We did not develop specific indicators for FY 2003. Progress toward answering this question will be published in the FY 2003 report.

Objective: Determine how the Earth system responds to natural and human-induced changes.

Annual Performance Goal (3Y10). Increase understanding of the effects of clouds and surface hydrologic processes on climate change.

It is important to establish a basis for determining the vertical distribution and optical properties of cloud particles to provide measurement-based estimates of atmospheric heating rather than relying on climatological statistics or models. Clouds are the most important factor that controls the Earth's radiation balance, which, along with evaporation and condensation of atmospheric and surface water, drives the major weather systems. Thus, determining the vertical distribution and optical properties of cloud particles will ultimately lead to better climate predictions. Soil moisture is an important land surface state variable, currently unmeasured at large spatial scales that also affects weather and climate.

The last set of indicators and associated progress was presented in the FY 2002 performance plan. We did not develop specific indicators for FY 2003. Progress toward answering this question will be published in the FY 2003 report.

Annual Performance Goal (3Y11). Increase understanding of how ecosystems respond to and affect global environmental change and affect the global carbon cycle.

Today, Earth's ecosystems are experiencing multiple, interacting, changing environmental conditions, and it will be vitally important to understand the implications of their responses, including some that may surprise us, for sustained agriculture, forestry, and fisheries, and for the continued provision of ecosystem goods and services that are valuable to human societies. We also need to know how their responses provide feedback to the atmosphere through fluxes of water, energy, and trace gases. Most importantly, we must develop understanding of the past, present, and future role of ecosystems as sources and sinks of carbon and in regulating the global carbon cycle.

The last set of indicators and associated progress was presented in the FY 2002 performance plan. We did not develop specific indicators for FY 2003. An assessment of progress toward answering this question will be published in the FY 2003 report.

Annual Performance Goal (3Y12). Increase understanding of how climate variations induce changes in the global ocean circulation by meeting at least 2 of 3 performance indicators.

Ocean circulation patterns strongly influence regional climates, yet these are known to have exhibited variability. For example, circulation associated with the global "conveyor" belt, including the Gulf Stream, provides for the relatively mild climate of northern Europe. Changes in such large-scale ocean circulation could significantly impact the habitability of this region in particular.

> <u>Performance Indicator</u>: Use diagnostic analysis of seasonal and interannual variability induced in the interior ocean based on Seawinds high-resolution ocean winds to evaluate improvements in climate and marine weather forecasting. (Ocean Surface Vector Winds Science Team http://winds.jpl.nasa.gov).

> <u>Performance Indicator</u>: Use near decade-long sea surface topography and in situ upper-ocean temperature profile measurement time series to develop a high resolution Pacific Ocean model to elucidate the mechanisms of the Pacific Decadal Oscillation and its impact on seasonal/decadal climate variations [http://decvar.org].

> <u>Performance Indicator</u>: Utilize space-based Ocean Topography time series, in situ observations of the World Climate Research Program, and assimilation of these data into ocean models to ascertain whether detectable changes in the deep ocean have occurred over the last decade.

Annual Performance Goal (3Y13). Increase understanding of stratospheric trace constituents and how they respond to change in climate and atmospheric composition.

Stratospheric composition, most importantly amounts of UV-absorbing ozone, responds to concentrations of chemically active trace gases and underlying meteorological conditions, such as temperature and wind distributions. Changing atmospheric conditions associated with global chemical change (and associated global warming) have the potential to affect the stratosphere, which can in turn affect fluxes of biologically damaging UV radiation at the Earth's surface.

> <u>Performance Indicator</u>: Utilize combined data sets from ground-based, sub-orbital, and space-based measurements to assess the possible impact of the increased abundances of greenhouse gases on the future evolution of Northern Hemisphere high latitude ozone concentrations. This will include extended analysis of data from the SAGE III Ozone Loss and Validation Experiment (SOLVE).

> <u>Performance Indicator</u>: Quantify the relationship between wintertime tropospheric wave energy and late winter temperatures in the Arctic lower stratosphere in order to analyze the effects of changing tropospheric weather patterns on Arctic ozone chemistry.

Annual Performance Goal (3Y14). Increase understanding of global sea level and how it is affected by climate change.

The polar ice sheets are a repository for about 75% of the Earth's fresh water and a reduction in their combined mass of just 1% would increase sea level by about 90 cm. Of the order of 100 million people would be at direct risk from a sea level rise of this magnitude (Intergovernmental Panel on Climate Change (IPCC), 1995) and many more would be indirectly affected through economic and other impacts. It is therefore important to establish whether the ice sheets have the potential, under climate change scenarios, to exhibit major changes in mass balance and if so, what the expected time-scale for such changes would be.

> Performance Indicator: Compare remotely sensed discharge fluxes of ten outlet glaciers in Antarctica to estimates based on balance velocities to determine the basin mass balance, which will provide an assessment of how major outlet glaciers contribute to sea level rise.

> Performance Indicator: Initiate development of improved models of outlet glacier flow characteristics that will assess nature of discharge and sensitivity to climate changes, which will improve prediction capabilities of sea level rise from ice sheet dynamics.

Annual Performance Goal (3Y15). Increase understanding of the effects of regional pollution on the global atmosphere, and the effects of global chemical and climate changes on regional air quality by meeting at least 4 of 5 performance indicators.

There is significant evidence that pollutant gases can be transported over very long distances (e.g., across the Pacific or Atlantic oceans). The global effects of atmospheric pollution (on agriculture, materials, human health, etc.) are poorly known due to inexact characterization of tropospheric transport, physics, and chemistry.

> Performance Indicator: Continue and extend the four-year data record of tropical ozone soundings in order to establish a climatology (i.e. the natural pattern/cycle of ozone) of the high-resolution vertical distribution of ozone (i.e. the concentration at each altitude) in the tropics, leading to improved retrievals of tropospheric ozone concentrations from space-based measurements.

> Performance Indicator: Characterize the atmospheric plume from East Asia and assess its contribution to regional and global atmospheric chemical composition by completing the archival of the Transport of Chemical Evolution over the Pacific (TRACE-P) airborne mission and associated data sets, which will improve the assessment of intercontinental transport of pollution.

> Performance Indicator: Update the estimate of the tropospheric distributions and possible trends of hydroxyl (OH) radicals and examine the consistency between different model types (i.e. inverse and

assimilation) in determining global OH fields using multiple data sets, which will allow assessment of the atmosphere's capacity for self-cleansing.

Performance Indicator: Continue development and testing of a coupled aerosol-chemistry-climate general circulation model to project future changes in atmospheric composition over the 21st century. This model, which will include first-time parameterization of tropospheric aerosol chemistry, will help to diagnose the climatic consequences of these emissions and the associated feedbacks on atmospheric composition.

Performance Indicator: Improve estimates of the stratospheric contribution to tropospheric ozone through chemical transport models. The stratosphere-troposphere exchange included in these model calculations will be examined for its sensitivity to global warming.

Objective: Identify the consequences of change in the Earth system for human civilization.

Annual Performance Goal (3Y16). Increase understanding of variations in local weather, precipitation, and water resources and how they relate to global climate variation.

This activity establishes a basis for determining what changes will be induced by climate trends in the frequency, strength, and path of weather systems, which produce clouds and rain which replenish fresh water supplies.

The last set of indicators and associated progress was presented in the FY 2002 performance plan. We did not develop specific indicators for FY 2003. An assessment of progress toward answering this question will be published in the FY 2003 report.

Annual Performance Goal (3Y17) Increase understanding of the consequence of land cover and land use change for the sustainability of ecosystems and economic productivity.

Today, land cover, and land use changes are primarily due to human activities, and are most prevalent where human populations are large; thus the consequences of land cover and land use change impact our daily lives and the potential sustainability of food production, natural resource use, and environmental quality. Consequences of concern include changes in carbon sources and sinks; the loss of biodiversity; inputs of sediments, nutrients, and pollutants to coastal regions; land degradation, and increased risks to human health.

The last set of indicators and associated progress was presented in the FY 2002 performance plan. We did not develop specific indicators for FY 2003. An assessment of progress toward answering this question will be published in the FY 2003 report.

Annual Performance Goal (3Y18). Increase understanding of the consequences of climate and sea level changes and increased human activities on coastal regions.

The consequences of global environmental change are often seen in the coastal zone. Human populations are concentrated near coastlines, and there are severe impacts on coastal communities from pollution, excess nutrients, storm-surge, and sea-level rise. It will be important to understand the relative contributions of each of these factors to the overall changes in coastal regions, and especially, their effect on the resident human communities.

The last set of indicators and associated progress was presented in the FY 2002 performance plan. We did not develop specific indicators for FY 2003. An assessment of progress toward answering this question will be published in the FY 2003 report.

Objective: Enable the prediction of future changes in the Earth system.

Annual Performance Goal (3Y19). Increase understanding of the extent that weather forecast duration and reliability can be improved by new space-based observations, data assimilation, and modeling.

This activity contributes to improving the accuracy of short-term weather predictions and increasing the period of validity of long-range forecasts that are used by government, business, and individuals to protect lives and property and make investment decisions.

The last set of indicators and associated progress was presented in the FY 2002 performance plan. We did not develop specific indicators for FY 2003. An assessment of progress toward answering this question will be published in the FY 2003 report.

Annual Performance Goal (3Y20). Increase understanding of the extent that transient climate variations can be understood and predicted

This activity contributes to the ability to predict global and regional climate on seasonal-to-interannual time scales with sufficient accuracy for concerned socioeconomic interests to estimate the likely impact of climate variations, such as those associated wit EL Niño /La Nina, and to issue warnings and make appropriate contingency plans. NASA will endeavor to transition the results of this research to those public agencies that have operational planning and warning responsibilities. In addition, NASA will also make the results available to concerned interests in the private sector.

The last set of indicators and associated progress was presented in the FY 2002 performance plan. We did not develop specific indicators for FY 2003. An assessment of progress toward answering this question will be published in the FY 2003 report.

Annual Performance Goal (3Y21). Increase understanding of the extent that long-term climate trends can be assessed or predicted.

This activity will provide information needed to determine policies for possible mitigation of, or adaptation to, climate change. Specifically, it will provide information on the causes of recent and current climate changes as well as the expected magnitude and causes of future climate trends including the nature of regional climate changes. An integral part of this research is an assessment of the reliability of climate predictions and how alternative assumptions and policies affect them.

> The last set of indicators and associated progress was presented in the FY 2002 performance plan. We did not develop specific indicators for FY 2003. An assessment of progress toward answering this question will be published in the FY 2003 report.

Annual Performance Goal (3Y22). Increase understanding of the extent that future atmospheric chemical impacts on ozone and climate can be predicted by meeting at least 2 of 3 performance indicators.

A sound scientific basis is essential for informed decision making at the national and international level on environmental issues that underlie human health and well being as well as the health of the numerous ecosystems. Only through the integration of science and policy, as occurred effectively through the assessment process (for example the various assessment panels associated with the Montreal Protocol), can the sustainable development of our Nation be insured.

> Performance Indicator: Analyze the measured trends in atmospheric trace gas concentrations using updated data sets and compare the results with those estimated from industrial production and emission data. The analysis will be used to assess the completeness of our understanding of the atmospheric persistence and degradation of industrial chemicals as well as to examine the efficiency of current regulatory agreements and international reporting on the production and emissions of regulated chemicals. Provide the results of such analyses for inclusion in the next international Assessments of Stratospheric Ozone Depletion.

> Performance Indicator: Perform laboratory studies designed to assess the atmospheric fate of industrial and naturally occurring chemicals by characterizing the key photochemical processes responsible for their atmospheric breakdown.

> Performance Indicator: Complete the implementation of the Global Modeling Initiative (GMI) to provide metrics, benchmarks, and controlled numerical experiments for model and algorithm simulations performance, which will allow the development of standards of model behavior for participation in national/international assessments.

Annual Performance Goal (3Y23). Increase understanding of the extent that future concentrations of carbon dioxide and methane and their impacts on climate can be predicted.

A sound scientific basis is essential for informed decision making at the national and international level on environmental issues that relate to the Earth's future climate and underlie human health and well being as well as the health of the numerous ecosystems. Only through the integration of science and policy, as occurred effectively through the assessment process (for example the various assessment panels associated with the Montreal Protocol), can the sustainable development of our Nation be insured.

The last set of indicators and associated progress was presented in the FY 2002 performance plan. We did not develop specific indicators for FY 2003. An assessment of progress toward answering this question will be published in the FY 2003 report.

Strategic Goal: Expand and accelerate the realization of economic and societal benefits from Earth science, information, & technology.

Scientific data must be transformed into information products useful to non-scientists in order for the economy and society to realize the full benefit of it. Our applications and education programs are designed to achieve this end through partnerships between NASA and professional information product providers and educators. The accomplishment of the identified performance indicators will enable the user community to accomplish their day-to-day decision-making in a more effective manner resulting in either cost savings, improved timeliness or quality, or to accomplish tasks that were not previously possible with conventional means. The accomplishment of the performance indicators will enable the U.S. taxpayer to reap the potential socio-economic benefits of NASA's investment in Earth science and technology.

Objective: Demonstrate scientific and technical capabilities to enable the development of practical tools for public and private sector decision-makers.

Annual Performance Goal (3Y24): Provide regional decision-makers with scientific and applications products and tools.

Increased application of and access to ESE science and technology results will enable the Nation to reap significant benefits in the areas of community growth and infrastructure, disaster management, environmental assessment, and resource management. The performance indicators are aimed at measuring: (a) the identification of the most significant needs in the federal, state, local, and tribal government community that can benefit from these results; (b) the development of new and advanced applications as well as related methods and practices in cooperation with the user community; and (c) the demonstration and distribution of these results to the targeted users. The accomplishment of the identified target indicators and related application activities will enable the user community to accomplish their day-to-day decision-making in a more effective and efficient manner resulting in either cost savings, improved timeliness or quality, or in an ability to accomplish tasks that were not previously possible with conventional means. The accomplishment of the performance indicators will enable the U.S. taxpayer to reap the potential socio-economic benefits of NASA's investment in Earth science and technology.

Performance Indicator: Identify at least 2 common information requirements that address the Applications Program's constituencies' user needs and develop plans that will address those requirements and successfully move applications in those areas toward operational use.

Performance Indicator: Verify and validate technology, algorithms, and scientific results in partnership with selected commercial partners. Fully verify and validate at least 2 demonstration products that meet program priorities.

Performance Indicator: Plan, implement and/or manage twenty demonstration projects by the end of FY 2003 in cooperation with state, local, and tribal decision-makers. The progress of each project towards full implementation and adoption by the end users will be measured systematically.

Objective: Stimulate public interest in and understanding of Earth system science and encourage young scholars to consider careers in science and technology.

Annual Performance Goal (3Y25): Share the excitement of NASA's scientific discoveries and the practical benefits of Earth science to the public in promoting understanding of science and technology in service to the society. Success will equate to meeting 3 of 4 performance indicators.

Increased public awareness and understanding of how the Earth functions as a system and increased literacy in Earth science and technology will result in attracting the next generation of scientists and engineering students to pursue their degrees in Earth system science. This will build capacity for productive use of Earth science information in resolving everyday practical problems.

Performance Indicator: Sponsor 2-3 leading undergraduate institutions to develop courses that enable pre-service science educators to become proficient in Earth system science and in using NASA remotely sensed observations in such curriculum.

Performance Indicator: Work with at least one professional organization to develop content guidelines for professional practice of Earth remote sensing and geospatial data.

Performance Indicator: Provide, in public venues, at least 2-3 stories per month that cover scientific discoveries, practical benefits or new technologies sponsored by NASA's Earth science program.

Performance Indicator: Continue to train a pool of highly qualified scientists and educators in Earth science and remote sensing by sponsoring approximately 140 graduate fellowships (approximately 1/3 each in their first, second and third year) and approximately 25-30 New Investigator awards per year to recent Ph.D. recipients.

Strategic Goal: Develop and adopt advanced technologies to enable mission success and serve national priorities.

New and less costly remote sensing capabilities are made possible by targeted investment in advanced technologies. These technologies will make possible the next generation of weather, climate, and Earth systems monitoring satellites. They will leverage advances in information technologies to make vast quantities of Earth science data useful and accessible to scientists, practitioners, and the public.

Objective: Develop advanced technologies to reduce the cost and expand the capability for scientific Earth observation.

Annual Performance Goal (3Y26): Successfully develop and infuse technologies that will enable future science measurements, and/or improve performance as well as reduce the cost of existing measurements. Increase the readiness of technologies under development, retiring risks, and advancing them to a maturity level where they can be infused into new missions with shorter development cycles. Success will equate to meeting 3 of 4 performance indicators.

New space-based technologies enable measurements that were not previously possible. Often, these measurements support new Earth-science research activities from the vantage point of space and enable monitoring that leads to early warnings to the public of natural hazards (ozone, fire, flood, earthquake, and volcano threats) or life threatening weather conditions. Alternatively, many new technologies reduce the cost of existing measurements while improving their quality. Predictive information can be generated for the public with more reliability, at lower cost, with delivery to users in a shorter period.

A key enabler for advanced technology infusion is space flight validation where the risk to the first uses is perceived to be high, but the payoff to science and applications is high. Consequently, space flight validation of breakthrough technologies to enable high priority future science measurement capabilities is an integral part of the technology infusion strategy.

Advanced information system capabilities will enable increased on-board autonomy for space-based assets, new levels of performance for ground-based analysis, and simulation of Earth-system processes towards making available such information to users in a timely and affordable fashion.

Performance Indicator: Annually advance 25% of funded technology developments by one Technology Readiness Level (TRL).

Performance Indicator: Annually mature at least three (3) technologies to the point where they can be validated in space or incorporated directly into a science and/or operational project(s).

Performance Indicator: Annually infuse at least one (1) technology development to a commercial entity; into a remote sensing or in-situ project; or into the ESE information systems infrastructure.

Performance Indicator: Annually establish at least one (1) joint agreement with a program external to NASA's ESE that results in the inclusion of at least one new ESE technology requirement.

Objective: Develop advanced information technologies for processing, archiving, accessing, visualizing, and communicating Earth science data.

Annual Performance Goal (3Y27): Develop hardware/software tools to demonstrate high-end computational modeling to further our understanding and ability to predict the dynamic interaction of physical, chemical, and biological processes affecting the earth. Success will equate to meeting 2 of 3 indicators.

Advanced computational capabilities support deployment of increasingly complex observation systems; higher quality, more refined characterization of Earth-system processes; accurate longer-range predictions of natural hazards and life threatening weather conditions; and near real-time delivery of data and information to users.

Performance Indicator: Successfully demonstrate networked high performance computer for Earth science modeling challenges.

Performance Indicator: Publish software libraries that enable climate models to scale to at least 512 nodes on a high performance computer cluster.

Performance Indicator: Demonstrate quasi-operational usage of a high performance computer with a throughput of at least 30 days/day of data assimilation.

Performance Indicator: Successfully demonstrate an increase in sustained high-end computing performance over the present level of 100 gigaflops. Additional scenarios of climate change simulations and the model sensitivities to the parameterizations can be assessed with the increased sustained performance.

Annual Performance Goal (3Y28): Develop baseline suite of multidisciplinary models and computational tools leading to scalable global climate simulations.

Performance Indicator: Successfully demonstrate up to three Earth science modeling codes interoperating on a functioning Modeling Framework early prototype. (A Modeling Framework means the existence of a consistent pre-defined interface between different model components. The model components are swappable and interchangeable between different models if these models follow the same framework design.)

Performance Indicator: Demonstrate a doubling of performance over FY 2002 in at least one (1) suite of multidisciplinary models or computational tool sets that support the Earth Science Research Strategy.

Objective: Partner with other domestic and international agencies to develop and implement better methods for using remotely sensed observations in Earth system monitoring and prediction.

The challenges of Earth System Science and its applications including sustainable development, and mitigation of risks to people, property, and the environment from natural disasters, require collaborative efforts among a broad range of domestic and international partners. This cooperation provides significant benefits to NASA's ESE through the pooling of financial resources, access to unique domestic and foreign capabilities including infrastructure and expertise, increases in mission flight opportunities and enhances the overall scientific return.

Annual Performance Goal (3Y29): Collaborate with other domestic and international agencies in developing and implementing better methods for using remotely sensed observations to support national and international assessments of climate changes and their practical consequences. Success will equate to meeting 4 of 5 performance indicators.

Performance Indicator: Continue collaborative relations with such Federal agencies as the U.S. Department of Transportation (DOT), the U.S. Department of Commerce (DOC), the Federal Aviation Administration (FAA), the U.S. Geological Survey (USGS), the U.S. Department of Agriculture (USDA) and the Environmental Protection Agency (EPA) to promote the use of remotely sensed data and information to accomplish U.S. strategic scientific, environmental and economic objectives.

Performance Indicator: Continue to identify and establish international cooperation with international agencies to promote the use of remotely sensed data and information to accomplish U.S. strategic scientific, environmental, and economic objectives.

Performance Indicator: Demonstrate enhanced interoperability and interconnectivity of international remote sensing information systems and services through NASA's participation in the Committee on Earth Observation Satellites (CEOS) Working Group on Information Systems and Services.

Performance Indicator: Demonstrate enhanced mission coordination and complementarity of remote sensing data through NASA's participation in the CEOS Working Group on Calibration and Validation.

Performance Indicator: Demonstrate the establishment of an agreed international approach to an integrated global observing strategy for the oceans and the terrestrial carbon cycle through participation in the Integrated Global Observing Strategy - Partners (IGOS-P).

Enterprise-Wide Activities that enable achievement of Earth Science strategic goals.

Annual Performance Goal (3Y30): Successfully develop one (1) spacecraft and have ready for launch. Operate instruments on orbiting spacecraft to enable Earth Science research and applications goals and objectives.

Performance Indicator: Successfully develop and have ready for launch at least one spacecraft.

Performance Indicator: At least 90% of the total on-orbit instrument complement will be operational during their design lifetime.

Annual Performance Goal (3Y31): Successfully disseminate Earth Science data to enable our science research and applications goals and objectives. Success will equate to meeting 4 of 5 performance indicators.

Performance Indicator: Make available ESE acquired data and information on Earth's atmosphere, land and/or oceans to users within 3-5 days of their request.

Performance Indicator: Increase by 20 - 30% the total volume of data acquired by and available from NASA for its research programs compared to FY 2002. (This equates to a maximum of 1170 terabytes)

Performance Indicator: Maintain satisfactory support for the number of distinct NASA ESE data and information center customers compared to FY 2002. (This equates to 2,019,600 users).

Performance Indicator: Enable production of and distribute scientifically valid data sets from the Aqua mission.

Performance Indicator: User Satisfaction: Maintain or improve the overall level of ESE data center customer satisfaction as measured by User Working Group surveys.

Annual Performance Goal (3Y32): Safely operate airborne platforms to gather remote and *in situ* earth science data for process and calibration/validation studies.

Performance Indicator: Support and execute seasonally dependent coordinated research field campaigns within two-weeks of target departure with the aid of airborne and sub-orbital platforms, as scheduled at the beginning of the fiscal year.

Verification and Validation

While performance indicators are noted in order to demonstrate significant scientific progress toward the annual performance goal, the ESE will also rely on external expert review. The Earth System Science and Applications Advisory Committee (ESSAAC) of the NASA Advisory Council will conduct an annual assessment of the ESE near-term science objectives. It will provide a qualitative progress measurement (Green, Yellow, or Red). "Green" will indicate that the objective was met; "Yellow" will indicate a concern that an objective was not fully accomplished; and "Red" will indicate that events occurred that prevented or severely impaired the accomplishment of the objective. The assessment will include commentary to clarify and supplement the qualitative measures.

The ESSAAC is a committee of the NASA Advisory Council under the Federal Advisory Committee Act, and comprises outside scientific and technical experts from academia, industry and other government agencies. ESSAAC meets at least twice a year to review plans and progress in the ESE. After the end of each fiscal year, the ESE will provide to ESSAAC a self-assessment in each of the relevant objectives, highlighting performance against the metrics in the Performance Plan for that year. ESSAAC will deliberate internally and render its own assessment, which may confirm or modify the ESE self-assessment. The ESSAAC assessment will be reported in the Performance Report for that year. This process will be repeated annually.

The ESE will regularly review performance objectives as part of an existing monthly review process. Tracking current performance on a monthly basis for each specific FY 2003 annual performance goal enables the ESE to institute measures to ensure improvement and progress toward meeting its strategic goals.

MULTI-YEAR PERFORMANCE TREND

Earth Science

***New objectives were developed in FY 2002. The APGs can be mapped to the following new objectives:**
- **Objective (1A): Discern and describe how the Earth is changing.**
- **Objective (1B): Identify and measure the primary causes of change in the Earth system.**
- **Objective (1C): Determine how the Earth system responds to natural and human-induced changes**
- **Objective (1D): Identify the consequences of change in the Earth system for human civilization.**
- **Objective (IE): Enable the prediction of future changes in the Earth system.**

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

	FY 99	FY 00	FY01
Annual Performance Goal and APG #	Collect near-daily measurements of ocean color (index of ocean productivity from which calculations of ocean update of carbon are made). (Y3). Refresh the global archive of 30m land imagery from Landsat 7, two to three times per year. A single global archive has not been constructed since late 1970's. This will include a 15m panchromatic band (Y1). 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 TERRA (Y2).	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 (0Y4). Continue the ocean color time series with 60% global coverage every 4 days (0Y3). Continue the development of a global land-cover/use change data set based on Landsat and EOS instrument, at seasonal refresh rate (0Y1). 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 TERRA (0Y2). 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 (0Y7).	Increase understanding of the dynamics of the global carbon cycle by developing, analyzing and documenting multi-year data sets and meeting at least 3 of 4 performance indicators in this research area (1Y3). Explain the dynamics of global carbon cycle by building improved models and prediction capabilities and meeting 2 of 2 performance indicators in this research area (1Y4).
APG Assessment	Yellow	0Y4 was yellow. 0Y3, 0Y1, 0Y2, and 0Y7 were green.	TBD

Strategic Objective: Understand the causes and consequences of land-cover/land-use change (continued)

	FY 02	FY 03	FY 03 Cont'd
Annual Performance Goal and APG #	Increase understanding of global ecosystem change by meeting at least 3 of 4 performance indicators (2Y3). Increase understanding about the changes in global land cover and land use and their causes by meeting at least 2 of 3 performance indicators (2Y8). Increase understanding of how ecosystems respond to and affect global environmental change and affect the global carbon cycle by meeting at least 4 of 5 performance indicators (2Y11). Increase understanding of the consequence of land cover and land use change for the sustainability of ecosystems and economic productivity by meeting at least 2 of 3 performance indicators (2Y17). Increase understanding of the consequences of climate and sea level changes and increased human activities on coastal regions by meeting 2 of 2 performance indicators (2Y18).	Increase understanding of global ecosystems change. Next set of indicators to measure progress toward answering this question will be given in the FY04 plan. Last set of indicators and associated progress was presented in FY02 performance plan. An assessment of progress toward answering this question will be published FY03 report. (3Y3). Increase understanding about the changes in global land cover and land use and their causes. Next set of indicators to measure progress toward answering this question will be given in the FY04 plan. Last set of indicators and associated progress was presented in FY02 performance plan. An assessment of progress toward answering this question will be published in the FY03 report. (3Y8). Increase understanding of how ecosystems respond to and affect global environmental change and affect the global carbon cycle. Next set of indicators to measure progress toward answering this question will be given in the FY04 plan. Last set of indicators and associated progress was presented in FY02 performance plan. An assessment of progress toward answering this question will be published in the FY03 report. (3Y11). Increase understanding of the consequence of land cover and land use change for the sustainability of ecosystems and economic productivity. Next set of indicators to measure progress toward answering this question will be given in the FY04 plan. Last set of indicators and associated progress was presented in FY02 performance plan. An assessment of progress toward answering this question will be published in the FY03 report. (3Y17).	Increase understanding of the consequences of climate and sea level changes and increased human activities on coastal regions. Next set of indicators to measure progress toward answering this question will be given in the FY04 plan. Last set of indicators and associated progress was presented in FY02 performance plan. An assessment of progress toward answering this question will be published in the FY03 report. (3Y18).
APG Assessment	TBD	TBD	TBD

Strategic Objective: Understand the causes and consequences of land-cover/land-use change (continued)

	FY 02	**FY 03**	
Annual Performance Goal and APG #			
APG Assessment	TBD		

***New objectives have been developed for FY 2002. The APGs can be mapped to the following new objectives:**

Objective (1A): Discern and describe how the Earth is changing.

Objective (1B): Identify and measure the primary causes of change in the Earth system.

Objective (1C): Determine how the Earth system responds to natural and human-induced changes

Objective (1D): Identify the consequences of change in the Earth system for human civilization.

Objective (IE): Enable the prediction of future changes in the Earth system.

Strategic Objective: Objective: Predict seasonal-to-interannual climate variations

	FY 99	FY 00	FY01
Annual Performance Goal and APG #	TRMM will begin the second of a 3-year sequence of instantaneous measurements of rainfall rates and monthly accumulations in the global tropics. This will be the first measurement of global tropical rainfall. Current uncertainty is 50 percent. TRMM data will reduce uncertainty to 10 percent. (Y4). QuikScat to provide 25km resolution wind speed & direction measurements over at least 90% of the ice-free oceans every two days. Resolution increases by a factor of two, and a 15% increase of coverage over previous measurement (Y5).	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 (0Y9). 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 Nino or La Nina occurrence in the tropical Pacific. Results of research will be published in the 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 for seasonal-to-interannual climate variations and their regional climate consequences. The main focus is on North America (0Y10).	Increase understanding of the dynamics of global water cycle by developing, analyzing, and documenting multi-year data sets and meeting 2 of 2 performance indicators in this research area. (1Y5). Explain the dynamics of global water cycle by building improved models and prediction capabilities and meeting at least 2 of 3 performance indicators in this research area (1Y6).
APG Assessment		Green	TBD

Strategic Objective: Objective: Predict seasonal-to-interannual climate variations (continued)

	FY 02	FY 03	FY 03 Cont'd
Annual Performance Goal and APG #	Increase understanding of global precipitation, evaporation and how the cycling of water is changing by meeting at least 3 of 4 performance indicators (2Y1). Increase understanding of global ocean circulation and how it varies on interannual, decadal, and longer time scales by meeting 2 of 2 performance indicators (2Y2). Increase understanding of how climate variations induce changes in the global ocean circulation by meeting at least 4 of 6 performance indicators (2Y12) Increase understanding of variations in local weather, precipitation and water resources and how they relate to global climate variation by meeting 2 of 2 performance indicators (2Y16) Increase understanding of the extent that weather forecast duration and reliability can be improved by new space-based observations, data assimilation and modeling by meeting at least 2 of 3 performance indicators (2Y19). Increase understanding of the extent that transient climate variations can be understood and predicted by meeting at least 4 of 5 performance indicators (2Y20).	Increase understanding of global precipitation, evaporation and how the cycling of water through the earth system is changing. Next set of indicators to measure progress toward answering this question will be given in the FY04 plan. Last set of indicators and associated progress was presented in FY02 performance plan. An assessment of progress toward answering this question will be published in the FY03 report. (3Y1). Increase understanding of global ocean circulation and how it varies on interannual, decadal, and longer time scales.(3Y2). Increase understanding of how climate variations induce changes in the global ocean circulation by meeting at least 2 of 3 performance indicators (3Y12) Increase understanding of variations in local weather, precipitation and water resources and how they relate to global climate variation. Next set of indicators to measure progress toward answering this question will be given in the FY04 plan. Last set of indicators and associated progress was presented in FY02 performance plan. An assessment of progress toward answering this question will be published in the FY03 report. (3Y16) Increase understanding of the extent that weather forecast duration and reliability can be improved by new space-based observations, data assimilation and modeling. Next set of indicators to measure progress toward answering this question will be given in the FY05 plan. Last set of indicators and associated progress was presented in FY02 performance plan. An assessment of progress toward answering this question will be published in the FY03 report. (3Y19)	Increase understanding of the extent that transient climate variations can be understood and predicted. Next set of indicators to measure progress toward answering this question will be given in the FY05 plan. Last set of indicators and associated progress was presented in FY02 performance plan. An assessment of progress toward answering this question will be published in the FY03 report. (3Y20).
APG Assessment	TBD	TBD	

<u>Strategic Objective</u>: Objective: Predict seasonal-to-interannual climate variations (continued)

	FY 99	**FY 00**	**FY01**
Annual Performance Goal and APG #		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 (0Y11). Launch the NASA-CNES Jason-1 mission. This follow-on to TOPEX/ Poseidon is to achieve a factor-of-four improvement in accuracy in measuring ocean basin-scale sea-level variability. This is 1 order of magnitude better than that specified for TOPEX/Poseidon. (0Y12). Generate the first basin-scale high-resolution estimate of the state of the Pacific Ocean as part of the international Global Ocean Data Assimilation Experiment (GODAE) (0Y47).	
APG Assessment	Blue, green, yellow or red	0Y11 was green. 0Y12 was yellow 0Y47 was green.	

	FY 02	**FY 03**	
Annual Performance Goal and APG #			
APG Assessment	TBD	TBD	

***New objectives have been developed for FY 2002. The APGs can be mapped to the following new objectives:**

Objective (1A): Discern and describe how the Earth is changing.

Objective (1B): Identify and measure the primary causes of change in the Earth system.

Objective (1C): Determine how the Earth system responds to natural and human-induced changes

Objective (1D): Identify the consequences of change in the Earth system for human civilization.

Objective (IE): Enable the prediction of future changes in the Earth system.

<u>Strategic Objective</u>: Identify natural hazards, processes, and mitigation strategies

	FY 99	FY 00	FY01
Annual Performance Goal and APG #	The Enterprise will provide the technology and instruments to create the first digital topographic map of 8o percent of Earth's land surface, everything between 60°N and 56°S. SRTM will be ready to launch in September 1999. (Y6). Use GPS array in southern California to monitor crustal deformation on a daily basis with centimeter precision; initiate installation of the next 100 stations. Data will be archived at JPL and run in models, with results given to the California Seismic Safety Commission and FEMA. (Y7). Use GPS data to test improved algorithms for sounding the atmosphere with the occulted GPS signal. Data will be archived at JPL and results published in science literature. (Y8).	Use Southern California Global Positioning System (GPS) array data to understand the connection between seismic risk and crustal strain leading to Earthquakes (0Y37). Develop models to use time-varying gravity observations for the first time in space (0Y38). Demonstrate the utility of spaceborne data for floodplain mapping with the Federal Emergency Management Agency (0Y39). Develop an automatic volcano cloud/ash detection algorithm employing EOS data sets for use by the Federal Aviation Administration (0Y40).	Increase understanding of the dynamics of the Earth's interior and crust by developing, analyzing, and documenting multi-year data sets and meeting 2 of 2 performance indicators in this research area (1Y11). Explain the dynamics of the Earth's interior and crust by building improved models and prediction capabilities and meeting 2 of 2 performance indicators in this research area (1Y12).
APG Assessment	Green	Green	TBD

<u>Strategic Objective</u>: Identify natural hazards, processes, and mitigation strategies (continued)

	FY 02	**FY 03**	
Annual Performance Goal and APG #	Increase understanding of the motions of the Earth, the Earth's interior, and what information can be inferred about the Earth's internal processes by meeting at least 3 of 4 performance indicators (2Y6). Increase understanding of the Earth's surface and how it is transformed and how such information can be used to predict future changes by meeting at least 4 of 5 performance indicators (2Y9).	Increase understanding of the motions of the Earth, the Earth's interior, and what information can be inferred about the Earth's internal processes. Next set of indicators to measure progress toward answering this question will be given in the FY05 plan. Last set of indicators and associated progress was presented in FY02 performance plan. An assessment of progress toward answering this question will be published in the FY03 report. (3Y6). Increase understanding of the Earth's surface and how it is transformed and how such information can be used to predict future changes. Next set of indicators to measure progress toward answering this question will be given in the FY05 plan. Last set of indicators and associated progress was presented in FY02 performance plan. An assessment of progress toward answering this question will be published in the FY03 report. (3Y9).	
APG Assessment	TBD	TBD	

***New objectives have been developed for FY 2002. The APGS can be mapped to the following new objectives:**

Objective (1A): Discern and describe how the Earth is changing.
Objective (1B): Identify and measure the primary causes of change in the Earth system.
Objective (1C): Determine how the Earth system responds to natural and human-induced changes
Objective (1D): Identify the consequences of change in the Earth system for human civilization.
Objective (IE): Enable the prediction of future changes in the Earth system.

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

	FY 99	FY 00	FY01
Annual Performance Goal and APG #	MODIS, MISR, ASTER, CERES (TERRA instruments) will begin to conduct daily observations of cloud properties such as extent, height, optical thickness and particle size. Data will be distributed through the Goddard DAAC (Y9). TERRA will map aerosol formation, distribution and sinks over the land and oceans (Y10). The TERRA instrument will achieve a 40-percent reduction in the uncertainty in Earth's radiation balance (that is improved angular models leading to an estimated error reduction in regional-scale monthly average net radiation of about 50 percent. (Y11).	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 (0Y13). 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 (0Y14). Provide for the continuation of the long-term, precise measurement of the total solar irradiance with the launch of EOS ACRIM (0Y15). Acquire, through a Radarsat repeat of Antarctic Mapping Mission conducted in Sept.-Oct. 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 (0Y16). 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) (OY17).	Increase understanding of the dynamics of long term climate variability by developing, analyzing, and documenting multi-year data sets and meeting at least 2 of 3 performance indicators in this research area (1Y7). Explain the dynamics of long term climate variability by building improved models and prediction capabilities and meeting at least 3 of 4 performance indicators in this research (1Y8).
APG Assessment	Yellow	All were green	TBD

Strategic Objective: Detect long-term climate change, causes, and impacts (continued)

	FY 02	FY 03	
Annual Performance Goal and APG #	Increase understanding of change occurring in the mass of the Earth's ice cover by meeting at least 3 of 4 performance indicators (2Y5). Increase understanding of the effects of clouds and surface hydrologic processes on climate change by meeting at least 4 of 5 performance indicators (2Y10). Increase understanding of global sea level and how it is affected by climate change by meeting at least 2 of 3 performance indicators (2Y14). Increase understanding of the extent that long-term climate trends can be assessed or predicted by meeting at least 4 of 5 performance indicators (2Y21).	Increase understanding of change occurring in the mass of the Earth's ice cover by meeting at least 3 of 4 performance indicators (3Y5). Increase understanding of the effects of clouds and surface hydrologic processes on climate change. Next set of indicators to measure progress toward answering this question will be given in the FY04 plan. Last set of indicators and associated progress was presented in FY02 performance plan. An assessment of progress toward answering this question will be published in the FY03 report. (3Y10). Increase understanding of global sea level and how it is affected by climate change. (3Y14). Increase understanding of the extent that long-term climate trends can be assessed or predicted. Next set of indicators to measure progress toward answering this question will be given in the FY05 plan. Last set of indicators and associated progress was presented in FY02 performance plan. An assessment of progress toward answering this question will be published in the FY03 report. (3Y21). Increase understanding of extent that future concentrations of carbon dioxide and methane and impacts on climate can be predicted. Next set of indicators to measure progress toward answering this question will be given in the FY05 plan. Last set of indicators and associated progress was presented in FY02 performance plan. An assessment of progress toward answering this question will be published in the FY03 report. (3Y23)	
APG Assessment	TBD	TBD	

<u>Strategic Objective</u>: Detect long-term climate change, causes, and impacts (continued)

	FY 99	**FY 00**	**FY01**
Annual Performance Goal and APG #		Initiate a program of airborne mapping of layers within the Greenland ice sheet to decipher the impact of past climate variation of polar regions (0Y18). Develop a remote-sensing instrument/technique for ocean surface salinity measurements from aircraft. Goal: to improve measurement accuracy to ` order of magnitude better than available in FY98. The ultimate goal is the capability to globally measure sea surface salinity from space (0Y19). Continue to improve the design and sophistication of a global climate system model, including use of higher 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 (0Y20).	
APG Assessment	Blue, green, yellow or red	All were green	

	FY 02	**FY 03**	
Annual Performance Goal and APG #			
APG Assessment			

<u>*New objectives have been developed for FY 2002. The APGs can be mapped to the following new objectives:</u>

Objective (1A): Discern and describe how the Earth is changing.
Objective (1B): Identify and measure the primary causes of change in the Earth system.
Objective (1C): Determine how the Earth system responds to natural and human-induced changes
Objective (1D): Identify the consequences of change in the Earth system for human civilization.
Objective (IE): Enable the prediction of future changes in the Earth system.

<u>Strategic Objective</u>: Understand the causes of variation in atmospheric ozone concentration and distribution.

	FY 99	FY 00	FY01
Annual Performance Goal and APG #	TOMS data will be used for new retrieval methods to collect and analyze three new data products, including surface ultraviolet, tropospheric aerosols, and tropospheric columns. With SBUV/2 data, TOMS will make a continuous 20-year data set for total ozone-measuring effectiveness of Montreal Protocol. New and extended data products will be made available on TOMS web site. (Y12). Complete initiation of the full Southern Hemisphere Additional Ozonesonde network to obtain the first-ever climatology of upper tropospheric ozone in the tropics (Y14). With data from other atmospheric ozone programs, 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 unpolluted areas. Complete the field measurements 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). Results will be fully analyzed and published. (Y15).	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 (0Y22). (Green) Complete the analysis and publication of the PEM-Tropics-B field experiment (0Y23). (Green) Complete the Troposphere Chemistry aircraft instrument size and weight reductions (by ~40%) initiative (0Y24). (Green) Complete the planning for major new 2001 airborne/unmanned aerospace vehicle mission that will use a smaller Troposphere Chemistry aircraft instrument (0Y25).	Increase understanding of the dynamics of atmospheric composition by developing, analyzing, and documenting multi-year data sets and meeting at least 4 of 5 performance indicators in this research area (1Y9). Explain the dynamics of atmospheric chemistry by building improved models and prediction capabilities and meeting at least 2 of 3 performance indicators in this research area (1Y10).
APG Assessment	Yellow	All were green.	TBD

Strategic Objective: **Understand the causes of variation in atmospheric ozone concentration and distribution (continued)**

	FY 02	FY 03	FY04
Annual Performance Goal and APG #	Increase understanding of stratospheric ozone changes, as the abundance of ozone-destroying chemicals decreases and new substitutes increases by meeting 2 of 2 performance indicators (2Y4). Increase understanding of trends in atmospheric constituents and solar radiation and the role they play in driving global climate by meeting at least 3 of 4 performance indicators (2Y7). Increase understanding of stratospheric trace constituents and how respond to change in climate and atmospheric composition by meeting 2 of 2 performance indicators (2Y13). Increase understanding of the effects of regional pollution on the global atmosphere, and the effects of global chemical and climate changes on regional air quality by meeting at least 4 of 5 performance indicators (2Y15). Increase understanding of the extent that future atmospheric chemical impacts on ozone and climate can be predicted by meeting at least 2 of 3 performance indicators (2Y22).	Increase understanding of stratospheric ozone changes, as the abundance of ozone-destroying chemicals decreases and new substitutes increases by meeting 2 of 2 performance indicators (3Y4). Increase understanding of trends in atmospheric constituents and solar radiation and the role they play in driving global climate by meeting at least 4 of 5 performance indicators (3Y7). Increase understanding of stratospheric trace constituents and how respond to change in climate and atmospheric composition by. (3Y13). Increase understanding of the effects of regional pollution on the global atmosphere, and the effects of global chemical and climate changes on regional air quality by meeting at least 4 of 5 performance indicators (3Y15). Increase understanding of the extent that future atmospheric chemical impacts on ozone and climate can be predicted by meeting at least 2 of 3 performance indicators (3Y22).	
APG Assessment	TBD	TBD	

Strategic Objective: Understand the causes of variation in atmospheric ozone concentration and distribution (continued)

	FY 99	FY 00	FY01
Annual Performance Goal and APG #	Use SAGE III to improve the collection and analysis of measurements provided by SAGE II, and add: nitrogen trioxide and chlorine dioxide measures; additional wavelength sampling to directly measure and retrieve aerosols throughout the troposphere; and, higher spectral resolution (Y13). With data from other atmospheric ozone programs, measure surface levels of chlorine-and bromine-containing chemical compounds addressed in the Montreal Protocol to document decreasing concentrations of regulated compounds and increasing concentrations of replacement compounds. Analyses will be provided to researchers supporting the WMO assessment process. (Y16). APGs Y13 and Y16 are linked to FY00-FY03 APGs (see previous pages).		
APG Assessment	Yellow		

	FY 02	FY 03	FY04
Annual Performance Goal and APG #			
APG Assessment			

FY 2002-2003 Enterprise-Wide Supporting Activities/FY 99-01 Objective: Successfully launch spacecraft

	FY 99	FY 00	FY01
Annual Performance Goal and APG #	The Enterprise will successfully launch three spacecraft within 10% of budget on average (Y35).	Launch three spacecraft and deliver two instruments for international launches within 10% of budget on average (0Y36).	Successfully develop, have ready for launch, and operate instruments on a least two spacecraft within 10 percent of their schedules and budget to enable Earth Science research and applications goals and objectives (1Y1).
APG Assessment	Yellow	Green	TBD

	FY 02	FY 03	FY 04
Annual Performance Goal and APG #	Successfully develop, have ready for launch, and operate instruments on at least two spacecraft to enable Earth Science research and applications goals and objectives (2Y29).	Successfully develop one spacecraft and have ready for launch. Operate instruments on orbiting spacecraft to enable Earth Science research and applications goals and objectives. (3Y30).	
APG Assessment	TBD	TBD	

FY 2002-2003 Enterprise-Wide Supporting Activities/FY 99-01 Objective: Implement open, distributed, and responsive data system architectures

	FY 99	**FY 00**	**FY01**
Annual Performance Goal and APG #	Make available data on prediction, land surface, and climate to users within 5 days (Y17). Increase the volume of data archived by 10% compared to FY97 (target = 139 terabytes). Goddard has been collecting trend data since FY94. (Y18). Increase the number of distinct customers by 20% compared to FY97 (target = 839,000). Goddard has been collecting trend data since FY94 (Y19). Increase products delivered from the DAACs by 10% compared to FY97 (target = 3.8 million). Goddard has been collecting trend data since FY94 (Y20).	EOSDIS make available data on prediction, land surface, and climate to users within five days (0Y26). EOSDIS will double the volume of data archived compared to FY98 (0Y27). EOSDIS will increase the number of distinct customers by 20% compared to FY98 (0Y28). EOSDIS will increase products delivered from the DAACs by 10% compared to FY98 (0Y29).	Successfully disseminate Earth Science data to enable our science research and applications goals and objectives by meeting all performance indicators in this research area (1Y2).
APG Assessment	Blue	All were blue.	TBD

	FY 02	**FY 03**	**FY 04**
Annual Performance Goal and APG #	Successfully disseminate Earth Science data to enable our science research and applications goals and objectives. Success will equate to meeting 4 of 5 performance indicators (2Y30). Safely operate airborne platforms to gather remote and in situ earth science data for process and calibration/validation studies (2Y31).	Successfully disseminate Earth Science data to enable our science research and applications goals and objectives. Success will equate to meeting 4 of 5 performance indicators (3Y31). Safely operate airborne platforms to gather remote and in situ earth science data for process and calibration/validation studies (3Y32).	
APG Assessment	TBD	TBD	

Strategic Objective: Stimulate public interest in and understanding of Earth system science and courage young scholars to consider careers in science and technology/FY 99-01 Objective: Increase public understanding of Earth system science through education and outreach.

	FY 99	FY 00	FY01
Annual Performance Goal and APG #	Award 50 new graduate student research grants and 20 early career postdoctoral fellowships in Earth Science. (Y21). Conduct over 300 teacher workshops to train teachers in use of Earth Science Enterprise education products (Y22). Increase number of schools participating in GLOBE from to 8,000, from 5,900 in FY98, a 35-percent increase; increase participating countries from 70 in FY98 to 72 (Y23).	Award 50 new graduate student research grants and 20 early career fellowships in Earth Science (0Y30). Conduct at least 300 workshops to train teachers in use of ESE education products (0Y31). Increase number of schools participating in GLOBE to 10,500, a 30% increase over FY99; increase participating countries to 77 (from 72). (0Y32).	Increase public understanding of Earth system science through formal and informal education by meeting at least 3 of 4 performance targets in this area (1Y18).
APG Assessment	Green	0Y30 was green. 0Y31 was blue. 0Y32 was yellow.	TBD

	FY 02	FY 03	FY 04
Annual Performance Goal and APG #	Share NASA's discoveries in Earth science with the public to enhance understanding of science and technology (2Y24).	Share the excitement of NASA's scientific discoveries and the practical benefits of earth science to the public in promoting understanding of science and technology in service to society. Success will equate to meeting 3 of 4 performance targets. (3Y25).	
APG Assessment	TBD	TBD	

Strategic Objective: Develop advanced technologies to reduce the cost and expand the capability for scientific Earth observation/FY 99-01 Objective: Develop and transfer advanced remote-sensing technologies.

	FY 99	FY 00	FY01
Annual Performance Goal and APG #	Annually advance at least 25% of funded instrument technology developments one TRL (Y30). Demonstrate a new capability to double the calibration quality for moderate-resolution land imagery. (Y28). Annually transfer at least one technology development to a commercial entity for operational use (Y29).	Advance at least 25% of funded instrument technology development one TRL to enable future science missions and reduce their total cost (0Y35). Achieve a 50% reduction in mass for future land imaging instruments (0Y33). Transfer at least one technology development to a commercial entity for operational use (0Y34).	Achieve success with timely development and infusion of technologies. Enable future science missions by increasing technology readiness for mission concepts to reduce their total cost. Do this by meeting at least 3 of 4 performance indicators for this advanced technology area (1Y13).
APG Assessment	Green	0Y35 was blue 0Y33 and 0Y34 were green	TBD

	FY 02	FY 03	FY 04
Annual Performance Goal and APG #	Successfully develop and infuse technologies that will enable future science measurements, and/or improve performance and reduce the cost of existing measurements. Increase the readiness of technologies under development, advancing them to a maturity level where they can be infused into new missions with shorter development cycles (2Y25).	Successfully develop and infuse technologies that will enable future science measurements, and/or improve performance and reduce the cost of existing measurements. Increase the readiness of technologies under development, retiring risks and advancing them to a maturity level where they can be infused into new missions with shorter development cycles. Success will equate to meeting 3 of 4 performance indicators. (3Y26).	
APG Assessment	TBD	TBD	

Strategic Objective: Develop advanced information systems for processing, archiving, accessing, visualizing, and communicating Earth science data. (Introduced in FY02)

	FY 99	FY 00	FY 01
Annual Performance Goal and APG #			
APG Assessment			

	FY 02	FY 03	FY 04
Annual Performance Goal and APG #	Develop hardware/software tools to demonstrate high-end computational modeling to further our understanding and ability to predict the dynamic interaction of physical, chemical and biological processes affecting the earth (2Y26). Develop baseline suite of multidisciplinary models and computational tools leading to scalable global climate simulations. (2Y27)	Develop hardware/software tools to demonstrate high-end computational modeling to further our understanding and ability to predict the dynamic interaction of physical, chemical and biological processes affecting the earth. Success will equate to meeting 2 of 3 performance indicators. (3Y27) Develop baseline suite of multidisciplinary models and computational tools leading to scalable global climate simulations. (3Y28)	
APG Assessment	TBD	TBD	

Strategic Objective: Demonstrate scientific and technical capabilities to enable the development of practical tools for public and private-sector decision makers/FY 99-01 Strategic Objective: Extend the use of Earth Science research for regional, state, and local applications

	FY 99	FY 00	FY01
Annual Performance Goal and APG #	Establish at least five Regional Earth Science Applications Centers (RESACs) (Y31). Complete solicitation for seven co-operative agreements with State and local governments in areas of land use planning, land capability analysis, critical areas management, and water resource management (Y33). Establish at least eight new projects, with USDA, in the areas of vegetation mapping and monitoring, risk and damage assessment, resources management and precision agriculture (Y32).	At least one of seven Regional Earth Science Applications Center (RESAC) becomes self-sustaining. Continue funding for the remaining centers (0Y41). Develop two new validated commercial information products as a result of verification and validation partnerships with industry (0Y46). Implement at least five joint applications research projects/partnerships with State and local governments in remote –sensing applications (0Y43).	Provide regional decision-makers with scientific and applications products/tools by meeting at least 7 of 8 performance indicators for this applications research area (1Y14). Improve access to and understanding of remotely sensed data and processing technology by meeting 3 of 3 performance indicators in this area (1Y15).
APG Assessment	Blue	0Y41 was yellow 0Y46 and 0Y43 were green	TBD

	FY 02	FY 03	FY 04
Annual Performance Goal and APG #	Provide regional decision-makers with scientific and applications products and tools (2Y23).	Provide regional decision-makers with scientific and applications products and tools by meeting 3 of 3 performance indicators. (3Y24)	
APG Assessment	TBD	TBD	

Strategic Objective: Partner with other agencies to develop and implement better methods for using remotely sensed observations in Earth system monitoring and prediction/FY 99-01 Strategic Objective: Extend the use of Earth Science research for regional, state, and local applications.

	FY 99	**FY 00**	**FY 01**
Annual Performance Goal and APG #			
APG Assessment			

	FY 02	**FY 03**	**FY 04**
Annual Performance Goal and APG #	Collaborate with other Federal and international agencies in developing and implementing better methods for using remotely sensed observations (2Y28)	Collaborate with other domestic and international agencies in developing and implementing better methods for using remotely sensed observations. Success will equate to meeting 4 of 5 performance indicators. (3Y29)	
APG Assessment	TBD	TBD	

FY 99-01 Objective: Support the development of a robust commercial remote sensing industry.

	FY 1999	FY 2000	FY 2001	FY 2002
Annual Performance Goal and APG #	Establish at least 75 commercial partnerships in "value-added" remote sensing product development; an increase from 37 over FY97 (Y34).	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 ERDAS, Inc.). (0Y44). Provide three commercial sources of science data (from the data buy) for global change research and applications (0Y45). Develop two new validated commercial information products as a result of verification and validation partnerships with industry (0Y46).	Stimulate the development of a robust commercial remote sensing industry by meeting at least 4 of 5 performance indicators in this area (1Y16). Increase efficiencies in food and fiber production with the aid of remote sensing by meeting the performance indicator in this area (1Y17).	**Note: No longer a strategic objective.**
Assessment	Blue	0Y44 was yellow 0Y45 and 0Y46 were green	TBD	

FY 99-01 Strategic Objective: Make major scientific contributions to national and international environmental assessments

	FY 1999	FY 2000	FY 2001	FY 2002
Annual Performance Goal and APG #	Make significant contribution to World Meteorological Organization (WMO) Ozone Assessment by providing a lead chapter author and most of the global-scale data (Y26). Contribute model results of climate affects of measured aircraft emissions and provide report to IPCC assessment report (Y24). Make significant contributions to US. Regional/national assessments in partnership with U.S. Global Change Research Program agencies (Y25). Provide lead chapter author and most of the global-scale data and contributing researchers to the IPCC Assessment Report, sponsored by the United Nations Environment Program and WMO (Y27).	Sponsor two regional national assessment studies of environmental variations and natural resources vulnerability (0Y48). (Green) 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. (0Y5). (Green)	**Note: Incorporated into science objectives in FY01 and beyond.**	
Assessment	Green	Green		

FY 99-01 Strategic Objective: Make major scientific contributions to national and international environmental assessments (continued)

	FY 1999	FY 2000	FY 2001	FY 2002
Annual Performance Goal and APG #		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. (0Y6). 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 Program for their 2000 assessment report (0Y8).		
Assessment		0Y6 was yellow. 0Y8 was green.		

APG #	Office of Earth Science FY 2003 Budget Link Table	Budget Category	Earth Observing System	Earth Explorers	Operations	Research and Technology	Investments
3Y1	Increase understanding of global precipitation, evaporation and how the cycling of water through the earth system is changing		X		X	X	
3Y2	Increase understanding of global ocean circulation and how it varies on interannual, decadal, and longer time scales				X	X	
3Y3	Increase understanding of global ecosystems change		X			X	
3Y4	Increase understanding of stratospheric ozone changes, as the abundance of ozone-destroying chemicals decreases and new substitutes		X		X	X	
3Y5	Increase understanding of change occurring in the mass of the Earth's		X	X		X	
3Y6	Increase understanding of the motions of the Earth, the Earth's interior, and what information can be inferred about the Earth's internal			X		X	
3Y7	Increase understanding of trends in atmospheric constituents and solar radiation and the role they play in driving global climate		X			X	
3Y8	Increase understanding about the changes in global land cover and land use and their causes		X			X	
3Y9	Increase understanding of the Earth's surface and how it is transformed and how such information can be used to predict future changes		X	X		X	
3Y10	Increase understanding of the effects of clouds and surface hydrologic processes on climate change		X			X	
3Y11	Increase understanding of how ecosystems respond to and affect global environmental change and affect the global carbon cycle		X		X	X	
3Y12	Increase understanding of how climate variations induce changes in the global ocean circulation		X			X	
3Y13	Increase understanding of stratospheric trace constituents and how they respond to change in climate and atmospheric composition				X	X	
3Y14	Increase understanding of global sea level and how it is affected by climate change					X	

APG #	**Office of Earth Science** **FY 2003 Budget Link Table**	**Budget Category**	Earth Observing System	Earth Explorers	Operations	Research and Technology	Investments
3Y15	Increase understanding of the effects of regional pollution on the global atmosphere, and the effects of global chemical and climate changes on regional air quality		X		X	X	
3Y16	Increase understanding of variations in local weather, precipitation and water resources and how they relate to global climate variation		X		X	X	
3Y17	Increase understanding of the consequence of land cover and land use change for the sustainability of ecosystems and economic productivity		X			X	
3Y18	Increase understanding of the consequences of climate and sea level changes and increased human activities on coastal regions		X			X	
3Y19	Increase understanding of the extent that weather forecast duration and reliability can be improved by new space-based observations, data assimilation and modeling				X	X	
3Y20	Increase understanding of the extent that transient climate variations can be understood and predicted		X		X	X	
3Y21	Increase understanding of the extent that long-term climate trends can be assessed or predicted					X	
3Y22	Increase understanding of the extent that future atmospheric chemical impacts on ozone and climate can be predicted					X	
3Y23	Increase understanding of the extent that future concentrations of carbon dioxide and methane and their impacts on climate can be					X	
3Y24	Provide regional decision-makers with scientific and applications products and tools.					X	
3Y25	Share the excitement of NASA's scientific discoveries and the practical benefits of Earth science to the public in promoting understanding of science and technology in service to society					X	

APG #	**Office of Earth Science FY 2003 Budget Link Table**	**Budget Category**	Earth Observing System	Earth Explorers	Operations	Research and Technology	Investments
3Y26	Successfully develop and infuse technologies that will enable future science measurements, and/or improve performance and reduce the cost of existing measurements. Increase the readiness of technologies under development, retiring risks, and advancing them to a maturity level where they can be infused into new missions with shorter					X	
3Y27	Develop hardware/software tools to demonstrate high-end computational modeling to further our understanding and ability to predict the dynamic interaction of physical, chemical and biological					X	
3Y28	Develop baseline suite of multidisciplinary models and computational tools leading to scalable global climate simulations					X	
3Y29	Collaborate with other domestic and international agencies in developing and implementing better methods for using remotely sensed observations to support national and international assessments of climate changes and their practical consequences					X	
3Y30	Successfully develop one (1) spacecraft and have ready for launch. Operate instruments on orbiting spacecraft to enable Earth science research and applications goals and objectives		X	X		X	
3Y31	Successfully disseminate Earth Science data to enable our science research and applications goals and objectives		X			X	
3Y32	Safely operate airborne platforms to gather remote and in situ earth science data for process and calibration/validation studies					X	

Human Exploration and Development of Space
FY 2003 Performance Plan

Mission

As America enters a new millennium, people the world over are reflecting on the accomplishments of the past and speculating about opportunities of the future. Some of the most inspiring and important accomplishments of the past four decades have resulted from the space program. Events such as the planet-wide impact of the Apollo landings on the moon and images of the Earth; discoveries such as the astonishing Hubble Space Telescope (HST) photos of solar system formation; achievements such as the sending of the first human-built spacecraft—Pioneer and Voyager spacecraft—beyond our solar system; and new capabilities such as communications and weather satellites. Space has touched the lives of many hundreds of millions worldwide.

The mission of HEDS is to expand the frontiers of space and knowledge by exploring, using, and enabling the development of space for human enterprise. To achieve this mission, NASA's Human Exploration and Development of Space (HEDS) Enterprise is pursuing four strategic goals:

- Explore the space frontier
- Enable humans to live and work permanently in space
- Enable the commercial development of space, and
- Share the experience and benefits of discovery

HEDS begins with the foundation of the Space Shuttle and the International Space Station, now under construction in Earth orbit, and look to the future by fostering technology development and commercialization in space.

HEDS also aspires to make possible U.S. leadership of international efforts to extend permanently human presence beyond the bounds of Earth, involving both machines and humans as partners in innovative approaches to exploration. HEDS engages the private sector in the commercial development of space in order to enable the continuation of current space business and the creation of new wealth and new jobs for the U.S. economy.

Accomplishment of these goals will enable historic improvements in our understanding of nature, in human accomplishment, and in the quality of life. The Human Exploration and Development of Space Strategic Plan is a first step. This performance plan shows how we plan to measure our success.

Resource Requirements:

(NOA, dollars in millions)	FY1999	FY 2000	FY 2001	FY 2002	FY 2003
$M	6,345	6,302	5,973	6,830	6,131
CS FTE	7,209	7,416	7,936	7,182	6,877

Implementation Strategy

Goal 1 - Explore the Space Frontier
There are certain ideas that many believe to be inherent in the human psyche and integral to American culture: ambition for progress, curiosity about the unknown, the need to pose profound questions and to answer them, the concept of new frontiers that—once achieved—promise a better quality of life for all peoples. Space is such a frontier. Earth orbit, the Moon, near-Earth space, Mars and the asteroids, eventually the moons of the giant planets of the outer solar system, and someday more distant worlds—these are collectively the endless, ever-expanding frontier of the night sky under which the human species evolved and toward which the human spirit is inevitably drawn. It is a fundamental goal of NASA to expand the space frontier progressively through human exploration, utilization of space for research, and commercial development.

Strategic Objectives
- Invest in the development of high-leverage technologies to enable safe, effective and affordable human/robotic exploration.
- Conduct engineering research on the International Space Station to enable exploration beyond Earth orbit.
- Enable human exploration through collaborative robotic missions.
- Define innovative human exploration mission approaches.
- Develop exploration/commercial capabilities through private sector and international partnerships.

Goal 2 - Enable Humans to Live and Work Permanently in Space
Advances in technology notwithstanding, the human element continues to be the major factor in the success or failure of most terrestrial enterprises. In many cases, innovative technologies are most effective when used to leverage or enhance the productivity of humans. Moreover, the human element is a quintessential component in the public's continuing interest in, and support for the space program. Human presence will be an essential factor in successfully opening the space frontier and expanding knowledge through research in space. As our activities in space grow, so too must human involvement. In this way, we open the door to an array of benefits, tangible and intangible, for the people of the United States and the world. It is, therefore, a goal of NASA to enable and establish permanent and productive human presence in space, to advance America's aspirations and opportunities in space through new technologies and new ways of doing business.

Strategic Objectives

- Provide and make use of safe, affordable, and improved access to space.
- Operate the International Space Station to advance science, exploration, engineering, and commerce.
- Ensure the health, safety, and performance of humans living and working in space.
- Meet sustained space operations needs while reducing costs.

Goal 3 - Enable the Commercial Development of Space

Commerce is essential to human society; free market transactions are the foundation of the dramatic progress humankind has made during the past several centuries. Wherever humans go and wherever they live, there too is commerce. Moreover, the free market is an effective mechanism for delivering tangible benefits from space broadly to the American people.

If humanity is to explore and develop space, to better exploit the space environment for profound scientific discoveries, and someday to settle the space frontier, it may be through the continuing expansion of the private sector—of individuals and of industry—into space. As the space frontier opens, it is important must therefore seek to expand the free market into space.

It is a goal of NASA to enable the commercial development of space.

Strategic Objectives

- Improve the accessibility of space to meet the needs of commercial research and development.
- Foster commercial endeavors with the International Space Station and other assets.
- Develop new capabilities for human space flight and commercial applications through partnerships with the private sector.

Goal 4 - Share the Experience and Benefits of Discovery

Americans—of all backgrounds—should have the opportunity to share in the experience and benefits of space exploration and development. During the past four decades, ambitious human space flight missions have inspired generations of young people to undertake careers in science, mathematics, and engineering— benefiting both themselves and society. The space program can enrich society by directly enhancing the quality of education. Terrestrial applications of technologies developed for space have saved many lives, made possible medical breakthroughs, created countless jobs, and yielded diverse other tangible benefits for Americans. The further commercial development of space will yield still more jobs, technologies, and capabilities to benefit people the world over in their everyday lives. A goal of NASA is therefore to share the experience, the excitement of discovery, and the benefits of human space flight with all.

Strategic Objectives

- Engage and involve the public in the excitement and the benefits of—and in setting the goals for—the exploration and development of space.
- Provide significantly more value to significantly more people through exploration and space development efforts.
- Advance the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets.

Performance Measures

Goal 1: Explore the Space Frontier

Objective: Invest in the development of high-leverage technologies to enable safe, effective and affordable human/robotic exploration.

Annual Performance Goal 3H01: The HEDS Advanced Programs office works collaboratively with other NASA Enterprises and Field Centers on advanced planning activities to leverage available resources in advanced technologies that will enable safe, effective, and affordable human/robotic exploration.

- NASA Exploration Team (NEXT) will produce and distribute an annual report documenting advanced planning activities and advanced technology advancement.

Objective: Conduct engineering research on the International Space Station to enable exploration beyond Earth orbit.

Annual Performance Goal 3H02: Provide for science and technology research on the International Space Station a minimum average of five mid-deck lockers for each Space Shuttle mission to the ISS and maintain 80% availability of Space Station resources to support science and technology research.

- Demonstrate that an average of five mid-deck lockers was used to support research for each Space Shuttle mission going to the International Space Station (source International Space Station manifest).
- Formulate a customer survey that measures customer satisfaction of available Space Station resources to ISS researchers.
- Determine if adequate resources were available to the science and technology researchers conducting experiments on the International Space Station -- Conduct a customer survey of International Space Station researchers at the conclusion of their research on Space Station (80% customer satisfaction on available resources = green).

Annual Performance Goal 3H25: Space Shuttle supports exploration by transporting payloads, logistics, and crew to the International Space Station.

- Achieve 100% on-orbit mission success for all flights in FY 2003. For this metric, mission success criteria are those provided to the prime contractor (SFOC) for purposes of determining successful accomplishment of the performance incentive fees in the contract

Public Benefit: Many of the key technologies needed for future human/robotic exploration and development of space will require testing and later demonstrations in the actual space environment before they can be cost-effectively applied in future space systems. Conducting engineering research and development at the International Space Station, will result in more timely, affordable and successful application of these new technologies (including the capability to design to cost and implement to cost for future HEDS projects). In addition, the space application of these technologies will result in expanded scope for human commerce and an improved quality of life by enabling potential high-value new space industries (e.g., advanced communications satellites, manufacturing in space, R&D in space, public space travel, space utilities, and others) while improving the quality of life (e.g., through advances in our understanding of human physiology and human factors, in medicine and medical systems). Promote continuous research and development activities through the International Space Station assembly period.

Objective: Enable human exploration through collaborative robotic missions.

Annual Performance Goal 3H03: Provide reliable launch services for approved missions.

- NASA success rate at or above a running average of 95% for missions noted on the Flight Planning Board manifest and launched pursuant to commercial launch service contracts.

Annual Performance Goal 3H04: Provide reliable space communication services for Space Science and Earth Science missions be consistent with program and project requirements.

- Achieve at least 95 percent of planned data delivery for space flight missions.

Public Benefit: A better understanding (at the earliest possible dates) of the space and planetary environments to which human explorers will one day travel will make possible a more focused, more effective and lower cost investment to develop the technologies needed for future human/robotic exploration and development of space. This knowledge and understanding will also make possible reduced risks to the health and safety of future astronauts. Overall, pursuing collaborative robotic missions will result in future human/robotic exploration missions with lower costs and greater benefits that would be otherwise achievable. HEDS supports this strategic objective by working collaboratively with other enterprises on advanced planning activities and providing launch services supporting NASA sponsored missions including robotic spacecraft missions.

Goal 2: Enable Humans to Live and Work Permanently in Space

Objective: Provide and make use of safe, affordable, and improved access to space.

Annual Performance Goal 3H05: Assure public, flight crew, and workforce safety for all Space Shuttle operations, measured by the following:

- Achieve zero type A (damage to property at least $1M or death) or B (damage to property at least $250K or disability/hospitalization) mishaps in FY 2003.
- Achieve an average of 8 or fewer flight anomalies per Space Shuttle mission.

Public Benefit: Successfully meeting goal 3H05 allows researchers to apply the knowledge gained from flying payloads on the Space Shuttle thus assuring a positive return on the public's investment in space transportation

Annual Performance Goal 3H06: Safely meet the FY 2003 manifest and flight rate commitment. Annual performance goal is measured for Space Shuttle performance only.

- Achieve 100% on-orbit mission success for all flights in FY 2003. For this metric, mission success criteria are those provided to the prime contractor (SFOC) for purposes of determining successful accomplishment of the performance incentive fees in the contract.

Public Benefit: Successfully meeting goal 3H06 allows researchers to apply the knowledge gained from flying payloads on the Space Shuttle thus assuring a positive return on the public's investment in space transportation

Annual Performance Goal 3H07: Maintain a "12-month" manifest preparation time.

- Baselined Flight Requirements Document (FRD) tracks achievement of this goal and it defines the primary cargo manifest that uses the "12 month" template. Achievement of performance goal is independent of delays caused by non-manifest related issues, for example payload readiness to launch.

Public Benefit: Ensuring the most effective and efficient access to space for primary payload customers while supporting the safety and reliability of the Shuttle transportation system.

Annual Performance Goal 3H08: Have in place a Shuttle safety investment program that ensures the availability of a safe and reliable Shuttle system for International Space Station assembly and operations.

- Meet the major FY 2003 Space Shuttle Safety Upgrade milestones. For this metric, major milestones are defined to be the Preliminary Design Review dates, Critical Design Review dates, Ready dates for upgrade installation/integration with flight hardware/software, and Ready dates for first flight.

Annual Performance Goal 3H09: HEDS will collaborate with NASA's Office of Human Resources and Education, and Second Generation Program Office to establish and implement an agency wide training program for employees that support the Space Launch Initiative needs. The training program will communicate and document "lessons learned" from other major technology development and operational programs. "Lessons learned" would be based on but not limited to both government and contractor experience on the Space Shuttle program, Saturn program, and other commercial launch vehicle programs. HEDS shall with the Second Generation Program Office and NASA's Office of Human Resources and Education:

- Establish and implement a curriculum in program and project management that communicates management practices, tools, and "lessons learned".
- Establish and implement a curriculum in systems engineering and management that communicates system engineering practices, tools, and "lessons learned".

Annual Performance Goal 3H10: HEDS Enterprise will work with the Second Generation Program to define available opportunities to utilize Office of Space Flight assets to test 2nd Generation Reusable Launch Vehicle enabling technologies. HEDS shall:

- Develop comprehensive list of test environments and associated test specimen size that can be accommodated.
- Define available window(s) of opportunity.
- Participate in Second Generation Program technical interchange meetings.
- Attend quarterly SLI and Space Transportation reviews.

Public Benefit: Ensuring a safe and reliable space transportation system that maximizes long-term benefits to the public through support to the International Space Station program and other primary payload customers.

Objective: Operate the International Space Station to advance science, exploration, engineering, and commerce.

Annual Performance Goal 3H11: Demonstrate International Space Station on-orbit vehicle operational safety, reliability, and performance.

- Zero safety incidents (i.e. no on-orbit injuries)
- Actual resources available to the payloads measured against the planned payload allocation for power, crew time, and telemetry. (Green = 80% or greater)

Public Benefit: Meeting operations targets and beginning research activities will provide many benefits of space research directly to the public through new discoveries and improved technology applications in areas such as medicine, industrial processes and fundamental knowledge.

Annual Performance Goal 3H12: Demonstrate and document the International Space Station program progress and readiness at a level sufficient to show adequate support of the assembly schedule.

- Conduct monthly status reviews to show maturity and preparation of flight readiness products. Maintaining 80% of defined activities are within scheduled targets.

Public Benefit: Meeting development targets and beginning research activities will provide many benefits of space research directly to the public through new discoveries and improved technology applications in such areas as medicine, industrial processes and fundamental knowledge.

Annual Performance Goal 3H13: Successfully complete 90% of International Space Station planned mission objectives.

- Achieve 90% on-orbit mission success for planned International Space Station assembly and logistics activities on the Space Shuttle flights scheduled for FY 2003. Sum total of the successfully accomplished primary mission objectives divided by the total number of mission objectives per year.

Public Benefit: Improving life on Earth. Successfully implementing goal 3H12 brings the many benefits of space research directly to the public through new discoveries and improved technology applications in areas such as medicine, industrial processes and fundamental knowledge.

Objective: Meet sustained space operations needs while reducing costs.

Annual Performance Goal 3H14: Space Communications performance metrics for each Space Shuttle and International Space Station mission/expedition will be consistent with detailed program and project operations requirements in project Service Level Agreements.

- Achieve at least 95 percent of planned data delivery for each Space Shuttle mission and International Space Station expedition

Public Benefit: The public's investment in space operations demands NASA's attention to safety first and cost reduction whenever possible. We are accountable for maximizing the return on the public's investment.

Annual Performance Goal 3H15: Develop and execute a management plan and open future Station hardware and service procurements to innovation and cost-saving ideas.

- Implement management plan – The International Space Station Integrated Program Management Plan (IPMP) addresses the cost and management challenges/risks in OMB, GAO and OIG reports. It contains reforms that strengthen headquarters involvement, increases communications, provide more accurate assessment and maintains budget accountability. Instituted processes will define the International Space Station baseline, develop a WBS and associated schedule and cost milestones for core complete, provide funding rationale and justification for the operations budget, simplify contract relationships, improve the MIS, provide rigorous and independent cost estimates, provide more accurate assessments of Program trends and issues to develop an early warning system of major program risks and cost growth, and assure budget and earned value plans are met. Assessment reports will include documentation of the discovery and resolution of major issues. The Integrated Program Management Plan (IPMP) is a more comprehensive management document that incorporates the Program Management Action Plan (PMAP).

Public Benefit: To ensure effective management of the International Space Station program.

Goal 3: Enable the Commercial Development of Space

Objective: Improve the accessibility of space to meet the needs of commercial research and development.

Annual Performance Goal 3H16: The Space Communications program will conduct tasks that enable commercialization and will minimize investment in government infrastructure for which commercial alternatives are being developed.

- Increase the percentage of the space operations budget allocated to the acquisition of communications and data services from the commercial sector from 15% in FY 2001 and 20% in FY 2002 to 25% in FY 2003.

Public Benefit: The public's investment in space operations demands NASA's attention to safety first and cost reduction whenever possible. We are accountable for maximizing the return on the public's investment.

Annual Performance Goal 3H17: Establish mechanisms to enable NASA access to the use of U.S. commercially developed launch systems.

- Assure that NASA launch service contracts include annual on-ramps for newly developed commercial launch services as they meet NASA's risk mitigation policy.

Public Benefit: New commercially developed launch services will be able to compete for NASA launches when they meet NASA's risk mitigation policy.

Objective: Foster commercial endeavors with the International Space Station and other assets.

Annual Performance Goal 3H18: Establish mechanisms to enable NASA to utilize commercial payload processing facilities.

- Fifty percent or greater of the Space Shuttle (excluding International Space Station) and ELV (excluding planetary) payloads will be processed utilizing commercial facilities.

Annual Performance Goal 3H19: Increase collaboration in space commerce with a variety of industry, academia and non-profit organizations.

- Materially participate in the development and issuance of a NASA-wide enhanced space commerce strategy document; and produce formal documents that demonstrate serious potential collaboration with at least three private sector companies

Objective: Develop new capabilities for human space flight and commercial applications through partnerships with the private sector.

Annual Performance Goal 3H20: NASA will aggressively pursue Space Shuttle competitive sourcing opportunities that improve the Shuttle's safety and operational efficiency.

- Obtain Administration approval of Space Shuttle competitive sourcing plan and implementation approach.
- Complete cost benefit analyses of competitive sourcing opportunities by an independent third party.
- Pursue contract mechanisms for shuttle competitive sourcing which assures maintenance of shuttle system safety,

Public Benefit: Partnership with commercial interests brings the results and benefits of living and working in space to the public more quickly than the government could do by itself.

Goal 4: Share the Experience and Benefits of Discovery

Objective: Engage and involve the public in the excitement and the benefits of and in setting the goals for the exploration and development of space.

Annual Performance Goal 3H21: Conduct HEDS related Education and Outreach Programs to improve the engagement/involvement of the formal education, informal education, and the general public communities.

- Revise and implement action plans for the Education and Outreach Programs.
- Continuously evaluate HEDS Education and Outreach Programs and events to provide information about their effectiveness in meeting identified goals.

Public Benefit: Continuing to improve the involvement of formal education, informal education, and the general public communities in setting the HEDS goals and activities will assure that future exploration and development of space programs are well aligned with the interests and the intentions of the primary constituents for NASA exploration programs and projects that are more cost-effective in achieving educational and public goals and objectives.

Objective: Provide significantly more value to significantly more people through exploration and space development efforts.

Annual Performance Goal 3H22: Expand public access to HEDS missions information (especially International Space Station) by working with industry, academia, and the media to create media projects and public engagement initiatives that allow "first-hand" public participation using telepresence for current missions, and virtual reality or mock-ups for future missions beyond Earth orbit.

- Museums – track the number of science museums and other informal education forums incorporating first person participation with the International Space Station.
- Develop a seamless education/outreach website presence providing public and educational access and availability to HEDS education/outreach programs, products, and public affairs information.
- Publish a HEDS Commercial Outreach Initiative Notice of Opportunity designed to enhance public knowledge about human exploration of space.

Public Benefit: Continuing to improve public involvement in the conduct of and results from future HEDS activities will assure that future exploration and development of space programs are well understood by the primary constituents for NASA exploration programs. In addition, more effective communication of the knowledge and technologies resulting from HEDS activities will promote a rapid transition of these innovations into private sector applications, with resulting benefits to the economy and quality of life.

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

Annual Performance Goal 3H23: Initiate the development and implementation of a formal and systematic mechanism to integrate HEDS latest research knowledge into the K-12/University classroom environment.

- Ensure the number of HEDS research projects, which are currently flying or scheduled to fly on the Space Shuttle and International Space Station, will be transferred to and made accessible to the education community.
- Enhance the formal and informal education programs through research, products, services, and distance learning technologies.
- Collaborate with other NASA education organizations and the external education community to ensure that HEDS-related educational materials and products are developed and made available to K-12 educators.

Annual Performance Goal 3H24: Engage and collaborate with research universities (1) for joint generation of new knowledge in HEDS related areas, (2) for the advancement of the HEDS mission and development of cutting edge technical capabilities, and (3) for ensuring a high quality future workforce.

- Track the number of collaborative partnerships with research universities
- Develop, utilize, and disseminate science, mathematics, and technology instructional materials based on HEDS unique missions and results, and to support the development of higher education curricula.

- Increase the number of opportunities for teachers and students to enhance their knowledge of HEDS and science, mathematics, technology, engineering and to enhance their skills through mechanisms such as internships, professional development workshops, and research opportunities.

Public Benefit: HEDS is an important investment in the future of the US. By presenting and disseminating informational and educational materials on HEDS, including new discoveries, in a form that is accurate and current, understandable to both educators and students, and tied to local, state, and national curriculum frameworks, HEDS can contribute to advancing the academic achievements of the Nation. Similarly, by effectively advancing scientific and technological achievements, new discoveries and new industries will result, contributing to a stronger economy in the future.

Management Challenges and High Risk Areas

NASA is responding to feedback from it stake holders regarding management challenges and high-risk areas. The HEDS related material is identified below starting with the reference, relevant excerpt(s) or section(s), and related Annual Performance Goal.

FY 2002 President's Budget: A Blueprint for New Beginnings – A Responsible Budget for America's Priorities
Fulfilling the President's promise to make Government more market-based, NASA will pursue management reforms to promote innovation, open Government activities to competition, and improve the depth and quality of NASA's research and development (R&D) expertise. These reforms, described below, will help reduce NASA's operational burden and focus resources on Government-unique R&D at NASA.

International Space Station: NASA will undertake reforms and develop a plan to ensure that future International Space Station costs will remain within the President's 2002 Budget plan. Annual Performance Goal **3H15**

Space Shuttle Competitive Sourcing: NASA will aggressively pursue Space Shuttle competitive sourcing opportunities that improve the Shuttle's safety and operational efficiency. Annual Performance Goal **3H20**

General Accounting Office (GAO): Major Management Challenges and Program Risks National Aeronautics and Space Administration (NASA), January 2001
Controlling International Space Station Development and Support Costs: Annual Performance Goal **3H15**

NASA Office of Inspector General (OIG): NASA's Top 10 Management Challenges, December 2000
International Space Station – cost and planning. Annual Performance Goal **3H15**

Comments related to GAO concerning changes in Annual Performance Goals (APGs): In a previous meeting with GAO concerns were raised over changing the annual performance goals. Annual performance goals are set for a particular year to meet a strategic goal and strategic objective. Annual performance goals by their nature can change yearly. Strategic goals and strategic objectives do not change yearly but are locked in place for at least three years. These are the goals and objectives we track to show a trend not the APGs. The last change to the NASA Strategic Plan took place in October 2000 -- this accounts for the changes in strategic goals and strategic objectives from FY 2001 to FY 2002. The Performance Plan for FY 2002 is the first year under the new NASA Strategic Plan. At present HEDS has not changed its strategic goals or strategic objectives since the publication of the NASA Strategic Plan 2000.

Verification and Validation

Internal Assessment

Interim evaluation and monitoring of performance targets will be conducted – as required – as an element of regular meetings of the Office of Space Flight and HEDS Management Boards.

Final data collection, reporting and verification for inclusion in NASA's Annual Performance Report will rely on several different processes depending on the particular Annual Performance Goal. Wherever possible, a specific tangible product has been identified in the indicator for individual performance goals to strengthen the validation process.

For many HEDS performance goals, (e. g. Space Shuttle in-flight anomalies, International Space Station assembly milestones) verification of performance is straightforward and progress is monitored through regular management channels and reports.

External Assessment

To assist in evaluating those performance goals that are more difficult to associate with specific tangible products, HEDS will employ an annual external assessment process. Past external assessors have included the: NASA Advisory Council, Space Flight Advisory Committee, General Accounting Office, NASA's Office of the Inspector General, and National Research Council.

The Space Flight Advisory Committee (an OSF Advisory Committee) reviews and evaluates OSF performance annual performance goals.

FY 2003 MULTI-YEAR PERFORMANCE TREND

Human Exploration and Development of Space

Invest in the development of high-leverage technologies to enable safe, effective, and affordable human/robotic exploration.

	FY 1999	**FY 2000**	**FY 2001**
Explore the Space Frontier		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.	1H32: Initiate the HEDS Technology/Commercialization program and establish a synergistic relationship with industry.
Assessment		Yellow	TBD

Conduct engineering research on the International Space Station to enable exploration beyond Earth orbit.

	FY 1999	**FY 2000**	**FY 2001**
Explore the Space Frontier			
Assessment			

Invest in the development of high-leverage technologies to enable safe, effective, and affordable human/robotic exploration.

	FY 2002	**FY 2003**	**FY 2004**
Explore the Space Frontier		3H01: The HEDS Advanced Programs office work collaboratively with other NASA Enterprises and Field Centers on advanced planning activities and leverage available resources in advanced technologies that will enable safe, effective, and affordable human/robotic exploration.	
Assessment		TBD	

Conduct engineering research on the International Space Station to enable exploration beyond Earth orbit.

	FY 2002	**FY 2003**	**FY 2004**
Explore the Space Frontier		3H25: Space Shuttle supports exploration by transporting payloads, logistics, and crew to the ISS.	
Assessment			

Enable human exploration through collaborative robotic missions

	FY 1999	FY 2000	FY 2001
Explore the Space Frontier		OH35: Complete the integration and testing of the Mars In-situ Propellant Production Precursor (MIP) flight unit for the 2001 Mars Surveyor mission.	1H1: Complete testing and delivery for spacecraft integration of experiments for the Mars Surveyor Program 2001 missions.
Assessment		Red	TBD
Explore the Space Frontier		OH35: Complete the integration and testing of the Mars In-situ Propellant Production Precursor (MIP) flight unit for the 2001 Mars Surveyor mission.	1H1: Complete testing and delivery for spacecraft integration of experiments for the Mars Surveyor Program 2001 missions.
Assessment		Red	TBD

Provide and make use of safe, affordable and improved access to space.

	FY 1999	FY 2000	FY 2001
Enable Humans to live and Work Permanently in Space	9H15: Achieve seven or fewer flight anomalies per mission	0H12: Achieve seven or fewer flight anomalies per mission	1H7: Achieve 8 or fewer flight anomalies per mission.
Assessment	Green	Green	TBD

Enable human exploration through collaborative robotic missions

	FY 2002	FY 2003	FY 2004
Explore the Space Frontier		3H04: Provide reliable space communication services for Space Science and Earth Science missions be consistent with program and project requirements.	
Assessment			
Explore the Space Frontier	2H03: Provide reliable launch services for approved missions. • NASA success rate at or above a running average of 95% for missions noted on the Flight Planning Board manifest and launched pursuant to commercial launch service contracts.	3H03: Provide reliable launch services for approved missions. • NASA success rate at or above a running average of 95% for missions noted on the Flight Planning Board manifest and launched pursuant to commercial launch service contracts.	
Assessment	TBD	TBD	

Provide and make use of safe, affordable and improved access to space.

Enable Humans to live and Work Permanently in Space	2H06: Assure public, flight crew, and workforce safety for all Space Shuttle operations, measured by the following: • Achieve zero type A or B mishaps in FY 2002. • Achieve an average of 8 or fewer flight anomalies per Space Shuttle mission	3H05: Assure public, flight crew, and workforce safety for all Space Shuttle operations, measured by the following: • Achieve zero type A or B mishaps in FY 2003 • . Achieve an average of 8 or fewer flight anomalies per Space Shuttle mission	
Assessment	TBD	TBD	

Provide and make use of safe, affordable and improved access to space.

	FY 1999	**FY 2000**	**FY 2001**
Enable Humans to live and Work Permanently in Space	9H16: Achieve 85% on time, successful launches, excluding weather risk.	0H13: Achieve 85% on time, successful launches, excluding weather risk. Changed to: Achieve 100% on-orbit mission success.	1H30: Achieve 100% on-orbit mission success
Assessment	Yellow	Green	TBD
Enable Humans to live and Work Permanently in Space	9H17: Achieve a 13-month manifest preparation time.	0H14: Achieve a 12- month manifest preparation time.	
Assessment	Green	Green	
Enable Humans to live and Work Permanently in Space	9H18: Achieve a 60% increase in predicted reliability of Space Shuttle over 1995	0H15: Have in place an aggressive Shuttle program that ensures the availability of a safe and reliable Shuttle system through the ISS era.	1H6: Expedite a safety improvement program to ensure the continued safe operations of the Space Shuttle that ensures the availability of a safe and reliable Shuttle system to support Space Station Assembly milestones and operations.
Assessment	Green	Red	TBD

Provide and make use of safe, affordable and improved access to space.

	FY 2002	**FY 2003**	**FY 2004**
Enable Humans to live and Work Permanently in Space	2H07: Safely meet the FY 2002 manifest and flight rate commitment. Annual performance goal is measured for Space Shuttle performance only.	3H06: Safely meet the FY 2003 manifest and flight rate commitment. Annual performance goal is measured for Space Shuttle performance only.	
Assessment	TBD	TBD	
Enable Humans to live and Work Permanently in Space	2H08: Maintain a "12-month" manifest preparation time.	3H07: Maintain a "12-month" manifest preparation time.	
Assessment	TBD	TBD	
Enable Humans to live and Work Permanently in Space	2H09: Have in place a Shuttle safety investment program that ensures the availability of a safe and reliable Shuttle system for ISS assembly and operations.	3H08: Have in place a Shuttle safety investment program that ensures the availability of a safe and reliable Shuttle system for ISS assembly and operations.	
Assessment	TBD	TBD	

Provide and make use of safe, affordable and improved access to space.

	FY 1999	FY 2000	FY 2001
Enable Humans to live and Work Permanently in Space			
Assessment			
Enable Humans to live and Work Permanently in Space			
Assessment			

Provide and make use of safe, affordable and improved access to space.

	FY 2002	FY 2003	FY 2004
Enable Humans to live and Work Permanently in Space		3H09: HEDS will collaborate with NASA's Office of Human Resources and Education, and Second Generation Program Office to establish and implement an agency wide training program for employees that support the Space Launch Initiative needs. The training program will communicate and document lessons learned from other major technology development and operational programs. Lessons learned would be based on but not limited to both government and contractor experience on the Space Shuttle program, Saturn program, and other commercial launch vehicle programs.	
Assessment		TBD	
Enable Humans to live and Work Permanently in Space		3H10: HEDS Enterprise will work with the Second Generation Program to define available opportunities to utilize Office of Space Flight assets to test 2nd Generation Reusable Launch Vehicle enabling technologies.	
Assessment		TBD	

Operate the International Space Station to advance science, exploration, engineering and commerce.

	FY 1999	FY 2000	FY 2001
Enable Humans to live and Work Permanently in Space		0H61: Conduct operations with a three-person human presence on the ISS.	1H12: Successfully complete the majority of combined ISS planned operations schedules and milestones as represented by permanent human on-orbit operations.
Assessment		Yellow	TBD
Enable Humans to live and Work Permanently in Space	9H42: Initiate full-scale Multi-Element Integration Testing (MEIT) for elements in the first four launch.		1H10: Successfully complete the majority of the planned development schedules and milestones required to support the Multi-element Integration Testing.
Assessment	Green		TBD
Enable Humans to live and Work Permanently in Space	9H44: Conduct physical integration of the Z1 Truss launch package and initiate MEIT.		
Assessment	Green		
Enable Humans to live and Work Permanently in Space	9H43: Deliver the U.S. laboratory module to the launch site in preparation for MEIT.	0H16: Deploy and activate the U.S. Laboratory Module to provide a permanent on orbit laboratory capability.	
Assessment	Green	Yellow	
Enable Humans to live and Work Permanently in Space	9H19: Deploy and activate the Russian-built Functional Cargo Block as the early propulsion and control module.	0H18: Deploy and activate the Airlock to provide an ISS-based EVA capability.	1H11: Successfully complete the majority of the ISS planned on-orbit activities such as delivery of mass to orbit and enhanced functionality.
Assessment	Green	Yellow	TBD

Operate the International Space Station to advance science, exploration, engineering and commerce.

	FY 2002	FY 2003	FY 2004
Enable Humans to live and Work Permanently in Space	2H10: Demonstrate ISS on-orbit vehicle operational safety, reliability, and performance.	3H11: Demonstrate ISS on-orbit vehicle operational safety, reliability, and performance.	
Assessment	TBD	TBD	
Enable Humans to live and Work Permanently in Space	2H11: Demonstrate ISS program progress and readiness at a level sufficient to show adequate readiness in the assembly schedule.	3H12: Demonstrate and document the ISS program progress and readiness at a level sufficient to show adequate support of the assembly schedule.	
Assessment	TBD	TBD	
Enable Humans to live and Work Permanently in Space			
Enable Humans to live and Work Permanently in Space			
Assessment			
Enable Humans to live and Work Permanently in Space	2H12: Successfully complete 90% of the ISS planned mission objectives.	3H13: Successfully complete 90% of the ISS planned mission objectives.	
Assessment	TBD	TBD	

Operate the International Space Station to advance science, exploration, engineering and commerce.

	FY 1999	FY 2000	FY 2001
Enable Humans to live and Work Permanently in Space	9H41: Deploy and activate the first U.S.-built element, Unity (Node 1), to provide docking locations and attach ports.	0H17: Deploy and activate the Canadian-built Space Station Remote Manipulator System to provide an ISS-based remote manipulating capability for maintenance and assembly.	
Assessment	Green	Yellow	
Enable Humans to live and Work Permanently in Space		0H19: Deliver to orbit the first of three Italian-build Multi-Purpose Logistic Modules to provide a reusable capability for delivering payload and systems racks to orbit.	
Assessment		Yellow	
Enable Humans to live and Work Permanently in Space		0H20: Complete preparations for the initial ISS research capability through the integration of the first rack of the Human Research Facility (HRS-1), five EXPRESS racks with small payload research and the Microgravity Science Glovebox (MSG).	1H13: Successfully complete the majority of the planned research activities in support of initiation of on-orbit research opportunities
Assessment		Yellow	TBD
Enable Humans to live and Work Permanently in Space			1H14: Successfully complete no less than 85% of the planned Russian Program Assurance schedules and milestones required for the development of the Propulsion Module.
Assessment			TBD

Operate the International Space Station to advance science, exploration, engineering and commerce.

	FY 2002	FY 2003	FY 2004
Enable Humans to live and Work Permanently in Space			
Assessment			
Enable Humans to live and Work Permanently in Space			
Assessment			
Enable Humans to live and Work Permanently in Space			
Assessment			
Enable Humans to live and Work Permanently in Space			
Assessment			

Operate the International Space Station to advance science, exploration, engineering and commerce.

	FY 1999	FY 2000	FY 2001
Enable Humans to live and Work Permanently in Space		0H22: Complete the production of the X-38 first space flight test article in preparation for a Shuttle test flight in 2001.	1H15: Successfully complete no less than 75% of the planned crew return capability schedules. FY01 indicators will include accomplishment of program schedule milestones for Phase 1 development of a Crew Return Vehicle (CRV) that could provide the U.S. crew return capability.
Assessment		Yellow	TBD

Meet sustained space operations needs while reducing costs.

	FY 1999	FY 2000	FY 2001
Enable Humans to live and Work Permanently in Space	9H30: Complete the development of a commercialization plan for the ISS and the Space Shuttle in partnership with the research and commercial communities, and define and recommend policy and legislative changes.	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.	
	Yellow	Red	
Enable Humans to live and Work Permanently in Space	9H34: Develop options and recommendations to commercialize space communications.	0H42: Increase the expenditures for commercial services to 10% of the total space communications budget by FY 2000.	1H20: Increase the percentage of the space operations budget allocated to acquisition of communications and data services from the commercial sector to 15%.
Assessment	Red	Green	TBD

Operate the International Space Station to advance science, exploration, engineering and commerce.

	FY 2002	FY 2003	FY 2004
Enable Humans to live and Work Permanently in Space			
Assessment			

Meet sustained space operations needs while reducing costs.

	FY 2002	FY 2003	FY 2004
Enable Humans to live and Work Permanently in Space		3H14: Space Communications performance metrics for each Space Shuttle and ISS mission/expedition will be consistent with detailed program and project operations requirements in project Service Level Agreements.	
Enable Humans to live and Work Permanently in Space	2H15: The Space Communications program will conduct tasks that enable commercialization and will minimize investment in government infrastructure for which commercial alternatives are being developed.	3H15: Develop and execute a management plan and open future Station hardware and service procurements to innovation and cost-saving ideas.	
Assessment	TBD		

Meet sustained space operations needs while reducing costs.

	FY 1999	FY 2000	FY 2001
Enable Humans to live and Work Permanently in Space		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.	1H21: Achieve at least 95 percent of planned data delivery from space flight missions as documented in space, ground, deep space, and NASA integrated service networks performance metrics consistent with detailed program and project operations requirements in project service level agreements.
Assessment		Green	TBD
Enable Humans to live and Work Permanently in Space		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.	
Assessment		No longer applicable - see 2000 Performance Report	
Enable Humans to live and Work Permanently in Space	9H33: Reduce space communications operations costs by 30 to 35% compared to the FY96 budget, through a consolidated space communications contract to meet established budget targets.	0H43: Reduce the space communications budget submit for FY 2000 by 30-35% from the FY 1996 congressional budget submit.	
Assessment	Green	Green	

Meet sustained space operations needs while reducing costs.

	FY 2002	FY 2003	FY 2004
Enable Humans to live and Work Permanently in Space	2H16: Performance metrics for each mission will be consistent with detailed program and project operations requirements in project Service Level Agreements • Achieve at least 95 percent of planned data delivery for space flight missions.	Captured by metric 3H14	
Assessment	TBD		
Enable Humans to live and Work Permanently in Space	2H19: Develop and execute a management plan and open future Station hardware and service procurements to innovation and cost-saving ideas.		
Assessment			
Enable Humans to live and Work Permanently in Space			
Assessment			

Improve the accessibility of space to meet the needs of commercial research and development.

	FY 1999	FY 2000	FY 2001
Enable the Commercial Development of Space			
Assessment			
Enable the Commercial Development of Space			
Assessment			
Enable the Commercial Development of Space			
Assessment			

Foster commercial endeavors with the International Space Station and other assets.

	FY 1999	FY 2000	FY 2001
Enable the Commercial Development of Space			
Assessment			

Improve the accessibility of space to meet the needs of commercial research and development.

	FY 2002	FY 2003	FY 2004
Enable the Commercial Development of Space		3H16: The Space Communications program will conduct tasks that enable commercialization and will minimize investment in government infrastructure for which commercial alternatives are being developed.	
Assessment		TBD	
Enable the Commercial Development of Space	2H17: Provide an average of five mid-deck lockers on each Space Shuttle mission to the International Space Station for research.	3H02: Provide for science and technology research on the ISS a minimum average of 5 mid-deck lockers for each Space Shuttle mission to the ISS and maintain 80% availability of Space Station resources to support science and technology research.	
Assessment	TBD		
Enable the Commercial Development of Space	2H18: Establish mechanisms to enable NASA access to the use of U.S. commercially developed launch systems.	3H17: Establish mechanisms to enable NASA access to the use of U.S. commercially developed launch systems.	
Assessment	TBD	TBD	

Foster commercial endeavors with the International Space Station and other assets.

	FY 2002	FY 2003	FY 2004
Enable the Commercial Development of Space	2H26: Increase collaboration in space commerce with a variety of industry, academia and non-profit organizations.	3H18: Establish mechanisms to enable NASA to utilize commercial payload processing facilities.	
Assessment	TBD		

Foster commercial endeavors with the International Space Station and other assets.

	FY 1999	FY 2000	FY 2001
Enable the Commercial Development of Space			
Assessment			

Develop new capabilities for human space flight and commercial applications through partnerships with the private sector

	FY 1999	FY 2000	FY 2001
Enable the Commercial Development of Space		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.	
Assessment		Green	
Enable the Commercial Development of Space			1H23: Foster commercial endeavors by reviewing and/or implementing new policies and plans, such as the Space Station resource pricing policy and intellectual property rights policy. Ensure that Space Station resources allocated to commercial research are utilized by commercial partners to develop commercial products and improve industrial processes.
Assessment			TBD

Foster commercial endeavors with the International Space Station and other assets.

	FY 2002	FY 2003	FY 2004
Enable the Commercial Development of Space		3H19: Increase collaboration in space commerce with a variety of industry, academia and non-profit organizations.	
Assessment			

Develop new capabilities for human space flight and commercial applications through partnerships with the private sector

	FY 2002	FY 2003	FY 2004
Enable the Commercial Development of Space	2H21: Continue implementation of planned and new privatization efforts through the Space Shuttle prime contract and further efforts to safely and effectively transfer civil service positions and responsibilities to private industry.	3H20: NASA will aggressively pursue Space Shuttle competitive sourcing opportunities that improve the Shuttle's safety and operational efficiency.	
Assessment			
Enable the Commercial Development of Space	2H21: Continue implementation of planned and new privatization efforts through the Space Shuttle prime contract and further efforts to safely and effectively transfer civil service positions and responsibilities to private industry.	3H20: NASA will aggressively pursue Space Shuttle competitive sourcing opportunities that improve the Shuttle's safety and operational efficiency.	
Assessment			

Engage and involve the public in the excitement and the benefits of—and in setting the goals for—the exploration and development of space.

	FY 1999	**FY 2000**	**FY 2001**
Share the Experience and Benefits of discovery			
Assessment			

Provide significantly more value to significantly more people through exploration and space development efforts.

	FY 1999	**FY 2000**	**FY 2001**
Share the Experience and Benefits of discovery			
Assessment			

Engage and involve the public in the excitement and the benefits of—and in setting the goals for—the exploration and development of space.

	FY 2002	FY 2003	FY 2004
Share the Experience and Benefits of discovery		3H21: Conduct HEDS related Education and Outreach Programs to improve the engagement/involvement of the formal education, informal education, and the general public communities.	
Assessment		TBD	

Provide significantly more value to significantly more people through exploration and space development efforts.

	FY 2002	FY 2003	FY 2004
Share the Experience and Benefits of discovery	2H24: Expand public access to HEDS missions information (especially ISS) by working with industry to create media projects and public engagement initiatives that allow "first-hand" public participation using telepresence for current missions, and virtual reality or mock-ups for future missions beyond Earth orbit.	3H22: Expand public access to HEDS missions information (especially ISS) by working with industry, academia, and the media to create media projects and public engagement initiatives that allow "first-hand" public participation using telepresence for current missions, and virtual reality or mock-ups for future missions beyond Earth orbit.	
Assessment	TBD	TBD	

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

	FY 1999	FY 2000	FY 2001
Share the Experience and Benefits of discovery			
Assessment			
Share the Experience and Benefits of discovery			
Assessment			

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

	FY 2002	FY 2003	FY 2004
Share the Experience and Benefits of discovery	2H28: Initiate the development and implementation of a formal and systematic mechanism to integrate HEDS latest research knowledge into the K-12 and University classroom environment.	3H23: Initiate the development and implementation of a formal and systematic mechanism to integrate HEDS latest research knowledge into the K-12 / University classroom environment.	
Assessment		TBD	
Share the Experience and Benefits of discovery		3H24: Engage collaborate with research universities (1) for joint generation of new knowledge in HEDS related areas, (2) for the advancement of the HEDS mission and development of cutting edge technical capabilities, and (3) for ensuring a high quality future workforce.	
Assessment		TBD	

Human Exploration and Development of Space FY 2003 Annual Performance Goals	Budget Category	Access to Space (ELV's and Payloads)	Advanced Programs	External Affairs	International Space Station	Office of the Chief Engineer	Space Communications (Space Operations)	Space Shuttle
Annual Performance Goal								
3H01: The HEDS Advanced Programs office work collaboratively with other NASA Enterprises and Field Centers on advanced planning activities and leverage available resources in advanced technologies that will enable safe, effective, and affordable human/robotic exploration.			X					
3H02: Provide for science and technology research on the International Space Station a minimum average of five mid-deck lockers for each Space Shuttle mission to the ISS and maintain 80% availability of Space Station resources to support science and technology research.					X			
3H03: Provide reliable launch services for approved missions.		X						X
3H04: Provide reliable space communication services for Space Science and Earth Science missions consistent with program and project requirements.							X	
3H05: Assure public, flight crew, and workforce safety for all Space Shuttle operations.								X
3H06: Safely meet the FY 2003 manifest and flight rate commitment. Annual performance goal is measured for Space Shuttle performance only.								X
3H07: Maintain a “12-month” manifest preparation time.		X						X

Human Exploration and Development of Space FY 2003 Annual Performance Goals	Budget Category	Access to Space (ELV's and Payloads)	Advanced Programs	External Affairs	International Space Station	Office of the Chief Engineer	Space Communications (Space Operations)	Space Shuttle
Annual Performance Goal								
3H08: Have in place a Shuttle safety investment program that ensures the availability of a safe and reliable Shuttle system for International Space Station assembly and operations.								X
3H09: HEDS will collaborate with NASA's Office of Human Resources and Education, and Second Generation Program Office to establish and implement an agency wide training program for employees that support the Space Launch Initiative needs. The training program will communicate and document "lessons learned" from other major technology development and operational programs. "Lessons learned" would be based on but not limited to both government and contractor experience on the Space Shuttle program, Saturn program, and other commercial launch vehicle programs.					X	X		
3H10: HEDS Enterprise will work with the Second Generation Program to define available opportunities to utilize Office of Space Flight assets to test 2nd Generation Reusable Launch Vehicle enabling technologies.						X		X
3H11: Demonstrate International Space Station on-orbit vehicle operational safety, reliability, and performance.					X			

Human Exploration and Development of Space FY 2003 Annual Performance Goals	**Budget Category**	Access to Space (ELV's and Payloads)	Advanced Programs	External Affairs	International Space Station	Office of the Chief Engineer	Space Communications (Space Operations)	Space Shuttle
Annual Performance Goal								
3H12: Demonstrate and document the International Space Station program progress and readiness at a level sufficient to show adequate support of the assembly schedule.					X			
3H13: Successfully complete 90% of International Space Station planned mission objectives.					X			
3H14: Space Communications performance metrics for each Space Shuttle and International Space Station mission/expedition will be consistent with detailed program and project operations requirements in project Service Level Agreements.							X	
3H15: Develop and execute a management plan and open future Station hardware and service procurements to innovation and cost- saving ideas.					X			
3H16: The Space Communications program will conduct tasks that enable commercialization and will minimize investment in government infrastructure for which commercial alternatives are being developed.							X	
3H17: Establish mechanisms to enable NASA access to the use of U.S. commercially developed launch systems.		X						
3H18: Establish mechanisms to enable NASA to utilize commercial payload processing facilities.		X						

Human Exploration and Development of Space FY 2003 Annual Performance Goals	**Budget Category**	Access to Space (ELV's and Payloads)	Advanced Programs	External Affairs	International Space Station	Office of the Chief Engineer	Space Communications (Space Operations)	Space Shuttle
Annual Performance Goal								
3H19 - Increase collaboration in space commerce with a variety of industry, academia and non-profit organizations.				X				
3H20: NASA will aggressively pursue Space Shuttle competitive sourcing opportunities that improve the Shuttle's safety and operational efficiency.								X
3H21: Conduct HEDS related Education and Outreach Programs to improve the engagement/involvement of the formal education, informal education, and the general public communities.				X				
3H22: Expand public access to HEDS missions information (especially International Space Station) by working with industry, academia, and the media to create media projects and public engagement initiatives that allow "first-hand" public participation using telepresence for current missions, and virtual reality or mock-ups for future missions beyond Earth orbit.				X				
3H23: Initiate the development and implementation of a formal and systematic mechanism to integrate HEDS latest research knowledge into the K-12/University classroom environment.				X				

Human Exploration and Development of Space FY 2003 Annual Performance Goals	Budget Category	Access to Space (ELV's and Payloads)	Advanced Programs	External Affairs	International Space Station	Office of the Chief Engineer	Space Communications (Space Operations)	Space Shuttle
Annual Performance Goal								
3H24: Engage and collaborate with research universities (1) for joint generation of new knowledge in HEDS related areas, (2) for the advancement of the HEDS mission and development of cutting edge technical capabilities, and (3) for ensuring a high quality future workforce.				X				
3H25: Space Shuttle supports exploration by transporting payloads, logistics, and crew to the International Space Station.								X

Aerospace Technology
FY 2003 PERFORMANCE PLAN

1. Mission: The Office of Aerospace Technology (OAT) Enterprise mission is to maintain U.S. preeminence in aerospace research and technology. The Enterprise plays a key role in 1) maintaining a safe and efficient national aviation system 2) enabling an affordable, reliable space transportation system, and developing basic technologies for a broad range of space missions. Research and development programs conducted by the Enterprise also contribute to NASA's science and exploration missions, national security, economic growth, and the long-term competitiveness of American aerospace companies.

A modern air and space transportation system is fundamental to our national economy, quality of life, and security of the United States, For 75 years, a strong base for aerospace technology research and development has provided enormous contributions to this system, contributions that have fostered the economic growth of our Nation and provided unprecedented mobility for U. S. citizens. Although major technical advances have made our Nation's air and space transportation system the largest and best of its kind, the future holds critical challenges to its continued growth and performance. Because the U. S. air and space transportation system serves both critical national security needs and the public good, ensuring the continued health and preeminence of that system is a key issue for the future of the Nation.

In order to develop the aerospace systems of the future, revolutionary approaches to system design and technology development will be necessary. Pursuing technology fields that are in their infancy today, developing the knowledge bases necessary to design radically new aerospace systems, and performing efficient, high-confidence design and development of revolutionary vehicles are challenges that face us in innovation. These challenges are intensified by the demand for safety in our highly complex aerospace systems.

Although NASA technology benefits the aerospace industry directly, the creative application of NASA's advanced technology to disparate design and development challenges has made numerous contributions to other areas such as the environment, surface transportation, and medicine.

2. Resource Requirements:

	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
NOA $M	1,339	1,125	1,404	2,508	2,816
CS FTE	4,227	4,345	6,170	6,140	6,344

3. Implementation Strategy: The foundation for the Aerospace Technology Enterprise program is based on the accomplishment of three goals. (A fourth goal, Commercialize Technology, is addressed in NASA's crosscutting goals: Providing Aerospace Products and Capabilities (APG 3P7) and Communicate Knowledge (APG 3CK3) performance plan.) Enterprise objectives are outcome-focused and "stretch" beyond our current knowledge base. The outcome-focused nature of the objectives projects a preferred end-state within the air and space transportation and mission spacecraft and instrument systems. The Enterprise goals are:

Goal 1 – Revolutionize Aviation: Enable the safe, environmentally friendly expansion of aviation. Expanding the aviation system of the future to meet demands for growth will mean providing a more distributed, flexible, and adaptable network of airways. This growth must take place within the physical and environmental constraints of today's system, while meeting the evolving needs of air travel. The system of the future will continue to be international in scope, requiring close coordination across a global network. Advanced vehicles will operate in this new infrastructure with better performance and new capabilities. Advanced information and sensor technologies will make air travel safer and more efficient. Air transportation will be easily accessible from urban, suburban, or rural communities. Airplanes will be cleaner, quieter, and faster. NASA aims to revolutionize aviation by delivering the long-term, high payoff aerospace technologies, materials, and operations, research needed for enabling these new vehicle and system characteristics and capabilities.

Goal 2: – Advance Space Transportation Create a safe, affordable highway through the air and into space. Revolutionizing our space transportation system to significantly reduce costs and increase reliability and safety will open the space frontier to new levels of exploration and commercial endeavor. With the creation of the Integrated Space Transportation Plan (ISTP), NASA defined a single, integrated investment strategy for all its diverse space transportation efforts. By investing in a sustained progression of research and technology development initiatives, NASA will enable future generations of reusable launch vehicles and in-space transportation systems that will surmount the Earth-to-orbit challenge and allow less costly, more frequent, and more reliable access to our neighboring planets and the stars beyond.

Goal 3 – Pioneer Revolutionary Technology: Enable a revolution in aerospace systems. In order to develop the aerospace systems of the future, revolutionary approaches to system design and technology development will be necessary. Pursuing technology fields that are in their infancy today, developing the knowledge bases necessary to design radically new aerospace systems, and developing tools for efficient high-confidence design and development of revolutionary vehicles are some of the challenges that are being addressed. In addition, the NASA Aerospace Enterprise is also developing the fundamental new technologies that will be used by other NASA Enterprises to accomplish their strategic Objectives. In these cases, the technology transition plans are developed that will allow the smooth incorporation of these revolutionary technologies into NASA missions. These technologies will enable the collection, analysis, and distribution of increased and previously unobtainable scientific data and discoveries in an expeditious and efficient manner.

The Aerospace Technology Enterprise program work breakdown structure has been restructured to create a clear linkage between the Enterprise strategic goals and the program management structure. This restructuring creates an unambiguous linkage from National policy, to the Agency strategic plan to the budget and provides a foundation for transparent, measurable performance reporting. Enterprise programs are often conducted in cooperation with other Federal agencies, primarily the Federal Aviation Administration and the Department of Defense. These partnerships take advantage of the national investment in aeronautics and space capabilities and eliminate unnecessary duplication. The Enterprise supports the maturation of technology to a level such that it can be confidently integrated into current and new systems. In most cases, technologies developed by the Enterprise can be directly transferred to the external customer. The Enterprise approach for implementing the program begins with investment decisions based on rigorous systems analysis. Independent programmatic and expert reviews will provide supplemental information that will be incorporated in management decisions. Annual program reviews will be used to measure progress (technical, schedule and cost) against requirements and deliverables, and outside expert technical reviews will assure the quality of the products and future directions to meet strategic goals. The Enterprise research and technology programs are:

Revolutionize Aviation – Aviation Safety Program: The Aviation Safety program is developing and demonstrating technologies and strategies to improve aviation safety by reducing both aircraft accident and fatality rates. The program is structured around developing technologies along three major thrusts: (1) aviation system monitoring and modeling to help aircraft and aviation system operators identify unsafe conditions before they lead to accidents; (2) accident prevention in targeted accident categories, including system-wide, single aircraft, and weather; and (3) accident mitigation to increase accident survivability in those cases when accidents do occur.

Revolutionize Aviation – Vehicle Systems Program: The Vehicle Systems program is taking advantage of the emergence of revolutionary advances in biotechnology, nanotechnology, and information technology to enable significant advances it the functionality of 21st Century aircraft. It consists of a balance of mid- and far-term technology development activities, including the areas of materials, structures, aerodynamics, flight control, propulsion, and power, and the integration of these technologies into new vehicle concepts. Experimental vehicles will be developed for flight-testing to further mature the technologies that can be developed with government and industry partners into high leverage products.

Revolutionize Aviation – Airspace Systems Program: The objective of the Aviation System Capacity Program is to enable improvements in mobility, capacity, efficiency and access of the airspace system by developing, validating and transferring technologies that improve collaboration, predictability and flexibility for the airspace users, enable runway-independent aircraft, provide more access for general aviation operations, and maintain system safety and environmental protection. The program is developing decision support tools that will be transferred to the Federal Aviation Administration and the airlines, as well as an airspace systems modeling capability to simulate and analyze new and innovative future air traffic management concepts. Additionally, the program is developing airborne technologies for precision guidance of small aircraft to virtually any small airport to create alternative means to respond to the demand for increased throughput in the National Airspace System in the near term.

Advance Space Transportation – 2nd Generation Reusable Launch Vehicle Program: The 2nd Generation Reusable Launch Vehicle (RLV) program performs systems engineering, technology development and architecture definition trade studies to define at least two 2nd Generation RLV architecture designs that will best meet the requirements to make access to space safer, more reliable, and less expensive for present and future customers. The systematic approach targets the research and development of high-priority advanced technologies to be integrated into at least two vehicle architectures to provide the foundation for future potential full-scale development decisions.

Advance Space Transportation – Space Transfer and Launch Technology Program: The Space Transfer and Launch Technology program is developing high-payoff technologies for the 3rd generation of reusable launch vehicles to enable missions that are currently not technically or economically feasible. The efforts are centered around integrated ground demonstrations of potential hypersonic launch platforms, including rocket based combined cycle systems, turbine based combined cycle systems and flight demonstration of high speed scramjet propulsion/airframe integration, for safe, routine earth-to-orbit transportation to enable new commercial space markets, ensure seamless aerospace national security and enable the human exploration and development of space.

Pioneer Revolutionary Technology – Computing, Information and Communications Technology Program. The Computing, Information and Communications Technology program is developing and demonstrating revolutionary computing, information and communications technologies in the specific areas of autonomy, human-centered systems, intelligent data understanding, advanced computing and networking, information environments, and fundamental information, bio- and nano-technologies. Through their integration and transfer into aerospace systems and missions, these new technologies will enable: smarter, more adaptive systems and tools that work collaboratively with humans; seamless access to ground-, air- and space-based distributed hardware, software and information resources to enable NASA missions in aerospace, Earth science and space science; and broad, continuous presence and coverage for high rate data delivery from ground-, air-, and space-based assets directly to the users.

Pioneer Revolutionary Technology – Enabling Concepts and Technologies Program. The Enabling Concepts and Technologies program provides revolutionary aerospace system concepts that can enable NASA's strategic visions and expand future mission possibilities. As the front end of the enabling technology pipeline that feeds the focused technology development programs of NASA's Enterprises, the program develops potentially high pay-off technologies that may involve considerable risk to successful or rapid development. These areas include: sensing and spacecraft systems to enable bold new missions of exploration and to provide increased scientific return at lower cost; advanced energetics technology to provide power, propulsion, and electric thrust augmentation for enhanced mission capabilities and to enable missions beyond current horizons; and fundamental research in high-payoff spacecraft technologies such as micro-electronic and mechanical systems (MEMS), high performance materials, and nanotechnology to stimulate breakthroughs that could enable new system concepts.

Pioneer Revolutionary Technology – Engineering for Complex Systems Program. The Engineering for Complex Systems program has a three-pronged approach to achieving its objective of enabling ultra-high levels of safety and mission success through the infusion of advanced information. First, the program intends to significantly advance the scientific and engineering understanding of system complexities and failures, including human and organizational risk characteristics. Second, processes, tools and organizational methods will be developed to quantify, track, visualize and trade-off system designs and/or mission options with an emphasis on risk management throughout the system lifecycle. Third, software based resiliency tools and technologies will be developed to help mitigate risk in the operational and maintenance phases of the program lifecycles.

4. Performance Metrics:

Goal 1 – Revolutionize Aviation: Enable the safe, environmentally friendly expansion of aviation.

Objective One – Increase Safety: Make a safe air transportation system even safer by reducing the aircraft accident rate by a factor of 5 by 2007 and by a factor of 10 by 2022.

Strategy:

- **System Monitoring and Modeling:** Develop technologies for using the vast amounts of data available within the aviation system to identify, understand, and correct aviation system problems before they lead to accidents.

- **Accident Prevention:** Identify interventions and develop technologies to eliminate the types of accidents that can be categorized as "recurring."
- **Accident Mitigation:** Develop technologies to reduce the risk of injury in the unlikely event of an accident.

Public Benefit: These innovative technologies will improve the safety of the flying public. The public benefit can be characterized in three ways: (1) elimination of major categories of recurring accidents; (2) early warning and prevention of hidden and potential safety issues, and (3) reduced risk of injury to passengers and crew in the unlikely event of an accident.

Technical Approach: The Aviation Safety program has examined the historical aviation accident trends and determined high payoff technologies that will improve the safety of the National Airspace System. In cooperation with the Federal Aviation Administration and the aviation industry, research and technology will address accidents and incidents involving hazardous weather, controlled flight into terrain, human-performance related casual factors, and mechanical or software malfunctions and the development and integration of information technologies needed to build a safer airspace system and provide information for the assessment of situations and trends that indicate unsafe conditions before they lead to accidents. The program is structured into three investment thrust areas consisting of vehicle safety, weather safety and system safety technologies. These investment areas address targeted accident categories, as well as known accident precursors, aviation hazards and human survival rates when accidents do occur and cover all parts of the aviation system, including aircraft, people, and operations. In addition, the Vehicle Systems program will explore revolutionary and high-risk technology that will significantly improve the safety of future generations of aircraft and engine systems.

APG 3R1: Demonstrate progress in maturing, through flight tests and/or simulations, the critical technologies that will be necessary to meet the aviation safety objective. These tests and simulations are critical steps in the development of a suite of technologies that when completely developed and implemented by the customer, will provide a minimum of 50 percent reduction in fatal accident rate.

Performance Indicators:

System Monitoring and Modeling

- Demonstrate fast time simulation of system wide risks
- Model high error rate probability context and solution

Accident Prevention

- Provide new software certification procedures
- Demonstrate flight critical system validation methods
- Demonstrate a smart icing system that will sense the presence of ice accretion on the aircraft, automatically activate and manage the ice protection systems, and provide the pilot with feedback including the effect on measured aircraft performance, stability and control
- Complete initial flight evaluation of synthetic vision concepts
- Complete initial evaluation of a next-generation cockpit weather information and digital datalink technologies

- Validate life prediction methodology for critical powder metallurgy super-alloy engine components (nickel-based turbine disk) to enhance aircraft safety
- Initiate intelligent flight control generation I flight test
- Conduct flight testing of the research flight computing system which includes intelligent flight control and propulsion control
- Develop a transient disturbances recovery strategy for implementation in the SPIDER architecture

Objective Two – Reduce Emissions: Protect local air quality and our global climate by reducing oxides of nitrogen (NO_X) emissions of future aircraft by 70 percent by 2007 and by 80 percent by 2022 (Baseline: 1996 ICAO Standard) and also reducing carbon dioxide (CO_2) emissions of future aircraft by 25 percent by 2007 and by 50 percent by 2022.

Strategy:

- **Airframe Weight and Drag Reduction:** Develop airframe technologies that reduce fuel consumption and therefore reduce CO_2 and NO_X emissions.
- **Propulsion Optimization:** Develop advanced engine system technologies to reduce emissions such as NO_X that have an impact on local air quality and those such as CO_2 that affect the global climate.
- **Operation Optimization:** Develop more efficient operations at and around airports, in order to reduce aviation fuel burn and therefore reduce emissions.
- **Alternative Vehicle Concepts:** Develop advanced concepts for propulsion systems, airframe structures, and fuels that dramatically reduce or completely eliminate emissions from civil aviation aircraft.

Public Benefit: NO_X emissions are a known pollutant that degrades local air quality CO_2 emissions affect global air quality and have been identified as a major driver of climate change.. In summary, the public benefit of the NASA technologies can be characterized in three ways: (1) significant or total elimination of aircraft emissions as a source of climate change, (2) minimization of the impact of aviation operations on local air quality, and (3) elimination of unnecessary aviation emissions due to operational procedures. Another potential benefit of significantly improved vehicle efficiency is reduced air travel costs.

Technical Approach: NASA is addressing this problem by developing critical engine technologies that provide a significant reduction in emissions (primarily NO_X) as well as both airframe and other engine technologies that provide a dramatic increase in efficiency that will result reduced fuel burn. Reduced fuel burn leads to a reduction in total emissions, including carbon dioxide (CO_2). Independent assessments will be made throughout the life of the programs to evaluate our progress towards these ambitious goals and provide a sound foundation to make adjustments in technology investments. Adequate technology maturation from subcomponent testing in the laboratory, to component testing in more realistic environments, to full integrated testing in a relevant environment will be key to ensuring that these technologies are used in future air fleets. The technology development efforts are being conducted in close cooperation and coordination with the Department of Defense and industry.

The NO_X emissions reduction objective (70 percent landing and takeoff (LTO) NO_X reduction) will be accomplished via advanced combustor designs. NASA will continue to build on the knowledge gained through the development of the low NO_X combustor technology, which demonstrated a 50 percent NO_X reduction and is now being incorporated in production engines, to achieve the 70 percent goal. Several promising technologies have met the 70 percent goal in laboratory tests (i.e. flame tubes) and are being prepared for sector tests. This is one of a series of tests (i.e. sector, annular and full combustor) with intervening modifications and enhancements that are be required to maintain performance during these increasingly more demanding tests. This process ensures that the technology is developed sufficiently for subsequent transfer to industry.

CO_2 reduction is directly related to fuel burn and as the fuel burn decrease; both the CO_2 and NO_X emittants decrease. To achieve the reductions in fuel burn, NASA is developing technologies that will produce more efficient engines and airframes. Specific engine technologies that are being pursued include revolutionary, highly loaded compressor and turbine designs, ultra effective cooling configurations in turbines and combustor, innovative engine and airframe integration methods, and high temperature, durable propulsion materials supporting more efficient and higher performance cycle operations. The airframe effort is focused on the use of advanced materials and technologies to reduce weight and drag of current aircraft and engine configurations. In addition non-traditional aircraft configuration and propulsion systems (e.g., fuel cells) will be investigated for feasibility including an assessment of the potential benefits and technology barriers.

APG 3R2: Complete combustor sector test for concepts capable of achieving the 70%NO_X goal by 2007 and select the most promising approaches leading to full annular rig testing for large and regional jet engine applications. Complete an Interim Technology Assessment of the aggregate potential benefits from the engine and airframe technologies to reduce emissions. The results from this analysis will provide a benchmark for measuring overall progress, and guide future investment decisions.

Performance Indicators:

Airframe Weight and Drag

- Demonstrate the fabrication of carbon nanotube laminates
- Demonstrate advanced aeroelastic wing twist (flexible wing) on an F-18 to determine available roll power.
- Complete laminar flow experiment on F-15 testbed
- Demonstrate adaptive drag reduction techniques

Propulsion Optimization

- Engine test a coated polymer matrix composite inlet guide vane
- Simulate a benchmark combustion experiment with a liquid spray injector
- Develop a ceramic matrix composite (CMC) turbine vane
- Demonstrate a CMC complex part in rig test
- Downselect large engine contractor for full annular combustor testing
- Downselect regional engine contractor for full annular combustor testing
- Complete sector evaluations of 70% LTO NO_X configurations
- Complete an interim technology benefits assessment

Alternative Vehicle Concepts

- Complete evaluation of active flow control concepts for propulsion airframe integration (PAI)
- Complete initial high Reynolds number validation in wind tunnel of PAI method
- Complete evaluation of estimated technology benefits on future vehicle concepts
- Complete flutter risk assessment of high-speed slotted wing
- Validate nonlinear structural analysis tools
- Conduct testing of Stingray vehicle (morphing)
- Complete oil free FJX-2 core testing
- Demonstrate a prototype electric powered UAV capable of sustaining 14 hours of operation above an altitude of 50,000 feet

Objective Three – Reduce Noise: Benefit airport neighbors, the aviation industry, and travelers by reducing the perceived noise of future aircraft by a factor of two (10 decibels) by 2007 and by a factor of four (20 decibels) by 2022 (using 1997 subsonic aircraft technology as the baseline) thereby confining aircraft noise to within the airport boundary.

Strategy:

- **Propulsion System Source Noise Reduction:** Develop technologies to reduce engine noise at the source.
- **Aircraft System Source Noise Reduction:** Develop technologies to diminish airframe-related noise.
- **Operational Noise Reduction:** Develop advanced aircraft operating procedures, including steeper glide-slopes and precision, wind-compensated flight paths

Public Benefit: Reduction in noise impact surrounding airports, ultimately confining objectionable air transport noise within the compatible land-use areas around airports will benefit homes and businesses located close to an airport and enable faster and more efficient growth in the nation's air system by reducing constraints on where new airports and runways can be located.

Technical Approach: NASA is conducting a balanced effort at making major advances in noise reduction by 2007 and looking to high impact technologies to affect the more substantial targets of 2022. The work to be completed in FY 2003 provides the foundation for the future developmental efforts and has demonstrated technologies that when incorporated in aviation systems will result in an additional 2-decibel reduction from the 1997 baseline aircraft. The fundamental understanding of source noise mechanisms gained from computational, as well as experimental diagnostic investigations, will lead to the discovery and optimization of component noise reduction concepts necessary to achieve the Enterprise 10 decibel noise reduction objective. A critical step in the achievement of the Enterprise goals will be the development and validation of advanced physics-based noise prediction models. These models will be used to identify and assess the benefits of potential engine and airframe noise reduction technologies as well as improvements tat could result from changes in aircraft operations. Technologies and operational concepts will be selected for development and subsequent validation in laboratory and flight experiments.

Adequate technology maturation from subcomponent testing in the laboratory, to component testing in more realistic environments, to full integrated testing in a relevant environment will be key to ensuring that these technologies are used in future air fleets.

Independent assessments will be made throughout the life of the programs to evaluate progress towards these ambitious goals and make adjustments in technology investments.

APG 3R3: Complete development of initial physics-based prediction models to guide the development potential noise reduction technology concepts. Complete an interim technology assessment of the potential benefits for these concepts to reduce noise emissions. The results from this analysis will provide a benchmark for measuring overall progress, and guide future investment decisions.

Performance Indicators:

Propulsion System Source Noise Reduction.

- Three-dimensional noise propagation code for engine nacelles

Aircraft System Source Noise Reduction

- Develop initial physics-based noise prediction models

Operational Noise Reduction

- Quantify potential benefits of advanced noise abatement profiles and procedures at key airports

Integrated Activities

- Complete an interim technology benefits assessment
- Develop initial physics-based noise prediction models

Objective Four – Increase Capacity: Enable the movement of more air passengers with fewer delays by doubling the capacity of the aviation system within 10 years and tripling it within 25 years based on 1997 levels.

Strategy:

- **Infrastructure and Operation Optimization:** Optimize use of the current infrastructure without adding new airports or new runways by developing air traffic management technologies that increase the efficiency and capacity of the National Airspace System (NAS).
- **Alternative Vehicle Concepts:** Develop new civil aviation vehicle concepts that are designed to use segments of the NAS not suited for traditional commercial aircraft, such as short runways and vertical take-off and landing pads.
- **Alternative Infrastructure Concepts:** Develop entirely new concepts and systems, such as fully automated towers and airports that would increase the use and capacity of the Nation's 5000 public-use airports.

Public Benefit: Increase the capacity of the NAS sufficiently to meet projected public demand and alleviate delays without compromising safety. Although the events of September 11 have temporarily reduced demand on the nation's air system, delays are expected to return as demand for passenger and cargo flights increase.

Technical Approach: As part of the Airspace Systems Program, and in cooperation with the FAA, development of airspace systems technologies capable of meeting the strategic goal is being approached through two paths. First, to improve the gate-to-gate air traffic management and control process to increase capacity within the existing and planned aviation system for the next 15 years, the AATT project focuses on developing decision support technologies to assist air traffic controllers, pilots and aircraft operators in using airspace more efficiently through reduced spacing, improved scheduling, collaboration with operators, and other techniques. The project is conceiving new tools, developing them through laboratory simulations, and maturing them through field-testing. Some tools have been delivered to and accepted by the FAA for implementation in their "Free Flight" concept, some tools are in field testing and others are in the laboratory development phase. Second, in the first steps toward evaluating concepts of air traffic management that will enable three times the capacity, the Virtual Airspace Modeling and Simulation (VAMS) project, initiated in FY 2002, will establish a virtual airspace simulation environment for the test and evaluation of new and innovative solutions to the nation's aviation system problems. The challenge that technology development will address is the need for real-time analysis with never-before-achieved fidelity of a complex system. This capability is key to evaluating revolutionary air traffic management operational and technological concepts to dramatically reduce airport congestion and delays while maintaining or increasing air system safety and provide the information needed to establish a direction for the future air traffic management system beyond the technologies developed under AATT

APG 3R4: Complete development, initial functionality and evaluate human factors for at least one decision support tool to enable achievement of the planned progress towards the goal of doubling the capacity of the National Airspace System in 10 years. Complete the initial build of a toolbox of state-of-the-art airspace models to enable the planned progress towards the 2022 Objective.

Performance Indicators:

- Develop, demonstrate initial functionality, and evaluate human factors for a decision support tool for complex airspace
- Develop, demonstrate initial functionality, and evaluate human factors for an active terminal area decision support tool
- Complete initial build of state-of-the-art airspace model toolbox
- Provide strategies for improving training and procedures to reduce misunderstandings between pilots and air traffic controllers

Objective Five – Increase Mobility: Enable people to travel faster and farther, anywhere, anytime by reducing the time for inter-city door-to-door transportation by half by 2007 and by two-thirds by 2022, and reducing long-haul transcontinental travel time by half by 2022

Strategy:

- **Small Aircraft Transportation:** Develop vehicle, communication, and information technologies to allow small aircraft to operate easily and affordably at small airports in most weather conditions.
- **Supersonic Transportation:** Develop technologies critical to the economic viability of supersonic transport, such as propulsion concepts that meet stringent noise and emissions criteria.
- **Advanced Mobility Concepts and Technology:** Investigate non-traditional vehicles and operations concepts to take advantage of operational airspace that is currently underused.

Public Benefit: By developing new technologies that could permit small aircraft operations during near all weather at thousands of airports in the United States the capability of the nation's air system to transport goods, individuals, families, or groups of business associates could be greatly increased. The Small Aircraft Transportation System (SATS) concept is conceived as a safe travel alternative freeing people and products from constraints of today's ground and air transportation systems, by creating access to more communities in less time. The SATS concept increases reliable air access to virtually any community could lead to transportation services that improve all aspects of quality of life. While not specifically designed for current commercial operations, over time, the targeted technologies would also provide benefits to commuter and major air carrier operations in the hub-and-spoke system as well, through other focused research programs.

Technical Approach: The technical approach for the program operates through a joint public-private R&D collaboration involving NASA, the DOT, FAA, and state & local authorities, universities, industry, and transportation service providers. The program balances technology development, technology validation and demonstration, and technology assessment and includes laboratory, simulation, and flight experiments. These technical efforts integrate selected airborne enabling technologies to create and demonstrate four specific SATS operating capabilities. Products will include the design guidelines, systems standards, and identification of certification issues for the enabling technologies and operating capabilities.

APG 3R5: Select candidate technologies for experimental flight evaluation based on their impact on mobility. Mobility metrics will be measured by accessibility, doorstep-to-destination transit time, system and user costs, and related trip reliability and safety metrics. These flight experiments will evaluate individually, at the sub-system level, the impact of selected technologies on lowering required landing minimums and increasing the volume of operations at non-towered landing facilities in non-radar airspace during instrument meteorological conditions.

Performance Indicators:

Small Aircraft Transportation

- Select flight experiment technologies
- Complete lower landing minimum flight experiment
- Complete higher volume operations flight experiment
- Evaluate integrated single-crew flight deck technologies
- Demonstrate increased mobility without compromising enroute capacity

Advanced Mobility Concepts and Technology

- Demonstrate the fabrication of carbon nanotube laminates
- Validate nonlinear structural analysis tools
- Publish AWS validated figures of merit and design guidelines
- Conduct Stingray vehicle testing (Morphing))

Goal 2 – Advance Space Transportation: Create a safe, affordable highway through the air and into space.

Objective Six – Mission Safety: Radically improve the safety and reliability of space launch systems by reducing the incidence of crew loss for a second generation Reusable Launch Vehicle (RLV) to 1 in 10,000 missions (a factor of 40) by 2010 and to less than 1 in 1,000,000 missions (an additional factor of 100) for a third generation RLV by 2025.

Strategy:

- **Reusable and Robust Propulsion Systems:** Develop technologies for inherent reliability, more robust subsystems, and an increased performance margin for propulsion and power systems.
- **Integrated Vehicle Health Management:** Develop advanced sensors and algorithms to integrate intelligence, such as real-time failure detection and isolation, into vehicle systems.
- **Crew Escape:** Develop systems to remove the crew safely from a vehicle in the event of catastrophic failure during the highest risk phases of a mission, including vehicle ascent and descent

Public Benefit: A safe earth-to-orbit space transportation system is a key enabler of the commercial development, civil exploration and National security of space. Human space flight remains a hazardous endeavor in spite of advances in aerospace technology.. NASA intends to substantially increase the safety of routine space operations by developing the technologies and architectures for the next generation of RLVs and by concurrently developing the advanced technologies that will be required for future generations of RLVs. These future vehicles and associated systems could enable a broad expansion in scientific research, open new commercial markets, improve national security, and the enable the human exploration and development of space.

Technical Approach (Next Generation): Building on 20 years of success with America's 1st Generation RLV—the Space Shuttle—the 2nd Generation RLV program defines the plan of action to design and develop America's next-generation RLV. In partnership with the Department of Defense (DoD), the U.S. aerospace industry, and academia, NASA will perform systems engineering, technology development and architecture definition trade studies to define at least two 2nd Generation RLV architecture designs that will best meet the requirements to make access to space safer, more reliable, and less expensive for present and future customers. The ongoing 2nd Generation RLV design-and-development activities took into account extensive NASA studies and contractor-provided input from prior solicitations, which focused on detailed requirements evaluation, updated market projections, and risk-reduction priorities and plans. This systematic approach targets the research and development of high-priority advanced technologies—such as lightweight structures, long-life rocket engines, advanced crew systems, life support, robotics, flight control and avionics, and thermal protection systems—to be integrated into at least two launch architectures to provide the foundation for future potential full-scale development decisions in FY 2006. The emphasis is on risk-reduction activities selected according to industry and NASA needs. The high priority risk reduction areas identified included technology development and demonstration, business and program planning, and systems engineering and analysis.

APG 3R6: Down-select to a minimum of two launch architectures for detailed development based on their ability to meet the safety and affordability goals. This selection will determine what launch architectures and critical technology developments will be continued through FY 2006.

Performance Indicators:

- Architecture systems requirements document for 2nd Generation RLV will be baselined
- Successful completion of the 2nd Generation RLV systems requirement review
- Successful completion of the main engine prototype critical design reviews
- Down-select to a minimum of two launch architectures for detailed development

Technical Approach (Future Generation): Significantly increase the inherent reliability, flexibility and intact abort options of future launch systems. This will be achieved primarily by dramatically increasing system margin (performance, weight and operating margins). In addition, NASA will work to reduce the variability and increase the intelligence, redundancy and robustness of future systems. As a critical first demonstration of dramatically increased system margin, NASA will ground validate a rocket based combined cycle engine, ground validate a Mach 4 turbine accelerator for a turbine-based combined cycle engine and flight validate a multi-Mach scramjet and critical supporting technologies and tools by 2007. These concepts utilize oxygen from the atmosphere to greatly increase the efficiency of the propulsion system. NASA will leverage investments of parallel programs to make advances in supporting technologies. Based on these results, a decision will be made on the next steps of flight validating combined cycle propulsion systems. This effort is being conducted in close cooperation and coordination with the DoD as part of the National Hypersonic's Plan.

APG 3R7: Complete the independent evaluation of three revolutionary hypersonic propulsion technology systems demonstrations and associated ground technologies. This independent evaluation will validate ability of each propulsion system, a rocket-based combined-cycle engine, a turbine-based combined cycle engine and a scramjet engine, to achieve the strategic objectives within cost and schedule.

Performance Indicators:

- Complete the independent evaluation of three revolutionary hypersonic propulsion technology systems demonstrations, including a rocket-based combined-cycle engine, a turbine-based combined cycle engine and a scramjet engine.
- Demonstrate resin transfer molded polymer matrix composite with 550°F use temperature
- Complete X-43 scramjet launch system preliminary design review
- Complete direct connect injector testing for RBCC engine
- Complete flowpath air augmented rocket for RBCC engine
- Complete water cooled single thruster for RBCC engine

Objective Seven – Mission Affordability: Create an affordable highway to space by reducing the cost of delivering a payload to low-Earth orbit to $1,000 per pound (a factor of 10) by 2010 and to $100 per pound (an additional factor of 10) by 2025 and reducing the cost of inter-orbital transfer by a factor of 10 within 15 years and by an additional factor of 10 by 2025.

Strategy:

- **Reusable and Robust Propulsion Systems:** Develop long-life, highly reusable engine systems and inherently reliable integrated propulsion systems.

- **Low-Cost, Lightweight Materials and Structures:** Reduce the overall system weight of vehicles using lightweight, long-life primary structures and low-cost metallic and non-metallic propellant tanks.
- **Operations Optimization:** Develop the capability for autonomous checkout and vehicle control, modular payload systems, and new launch site operations.
- **Risk Reduction:** Develop key technologies for full-scale development of a second-generation RLV system.

Public Benefit: An affordable earth-to-orbit space transportation system is a key enabler of the commercial development, civil exploration and national security. Human space flight remains an expensive endeavor in spite of advances in aerospace technology. NASA intends to substantially reduce the resources devoted to routine space operations by developing the technologies and architectures for the next generation of RLVs and by concurrently developing the advanced technologies that will be required for future generations of RLV. These future vehicles and their associated systems could enable a broad expansion in scientific research, ensure the seamless security of aerospace, open new commercial markets, increase national security, and enable the human exploration and development of space.

Technical Approach (Next Generation): Building on 20 years of success with America's 1st Generation RLV—the Space Shuttle—the 2nd Generation RLV program defines the plan of action to design and develop America's next-generation RLV. In partnership with the Department of Defense (DoD), the U.S. aerospace industry, and academia, NASA will perform systems engineering, technology development and architecture definition trade studies to define at least two 2nd Generation RLV architecture designs that will best meet the requirements to make access to space safer, more reliable, and less expensive for present and future customers. The ongoing 2nd Generation RLV design-and-development activities took into account extensive NASA studies and contractor-provided input from prior solicitations, which focused on detailed requirements evaluation, updated market projections, and risk-reduction priorities and plans. This systematic approach targets the research and development of high-priority advanced technologies—such as lightweight structures, long-life rocket engines, advanced crew systems, life support, robotics, flight control and avionics, and thermal protection systems—to be integrated into at least two launch architectures to provide the foundation for future potential full-scale development decisions in FY 2006. The emphasis is on risk-reduction activities selected according to industry and NASA needs. The high priority risk reduction areas identified included technology development and demonstration, business and program planning, and systems engineering and analysis.

APG 3R8 Down-select to a minimum of two launch architectures for detailed development based on their ability to meet the safety and affordability goals. This selection will determine what RLV architectures and critical technology developments will be continued through FY 2006.

Performance Indicators:

- Architecture systems requirements document for 2nd Generation RLV will be baselined
- Successful completion of the 2nd Generation RLV systems requirement review
- Successful completion of the main engine prototype critical design reviews
- Down-select to a minimum of two launch architectures for detailed development

Technical Approach (Future Generation): Significantly increase the inherent reliability, flexibility and intact abort options of future launch systems. This will be achieved primarily by dramatically increasing the system margin (performance, weight and operating). In addition, NASA will work to reduce the variability and increase the intelligence, redundancy and robustness of future systems. As a critical first demonstration of dramatically increased system margin, NASA will ground validate a rocket-based combined-cycle engine, ground validate a Mach 4 turbine accelerator for a turbine-based combined cycle engine, and flight validate a multi-Mach scramjet and critical supporting technologies and tools by 2007. These concepts utilize oxygen from the atmosphere to greatly increase the efficiency of the propulsion system. NASA will leverage investments of parallel programs to make advances in supporting technologies. Based on these results, a decision will be made on the next steps of flight validating combined cycle propulsion systems. This effort is being conducted in close cooperation and coordination with the DoD as part of the National Hypersonic's Plan.

APG 3R9 Complete the independent evaluation of three revolutionary hypersonic propulsion technology systems demonstrations and associated ground technologies. This independent evaluation will validate ability of each propulsion system, a rocket-based combined-cycle engine, a turbine-based combined cycle engine and a scramjet engine, to achieve the strategic objectives within cost and schedule.

Performance Indicators:

- Complete the independent evaluation of three revolutionary hypersonic propulsion technology systems demonstrations, including a rocket-based combined-cycle engine, a turbine-based combined cycle engine and a scramjet engine.
- Demonstrate reaction transfer molded polymer matrix composite (PMC) with 550°F use temperature
- Complete RBCC Engine Test of a PMC combustor support chamber
- Complete X-43 scramjet launch system preliminary design review
- Complete direct connect injector testing for RBCC engine
- Complete flowpath air augmented rocket for RBCC engine
- Complete water cooled single thruster for RBCC engine

Objective Eight – Mission Reach: Extend our reach in space with faster travel times by reducing the time for planetary missions by a factor of 2 by 2015 and by a factor of 10 by 2025.

Strategy:

- **Advanced Propulsion Concepts:** Identify and develop breakthrough technology for advanced propulsion systems.
- **Materials and Structures:** Develop lightweight airframes, tanks, and micro-components using nano-technology and ultra-high temperature ceramics.

Public Benefit A major NASA objective is the exploration of the solar system to provide the American public with an understanding of the nature, history, and origins of the planets and their moons. Some NASA planetary missions also seek evidence of existing or extinct life at key planets and moons or provide comparative planetary data that helps in the development of accurate, predictive environmental, weather, climate, natural disaster, and natural resource models for Earth. The distance of planetary science targets from Earth is a major obstacle to conducting these missions. Current launch vehicles and on-board chemical propulsion systems require years of transit time with spacecraft in dormant states to reach the outer planets. Once they arrive at a target, mass and power limits imposed by today's propulsion systems further limit the size of planetary mission science instruments. The technologies that are being developed will provide the major breakthroughs are needed to enable science missions that are beyond the limits of chemical systems in order to provide an increased understanding of our neighboring celestial bodies and galactic phenomena and, possibly, explore beyond them.

Technical Approach: The will focus on the discovery and development of high-risk, high-payoff technologies with specific application to enabling rapid interplanetary access. Innovative ideas from the external community, leveraged by emerging technologies outside the aerospace field, will complement NASA capabilities in critical areas. Very advanced concepts with potentially huge improvements over current systems, but that are in early stages of understanding and development, are emphasized. Among the current foci are an electric engine fueled by nuclear fusion, a magnetohydrodynamic (MHD) by-pass, and a Lithium propellant concept. Component and process technologies and performance prediction methods are being developed to enable subsystem test beds that will feed system level test-beds for methods that show promise. Technology products will be integrated into proof-of-concept systems to validate performance in practical applications as practical system emerge over a period expected to be 8-10 years.

APG 3R10 Complete initial component tests to provide data for evaluating feasibility of key concepts by completing all of the following indicators.

Performance Indicators:

- Demonstrate plasma compressors for fusion concept
- Successfully complete arc-shock tunnel tests for magneto-hydrodynamic bypass concept
- Initiate lithium propellant tests
- Complete magnetic nozzle high power (on the order of one gigawatt) test for high temperature plasma

Goal 3 – Pioneer Technology Innovation: Enable a revolution in aerospace systems.

Objective Nine – Engineering Innovation: Enable rapid, high-confidence, and cost efficient design of revolutionary systems by enabling the capability to predict and alleviate with 95 percent confidence, during mission design, all probable threats to mission success by 2012. By 2022 enable the capability to methodically design missions with safety, cost, technical performance, and life defined with 95 percent confidence.

Strategy:

- **Process and Concept Innovation:** Develop new processes and concepts for accomplishing full-life-cycle ("cradle-to-grave") planning and design of new, revolutionary aerospace systems.
- **Validation and Implementation:** Develop technologies and concepts for new ways of certifying and fielding new aerospace systems.
- **Information Technologies:** Develop computational capabilities and knowledge bases necessary to design new aerospace systems.

- **Advanced Engineering and Analysis Technologies:** Develop design tools and the ability to model any part of a new vehicle design during any part of the system's span and under all operating conditions and environments.

Public Benefit: Reduced cost and increased reliability and safety of aerospace systems.

Technical Approach: Two programs contribute to the accomplishment of this strategic goal. The Engineering for Complex Systems Program will develop comprehensive capabilities and components for knowledge access, model based reasoning, risk prediction & management, experience capture, software engineering tools, resilient software-based systems and design decision-making. Methods will be developed for integrating advanced system health measurement approaches in the design process that take advantage of current and future developments in on-board sensing, self-healing materials, and self-reliant systems.

The Computing, Information, and Communications Technology Program will develop technologies to provide seamless and collaborative access to distributed ground-, air-, or space based hardware resources. It will also develop technologies to provide seamless and collaborative access to distributed software resources, whether they are in the form of data, tools, processes, or knowledge. This will allow better sharing of information, improves tracking of assumptions about complex processes, and reduce time spent on hardware and software integration. These prediction, modeling, and design capabilities will be integrated into a progressively improving set of user-accepted tools that can enable reliable design for mission safety and accurate assessment of mission cost and performance. Broadly announced peer reviewed solicitations are used to capture innovative ideas from the external community and to leverage emerging technologies from outside the aerospace field. These concepts will be combined with NASA expertise to synergistically form the basis for generating research programs in current critical areas and identifying new areas for research. Technology products will be integrated into proof-of-concept systems to validate performance in practical applications.

APG 3R11: Complete development of an organizational risk model and establish initial high dependability computing testbeds and tools as defined in the following indicators.

Performance Indicators:

Process and Concept Innovation

- Complete initial Organizational Risk Model that captures and analyzes data on social/organizational system risks and manage and evolve the organization by enabling the description and analysis of risks in organizational level decisions

V**alidation and Implementation**

- Establish initial High Dependability Computing Testbeds - install, load and provide initial simulations for at least two key NASA software systems that mitigate risks in the areas of dependability, performance/risk measurement tools, and testing of complex intelligent systems.
- Demonstrate certifiable program synthesis technology

Advanced Engineering and Analysis Technologies

- Validate nonlinear structural analysis tools

Objective Ten – Technology Innovation: Enable fundamentally new aerospace system capabilities and missions by enabling a 500 percent increase in useful new science information acquired from NASA science missions, data sources, and science system simulations as compared to equivalent FY 2000-2002 science programs by 2012, and by 2022, a 1000 percent increase. Enable heretofore-impractical or unaffordable mission classes by improving, by a factor of 3 in 2012 and 10 in 2020 over comparable systems and concepts designed using FY 2000 – 2002 flight –ready technology, flight resources including payload mass, volume, and power. By FY 2012, enable mission systems that can operate safely and successfully with less than 10 percent of the human participation required for FY 2000-2002 designs, and by FY 2020 enable missions that can analyze unexpected events and adjust plans and adapt systems accordingly with no human participation.

Strategy:

- **Core Competencies:** Build and advance, within NASA, the technology competencies that have potential for major benefits to aerospace applications.
- **Enabling New Missions:** Develop technologies for missions that are currently unrealistic, from personal air transportation to interstellar travel. This thrust will remove barriers such as high technology costs, limits to human endurance, and immense mission timeframes, to open exciting new possibilities.
- **Enabling New Capabilities:** Develop capabilities that are not possible today, such as autonomy sufficient to conduct an entire mission without human intervention, or self-repair of a vehicle's skin.

Public Benefit: NASA's science objectives are to answer diverse and far-reaching scientific questions regarding the universe, galaxies, stars, and planets including their make-up, origins, and the physical, chemical and biological processes involved. These include understanding the Earth and Sun and modeling the complex processes and interactions of the two to provide models of weather, climate, natural disaster, and natural resources for the improvement of the quality of life on earth. The total range of observations, measurements, and data analyses needed to address these objectives far exceeds the capabilities and affordability of current capabilities. The Aerospace Technology Enterprise seeks to provide radical improvements in sensing, instrument, and data processing technologies that are applicable to broad classes of science missions that can obtain information not currently attainable and to provide needed information at a lower cost.

NASA is developing revolutionary technologies for sensing and spacecraft systems to provide increased scientific return from future missions at lower cost. Advanced technologies will allow NASA to explore new regions of space, and to gain greater knowledge of the Earth, the Solar System, and the Universe. More capable and cost-effective missions will provide a higher return on investment in NASA programs over the next decade. NASA research in this program could also lead to lighter weight, higher strength materials for commercial applications, power concepts for remote locations, and very small biochemical probes applicable to medicine.

A huge cost factor in the operation of aerospace systems, once they are deployed, is the workload and cost of human operators whether it be for air traffic control, Space Shuttle launch, Space Station operation, or the monitoring and control of science missions. Science missions are frequently terminated, even though the spacecraft is operating perfectly and has considerable remaining life, because the cost of operation is too high relative to the remaining scientific potential. The workload and danger to astronauts in operating current and future exploration missions is a serious concern. Operating spacecraft on planetary surfaces and behind planets and moons is dangerous to mission success without the ability for the spacecraft to react to unplanned events.

Systems will be developed that can think, team, and make decisions with minimum human involvement to enable space exploration at far lower cost in human resources and to far more inaccessible locations than is currently possible. In addition to enabling breakthrough opportunities for space missions, this technology could improve many aspects of life on earth, for example, automating complex or hazardous work environments such as mining, rescue in natural disasters, or underwater operations.

With the vast amounts of scientific data being returned to Earth for analysis, another critical area of importance for NASA is in the area of data mining and data understanding. Tools and techniques are required to automatically analyze the data and to extract relevant scientific features for further human analysis and knowledge extraction. In addition to feature recognition and extraction, a key goal of this technology is to provide the underlying basis for establishing causal effects through modeling that can be used for analysis and study of the underlying physical or biological phenomena.

Finally, new revolutionary technologies in distributed information environments are required to enable much of the key capabilities discussed above. Seamless access to ground-, air- and space-based data and information are needed for effective command and control of NASA's exploration assets, optimal science return and knowledge generation, and for engineering and scientific collaborations. This distributed information environment will also benefit many other aspects of human life including other areas of science discovery and key operational environments such as the National Air Space system.

Note on APG's for Technology Innovation objective: The research and technology development supporting the Technology Innovation objective is necessarily about discovery; that is, exploring new ideas that may have high payoffs, but are also high-risk because outcomes and the timing of the outcomes that are unknown. Without being able to predict these outcomes, yet ensure advances in the state-of-the-art, numerous ideas from numerous sources are investigated. The few ideas that are successfully implemented typically result in enabling new, in some cases, unexpected functionality in future systems, including sensors, spacecraft or missions. If we fail to meet an indicator, it does not preclude the state-of-the-art from being advanced on the attempt. The following APG's for the Technology Innovation objective are to "advance the state-of-the-art."

Technical Approach (Science Data): Develop fundamental advances in automated reasoning technologies for spacecraft and rover autonomy and mission planning and scheduling. Develop fundamental advancements in instrument and data delivery capabilities, such as sensitivity, spatial coverage, resolution, spectral bandwidth and selectivity, data delivery rate, and data quality that vastly expand the reach of space and earth science in observable phenomena, physical space/time, and information richness. Seek bold new approaches to measurement, sensing, and decision processes though new concepts in bio-/nano-/information technology. Develop breakthrough capabilities for accessing, analyzing, and applying new and existing science data and for simulating systems to increase quality, timeliness, and understanding of information obtained. Develop breakthrough capabilities for data fusion and synthesis (e.g. for combining data from experiment and computation) and for data, information and knowledge mining. Broadly announced peer reviewed solicitations are used to capture innovative ideas from the external community, to leverage emerging technologies outside the aerospace field, and to complement NASA capabilities in critical areas. Technology products are integrated into proof-of-concept systems to validate performance in practical applications. Potential NASA mission customers are involved in the technology planning process and co-funded partnerships with user Enterprises for transition of maturing technologies to mission applications are pursued actively.

APG 3R12: Advance the state-of-the-art in automated data analysis, mission command and communications, and science sensors and detectors that are potentially beneficial for future NASA missions.

Performance Indicators:

Automated Science Data Understanding

- Discover a novel feature in skewed data
- Demonstrate tools and techniques for automated feature extraction from large datasets
- Demonstrate distributed analysis and data processing to support new problem solving paradigms
- Demonstrate component autonomy technologies in planning and scheduling supporting Mars mission operations

Mission Command and Data Delivery

- Demonstrate technology capable of two-times improvement in Mars-to-Earth communications
- Demonstrate technology capable of ten-fold improvement in Earth-orbit to ground communications
- Demonstrate capability for ad-hoc space and surface networking

Science Sensors and Detectors

Demonstrate molecular-level sensors for environmental health monitoring
Demonstrate high-efficiency, tunable, narrow-line 2 micron laser transmitters

- Demonstrate a fully conductively cooled laser transmitter

Characterize 2 micron detector and receiver components

- Perform advanced quantum mechanical modeling and spectroscopy of laser systems
- Demonstrate photonic/electronic hybrid power devices compatible with flexible substrates
- Demonstrate terahertz amplifiers with gain above 500 gigahertz
- Demonstrate superconducting terahertz receivers
- Demonstrate a prototype liquid Helium 4° Kelvin miniature sorption cooler
- Demonstrate 20 channel radio frequency single electron transistor multiplexor
- Demonstrate a prototype 256x256 Gallium Nitride Schottky photodiode array
- Demonstrate a prototype 512x512 prototype MicroElectroMechanical Systems (MEMS) microshutter array
- Demonstrate a prototype continuous Adiabatic Demagnetization Refrigerator at less than 0.1 degree Kelvin

Technical Approach (Ultra Efficiency): NASA will focus on the development of high-risk, high-payoff technologies with broad application to many classes of missions. These technologies are unique to NASA's long-term needs, and are not being developed elsewhere. Fundamental research and development will be performed in a variety of technical areas, including micro-devices and sensors, on-board power, electric propulsion, structures and materials, and bio-nanotechnology. To reduce cost and enhance scientific capabilities, technology development will emphasize miniaturization and launch-packaging efficiency, integration of functions, frugal use of flight resources, and resiliency. Broadly announced peer-reviewed solicitations are used to capture innovative ideas from the external community, to leverage emerging technologies outside the aerospace field, and to complement NASA capabilities in critical areas. Technology products are integrated into proof-of-concept systems to validate performance in practical applications. Potential NASA mission customers are involved in the technology planning process and co-funded partnerships with user Enterprises for transition of maturing technologies to mission applications are actively pursued.

APG 3R13: Advance the state-of-the-art in power / propulsion systems, spacecraft systems, and large or distributed space systems and our knowledge of space environmental effects that are required to support future NASA missions.

Performance Indicators:

Advanced Power and Electric Propulsion Systems

- Validate ion optics for a 2X increase in life relative to Deep Space 1
- Complete Hall thruster life and operating point correlations
- Complete Hall thruster modeling
- Demonstrate feasibility of high efficiency (i.e., greater than 30 percent) multi-band-gap solar cell on silicon substrate
- Demonstrate single axis integrated momentum and power control with flywheels
- Demonstrate 100 percent thrust augmentation of high area ratio nozzle
- Complete laboratory characterization of solid hydrogen behavior in liquid helium

Micro and Multipurpose Spacecraft Components and Systems

- Demonstrate integrated micropropulsion subsystem with control electronics
- Demonstrate three-axis inertial measurement unit using microgyros
- Demonstrate alpha voltaic power microgenerator
- Demonstrate integrated microinductors for miniature voltage converter
- Demonstrate sun sensor on chip for microspacecraft navigation
- Demonstrate micro electromechanical system microvalve
- Demonstrate 200 watt-hours per kilogram multifunctional battery/spacecraft structure panel

Large and Distributed Space Systems Concepts

- Develop algorithms for attitude determination for spacecraft formations using Global Positioning System (GPS)
- Develop algorithms for attitude control of spacecraft formations using GPS
- Develop relative equations of motion for spacecraft formations at L2 libration point
- Identify viable new concepts for in-space assembly of large space systems
- Demonstrate a prototype membrane waveguide antenna for remote sensing
- Demonstrate the deployment and ultraviolet-rigidization of inflatable boom for solar sails in a laboratory environment
- Demonstrate the deployment of a space boom using shape-memory-composite materials
- Establish proof of concept for a printable electronic circuit on multifunctional membranes

- Demonstrate a prototype electric powered unpiloted air vehicle capable of sustaining 14 hours of operation above an altitude of 50,000 feet

Space Environments and Effects

- Deliver meteoroid environmental model for inner solar system, Venus, and Mars
- Deliver revised NASA / Air Force Spacecraft Charging Analyzer Program (NASCAP-2K, Version 2.0)
- Develop Electronic Properties of Materials Database for use by spacecraft charging models and materials engineers
- Deliver Magneto-tail Charged Particle model for materials degradation studies
- Deliver Low Earth Orbit Spacecraft Charging Guidelines
- Deliver initial state of the art materials knowledge base (SAM-K, Version 1.0)

Technical Approach (Self Reliance): Develop technologies that can enable systems and systems of systems that can think, reason, make decisions, adapt to change, and cooperate among themselves and with humans to provide safe and successful aerospace processes and mission functions with greatly reduced human participation in their execution. Technology products will be integrated into proof-of-concept systems to validate performance in practical applications. Broadly announced peer-reviewed solicitations are used to capture innovative ideas from the external community, to leverage emerging technologies outside the aerospace field, and to complement NASA capabilities in critical areas. Technology products will be integrated into proof-of-concept systems to validate performance in practical applications.

APG 3R14: Demonstrate progress toward achievement of systems and systems of systems that can think, reason, make decisions, adapt to change, and cooperate among themselves and with humans to provide safe and successful aerospace processes and mission functions with greatly reduced human participation by successfully demonstrating individual autonomy components.

Performance Indicator

- Demonstrate individual autonomy component technologies to be included in the larger, integrated demonstration

5. Management Challenges: The overall organizational and management structure of NASA technology development is built around its Strategic Enterprises, including specific program formulation and funding responsibility for all technology activities. This ensures that technology considerations are closely coupled with mission decisions, that technologies are relevant to Enterprise needs, and that mechanisms are provided to transfer successful maturing technologies into operational systems. NASA has undertaken sweeping changes in technology program management to strengthen and highlight the significance of advanced technology in NASA's future. These changes influence how NASA identifies new technology investments and how NASA ensures the efficient transition of new technologies into missions. Specifically, this includes: the realignment of the budget to more closely correspond with Enterprise Strategic Objectives, development and implementation of system analysis tools to aid in program assessment and development of technology portfolios, use of the Aerospace Technology Advisory Committee of the NASA Advisory Council and the National Research Council to provide independent relevance and quality reviews of the Enterprise's technology development projects, and strengthening the relationships with other NASA Enterprises in the development of the research program, and participation in technology maturation activities. Overall, the adjustments have resulted in a closer alignment of technology investments with the goals identified in the NASA Strategic Plan and will allow management to assess the quality and relevance of the Enterprise's research program.

Coordination and integration among all of the Agency's Enterprises is provided through the NASA Chief Technologist. The Chief Technologist advises the Administrator and other senior officials on matters relating to technology, assures an Agency-wide investment strategy for advanced innovative technology, and is the principal Agency advocate for advanced technology. The Chief Technologist also chairs the Technology Leadership Council, which includes the Associate Administrators for the Strategic Enterprises, the NASA Field Center Directors, the NASA Comptroller, and other senior NASA officials. This council establishes the technology strategy for the Agency, addresses critical issues, and is responsible for formulating and advancing NASA's vision for technology. The Associate Administrator for Aerospace Technology is the NASA Chief Technologist to centralize planning and execution of Agency-level technology within one organization while still providing for Enterprise-specific mission technology development by each of the other NASA Enterprises.

As part of the development of the FY 2003 budget development, the Aerospace Technology Enterprise has restructured its programs and projects to more closely align with its Strategic Objectives. This revised structure will simplify the management structure and increase responsiveness to the customer communities.

The Enterprise will also be using independent reviews to provide external assessments of its programs. In total these reviews will assess the programmatic status of each of the programs, the progress that the Enterprise is making toward the achievement of its strategic objectives, the scientific quality of its research, and relevance of the research to the customer's needs. The results of these reviews will provide the Enterprise with objective information on the status and effectiveness of its research programs and impact the content and future elements of the program. Each of these reviews is discussed below.

- An Inter-Center System Analysis Team has been formed and conducts an independent assessment of the progress the Enterprise is making toward the accomplishment of each of its strategic objectives. System analysis tools have been developed to support this process, which will provide the Enterprise with a benchmark for measuring its overall progress toward the accomplishment of its Strategic goals.

- An Independent Annual Review (IAR) will be performed to assess the progress and continued executability of each Enterprise program the annual program review will assess performance against plan, including technical performance, schedule and cost. Additionally the IAR will assess the future executability of the program plan. The IAR compiles its report and provides findings to the Enterprise and governing Program Management Council.

- The quality and relevance review process includes two separate and independent review mechanisms.

- The NASA Advisory Council Aerospace Technology Advisory Committee (ATAC) will conduct an annual review of the relevance and quality of Aerospace Technology Enterprise programs with emphasis on relevance. This review will provide input from our primary customers on the relevancy of our program to their needs and the agency goals.

- The National Research Council Aeronautics and Space Engineering Board (ASEB) will conduct periodic review of the quality and relevance of each Aerospace Technology Enterprise project with emphasis on quality. This review will assess: the scientific and technical quality of each research project, the quality of the performers conducting the research, whether the proper mix of personnel from government, industry, and academia are assigned to each project, the relevance of each project to the customer, and the quality of the program planning behind each project. The team will examine the research portfolio, the research goals, the research plans, the overall capabilities of the research team, the technical progress and prognosis of the research, and the relationship of the research to the broader scientific community.

The management challenges facing the Aerospace Technology Enterprise are similar to that of any organization that is responsible for the identification and development of revolutionary and high-risk technologies for a wide range of using organizations. These include:

- Ensuring that the user needs are well understood, reflected in the research plans and that the user also recognizes the benefits of the on-going research
- Ensuing research being conducted in the proper areas and that the far term research being conducted at the forefront of science and determined to be a world-class endeavor
- Ensuring that research is being conducted by the proper performer (government, academia, or industry).
- Ensuring the proper balance between fundamental and user driven research
- Ensuring that there is the proper balance between far term research and the application of fundamental science to solve real world problems
- Ensuring that the research plans are sound (including regular external reviews, off-ramps, and sunsets) and that adequate progress is being made toward the end objective
- Ensuring effective knowledge transfer

The Office of Aerospace Technology has established the following goals to address the above management challenges. The accomplishment of these goals is on an Enterprise wide basis since they address the totality of the research program and not individual goals / objectives.

APG 3R15: Implement an effective oversight process to insure that the research programs are addressing the correct areas, meeting user requirements, have the proper balance, are properly formulated and planned, and are making sufficient process toward the Enterprise goals

Performance Indicators:

Strategic Planning and Decisions

- Effective use of the Office of Aerospace Technology Investment Planning process to assess the needs against the current research portfolio and identify potential technology gaps
- Conducting a inter center system analysis to assess the progress the current research portfolio is making toward the accomplishment of the Enterprise Strategic Objectives

Program Quality and Relevance

- Conducting independent technical reviews to assess the relevance and quality of selected items of the research program. The reviews will examine the research portfolio, goals and the relationship to the broader scientific community, in terms of the quality of the technology being developed and the needs of the customer organizations.

- Establishment of a review team consisting of representatives of the customer NASA Enterprises and their mission programs and projects to conduct NASA mission relevancy reviews of the research program.

Program Management and Oversight

- Effective use of an Enterprise Program Management Council with appropriate representation from other NASA Enterprises and Offices
- Successful completion of a Program Readiness Review and Non-Advocate Review for every new program / project prior to program go-ahead
- Conducting an Independent Annual review (IAR) of each program to assess its progress and continued executability. The annual program review will assess performance against plan including technical performance, schedule, and cost. Additionally, the IAR will assess the future executability of the program.

APG 3R16: To contribute toward maintaining a well-prepared workforce pipeline, all Enterprise program activities will establish and implement, or continue implementation of, an education outreach plan that results in an educational product. The product shall be consistent with the NASA Implementation Plan for Education and use program content to demonstrate or enhance the learning objectives.

Performance Indicators:

- Implementation of current education outreach plans.
- Establishment of education outreach plans for all remaining programs
- Effective use of the 5 University-based Research, Education, and Training Institutes (RETIs).
- Inclusion of a University research strategy for each Enterprise program

Verification/Validation Summary: The data used to substantiate actual performance originates at the NASA Center responsible for project implementation. The data will be reviewed and verified by senior Center official and the program and project managers. The NASA HQ Program Executive Officer and Director of the Research and Technology Division will validate this data. The NASA Advisory Council will also provide an independent assessment of each Aerospace Technology program performance.

FY 2003 MULTI-YEAR PERFORMANCE TREND

Aerospace Technology

Goal 1: Revolutionize Aviation

Strategic Objective: Increase Safety-Make a safe air transportation system even safer

	FY 99	FY 00	FY01
Annual Performance Goal and APG #	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.	0R3: Flight demonstrate a conceptual aircraft flight deck integrated with evolving ground-based runway incursion avoidance technologies installed at a major airport.	1R1: NASA's research stresses aviation system monitoring and modeling, accident prevention and accident mitigation. The performance target is to complete 75% of the conceptual designs of systems for preventing and mitigating accidents, and to demonstrate tools for accident analysis and risk assessment.
Assessment	Green	Yellow	
Annual Performance Goal and APG #	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.		
Assessment	Yellow		
	FY 02	**FY 03**	
Annual Performance Goal and APG #	2R1: Complete the interim progress assessment utilizing the technology products of the Aviation Safety program as well as the related Aerospace Base R&T efforts and transfer to industry an icing CD-ROM, conduct at least one demonstration of an aviation safety related subsystem, and develop at least two-thirds of the planned models and simulations.	APG 3R1: Demonstrate progress in maturing, through flight tests and/or simulations, the critical technologies that will be necessary to meet the aviation safety objective. These tests and simulations are critical steps in the development of a suite of technologies that when completely developed and implemented by the customer, will provide a minimum of 50 percent reduction in fatal accident rate.	
Assessment	TBD	TBD	

Strategic Objective: Reduce Emissions-Protect local air quality and our global climate

	FY 99	**FY 00**	**FY01**
Annual Performance Goal and APG #	9R1: Demonstrate an advanced turbine-engine combustor that will achieve up to a 50 percent reduction of Oxides of Nitrogen emissions based on 1996 International Civil Aviation Organization (ICAO) standards.	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.	1R2: NASA's research stresses engine technology to reduce the emissions of oxides of nitrogen and carbon dioxide. The performance target is to complete one system level technology benefit assessment, one component concept selection and one new material system.
Assessment	Green	Blue	
	FY 02	**FY 03**	
Annual Performance Goal and APG #	2R2: NASA's research stresses engine technology to reduce the emissions of oxides of nitrogen (NOx) and carbon dioxide (CO2). The annual performance goal is to complete sector testing of a low-NOx combustor concept capable of a 70% reduction in NOx from the 1996 International Civil Aviation Organization (ICAO) baseline, and demonstrate at least one additional concept for the reduction of other emittants.	APG 3R2: Complete combustor sector test for concepts capable of achieving the 70%NOX goal by 2007 and select the most promising approaches leading to full annular rig testing for large and regional jet engine applications. Complete an Interim Technology Assessment of the aggregate potential benefits from the engine and airframe technologies to reduce emissions. The results from this analysis will provide a benchmark for measuring overall progress, and guide future investment decisions.	
Assessment	TBD	TBD	

<u>Strategic Objective</u>: Reduce Noise-Reduce aircraft noise to benefit airport neighbors, the aviation industry, and travelers

	FY 99	**FY 00**	**FY01**
Annual Performance Goal and APG #		0R2: Validate the technologies to reduce noise for large commercial transports by at least 7 decibels relative to 1992 production technology.	1R3: NASA's research has stressed reducing noise in the areas of engines, nacelles, engine/airframe integration, aircraft interiors and flight procedures. The performance target is completion of NASA's research in noise reduction through large scale demonstration of a 2-5 decibel reduction in aircraft noise based on 1997 production technology, and initial assessments of concepts offering additional reduction.
Assessment		Green	
	FY 02	**FY 03**	
Annual Performance Goal and APG #	2R3: NASA's research stresses reducing noise in the areas of engines, nacelles, engine-airframe integration, aircraft interiors and flight procedures. The annual performance goal is to assess and establish the strongest candidate technologies to meet the 10 decibel reduction in community noise.	APG 3R3: Complete development of initial physics-based prediction models to guide the development potential noise reduction technology concepts. Complete an interim technology assessment of the potential benefits for these concepts to reduce noise emissions. The results from this analysis will provide a benchmark for measuring overall progress, and guide future investment decisions.	
Assessment	TBD	TBD	

Strategic Objective: Increase Capacity-Enable the movement of more air passengers with fewer delays

	FY 99	FY 00	FY01
Annual Performance Goal and APG #		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.	1R4: NASA's research stresses operations systems for safe, efficient air traffic management and new aircraft configurations for high productivity utilization of existing runways. The performance target is to complete the civil tiltrotor project by validating databases for contingency power, flight paths, and noise reduction, as well as complete at least one demonstration of an airspace management decision support tool.
Assessment		Green	
	FY 02	**FY 03**	
Annual Performance Goal and APG #	2R4: NASA's research stresses operations systems for safe, efficient air traffic management and new aircraft configurations for high productivity utilization of existing runways. The annual performance goal is to develop a decision support tool, and define concepts for future aviation systems.	APG 3R4: Complete development, initial functionality and evaluate human factors for at least one decision support tool to enable achievement of the planned progress towards the goal of doubling the capacity of the National Airspace System in 10 years. Complete the initial build of a toolbox of state-of-the-art airspace models to enable the planned progress towards the 2022 Objective.	
Assessment	TBD	TBD	

Strategic Objective: Increase Mobility-Enable people to travel faster and farther, anywhere, anytime

	FY 99	**FY 00**	**FY01**
Annual Performance Goal and APG #	9R8: Conclude pre-flight ground testing of the general aviation piston and turbofan engines.	0R7: Perform flight demonstrations of advanced general aviation piston and turbine engines at the annual Oshkosh air show.	1R7: NASA's research stresses operations systems for safe, efficient air traffic management and new aircraft configurations for high productivity utilization of existing runways. The performance target is to complete the Advanced General Aviation Transport Experiments project by validating transportation system concepts through flight test and publish design guidelines.
Assessment	Yellow	Yellow	
Annual Performance Goal and APG #	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 (HSCT).		
Assessment	Green		

	FY 02	**FY 03**	
Annual Performance Goal and APG #	2R5: NASA's research stresses aircraft technologies which enable the use of existing small community and neighborhood airports, without requiring control towers, radar installations, and more land use for added runway protection zones. The annual performance goal is to baseline, in partnership with the FAA, the system engineering	APG 3R5: Select candidate technologies for experimental flight evaluation based on their impact on mobility. Mobility metrics will be measured by accessibility, doorstep-to-destination transit time, system and user costs, and related trip reliability and safety metrics. These flight experiments will evaluate individually, at the sub-system level, the impact of selected technologies on lowering required landing minimums and increasing the volume of operations at	
Assessment	TBD	TBD	

Goal 2: Advance Space Transportation

Strategic Objective: Mission Safety-Radically improve the safety and reliability of space launch systems

	FY 99	FY 00	FY 01	
Annual Performance Goal and APG #				
Assessment				

	FY 02	**FY 03**	
Annual Performance Goal and APG #	2R6: NASA's investments emphasize thorough mission needs development, requirements definition, and risk reduction effort leading to commercially owned and operated launch systems to meet NASA needs with commercial application where possible. The annual performance goal is to complete risk reduction and architecture reviews to support design and demonstration decisions.	APG 3R6: Down-select to a minimum of two launch architectures for detailed development based on their ability to meet the safety and affordability goals. This selection will determine what launch architectures and critical technology developments will be continued through FY 2006.	
Assessment	TBD	TBD	
Annual Performance Goal and APG #		APG 3R7: Complete the independent evaluation of three revolutionary hypersonic propulsion technology systems demonstrations and associated ground technologies. This independent evaluation will validate ability of each propulsion system, a rocket-based combined-cycle engine, a turbine-based combined cycle engine and a scramjet engine, to achieve the strategic objectives within cost and schedule.	
Assessment		TBD	

<u>Strategic Objective</u>: Mission Affordability-Create an affordable highway to space

	FY 99	**FY 00**	**FY01**
Annual Performance Goal and APG #	9R14: Continue the X-33 Vehicle Assembly in Preparation for Flight Testing.	0R9: Conduct the flight testing of the X-33 vehicle.	1R10: NASA's research stresses highly reliable, fully reusable configurations, advanced materials and innovative structures. The performance target is complete assembly of the third X-34 test vehicle, demonstrate 75% of supporting technology developments, and complete competitive solicitations for expanded 2nd generation reusable launch vehicle efforts.
Assessment	Green	Red	
Annual Performance Goal and APG #	9R15: Complete Vehicle Assembly and Begin Flight Testing of the X-34.	0R12: Complete vehicle assembly and begin the flight test of the second X-34 vehicle.	1R11: NASA's research stresses technology for reusable, long life, high power electric and advanced, clean chemical engines for earth orbital transfer and breakthrough propulsion, precision landing systems and aerocapture systems for planetary exploration. The performance target is to commence X-37 vehicle assembly, and complete one Pathfinder flight experiment.
Assessment	Yellow	Red	
Annual Performance Goal and APG #			
Assessment			
Annual Performance Goal and APG #		0R17: Complete small payload focused technologies and select concepts for flight demonstration of a reusable first stage (Bantam).	
Assessment		Red (project terminated 10/99)	

<u>Strategic Objective</u>: Mission Affordability-Create an affordable highway to space (cont.)

	FY 02	**FY 03**	
Annual Performance Goal and APG #	2R7: NASA's investments emphasize thorough mission needs development, requirements definition, and risk reduction effort leading to commercially owned and operated launch systems to meet NASA needs with commercial application where possible. The annual performance goal is to complete risk reduction and architecture reviews and initial hardware demonstrations to support design and demonstration decisions.	APG 3R8 Down-select to a minimum of two launch architectures for detailed development based on their ability to meet the safety and affordability goals. This selection will determine what RLV architectures and critical technology developments will be continued through FY 2006.	
Assessment	TBD	TBD	
Annual Performance Goal and APG #			
Assessment		TBD	
Annual Performance Goal and APG #		APG 3R9 Complete the independent evaluation of three revolutionary hypersonic propulsion technology systems demonstrations and associated ground technologies. This independent evaluation will validate ability of each propulsion system, a rocket-based combined-cycle engine, a turbine-based combined cycle engine and a scramjet engine, to achieve the strategic objectives within cost and schedule.	
Assessment		TBD	
Annual Performance Goal and APG #			
Assessment			

Strategic Objective: Mission Reach-Extend our reach in space with faster travel times

	FY 99	**FY 00**	**FY01**
Annual Performance Goal and APG #		0R10: Complete NASA Solar Electric Propulsion Technology Application Readiness (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).	
Assessment		Green	
	FY 02	**FY 03**	
Annual Performance Goal and APG #	2R8: NASA's long-term research emphasizes innovative propulsion systems. The performance target is to conduct a test of an advanced ion propulsion engine.	APG 3R10 Complete initial component tests to provide data for evaluating feasibility of key concepts by completing all of the following indicators.	
Assessment	TBD	TBD	

Goal 3: Pioneer Revolutionary Technology

<u>Strategic Objective</u>: Engineering Innovation-Enable rapid, high-confidence, and cost efficient design of revolutionary systems

	FY 99	**FY 00**	**FY01**
Annual Performance Goal and APG #	9R12: Demonstrate up to a 200-fold improvement over the 1992 baseline (reduction from 3,200 hours to 15) in the timeto-solution for a full combustor simulation on NASA's National Propulsion System Simulation advanced applications computational testbeds that can be increased to sustain teraFLOPS capability.	0R8: Demonstrate a prototype heterogeneous distributed computing environment.	1R8: Develop at least three new design tools, accomplish at least four demonstrations of advances in computation and communications, and complete the intelligent synthesis environment proof-of-concept system capability build to technology readiness level
Assessment	Blue	Green	
Annual Performance Goal and APG #	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.		
Assessment	Blue		
	FY 02	**FY 03**	
Annual Performance Goal and APG #	2R9: NASA's investments emphasize advances in experimental vehicles, flight testbeds, and computing tools to enable revolutionary designs. The annual performance goal is to conduct at least five demonstrations of revolutionary aerospace subsystems.	APG 3R11: Complete development of an organizational risk model and establish initial high dependability computing testbeds and tools as defined in the following indicators.	
Assessment	TBD	TBD	

Strategic Objective: Technology Innovation-Enable fundamentally new aerospace system capabilities and missions.

	FY 99	**FY 00**	**FY01**
Annual Performance Goal and APG #	9R10: Complete low altitude flights of an Remotely Piloted Aircraft (RPA) with a wingspan greater than 200 feet, suitable for flight to 100,000 feet in altitude once outfitted with high performance solar cells.	0R11: Demonstrate improved remotely piloted aircraft science mission capability by increasing operational deployment time from 3 weeks to 9 with minimum airfield provisions and unrestricted airspace. (Original) Demonstrate continuous over-the-horizon command and control capabilities ofan RPA that would extend the operating range from 40 to 200 nautical miles. (Replacement)	
Assessment	Green	Red (orig.); Green (replacement)	
Annual Performance Goal and APG #	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.		
Assessment	Green		
Annual Performance Goal and APG #		0R6: Demonstrate in flight an airframe-integrated, dual-mode, scramjet-powered vehicle.	1R9: NASA's research stresses affordable flight demonstrations of revolutionary vehicle concepts (low-cost X-Planes) to accelerate technology advances in laboratory research, new design tools and advanced simulation. The performance target is to demonstrate two new concepts in flight and identify five new concepts for further examination.
Assessment		Yellow	

Strategic Objective: Technology Innovation-Enable fundamentally new aerospace system capabilities and missions. (cont.)

	FY 02	FY 03	
Annual Performance Goal and APG #	2R10: NASA's investments emphasize revolutionary technologies such as nanotechnology, information technology and biotechnology which could enable new missions and capabilities. The annual performance goal is to develop at least two new materials concepts and demonstrate the feasibility of at least two nanotechnology concepts and two other concepts.	APG 3R12: Advance the state-of-the-art in automated data analysis, mission command and communications, and science sensors and detectors that are potentially beneficial for future NASA missions.	
Assessment	TBD	TBD	
Annual Performance Goal and APG #		APG 3R13: Advance the state-of-the-art in power / propulsion systems, spacecraft systems, and large or distributed space systems and our knowledge of space environmental effects that are required to support future NASA missions.	
Assessment		TBD	
		APG 3R14: Demonstrate progress toward achievement of systems and systems of systems that can think, reason, make decisions, adapt to change, and cooperate among themselves and with humans to provide safe and successful aerospace processes and mission functions with greatly reduced human participation by successfully demonstrating individual autonomy components.	

Management Challenge objective

	FY 99	FY 00	FY01
Annual Performance Goal and APG #	9R16: Complete 90 percent of all Enterprise-controlled milestones within 3 months of schedule.	0R13: Complete 90 percent of all Enterprise-controlled milestones within 3 months of schedule.	
Assessment	Yellow	Red	
Annual Performance Goal and APG #	9R17: 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.	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.	
Assessment	Blue	Green	
Annual Performance Goal and APG #	9R18: Complete the Triennial Customer Satisfaction Survey, and achieve an improvement from 30 percent to 35 percent in "highly satisfied" ratings from Enterprise customers.		1R12: Customer Feedback: Continue the solicitation of customer feedback on the services, facilities, and expertise provided by the Aerospace Technology Enterprise.
Assessment	Green		
Annual Performance Goal and APG #	9R19: Transfer at least 10 new technologies and processes to industry during the fiscal year.	0R15: Transfer at least 12 new technologies and processes to industry during the fiscal year.	
Assessment	Blue	Blue	
Annual Performance Goal and APG #	9R21: For all new program activities initiated in FY 99, 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	0R16: Continue the implementation of current education outreach plans and establish new plans for all new program activities initiated in FY 00.	1R13: Education Outreach: Continue the implementation of current education outreach plans, and establish new plans for all new program activities initiated in FY 2001.
Assessment	Yellow	Blue	
Annual Performance Goal and APG #	9R20: Establish an Aeronautics Education Laboratory in at least three new sites in the United States.		
Assessment	Blue		

Management Challenge objective (cont.)

	FY 02	FY 03	FY04
Annual Performance Goal and APG #			
Assessment			
Annual Performance Goal and APG #			
Assessment			
Annual Performance Goal and APG #	2R11: The annual performance goal is to continue the solicitation of customer feedback on the services, facilities, and expertise provided by the Aerospace Technology Enterprise.	APG 3R15:. Implement an effective oversight process to insure that the research programs are addressing the correct areas, meeting user requirements, have the proper balance, are properly formulated and planned, and are making sufficient process toward the Enterprise goals	
Assessment	TBD	TBD	
Annual Performance Goal and APG #	2R13: Review results of NASA and commercial-sector performed launch system architecture studies, related requirements, and refinements in planned risk reduction investments.		
Assessment	TBD		
Annual Performance Goal and APG #	2R12: Continue the implementation of current education outreach plans, and establish new plans for all new program activities initiated in FY 2002.	APG 3R16: To contribute toward maintaining a well-prepared workforce pipeline, all Enterprise program activities will establish and implement, or continue implementation of, an education outreach plan that results in an educational product. The product shall be consistent with the NASA Implementation Plan for Education and use program content to demonstrate or enhance the learning objectives.	
Assessment	TBD	TBD	
Annual Performance Goal and APG #			
Assessment			

Aerospace Technology FY 2003 Budget Link Table	**Budget Category**	Vehicle Systems	Aviation safety	Airspace Systems	2nd Generation	3rd Generation	Engineering for Complex Systems	Computing, Information and Communications Technology	Enabling Concepts and Technologies
Annual Performance Goal & APG #									
APG 3R1: Demonstrate progress in maturing, through flight tests and/or simulations, the critical technologies that will be necessary to meet the aviation safety objective. These tests and simulations are critical steps in the development of a suite of technologies that when completely developed and implemented by the customer, will provide a minimum of 50 percent reduction in fatal accident rate.		X	X						
APG 3R2: Complete combustor sector test for concepts capable of achieving the 70%NOX goal by 2007 and select the most promising approaches leading to full annular rig testing for large and regional jet engine applications. Complete an Interim Technology Assessment of the aggregate potential benefits from the engine and airframe technologies to reduce emissions. The results from this analysis will provide a benchmark for measuring overall progress, and guide future investment decisions.		X							
APG 3R3: Complete development of initial physics-based prediction models to guide the development potential noise reduction technology concepts. Complete an interim technology assessment of the potential benefits for these concepts to reduce noise emissions. The results from this analysis will provide a benchmark for measuring overall progress, and guide future investment decisions.		X							
APG 3R4: Complete development, initial functionality and evaluate human factors for at least one decision support tool to enable achievement of the planned progress towards the goal of doubling the capacity of the National Airspace System in 10 years. Complete the initial build of a toolbox of state-of-the-art airspace models to enable the planned progress towards the 2022 Objective.				X					

Aerospace Technology FY 2003 Budget Link Table	**Budget Category**	Vehicle Systems	Aviation safety	Airspace Systems	2nd Generation	3rd Generation	Engineering for Complex Systems	Computing, Information and Communications Technology	Enabling Concepts and Technologies
APG 3R5: Select candidate technologies for experimental flight evaluation based on their impact on mobility. Mobility metrics will be measured by accessibility, doorstep-to-destination transit time, system and user costs, and related trip reliability and safety metrics. These flight experiments will evaluate individually, at the sub-system level, the impact of selected technologies on lowering required landing minimums and increasing the volume of operations at non-towered landing facilities in non-radar airspace during instrument meteorological conditions		**X**		**X**					
APG 3R6: Down-select to a minimum of two launch architectures for detailed development based on their ability to meet the safety and affordability goals. This selection will determine what launch architectures and critical technology developments will be continued through FY 2006					**X**				
APG 3R7: Complete the independent evaluation of three revolutionary hypersonic propulsion technology systems demonstrations and associated ground technologies. This independent evaluation will validate ability of each propulsion system, a rocket-based combined-cycle engine, a turbine-based combined cycle engine and a scramjet engine, to achieve the strategic objectives within cost and schedule.						**X**			
APG 3R8: Down-select to a minimum of two launch architectures for detailed development based on their ability to meet the safety and affordability goals. This selection will determine what RLV architectures and critical technology developments will be continued through FY 2006.					**X**				
APG 3R9: Complete the independent evaluation of three revolutionary hypersonic propulsion technology systems demonstrations and associated ground technologies. This independent evaluation will validate ability of each propulsion system, a rocket-based combined-cycle engine, a turbine-based combined cycle engine and a scramjet engine, to achieve the strategic objectives within cost and schedule.						**X**			

Aerospace Technology FY 2003 Budget Link Table	**Budget Category**	Vehicle Systems	Aviation safety	Airspace Systems	2nd Generation	3rd Generation	Engineering for Complex Systems	Computing, Information and Communications Technology	Enabling Concepts and Technologies
APG 3R10: Complete initial component tests to provide data for evaluating feasibility of key concepts by completing all of the following indicators.									X
APG 3R11: Complete development of an organizational risk model and establish initial high dependability computing testbeds and tools as defined in the following indicators.		X					X	X	X
APG 3R12: Advance the state-of-the-art in automated data analysis, mission command and communications, and science sensors and detectors that are potentially beneficial for future NASA missions.								X	X
APG 3R13: Advance the state-of-the-art in power / propulsion systems, spacecraft systems, and large or distributed space systems and our knowledge of space environmental effects that are required to support future NASA missions.		X							X
APG 3R14: Demonstrate progress toward achievement of systems and systems of systems that can think, reason, make decisions, adapt to change, and cooperate among themselves and with humans to provide safe and successful aerospace processes and mission functions with greatly reduced human participation by successfully demonstrating individual autonomy components.								X	X
APG 3R15: Implement an effective oversight process to insure that the research programs are addressing the correct areas, meeting user requirements, have the proper balance, are properly formulated and planned, and are making sufficient process toward the Enterprise goals		X	X	X	X	X	X	X	X
APG 3R16: To contribute toward maintaining a well-prepared workforce pipeline, all Enterprise program activities will establish and implement, or continue implementation of, an education outreach plan that results in an educational product. The product shall be consistent with the NASA Implementation Plan for Education and use program content to demonstrate or enhance the learning objectives.		X	X	X	X	X	X	X	X

Biological and Physical Research Enterprise (BPRE)
FY 2003 Performance Plan

Mission

NASA's Office of Biological and Physical Research seeks

- to understand and enable the human experience in space, and
- use space to better understand the laws of nature and the evolution of life

The microgravity environment of space allows scientists to open a new window on the most basic and important biological, chemical, and physical processes. At the same time, the space environment poses major challenges to the well being of space travelers. Space flight exposes humans to low gravity and radiation environments never before encountered in our evolutionary history. As we seek to exploit the rich opportunities of space flight for fundamental research and commercial development, we must develop efficient and effective technologies and methods for protecting human health in space.

Goal 1: Conduct research to enable safe and productive human habitation of space.
BPRE conducts fundamental and applied research in the biological and physical sciences to reduce the health risks of space travel. We conduct research on technology for efficient, self-sustaining life-support systems to provide safe, hospitable environments for space exploration, and develop advanced technologies for healthcare delivery. Advances in healthcare first developed for the space flight environment are applied on Earth to enhance healthcare.

Goal 2: Use the space environment as a laboratory to test the fundamental principles of physics, chemistry, and biology.
The space environment offers a unique laboratory in which to study biological and physical processes. Researchers take advantage of this environment 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. Materials scientists study the role of gravity in important industrial processes. Physicists take advantage of microgravity to study exotic forms of matter that are better handled in space. Biological researchers investigate the role of gravity in life processes and how the space environment affects living organisms. The knowledge derived from BPRE's diverse research will inform and expand scientific understanding, support economic and technological progress, and help to enable human exploration of space.

Goal 3: Enable and promote commercial research in space.

BPRE provides knowledge, policies, and technical support to facilitate industry investment in space research. BPRE will continue to enable commercial researchers to take advantage of space flight opportunities for proprietary research. The commercial sector will grow to become the premier mechanism for applying space knowledge to benefit the American people. Commercial applications of space knowledge will generate new products, new jobs, and new spin-off companies.

*Goal 4: Use space research opportunities to improve academic achievement and the quality of life***.**
BPRE seeks to use its research activities to encourage educational excellence and to improve scientific literacy from primary school through the university level and beyond. We deliver value to the American people by facilitating access to the experience and excitement of space research. BPRE strives to involve society as a whole in the transformations that will be brought about by research in space.

Resource Requirements

(NOA, dollars in millions)

	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
$M	--	--	313	820	842
CS FTE			427	1,242	1,273

Each annual performance goal is associated with a specific program budget; however, the majority of BPRE performance goals are overarching and interdependent in nature. They are not budgeted as discrete elements of BPRE programs.

Implementation Strategy

BPRE's program is implemented at seven NASA Field Centers and the Jet Propulsion Laboratory, as well as through the participation of Commercial Space Centers (CSCs), a National Space Biomedical Research Institute, and a National Center for Microgravity Research on Fluids and Combustion. BPRE relies upon an extensive external community of academic, commercial and government scientists and engineers for the implementation of its programs. BPRE-supported science and technology research projects are reviewed by scientific or technical peers. In selecting investigations and projects to support—and ultimately for access to space—BPRE follows peer-review processes appropriately designed for scientific research, technology research and development, and commercial research. Our peer review processes ensure the competitiveness and quality of BPRE research.

BPRE implements its research programs through ground-based as well as space flight research. Ground-based research precedes flight research and employs NASA facilities such as drop towers, centrifuges, and bed-rest facilities. The space flight research programs use the full spectrum of platforms, including free-flying satellites, Space Shuttle, and the International Space Station (ISS). In FY 2002, BPRE assumed responsibility for the ISS research budget. The ISS research budget funds continued build-up and utilization of research equipment on the ISS to support in flight research during fiscal years 2002 and 2003, leading to a broad-based, multidisciplinary flight research program upon completion of the ISS assembly phase.

Roadmap: [Source: NASA Strategic Plan]

Near–term Plans (2000-2005)	Mid-term Plans (2006-2011)	Long-term Plans (2012-2025)
• Identify mechanisms of health risk and potential physiological and psychological problems to humans living and working in space, and begin developing and testing countermeasures. • Conduct scientific and engineering research and enable commercial research activities on the ISS to enrich health, safety, and the quality of life on Earth. • Begin developing interdisciplinary knowledge (e.g., biology, physics, materials) to support safe, effective, and affordable human/robotic exploration.	• Understand the effects of long-duration space flight (e.g., radiation), validate countermeasures and technology and begin developing countermeasures for long-duration space flight. • Extend our understanding of chemical, biological, and physical systems. • Test and validate technologies that can reduce the overall mass of human support systems by a factor of three (compared to 1990's levels).	• Apply and refine countermeasures for safe, effective, and affordable long-duration human space flight. • Achieve a deep understanding of the role of gravity in complex chemical, biological, and physical processes. • Test and validate technologies for safe, self-sufficient, and self-sustaining life support systems that can enable humans to live and work in space and on other planets for extended periods.

BPRE is preparing for the transition to a new era in human space flight. The International Space Station (ISS) will provide a growing capability as a research platform. BPRE will work to extract the maximum scientific and commercial return from this promising research facility while conducting research to ensure the health and safety of space travelers in the near term and into the future.

BPRE will conduct a rigorous prioritization exercise during the spring and summer of 2002 to prioritize the research questions being pursued. This prioritization will help focus resources on priority questions, increasing the speed and likelihood that they will be answered. The strategic roadmap shown above is subject to change based on this ongoing assessment of priorities.

Performance Measures
The following performance measures rely heavily on review by BPRE's advisory committee using standard color-coded assessment criteria as follows:

Blue = Annual Performance Goal exceeded, or performance is exceptional
Green = Annual Performance Goal met
Yellow:= Annual Performance Goal not met, but a recovery plan is in place for the coming fiscal year
Red = Annual Performance Goal not met.

Goal 1: Conduct research to enable safe and productive human habitation of space.

Objective: Conduct research to ensure the health, safety, and performance of humans living and working in space.

Millions of years of evolution have molded the human body to cope with and rely upon gravity. Virtually every system of the body responds when a person travels to space. Weight-bearing bones lose about 1% of bone mass per month. Muscles atrophy, and nerves in the balance system begin to rewire their connections to take account of the sudden disappearance of up and down. Many of these changes pose significant health issues, especially when space travelers return to gravity. NASA research will identify methods that will efficiently control the effects of space travel and ensure the health and safety of future space travelers. Humans can only travel to space by bringing a microcosm of the Earth with us. We need an atmosphere, food, water, and protection from temperature extremes and space radiation. NASA research will develop advanced technologies for efficient life support systems to provide these needs with minimal resupply from Earth.

Public Benefit: The primary goal of this research is to improve health and safety for space travelers; however, this research also has the potential to make significant contributions to medical care on Earth. For example, space flight can provide models for exploring osteoporosis and other diseases of muscle and bone. It has provided unique insights into nerve regeneration and the capacity of the nervous system to grow, change, and adapt in response to environmental stimuli. The parallels between aging and space travel are currently under study by researchers at NASA and the National Institutes of Aging. BPRE research on life support technologies will reduce the cost of space travel. This technology will also find application in process control systems for industry, and may even in help to provide clean environments in homes, vehicles, and offices.

Annual Performance Goal 3B1: Earn external review rating of "green" or "blue" by making progress in the following research focus areas: identify and test biomedical countermeasures that will make space flight safer for humans, and identify and test technologies that will enhance human performance in space flight.

Performance Indicators:

- Complete experiments that will determine whether pulmonary edema occurs in spaceflight (West-PUFF).
- Complete studies that will provide knowledge for the improvement psychological well being of ground and flight crews for ISS (Kansas-Psychosocial).
- Maintain a cutting-edge, investigator-initiated peer-reviewed research program in Biomedical Research and Countermeasures and in Advanced Human Support Technology, including a National Space Biomedical Research Institute that will perform team-based, focused countermeasure-development research.
- Complete and commission the Brookhaven Booster Application Facility (BAF) in June, 2003 to enable investigators to perform research using heavy ion radiation.
- Analyze data from STS-107 Flight experiments
- Gather data from experiments using the Human Research Facility on ISS
- Produce scientific discoveries in Biomedical research, and publish in mainstream peer-reviewed archival journals.
- Publish results of Bioastronautics experiments conducted during early ISS Increments (1 through 6) and preliminary results from Increments 7 and 8.

Public Benefit: Research on the biomedical issues of space flight is important for improving the safety of all future space travelers. In addition to its direct application to space flight, this research contributes to biomedical research progress on Earth. NASA has 18 active cooperative agreements with the National Institutes of Health that help both organizations advance the state of medical knowledge and practice.

Annual Performance Goal 3B2: Earn external review rating of “green” or “blue” by making progress in the following research focus area: identify and test new technologies to improve life support systems for spacecraft.

Performance Indicators:

- BPRE will demonstrate, through vigorous research and technology development, a **40%** reduction in the projected mass of a life support flight system compared to the system baselined for ISS. The quantitative calculation of this metric will be posted on the Internet.

Public benefit: The primary benefit of research on technologies for life support systems is to reduce the cost of human space travel while increasing safety and efficiency. However, these technologies are frequently applicable to technical problems here on Earth. For example, the small, light, low-power technologies that NASA is developing for monitoring space craft atmosphere may find applications in monitoring industrial processes, monitoring air quality in confined environments, and possibly for detecting terrorist activities.

Goal 2: Use the space environment as a laboratory to test the fundamental principles of physics, chemistry, and biology.

Objective: Investigate chemical, biological, and physical processes in the space environment, in partnership with the scientific community.

Gravity's influence is everywhere. From the structure that gives steel its strength, to the structure of bone in a growing child, gravity plays a role. Researchers can only eliminate the effects of gravity in space. In space, we can study how gravity has shaped life on Earth and how living things respond to its absence. We enter a new realm of research in physics, chemistry, and biology. BPRE relies on the advice of the Space Studies Board of the National Research Council, as well as the NASA Advisory Committees and associated cross-disciplinary task groups to set the strategic direction of the program.

BPRE will conduct a rigorous prioritization exercise during the spring and summer of 2002 to prioritize the research questions being pursued. This prioritization will help focus resources on priority questions, increasing the speed and likelihood that they will be answered.

Public Benefit: BPRE uses the space environment to conduct research in focused areas with the potential to improve life on Earth. These focused areas of research range from fundamental physics, to biotechnology and from materials science to basic biology. The benefits of fundamental physical and biological research in space include improved understanding of physical and biological processes that provide the foundation for improving the quality of life on Earth. For example:

- Combustion science research contributes to the understanding of burning and help to improve energy efficiency and reduce pollution.
- Biotechnology research may contribute to the development of new drugs and improve medical care by exploring and expanding advanced technologies for growing tissues outside the body.
- Basic physics research may lead to future advances in information technology.
- Fundamental Biology research in space provides a new window on evolution and development which may lead to improved medical care and improved plants for agriculture
- Materials scientists exploit the space environment to benchmark novel materials as well as to improve understanding of industrial processes here on Earth.

Annual Performance Goal 3B3: Earn external review rating of "green" or "blue" by making progress in the following research focus areas as described in the associated indicators: advance the scientific understanding of complex biological and physical systems.

Performance Indicators:

- Maintain a peer-reviewed research program in Complex Systems physics and chemistry.
- Analyze ISS flight experiments results in colloidal physics.

Public Benefit: Research on complex physical and biological systems has the potential to benefit industrial applications in optical computing and communications, pharmaceutical packaging, food manufacturing, cosmetics, and polymer manufacturing.

Annual Performance Goal 3B4: Earn external review rating of "green" or "blue" by making progress in the following research focus areas as described in the associated indicators: elucidate the detailed physical and chemical processes associated with macromolecular crystal growth and cellular assembling processes in tissue cultures.

Performance Indicators:

- Maintain a peer-reviewed research program in macromolecular and cellular biotechnology.
- Analyze ISS flight experiments results in macromolecular and cellular biotechnology

Public Benefit: This biotechnology research may have applications in structural biology, rational drug design, and artificial tissues engineering for medical applications.

Annual Performance Goal 3B5: Earn external review rating of "green" or "blue" by making progress in the following research focus area: investigate fundamental and unresolved issues in condensed matter physics and atomic physics, and carry out atomic clock development for space-based utilization.

Performance Indicators:

- Maintain an outstanding and peer-reviewed research program in condensed matter physics, Bose-Einstein Condensation, and atomic clocks development for space-based utilization.
- Produce scientific discoveries in atomic and condensed matter physics, and publish in mainstream peer-reviewed archival journals.

Benefit: This basic research has the potential to substantially enhance the accuracy of our time-keeping standard, support development of ultra-precise Global Positioning System time measurements, and support the development of molecular-based medical diagnostic devices.

Annual Performance Goal 3B6: Earn external review rating of "green" or "blue" by making progress in the following research focus area: Investigate fundamental and unresolved issues in fluid physics, and materials and combustion science using gravity as a theoretical and experimental revealing tool.

Performance Indicators:

- Maintain an outstanding and peer-reviewed program in fluid physics, and materials and combustion sciences.
- Employ a new annual process to solicit and select peer-reviewed ground-based investigations in materials science, fluid physics, and combustion research
- Analyze results of STS-107 flight experiments in combustion research and fluid physics

Public Benefit: This research has the potential to support advances in energy production efficiency, combustion products emission control, advanced materials manufacturing, and the chemical engineering industry.

Annual Performance Goal 3B7: Earn external review rating of "green" or "blue" by making progress in the following research focus area: understand the role of gravity in biological processes at all levels of biological complexity.

Performance Indicators:

- Maintain an outstanding and peer-reviewed program in fundamental space biology
- Solicit ground-based research in all Fundamental Biology disciplines
- Analyze data from STS-107 flight experiments
- Determine baseline data requirements for model specimens to be used on ISS
- Plan for incorporation of baseline data collection in ISS hardware validation flights

Public Benefit: This basic research has the potential to support improved medical care and agricultural performance by strengthening our basic understanding of biological processes.

Objective: Develop strategies to maximize scientific research output on the International Space Station and other space research platforms.

Space flight opportunities for biological and physical research are very limited. BPRE develops strategies and approaches to enhance flight opportunities and to support a balanced research program that maximizes scientific return.

Public Benefit: By working with the scientific community, BPRE seeks to maximize scientific return from space flight opportunities to achieve the greatest benefit for the investment that taxpayers make into this research program.

Annual Performance Goal 3B8: In close coordination with the research community, allocate flight resources and develop facilities to achieve a balanced and productive research program.

Performance Indicators:

- Complete Phase A definition studies and award contract to manage ISS utilization to a Non Government Organization (NGO)
- Coordinate scientific community participation in the definition of ISS research.
- Balance resource allocations and flight opportunities through a Partner Utilization Plan.
- Deploy ISS research facilities on-orbit consistent with budget constraints and BPRE prioritization

Goal 3: Enable and promote commercial research in space.

Objectives: Provide technical support for companies to begin space research.
Foster commercial research endeavors with the International Space Station and other assets.

Ultimately, the solutions to the challenges of human space flight will open up new avenues of commerce. Even now, dozens of commercial firms conduct small-scale research projects in space. BPRE provides knowledge, policies, and technical support to facilitate industry investment in space research. BPRE will continue to enable commercial researchers to take advantage of space flight opportunities for proprietary research. The commercial sector will grow to become the premier mechanism for applying space knowledge to benefit the American people. Commercial applications of space knowledge will generate new products, new jobs, and new spin-off companies.

Public Benefit: The benefits of commercial research in space include improved products and services to enhance economic performance on Earth. In the long-term, economic activity in space will provide strengthened infrastructure for the exploration and development of space.

Annual Performance Goal 3B9: Engage the commercial community and encourage non-NASA investment in commercial space research by meeting at least two of three performance indicators.

Performance Indicators:

- Maintain a ratio of Non-NASA funding to NASA funding not less than 3:1
- Ensure that at least one of 39 product lines currently under investigation is brought to market in FY 03.
- Enable at least 10 new active industrial partnerships to be established with the Space Product Development Commercial Space Centers

Objective: Systematically provide basic research knowledge to industry.

Public Benefit: Conducting outreach to the commercial community extends the benefits of commercial research to the broadest set of participants and strengthens the contributions of commercial research for the development of space.

Annual Performance Goal 3B10: Highlight ISS-based commercial space research at business meetings and conferences.

Performance Indicators:

- Support at least 3 business/trade conferences to highlight ISS-based commercial space research.

Goal 4: Use space research opportunities to improve academic achievement and the quality of life.

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

Public Benefit: BPRE seeks to use its research activities to encourage educational excellence and to improve scientific literacy from primary school through the university level and beyond.

Annual Performance Goal 3B11: Provide information and educational materials to American teachers.

Performance Indicators:

- Develop electronic and printed educational materials that focus on biological and physical research, and distribute these materials at least three conferences and through the Internet.

Objective: Engage and involve the public in research in space.

Public Benefit: BPRE delivers value to the American people by facilitating access to the experience and excitement of space research. BPRE strives to involve society as a whole in the transformations that will be brought about by research in space.

Annual Performance Goal 3B12: Work with media outlets and public institutions to disseminate BPRE information to wide audiences.

Performance Indicators:

- Work with Life Science Museum Network members to explore opportunities for the development of projects, special events, or workshops focused on Life Sciences biology-related research themes to attract and engage public audiences.
- Make available to wide audiences an online database of Commercial Space Center activities, including publications listings, patents, and other information useful to the public.

Verification/Validation

BPRE cooperates with NASA's Inspector General during an annual review of the accuracy of our reporting process. In addition, BPRE reviews its performance with the Biological and Physical Research Advisory Committee (BPRAC) of the NASA Advisory Committee. The BPRAC is not expected to independently confirm the accuracy of data presented by BPRE. Rather, the Committee's role is to assess progress based on the data that BPRE presents and apply its expert judgment based on a set of criteria jointly developed with BPRE to produce an evaluation. The Office of the Inspector General selects a subset of targets for detailed audits to determine the accuracy and reliability of BPRE's data on performance targets.

Annual performance goals 3B1 and 3B3 through 3B9 are fundamentally qualitative in nature and the committee will work with NASA to establish guidelines and criteria for assigning scores on these goals based on performance indicators as well as other information. Annual performance goal 3B2 is evaluated using a novel formula developed by BPRE's Advanced Human Support Technology program. Details of this process are available for review on the program's website at http://ADVLIFESUPPORT.JSC.NASA.GOV/ under the title "Advanced Life Support Metric Document

FY 2003 MULTI-YEAR PERFORMANCE TREND
Biological and Physical Research Enterprise (BPRE)

Strategic Objective: Conduct research to ensure the health, safety, and performance of humans living and working in space.

	FY 99	FY 00	FY 01
Annual Performance Goal and APG#	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. (H29)	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. (0H31)	Demonstrate, in ground test, at least one technology that could reduce up to 25% of life support logistics over ISS baseline and release report of progress for review on the Internet. (1H18)
Assessment	Green	Green	

<u>Strategic Objective</u>: Conduct research to ensure the health, safety, and performance of humans living and working in space.

	<u>FY 02</u>	<u>FY 03</u>	
Annual Performance Goal and APG#	Earn external review rating of "green" or "blue" by making progress in the following research focus areas as described in the associated indicators: • Identify and test biomedical countermeasures that will make space flight safer for humans. • Identify and test technologies that will enhance human performance in space flight. (2B1)	Earn external review rating of "green" or "blue" by making progress in the following research focus areas: • Identify and test biomedical countermeasures that will make space flight safer for humans. • Identify and test technologies that will enhance human performance in space flight. (3B1)	
Assessment			

<u>Strategic Objective</u>: Conduct research to ensure the health, safety, and performance of humans living and working in space.

	FY 99	FY 00	FY 01
Annual Performance Goal and APG#	Complete the development of countermeasure research protocols, and begin testing a minimum of three countermeasures intended to protect bone, muscle, and physical work capacity. (H25) Publish a report defining the time course adaptations in the balance system to altered gravitational environments. (H6) Document Mir radiation research data to facilitate ISS EVA planning. (H10) Document Mir data lessons learned to facilitate ISS biomedical and countermeasure research. (H7)	Develop medical protocols and test the capability of the Crew Health Care System as integrated in the ISS U.S. Laboratory. (0H26) 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. (0H25)	Develop new biomedical and technological capabilities to facilitate living and working in space and safe return to Earth. (1H17) Initiate implementation of the Bioastronautics Initiative by beginning a NASA /NCI collaboration and conducting a peer review of NSBRI to assess expansion. (1H31)
Assessment	Green	Green	

<u>Strategic Objective</u>: Conduct research to ensure the health, safety, and performance of humans living and working in space.

	<u>FY 02</u>	<u>FY 03</u>	
Annual Performance Goal and APG#	Earn external review rating of "green" or "blue" by making progress in the following research focus area: • Identify and test new technologies to improve life support systems for spacecraft. (2B2)	Earn external review rating of "green" or "blue" by making progress in the following research focus area: • Identify and test new technologies to improve life support systems for spacecraft. (3B2)	
Assessment			

<u>Strategic Objective</u>: Conduct research on biological and physical processes to enable future missions of exploration.

	FY 99	FY 00	FY 01
Annual Performance Goal and APG#	Publish a report of comparison of 3 different biological models to understand the influence of gravity on the nervous system. H8 Document Mir data lessons learned to facilitate ISS research in fundamental biology and regenerative life support. (H5)	Complete Radiation Research Instrument for 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. (0H33)	Initiate implementation of the Bioastronautics Initiative by beginning a NASA /NCI collaboration and conducting a peer review of NSBRI to assess expansion. (1H31)
Assessment	Green	Green	
Annual Performance Goal and APG#	Initiate a collaborative program to design and develop instruments. (H26)		Complete testing and delivery for spacecraft integration of experiments for the Mars Surveyor Program 2001 missions. (1H1)
Assessment	Green		

<u>Strategic Objective</u>: Conduct research on biological and physical processes to enable future missions of exploration.

	<u>FY 02</u>	<u>FY 03</u>	
Annual Performance Goal and APG#	Earn external review rating of "green" or "blue" by making progress in the following research focus areas: • Develop and test cutting-edge methods and instruments to support molecular-level diagnostics for physiological and chemical process monitoring. • Identify and study changes in biological and physical mechanisms that might be exploited for ultimate application to improving the health and safety of space travelers. (2B3)		
Assessment			
Annual Performance Goal and APG#			
Assessment			

Strategic Objective: Investigate chemical, biological, and physical processes in the space environment, in partnership with the scientific community.

	FY 99	FY 00	FY 01
Annual Performance Goal and APG#	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. (H13) Improve predictive capabilities of soot processes by at least 50% through analysis of MSL-1 data; publish results in peer-reviewed open literature. (H11) 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. (H12)	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. (0H11)	
Assessment	Green	Red	
Annual Performance Goal and APG#	Analyze Mir data to achieve a 3-year jump-start for cell culture and protein crystal growth research and document analyses & lessons learned. (H9)		
Assessment	Green		

<u>Strategic Objective</u>: Investigate chemical, biological, and physical processes in the space environment, in partnership with the scientific community.

	<u>FY 02</u>	<u>FY 03</u>	
Annual Performance Goal and APG#	Earn external review rating of "green" or "blue" by making progress in the following research focus areas as described in the associated indicators: • Advance the scientific understanding of complex biological and physical systems. (2B4)	Earn external review rating of "green" or "blue" by making progress in the following research focus areas as described in the associated indicators: • Advance the scientific understanding of complex biological and physical systems. (3B3)	
Assessment			
Annual Performance Goal and APG#	Earn external review rating of "green" or "blue" by making progress in the following research focus areas as described in the associated indicators: • Elucidate the detailed physical and chemical processes associated with macromolecular crystal growth and cellular assembling processes in tissue cultures. (2B5)	Earn external review rating of "green" or "blue" by making progress in the following research focus areas as described in the associated indicators: • Elucidate the detailed physical and chemical processes associated with macromolecular crystal growth and cellular assembling processes in tissue cultures. (3B4)	
Assessment			

<u>Strategic Objective</u>: Investigate chemical, biological, and physical processes in the space environment, in partnership with the scientific community.

	FY 99	FY 00	FY 01
Annual Performance Goal and APG#		Develop medical protocols and test the capability of the Crew Health Care System as integrated in the ISS U.S. Laboratory. (0H26)	Continue initial research on the International Space Station by conducting 6 to 10 investigations. (1H5)
Assessment		Green	
	FY 99	FY 00	FY 01
Annual Performance Goal and APG#			
Assessment			

<u>Strategic Objective</u>: Investigate chemical, biological, and physical processes in the space environment, in partnership with the scientific community.

	<u>FY 02</u>	<u>FY 03</u>	
Annual Performance Goal and APG#	Earn external review rating of "green" or "blue" by making progress in the following research focus areas as described in the associated indicators: • Initiate a focused research program specifically integrating fluid physics and materials science with fundamental biology. (2B6)		
Assessment			
Annual Performance Goal and APG#	Earn external review rating of "green" or "blue" by making progress in the following research focus area: • Investigate fundamental and unresolved issues in condensed matter physics and atomic physics, and carry out atomic clock development for space-based utilization. (2B7)	Earn external review rating of "green" or "blue" by making progress in the following research focus area: • Investigate fundamental and unresolved issues in condensed matter physics and atomic physics, and carry out atomic clock development for space-based utilization. (3B5)	
Assessment			

<u>Strategic Objective</u>: Investigate chemical, biological, and physical processes in the space environment, in partnership with the scientific community.

	<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>
Annual Performance Goal and APG#			
Assessment			
	<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>
Annual Performance Goal and APG#			
Assessment			

<u>Strategic Objective</u>: Investigate chemical, biological, and physical processes in the space environment, in partnership with the scientific community.

	FY 02	FY 03	
Annual Performance Goal and APG#	Earn external review rating of "green" or "blue" by making progress in the following research focus area: • Investigate fundamental and unresolved issues in fluid physics, and materials and combustion sciences using gravity as a theoretical and experimental revealing tool. (2B8)	Earn external review rating of "green" or "blue" by making progress in the following research focus area: • Investigate fundamental and unresolved issues in fluid physics, and materials and combustion science using gravity as a theoretical and experimental revealing tool. (3B6)	
Assessment			
Annual Performance Goal and APG#	Earn external review rating of "green" or "blue" by making progress in the following research focus area: • Understand the role of gravity in biological processes at all levels of biological complexity. (2B9)	Earn external review rating of "green" or "blue" by making progress in the following research focus area: • Understand the role of gravity in biological processes at all levels of biological complexity. (3B7)	
Assessment			

<u>Strategic Objective</u>: Develop strategies to maximize scientific research output on the International Space Station and other space research platforms.

	FY 99	FY 00	FY 01
Annual Performance Goal and APG#		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. (0H9)	Conduct outstanding peer-reviewed and commercial research on STS-107 to advance knowledge in the fields of medicine, fundamental biology, biotechnology, fluid physics, materials processing and combustion. (1H4)
Assessment		Green	
Annual Performance Goal and APG#	Support an expanded research program of approximately 800 investigations, an increase of ~9% over FY 1998. (H1) 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. (H2) Establish a National Center for Evolutionary Biology with participation of at least 5 research institutions and engaging at least 20 investigators. (H3)	Support an expanded research program of approximately 935 investigations, an increase of ~17% over FY 1999. Publish 100 percent of science research progress in the annual OLMSA Life Sciences and Microgravity Research Program Task Bibliographies and make this available on the Internet. (0H1)	Support an expanded, productive research community to include 975 investigations annually by 2001. (1H3)
Assessment	Green	Green	
Annual Performance Goal and APG#			
Assessment			

Strategic Objective: **Develop strategies to maximize scientific research output on the International Space Station and other space research platforms.**

	FY 02	FY 03	
Annual Performance Goal and APG#	In close coordination with the research community, allocate flight resources to achieve a balanced and productive research program. (2B10)	In close coordination with the research community, allocate flight resources and develop facilities to achieve a balanced and productive research program. (3B8)	
Assessment			
Annual Performance Goal and APG#			
Assessment			
Annual Performance Goal and APG#	Demonstrate progress toward ISS research hardware development. (2H13)		
Assessment			

Strategic Objective: **Foster commercial research endeavors with the International Space Station and other assets.**
Strategic Objective: **Provide technical support for companies to begin space research.**

	FY 99	FY 00	FY 01
Annual Performance Goal and APG#	Increase non-NASA investment (cash and in-kind) in space research from $35M in FY96 to at least $50M in FY 1999, a 40% increase. (H35) 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. (H30) Establish a new food technology Commercial Space Center. (H36)	Establish up to 2 new Commercial Space Centers. (0H47) 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. (0H49) Utilize at least 30% of Space Shuttle and ISS FY 2000 capabilities for commercial investigations, per the U.S. Partner Utilization Plan. (0H46)	Foster commercial endeavors by reviewing and/or implementing new policies and plans such as the Space Station resource pricing policy and intellectual property rights policy. Ensure that Space Station resources allocated to commercial research are utilized by commercial partners to develop commercial products and improve industrial processes. (1H23) Establish at least ten new, active industrial partnerships to research tomorrow's space products and improve industrial processes through NASA's Commercial Space Centers, and find opportunities for space experiments. (1H22)
Assessment	Green (H35, H36); Yellow (H30)	Green	

<u>Strategic Objective</u>: Foster commercial research endeavors with the International Space Station and other assets.
<u>Strategic Objective</u>: Provide technical support for companies to begin space research.

	FY 02	FY 03	
Annual Performance Goal and APG#	Engage the commercial community and encourage non-NASA investment in commercial space research by meeting at least three of four performance indicators. (2B11)	Engage the commercial community and encourage non-NASA investment in commercial space research by meeting at least two of three performance indicators. (3B9)	
Assessment			

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

	FY 99	FY 00	FY 01
Annual Performance Goal and APG#	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. (H37) Conduct at least two demonstrations of the applicability of the "Telemedicine Instrumentation Pack" for health care delivery to remote areas. (H39) Demonstrate the application of laser light scattering technology for early detection of eye-tissue damage from Diabetes; publish results in peer-reviewed open literature. (H40)	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. (0H56)	Support participation in HEDS research. (1H26)
Assessment	Green	Green	

Strategic Objective: Systematically provide basic research knowledge to industry.

	FY 99	FY 00	FY 01
Annual Performance Goal and APG#			
Assessment			

<u>Strategic Objective</u>: Advance the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets.

	<u>FY 02</u>	<u>FY 03</u>	
Annual Performance Goal and APG#	Provide information and educational materials to American teachers. (2B13)	Provide information and educational materials to American teachers. (3B11)	
Assessment			

<u>Strategic Objective</u>: Systematically provide basic research knowledge to industry.

	<u>FY 02</u>	<u>FY 03</u>	
Annual Performance Goal and APG#	Highlight ISS-based commercial space research at business meetings and conferences. (2B12)	Highlight ISS-based commercial space research at business meetings and conferences. (3B10)	
Assessment			

<u>Strategic Objective</u>: Engage and involve the public in research in space.

	<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>
Annual Performance Goal and APG#	Expand the microgravity research program's World Wide Web-based digital image archive established in 1998 by 50%. (H38)		
Assessment	Green		

Strategic Objective: **Engage and involve the public in research in space.**

	FY 02	FY 03	
Annual Performance Goal and APG#	Work with media outlets and public institutions to disseminate OBPR information to wide audiences. (2B14)	Work with media outlets and public institutions to disseminate BPRE information to wide audiences. (3B12)	
Assessment			

Biological and Physical Research FY 2003 Budget Link Table	**Budget Category**	**Advanced Human Support Technology**	**Biomedical Research & Countermeasures**	**Fundamental Space Biology**	**Physical Sciences Research**	**Space Product Development**	**Mission Integration**
Annual Performance Goals & APG#							
3B1: Earn external review rating of "green" or "blue" by making progress in the following research focus areas: 1) Identify and test biomedical countermeasures that will make space flight safer for humans; 2) Identify and test technologies that will enhance human performance in space flight.		X	X				
3B2: Earn external review rating of "green" or "blue" by making progress in the following research focus area: Identify and test new technologies to improve life support systems for spacecraft.			X				
3B3: Earn external review rating of "green" or "blue" by making progress in the following research focus areas as described in the associated indicators: Advance the scientific understanding of complex biological and physical systems.				X	X		
3B4: Earn external review rating of "green" or "blue" by making progress in the following research focus areas as described in the associated indicators: Elucidate the detailed physical and chemical processes associated with macromolecular crystal growth and cellular assembling processes in tissue cultures.					X		
3B5: Earn external review rating of "green" or "blue" by making progress in the following research focus area: Investigate fundamental and unresolved issues in condensed matter physics and atomic physics, and carry out atomic clock development for space-based utilization.					X		
3B6: Earn external review rating of "green" or "blue" by making progress in the following research focus area: Investigate fundamental and unresolved issues in fluid physics, and materials and combustion science using gravity as a theoretical and experimental revealing tool.					X		

Biological and Physical Research FY 2003 Budget Link Table	**Budget Category**	**Advanced Human Support Technology**	**Biomedical Research & Countermeasures**	**Fundamental Space Biology**	**Physical Sciences Research**	**Space Product Development**	**Mission Integration**
Annual Performance Goals & APG#							
3B7: Earn external review rating of "green" or "blue" by making progress in the following research focus area: Understand the role of gravity in biological processes at all levels of biological complexity.				X			
3B8: In close coordination with the research community, allocate flight resources and develop facilities to achieve a balanced and productive research program.		X	X	X	X	X	X
3B9: Engage the commercial community and encourage non-NASA investment in commercial space research by meeting at least two of three performance indicators.						X	
3B10: Highlight ISS-based commercial space research at business meetings and conferences.						X	
3B11: Provide information and educational materials to American teachers.		X	X	X	X	X	
3B12: Work with media outlets and public institutions to disseminate OBPR information to wide audiences.		X	X	X	X	X	

Manage Strategically

FY 2003 Performance Plan

Through NASA, the American people have invested in America's future by supporting a 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. Therefore, the goal of the Manage Strategically crosscutting process is to provide a basis for the Agency to carry out its responsibilities effectively, efficiently, and safely through sound management decisions and practices. 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 also 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. Finally, managing strategically ensures that the public's investment in NASA is well-served and that the Agency's initiatives and achievements continuously inspire and serve America and benefit the quality of life on Earth for all humankind.

The performance metrics selected for FY 2003 address key management challenges facing NASA, as well as the challenging, government-wide high risk areas of strategic human capital management and information security identified by the General Accounting Office. These management areas are also consistent with the Administration's reform agenda that emphasizes a Federal Government that is citizen-centered, results-oriented, and market-based.

Strategic Goal:
Enable the Agency to carry out its responsibilities effectively, efficiently, and safely through sound management decisions and practices.

<u>Performance Metrics</u>

<u>MS Objective #1</u>: Protect the safety of our people and facilities and the health of our workforce.

Public Benefit: Safety is NASA's number one core value. NASA protects the public's investment in our vision and missions by protecting the safety and health of our people, the public, and our high-value assets and facilities on and off the ground. To emphasize the critical importance of health, as addressed in the Agency's Safety Initiative, the Office of the Chief Health and Medical Officer (OCHMO) was created in May 2000. The OCHMO provides strategic direction and oversight in the Agency's pursuit of protecting the safety and health of the entire NASA workforce. The OCHMO also provides oversight of health care delivery and professional competency, assuring quality and consistency of services Agency-wide. And, the OCHMO ensures that NASA employees at all levels incorporate health and safety principles and practices into daily decision making and that the Agency adheres to the highest medical and ethical standards and satisfies all applicable regulatory and statutory requirements.

Annual Performance Goal (3MS1): NASA will increase the safety of its infrastructure and the health of its workforce through facilities safety improvements, reduced environmental hazards, increased physical security, enhanced safety and health awareness, and appropriate tools and procedures for health enhancement.

Performance Indicators for 3MS1:

- No fatalities will result from NASA mishaps.
- Per the Federal Worker 2000 Initiative, reduce the overall occurrence of injuries (due to occupational injury or illness) by 3% per year from the FY 1997 baseline to 1.15 occurrences per 100 workers.
- Award construction contract(s) for all identified critical facilities safety requirements as specified in the Agency Annual Construction Program.
- Ensure that at least 95% of Agency Minimum Essential Infrastructures (MEI) have completed all physical security countermeasure upgrades and are in compliance with Presidential Decision Directive 63.
- Close at least 90% of compliance findings from environmental functional reviews by target date, and track all findings to closure.
- Complete an environmental functional review of at least 30% of Centers and component facilities annually, reviewing all within a 3-year cycle.
- Increase the utilization rate of prevention and wellness programs (including health maintenance examinations, immunizations, skin cancer screenings, and website access) by 10% over FY 2000 rates.
- The OCHMO, supported by the Occupational Health Principal Center, will ensure that at least 90% of NASA Centers receive the tools and techniques necessary to improve their overall Health and Medical Quality Assurance programs.

Justification for Changes from FY 2002: Manage Strategically encourages the Agency to ensure rapid, reliable, easily accessible and open exchanges of information. In FY 2002, one of the performance indicators for enhancing employee health awareness and procedures for health enhancement was the establishment of a mechanism to aggregate and track epidemiological preventive health risk data as a basis for policy decisions. Unfortunately, the funding to establish an employee longitudinal health database was not approved in FY 2001 or in FY 2002. However, the recently established occupational health relational database - - Agency Health Enhancement Database (AHED) will enable accurate tracking of such health indicators as immunization screenings and training. While different, this database will provide a suitable basis for policy decisions. Over time, this database can be expanded and modified to include an epidemiological aspect as funding is authorized.

MS Objective #2: Achieve the most productive application of Federal acquisition policies.

Public Benefit: NASA serves the public interest by implementing acquisition efficiencies and cost-saving strategies that provide the best return on the public's investment. These include streamlining acquisition regulations, assigning contractors more program-integration responsibility and accountability, and moving civil service employees into review rather than operational positions. In addition, NASA continuously seeks opportunities to partner with small, small disadvantaged, and women-owned businesses to increase the competitive base from which we purchase goods and services.

Annual Performance Goal (3MS2): Continue to take advantage of opportunities for improved contract management by maintaining a high proportion of Performance Based Contracts (PBCs).

Performance Indicator for 3MS2:

- Maintain PBC obligations at 80% of funds available for PBCs (funds available exclude grants, cooperative agreements, actions under $100,000, SBIR, STTR, FFRDCs, intragovernmental agreements, and contracts with foreign governments and organizations).

Annual Performance Goal (3MS9): Continue integrating small, small disadvantaged, and women-owned businesses together with minority universities into the competitive base from which NASA can purchase goods and services.

Performance Indicators for 3MS9:

- Achieve at least an 8% Congressionally mandated goal for annual funding to small disadvantaged businesses (includes funding for prime and subcontractors awarded to programs supporting small disadvantaged businesses, Historically Black Colleges and Universities and other minority educational institutions, and women-owned small businesses).
- Award 1% of NASA's total contract and subcontract dollars to Historically Black Colleges and Universities and other minority institutions.

MS Objective #3: Manage our fiscal and physical resources optimally.

Public Benefit: NASA's budget and physical assets represent a significant investment to the American taxpayers, so it is incumbent on the Agency to manage these resources effectively and efficiently to optimize the return to the public on their investment. Agency strategies for ensuring optimal return include partnering, value engineering, outsourcing, performance-based contracting, energy conservation, recycling, and pollution prevention.

Annual Performance Goal (3MS3): Renew the Agency's management systems and facilities through the use of updated automated systems and facilities revitalization, and meet four out of five performance indicators in this area.

Performance Indicators for 3MS3:

- Increase facility capital repairs funding and reduce outdated, unused, marginal, and lower-priority facilities to improve facility revitalization rate to 100-year frequency.
- Reduce the Agency's unfunded environmental liability through a long-term strategy, annually investing an amount of not less than 3-5% of the Agency's environmental liability in environmental compliance and restoration (ECR) funding.

Annual Performance Goal **(3MS10):** Improve the Agency's financial management and accountability.

Performance Indicators for 3MS10:

- Cost at least 75% of the resources authority available to cost during the fiscal year.
- Complete the operational cutover to the new Core Financial System (CFS) at six Centers.
- Initiate at least one new Integrated Financial Management project.

MS Objective #4: Enhance the security, efficiency, and support provided by our information technology resources.

Public Benefit: The public's investment in NASA ensures that the Agency's explorers, pioneers, and innovators can continue to expand frontiers in air and space. Therefore, NASA's missions to advance and communicate scientific knowledge and understanding of the Earth, the solar system, and the universe, to use and develop space, and to research, develop, verify, and transfer advanced aeronautics and space technologies require optimal efficiencies in the use of NASA's limited Information Technology (IT) resources. To achieve this goal, NASA's IT planning is focused on four areas: safety and security, cost-effective common infrastructure and services, innovative technology and practices, and emerging IT areas (e.g., e-Business and e-Government).

Annual Performance Goal **(3MS4):** Improve IT infrastructure service delivery by providing increased capability and efficiency while maintaining a customer rating of satisfactory.

Performance Indicators for 3MS4:

- Maintain a customer rating of satisfactory for each major IT service.
- Hold costs per resource unit at or below established baselines for each major service.

Service	Established Cost Baseline
NASA ADP Consolidation Center (NACC)	$3,513,871/processing resource/quarter
NASA Integrated Services Network (NISN)	$0.78/ KBPS per month
Outsourcing Desktop Initiative for NASA (ODIN)	$2,940/General Purpose Seat

Annual Performance Goal **(3MS5)**: Enhance IT security by meeting established performance indicators in three critical areas.

Performance Indicators for 3MS5:

- Reduce IT system vulnerabilities specified for the year across all NASA Centers to at least the established target ratios.

- Meet established targets for IT security awareness training for all NASA employees, managers, and system administrators.
- Complete the IT security plans at a targeted level, including authorization to process, for critical NASA systems.

IT Security Element	**FY 2003 Target**
Ratio of Vulnerabilities Detected to Systems Scanned. *	.25
ITS Training: **	
Civil Service Employees	95%
Civil Service Managers	95%
Civil Service System Administrators	95%
IT Security Plans completed for critical systems and re-evaluated every 3 years. ***	100%

NOTES: * This goal/ratio is based on the Phase III list of vulnerabilities. The vulnerability list is dynamic, changes every quarter, has ever-increasing stringency, and requires manual audit of some system weaknesses. Therefore, the target ratio is larger than in FY 2002. ** Goal is to achieve this target by July 2002 and to achieve as close to 100% as possible in all three training levels. *** There is a grace period for a new or enhanced system to develop security plans. During this grace period, the absence of a completed plan does not count against the target.)	

Annual Performance Goal **(3MS6)**: Enhance mission success through seamless, community-focused electronic service delivery by meeting the established performance indicators in this area.

Performance Indicators for 3MS6:

- Implement the *eNASA Strategic Plan and Roadmap* to deliver electronic services and information to the public, partners, suppliers, key stakeholders, and the internal employees and teams that execute NASA's missions.
- Make the NASA Web more accessible, community-focused, and useful to all of NASA's diverse audiences as demonstrated by increased customer satisfaction from the FY 2002 baseline.
- Increase the scope and level of corporate and shared electronic services from the FY 2002 baseline.
- Process 60% of NASA's competitive grant opportunities online consistent with interagency efforts to simplify the grants process.

MS Objective #5: Invest wisely in our use of human capital, developing and drawing upon the talents of all our people.

Public Benefit: NASA's human capital investment strategies are rooted in the Agency's belief that employees are our most important resource. Therefore, to deliver on our research and development commitments to the public, NASA is constantly realigning this resource consistent with changing Agency goals and objectives. In addition, NASA is committed to attracting and retaining a workforce that is: (1) representative at all levels of the diverse public it serves; and (2) renowned for its world-class, cutting-edge skills and competencies.

Annual Performance Goal **(3MS7)**: Align management of human resources to best achieve Agency strategic goals and objectives.

Performance Indicators for 3MS7:

- Implement at least three of the National Recruitment Team's FY 2002 Report recommendations to enhance Centers' ability to attract, recruit, and retain a high-quality workforce.
- By the end of FY 2003, increase the availability of assessment tools in Agency-wide leadership and project management training and development over those available in FY 2001. (These types of tools include multi-rater instruments that assess knowledge, skills, competencies, and experiences in leadership and project management. They are used to develop current and future leaders within the Agency.)

Annual Performance Goal **(3MS8):** Attract and retain a workforce that is representative of America's diversity at all levels, and maximize individual performance through training and development experiences.

Performance Indicators for 3MS8:

- Increase representation of minorities by at least 0.6%, women by at least 0.4%, and individuals with targeted disabilities by at least 0.085%.
- Ensure that women, minorities, and employees with targeted disabilities participate in career development and training programs at rates equal to or greater than their workforce representation.

Verification/Validation

Performance plan goals, indicators, and accomplishment claims are subject to audit by a number of internal and external groups. To ensure this capability, NASA relies on a number of processes for verifying and validating performance claims.

First, whenever possible, data in support of performance claims are gleaned from and/or validated against officially maintained databases. The data-gathering process in all cases is subject to strict oversight, and independent audits and periodic checks by internal and/or external reviewers ensure the integrity of the databases. These databases include: the NASA Personnel Payroll System (NPPS); the Consolidated Agency Payroll and Personnel System (CAPPS); the Incident Reporting System (IRIS); the Financial and Contractual Status of Programs System (FACS); the NASA Environmental Tracking System (NETS); the Veterans Administration Workers' Compensation Database; the consolidated NASA Occupational Health Annual Cost and Staffing Report; the Agency Health Enhancement Database (AHED); NASA Center Personal Property Reports; and the Center Cost Avoidance Database.

Second, a number of specific verification and validation processes are in place to support performance claims in specific areas.

1. Integrated Financial Management System (IFMS) verification and validation are based on measures in the signed Program Commitment Agreement. Non-advocate and independent reviews are conducted periodically, and the results are reported to the HQ Program Management Council (PMC) and the IFM Council.

2. Performance Based Contracts (PBCs) verification and validation are based on contract sampling to validate PBC criteria and on Financial And Contractual Status (FACS) data.

3. Contract awards to small and small disadvantaged businesses are documented for verification and validation in the Summary Contractor Reports (SF 295) that are reviewed during Center Procurement Management Survey data checks. In addition, the Small Business Administration and the Department of Defense Contract Management Agency conduct periodic on-site surveys to verify and validate performance claims and process integrity. The Minority Business Resource Advisory Council and the NASA/Prime Contractor Roundtable also do periodic reviews and make recommendations for process improvements to NASA management.

4. Information Technology (IT): NASA and Center Chief Information Officers, staff of the NASA ADP Consolidation Center (NACC), project office staff of the NASA Integrated Services Network (NISN), project office staff of the Outsourcing Desktop Management Initiative (ODIN), and other process overseers verify and validate performance data during periodic reviews. In addition, NASA's IT customers are given frequent opportunities to offer evaluations and recommendations for improved IT performance.

5. Safeguarding employee health verification and validation is based upon specific indicators and statistics gathered through on-going Center occupational health site assessments and evaluations recorded in NASA's relational database, AHED.

NASA continues to seek new verification and validation techniques for on-going performance indicators and to develop additional performance indicators that can be verified and validated precisely.

Addressing Management Challenges/High Risk Areas

Procurement Management Challenges: NASA's Office of Procurement has undertaken proactive management approaches in three key areas: human capital; outsourcing and oversight; and electronic commerce.

- **Human Capital**: The Office of Procurement continues to emphasize three initiatives to address entry-level, mid-level, and senior-level staff developmental needs:

    - The NASA Career Development and Procurement Certification Programs, designed to ensure that acquisition professionals receive uniform, high quality training that meets or exceeds statutory standards;
    - NASA's Contracting Intern Program, designed to ensure that an adequate number of well-trained, college-educated, entry-level employees are available to the Agency to offset retirements and demographic trends (i.e., the aging of the work force); and
    - Rotational Assignments with Industry, designed to add a corporate experience dimension to the Office of Procurement's other developmental programs and to equip high performing, senior acquisition professionals with the tools they will need to assume procurement management and other leadership positions.

- **Outsourcing and Oversight**: As its personnel numbers have decreased, NASA has outsourced various functions (such as IT support) and has relied on less oversight of its contractors than it did historically. Given this environment, NASA recognized that it must manage risk within the acquisition process to achieve mission success without compromising safety. Therefore, NASA introduced a Risk-based Acquisition Management Initiative that re-focused risk as a key management concern and emphasized considerations of risk throughout the acquisition process. One of the key risk considerations in the acquisition process is the type and level of contractor surveillance to be performed.

- **Electronic Commerce**: The Office of Procurement continues to focus on the Internet as a means to achieve rapid, low-cost, reliable delivery of procurement information to broad audiences, especially small and small disadvantaged business concerns. The NASA Acquisition Internet Service (NAIS) remains a simple, effective, and user-friendly system for disseminating information on contract opportunities. NAIS continues to be NASA's primary mechanism for electronic commerce, and it has won both government and private sector praise for its accomplishments as a portal to a broad range of procurement-related functions and information.

Small Business Challenge: In the new century, the world of business is more diverse and more technologically driven. Businesses and their customers are much more diverse, and women, individuals with disabilities, and minority-owned businesses are important players. The rapid pace of technological advances poses both opportunities and challenges for small business. Small businesses are at the forefront of technological change because they are flexible and close to the customer. Accordingly, NASA's

Office of Small and Disadvantaged Business Utilization will continue its effort to increase contract and subcontract dollars awarded to small disadvantaged businesses, particularly in high technology areas. This includes the participation of such firms in NASA's technology transfer and commercialization activities.

In the FY 2002 NASA Performance Plan, the NASA Administrator established a specific Agency-wide goal for awards to Historically Black Colleges and Universities and other minority institutions of 1 percent of NASA's total contract and subcontract dollars to increase utilization of these entities. These awards will continue in FY 2003 and will be based upon conformance with NASA's mission needs, technical superiority, and cost reasonableness, and NASA expects that the entire student population of these colleges and universities will benefit from these expanded opportunities to satisfy NASA's programmatic requirements.

Fiscal Management Challenges: In FY 2001, a new contractor was selected to provide the Core Financial System (CFS) software. Additionally a provider was selected to implement the new software, and an Agency-level project team was put into place at the Marshall Space Flight Center (MSFC), the Lead Center for the project. The design phase was completed in June 2001.

In FY 2001, two "pathfinder" projects began to test the processes and technical requirements for Agency-wide implementation of new administrative systems. The Langley Research Center (LaRC) is leading the implementation of a new Travel Management system and is working with the receiving Centers and the Integration Project Office (IPO) to schedule follow-on Center implementations. The Goddard Space Flight Center (GSFC) is responsible for acquiring and implementing the Resume Management functional module throughout the Agency. (Resume Management is one of several modules within the Human Resources track of the IFM Program.) After a successful Operational Readiness Review in June 2001 at GSFC, implementation of the Agency's new automated Staffing and Recruitment System (NASA STARS) began at GSFC. Implementation will continue in a phased deployment through November 2001.

In FY 2002, MSFC begins implementation of the SAP Core Financial module, and full Agency rollout will be completed in FY 2003. The Rollout Phase for the Travel Management System begins in September 2001 after completion of the pilot at LaRC, and full Agency-wide implementation will be completed in April 2003. As Lead Center, GSFC will build and test a Budget Formulation Prototype and present options and recommended solutions to meet Agency budget formulation requirements. In accordance with one of the IFM Program's first principles, the Budget Formulation Prototype Project will use COTS software without modification.

The NASA Human Resources community will participate with SAP and other agencies in the federalization requirements of definition for the SAP software product. This collaboration to add unique federal functionality to the SAP Enterprise Resources Planning (ERP) solution could allow us to initiate a Human Resources Project in FY 2003.

IT Management Challenge: IT Security remains a significant area of management concern government-wide. In particular, IT security program reviews noted that NASA's IT security training practices were inadequate and inconsistent. To address these criticisms, NASA conducted specialized IT security awareness training for employees, managers, and system administrators in FY 2001-2002 and is expanding the use of web-based training to broaden course offerings, simplify distribution, and make training available to any employee who has access to the Internet.

While substantial progress has been made in closing out most of the GAO and internal review IT-security recommendations, NASA will continue making IT security an integral part of all systems operated by the Agency. We recognize that significant improvements must be followed by a focused, ongoing effort.

Strategic Human Capital Management Challenge: NASA is focusing on the restructure and revitalization of the workforce. This focus involves a human capital management strategy centered on:

- Strategic planning for human capital management;
- Attracting and retaining a high caliber, high tech, and diverse workforce whose skills and competencies are aligned with Agency mission objectives;
- Investing in the technical training and career development of this critical resource; and
- Cultivating a continued pipeline of talent to meet future science, math, and technology needs.

In formulating its human capital management strategy, the Agency considered findings and recommendations contained in both internal reviews and external reports relating to human capital issues, including those of the Aerospace Safety Advisory Panel, the Office of Management and Budget, and the General Accounting Office.

- **Human Capital Planning and Alignment**: In FY 2001, NASA initiated a strategic resources review based on NASA's future vision and mission. The challenge of the review is to identify the core competencies resident at the NASA Centers, to ensure that resources are prioritized and directed at the most critical Agency requirements, and to focus on the Agency's fundamental roles and missions. As part of the strategic resources review, NASA will identify human capital resource gaps between the Centers' existing capabilities and what is unique and required in-house to meet NASA's future goals. The Agency also will examine its management and organizational structure to identify opportunities for streamlining and for re-deploying resources from less critical activities at NASA Centers to the Agency's highest priority missions. Results of the review will be incorporated into future Agency Performance Plans. (The results of the review also may lead to requests for specific civil service reforms to ensure that NASA can recruit and retain top science, engineering, and management talent.)

In FY 2002-2003, NASA will develop and implement a process by which Centers will do consistent workforce planning. This planning process will link staffing, funding resources, mission and activities, and core competencies. In years to come, it will enable Centers to plan recruitment, retention, succession, and training and career development activities that are tailored to their unique circumstances while supporting Agency goals and objectives.

Another aspect of the Agency's approach to addressing workforce needs is to achieve an effective balance of permanent civil servants, time-limited civil services appointees, and individuals from the academic world who contribute through post-doctoral fellowships, grants programs, Intergovernmental Personnel Assignments, and other partnerships. The intent is to draw from a variety of sources to ensure effective use of talent both within and outside the Agency. Combined with contractor support (approximately 85 percent of NASA's annual budget is contracted out), this approach will permit the Agency to focus on being a premier research and development organization – doing the things that NASA does best and relying on others to take on operations and other appropriate functions.

• **Recruitment and Retention**: In order to be competitive with other employers, NASA recognizes it must have a continuing presence on college and university campuses. After years of downsizing, the NASA Centers are re-establishing recruitment networks and rebuilding the once extensive Co-operative Education Program. The Agency will continue to utilize the Presidential Management Intern Program and student employment programs as sources for entry-level hires. A new national recruitment initiative also has been established to institutionalize new Agencywide recruitment strategies and tools to enhance Centers' recruitment capabilities, focusing on "fresh-outs" to counterbalance the aging of the workforce.

NASA's programs excite the imagination, so the Agency has been able to attract people eager to be a part of NASA's mission. Potential candidates, however, also must weigh financial considerations. The NASA Centers utilize various hiring authorities that enable them to offer starting salaries above the minimum rate of a grade and, when appropriate, NASA Centers can offer retention allowances. In fact, using recruitment bonuses and retention allowances to attract and retain the "best and the brightest" has increased recently – a trend the Agency expects to continue because of the competitive job market and high cost of living surrounding some NASA Centers.

NASA also continues to emphasize quality of work-life initiatives such as alternative work schedules, family friendly leave programs, part-time employment and job sharing, telecommuting, dependent day care, and employee assistance programs. Promoting safety in the workplace and providing effective awards, recognition, and stimulating work enhances job satisfaction and fosters retention.

• **Training, Career Development, Leadership Continuity, and Succession Planning**: As important as it is to attract and retain the right people, it is equally vital to provide further training and development opportunities for those already in the workforce. In addition to funding university level courses, NASA has made a strong investment in ensuring NASA participation in conferences and symposia where breakthrough research and ideas are being presented and shared, as well as training in other core functional areas. NASA also is revitalizing the development of leadership and program/project management capabilities through a number of methods. The Agency's curriculum for developing project management leaders is being reviewed to ensure that appropriate skills and competencies are developed, and assessment tools and other training mechanisms to identify individual training needs are being emphasized to identify and develop project management and leadership potential.

NASA also is emphasizing "just in time" training opportunities for project leaders and team members to improve project team competencies. The Agency is pursuing learning through simulations, as well as coaching and mentoring opportunities, as well as developing e-learning alternatives that can be accessed at all locations and levels. For example, NASA demonstrated a prototype online tool for project management based on the Mars Pathfinder project and has established an e-zine (online magazine/journal) for sharing lessons learned in project management.

NASA also has updated its leadership model to reflect the cutting edge skills and behaviors required for effective Agency leadership. The model is linked to NASA's Strategic Plan and defines skill requirements for team leaders through senior executives. In addition, the new Global Leadership Program provides an international perspective and skills for NASA management in an increasingly global environment. And, NASA has developed partnerships with academia to provide fellowships in leadership and project management development. These include a partnership with the Massachusetts Institute of Technology in Project Management and another with the Darden Business School to develop a Business Education Program. Several other long-term developmental processes are in place at both the Center and the Agency levels. These include the Senior Executive Service Candidate Development Program and the Professional Development Program.

- **Future Pipeline**: NASA continues to look for ways to help ensure a future pipeline of talent from which NASA and others can draw. The new Agencywide Undergraduate Student Research Program began its pilot phase in FY 2001 with 107 students. It was developed to extend and strengthen NASA's commitment to educational excellence and university research, and to highlight the critical need to increase the nation's undergraduate and graduate science, engineering, mathematics, and technology skill base. The first class represents the nation's diversity and includes students from 29 states and Puerto Rico representing 70 different institutions. The program provides students opportunities for participating in research and gaining experience in their chosen disciplines. It also will build a national program bridge from existing NASA K12 Education Program activities to other NASA Higher Education Program options that encourage and facilitate student interest in future professional opportunities with NASA and its partner organizations. Such opportunities might include NASA career employment, temporary assignment, undergraduate and graduate co-op appointment, or contractor positions. In addition, in FY 2002-2003, the Agency plans to develop and implement a scholarship program targeted to the core skills needed to fulfill NASA's research and development mission and designed to guide students toward careers in engineering, physical sciences, biological and life sciences, and computer technology. NASA is pursuing legislation that would enable the Agency to include a service requirement in the scholarship program.

NASA recognizes its greatest strength is its people – essential to safe operations, mission success, and responsible stewardship of the taxpayers' dollars. The Agency will continue to pursue focused activities to position NASA as an employer of choice, recruit and retain the best talent, and provide learning and developmental opportunities for the workforce.

Environmental Management Challenge

The Environmental Management Division in NASA's Office of Management Systems takes a very proactive and integrated approach to environmental management. Consistent with the strategy articulated in *NASA Environmental Excellence for the Twenty-First Century*, the Agency is working on the immediate priority of bringing all NASA activities into compliance with current environmental requirements, while simultaneously restoring previously contaminated sites as quickly as funds allow. Conservation and pollution prevention will be considered in all new projects and programs to minimize environmental impacts and preserve our natural and cultural resources. This approach is clearly captured in NASA's environmental vision that "we will continue as a world leader in space exploration and aeronautics while maintaining environmental excellence." The strategy for achieving this vision includes four focus areas: prevention, compliance, restoration, and conservation.

NASA management is focusing attention on the decommissioning of the Plum Brook Reactor and consistent implementation of the National Environmental Policy Act (NEPA). In fact, both issues are on NASA's Top 10 Environmental Priorities. (The first five priorities are concerned with mandatory requirements that characteristically have associated legal liabilities. The next five priorities emphasize "best management practices" offering the Agency the greatest benefits in terms of efficiency, effectiveness and cost.) By placing emphasis on achieving the 10 priorities, NASA will greatly improve its legal and management situation in the area of environmental management.

MULTI-YEAR PERFORMANCE TREND

Manage Strategically

Strategic Objective: Protect the safety of our people and facilities and the health of our workforce.

	FY99	FY00	FY01
Annual Performance Goal and APG#	Reduce the number of Agency lost workdays (from occupational injury or illness) by 5 percent from the FY 1994-96 3-year average. (MS3) Achieve a 5 percent increase in physical resource costs avoided from the previous year through alternative investment strategies in environmental and facilities operations. (MS4)	Reduce the number of Agency lost workdays (from occupational injury or illness) by 5 percent from the FY 1994-96 3-year average. (0MS3) Achieve a 5 percent increase in physical resource costs avoided from the previous year through alternate investment strategies in environmental and facilities operations. (0MS12)	NASA will increase the safety of its infrastructure and workforce with facilities safety improvements, reduced environmental hazards, increased physical security, and enhanced safety awareness among its employees by meeting all five performance indicators in this area. (1MS1)
Assessment	MS3 was green. MS4 was green.	0MS3 was blue. 0MS12 was blue.	
	FY02	**FY03**	**FY04**
Annual Performance Goal and APG#	NASA will increase the safety of its infrastructure and the health of its workforce through facilities safety improvements, reduced environmental hazards, increased physical security, and enhanced safety and health awareness, and appropriate tools and procedures for health enhancement. (2MS1)	NASA will increase the safety of its infrastructure and the health of its workforce through facilities safety improvements, reduced environmental hazards, increased physical security, enhanced safety and health awareness, and appropriate tools and procedures for health enhancement. (3MS1)	
Assessment			

Strategic Objective: Achieve the most productive application of Federal acquisition policies.

	FY99	FY00	FY01
Annual Performance Goal and APG#	Increase obligated funds available for Performance Based Contracts (PBC) to 80 percent (funds available exclude grants, cooperative agreements, actions less than $100K, Small Business Innovative Research, Small Business Technology Transfer Programs, Federally Funded Research and Development Centers, intragovernmental agreements, and contracts with foreign governments or international organizations). (MS6) Achieve at least the congressionally mandated 8 percent goal for annual funding to small disadvantaged businesses (including prime and subcontractors to small disadvantaged businesses, Historically Black Colleges and Universities, other minority institutions, and women-owned small businesses). (MS7) 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. (MS9) Enhance contract management through improved systems and information for monitoring by implementing a strategy for evaluating the efficacy of procurement operations. (MS10)	Of funds available for Performance Based Contracts (PBCs), maintain PBC obligations at 80 percent (funds available exclude grants, cooperative agreements, actions less than $100K, SBIR, STTR, FFRDCs, intragovernmental agreements, and contracts with foreign governments or international organizations). (0MS5) Achieve at least the congressionally mandated 8 percent goal for annual funding to small disadvantaged businesses (including prime and subcontractors to small disadvantaged businesses, Historically Black Colleges and Universities, other minority institutions, and women-owned small businesses). (0MS8)	Continue to take advantage of opportunities for improved contract management by maintaining a high proportion of Performance Based Contracts, and maintain a significant involvement in NASA programs of small businesses, minority institutions, and minority and women-owned businesses by meeting 2 out of 3 performance indicators in this area. (1MS2)
Assessment	All targets were green	0MS5 was green. 0MS8 was blue.	

Strategic Objective: Achieve the most productive application of Federal acquisition policies.

	FY02	**FY03**	**FY04**
Annual Performance Goal and APG#	Continue to take advantage of opportunities for improved contract management by maintaining a high proportion of Performance Based Contracts (PBCs). (2MS2) Continue integrating small, small disadvantaged, and women-owned businesses together with minority universities into the competitive base from which NASA can purchase goods and services. (2MS9)	Continue to take advantage of opportunities for improved contract management by maintaining a high proportion of Performance Based Contracts (PBCs). (3MS2) Continue integrating small, small, disadvantaged, and women-owned businesses together with minority universities into the competitive base from which NASA can purchase goods and services. (3MS9)	
Assessment			

Strategic Objective: Manage our fiscal and physical resources optimally.

	FY99	FY00	FY01
Annual Performance Goal and APG#	Achieve 70 percent or more of the resources authority available to cost within the fiscal year. (MS5) Complete system validation of the Integrated Financial Management Program (IFMP), and complete system implementation at Marshall and Dryden. (MS12)	Cost 70 percent or more of available resources. (0MS4) Begin the implementation at the NASA installations of the Integrated Financial Management System following the completion of system testing. (0MS11)	Renew Agency's management systems, facilities, and human resources through updated use of automated systems, facilities revitalization, and personnel training by meeting 4 out of 7 performance indicators in this area. (1MS3)
Assessment	MS5 was green MS12 was red.	0MS4 was green 0MS11 was red.	
	FY 02	**FY03**	**FY04**
Annual Performance Goal and APG#	Revitalize Agency facilities, and reduce environmental liability. (2MS3) Improve the Agency's financial management and accountability. (2MS10)	Renew the Agency's management systems and facilities through the use of updated automated systems and facilities revitalization, and meet four out of five performance indicators in this area. (3MS3) Improve the Agency's financial management and accountability. (3MS10)	
Assessment			

Strategic Objective: Enhance the security, efficiency, and support provided by our information technology resources.

	FY99	FY00	FY01
Annual Performance Goal and APG#	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. (MS8) Complete remediation of mission-critical systems by March 1999, consistent with Government-wide guidance for the Year 2000. (MS11)	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. (0MS10)	Improve IT infrastructure service delivery to provide increased capability and efficiency while maintaining a customer rating of “satisfactory,” and enhance IT security through a reduction of system vulnerabilities across all NASA Centers, emphasizing IT security awareness training for all NASA personnel, by meeting 2 out of 2 performance indicators in this area. (1MS4)
Assessment	MS8 was green. MS11 was green.	0MS10 was green.	
	FY02	**FY03**	**FY04**
Annual Performance Goal and APG#	Improve IT infrastructure service delivery by providing increased capability and efficiency while maintaining a customer rating of satisfactory. (2MS4) Enhance IT security by meeting established performance indicators in three critical areas: IT system vulnerabilities detected, training, and IT security plans. (2MS5) Enhance mission success through seamless, community-focused electronic service delivery. (2MS6)	Improve IT infrastructure service delivery by providing increased capability and efficiency while maintaining a customer rating of satisfactory. (3MS4) Enhance IT security by meeting established performance indicators in three critical areas (IT system vulnerabilities, IT security awareness training, and IT security plans). (3MS5) Enhance mission success through seamless, community-focused electronic service delivery by meeting the established performance indicators in this area. (3MS6)	
Assessment			

Strategic Objective: Invest wisely in our use of human capital, developing and drawing upon the talents of all our people.

	FY99	**FY00**	**FY01**
Annual Performance Goal and APG#	Reduce the civil service workforce level to below 19,000. (MS1) Maintain a diverse NASA workforce through the downsizing efforts. (MS2)	Reduce the civil service workforce level to below 18,200. (0MS1) Maintain a diverse NASA workforce through the downsizing efforts. (0MS2)	Renew Agency's management systems, facilities, and human resources through updated use of automated systems, facilities revitalization, and personnel training by meeting 4 out of 7 performance indicators in this area. (1MS3)
Assessment	All targets were green.	0MS1 was no longer applicable. 0MS2 was green.	
	FY02	**FY03**	**FY04**
Annual Performance Goal and APG#	Align management of human resources to best achieve Agency strategic goals and objectives. (2MS7) Attract and retain a workforce that is representative at all levels of America's diversity. (2MS8)	Align management of human resources to best achieve Agency strategic goals and objectives. (3MS7) Attract and retain a workforce that is representative of America's diversity at all levels, and maximize individual performance through training and development experiences. (3MS8)	
Assessment			

Manage Strategically FY 2003 Annual Performance Goals	**Budget Category**	**HEDS**	**Biological and Physical Research**	**Aero-Space Technology**	**Space Science**	**Earth Science**	**Research and Program Management**
Annual Performance Goals & APG#							
3MS1: NASA will increase the safety of its infrastructure and the health of its workforce through facilities safety improvements, reduced environmental hazards, increased physical security, enhanced safety and health awareness, and appropriate tools and procedures for health enhancement.		X	X	X	X	X	X
3MS2: Continue to take advantage of opportunities for improved contract management by maintaining a high proportion of Performance Based Contracts (PBCs).		X	X	X	X	X	X
3MS9: Continue integrating small, small disadvantaged, and women-owned businesses together with minority universities into the competitive base from which NASA can purchase goods and services.		X	X	X	X	X	X
3MS3: Renew the Agency's management systems and facilities through the use of updated automated systems and facilities revitalization, and meet four out of five performance indicators in this area.		X	X	X	X	X	X
3MS10: Improve the Agency's financial management and accountability.		X	X	X	X	X	X
3MS4: Improve IT infrastructure service delivery by providing increased capability and efficiency while maintaining a customer rating of satisfactory.		X	X	X	X	X	X
3MS5: Enhance IT security by meeting established performance indicators in three critical areas (IT system vulnerabilities, IT security awareness training, and IT security plans).		X	X	X	X	X	X
3MS6: Enhance mission success through seamless, community-focused electronic service delivery by meeting the established performance indicators in this area.		X	X	X	X	X	X
3MS7: Align management of human resources to best achieve Agency strategic goals and objectives.		X	X	X	X	X	X
3MS8: Attract and retain a workforce that is representative of America's diversity at all levels, and maximize individual performance through training and development experiences.		X	X	X	X	X	X

Provide Aerospace Products and Capabilities

FY 2003 Performance Plan

Mission

The Provide Aerospace Products and Capabilities process is the means by which NASA's Strategic Enterprises and their Centers deliver systems (ground, aeronautics, space), technologies, data, and operational services to customers within and outside NASA. Through the use of Agency facilities, customers can conduct research, explore and develop space, and improve life on Earth. This process determines what cutting-edge technologies, processes, techniques, and engineering capabilities NASA must develop to implement its research agenda. This process also determines which technologies, processes, techniques, and engineering capabilities NASA can eliminate, downsize, or outsource to industry and academia so that resources are focused on critical needs that cannot be provided elsewhere. PAPAC helps to assure that NASA strategically utilizes public resources in an efficient and effective means such that the public benefit is maximized.

Implementation Strategy

The goal of this process is to enable NASA's Strategic Enterprises and their Centers to deliver products and services to customers more effectively and efficiently. The process is also used to enable the Communicate Knowledge process to extend the technology, research, and science benefits from NASA programs broadly to the public and commercial sectors.

Performance Metrics

<u>**Strategic Plan Goal:**</u>

To Enable NASA's Strategic Enterprises and their Centers to deliver products and services to their customers more effectively and efficiently.

Objectives: -Enhance Program safety and mission success in the delivery of products and operational services.

-Improve NASA's engineering capability to remain as a premier engineering research and development organization

-Capture engineering and technological best practices and process knowledge to continuously improve NASA's program/project management

Public Benefit: NASA's role in the advancement of research and technology is conducted through the construction and operation of facilities such as telescopes, satellites, and ground-based laboratories and test facilities. This element tracks the effectiveness and efficiency with which NASA's Strategic Enterprises and Centers serve their customers. NASA's improvements in program and project management yields an increased number of successful missions within budget, an increase of information to researchers and the public, more technological breakthroughs, and more discoveries about our planet and universe. NASA's ability to improve and maintain engineering capabilities results in more efficient processes and reduced cost.

APG 3P1: 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.

Indicator

- Development schedule and cost data are drawn from NASA budget documentation for major programs and projects to calculate the average performance measures.

APG 3P2: Track the availability of NASA's spacecraft and major ground facilities by keeping the operating time lost due to unscheduled downtime to less than 10% of scheduled operating time.

Indicator

- Each field center reports the operational downtime of the major spacecraft and groundfacilities.

Objective - Facilitate technology insertion and transfer, and utilize commercialization partnerships in research and development to the maximum extent practicable

Public Benefit: The percentage of NASA's R&D budget dedicated to commercial partnerships affects integrated technology planning and development with NASA partners. This reduces the taxpayer cost while increasing products and services to the consumer and allows NASA the ability to produce more technology break-thru and science by leveraging financial and human capital. This is an overwhelming benefit to the public investment. NASA believes that colleges and universities as well as government and industry bring their scientific, economic, engineering and social research competencies to bear on aerospace problems and on the broader social, economic, and international implications of our technical programs. It is expected that, in doing so, they will strengthen both their research and educational capabilities to contribute more effectively to the national well-being. Working with our academia, industry, Department of Defense, and Federal Aviation Administration partners, our joint goals reach beyond what can be accomplished today and stretch the imagination.

APG 3P3: Dedicate 10 to 20 percent of the Agency's Research & Development budget to commercial partnerships.

Indicator

- Each of the Enterprises reports contribution to commercial partnerships.

Verification and Validation

Data will be verified by collaborating with the Enterprises and Centers, and during the Quarterly Status Reviews and monthly status reports.

Data will be validated by various independent assessments of program/project activity, and the review of several Center and Agency databases.

Management Challenges/High Risk Areas

All of the PAPAC management challenges/high risk areas are being addressed in the implementation of the NASA Integrated Action Team (NIAT) actions. Each of the 17 NIAT actions has an Action Plan that defines how, when, and by whom the plan is being implemented. All of the action plans have been initiated, and most will be fully implemented by the end of FY 2002 although some will continue beyond that. The result of the NIAT assessment presents a framework for strengthening the approach used by NASA to formulate and implement its programs and projects and to improve the supportive nature of the environment in which they are executed.

The NIAT actions represent a systems solution to continually improve NASA's ability to effectively execute its programs and projects. This involves a comprehensive set of practices that focus on the objectives of well-prepared people, sound decision making, and effective communications.

Safety and Mission Assurance:

In response to NIAT 8, and as part of its assigned role to assist the Agency in decreasing the risk for mishap and failure, the Office of Safety and Mission Assurance is expanding and sharpening its focus on safety and mission assurance processes by:

1) Establishing clear commodity/product line oriented safety and mission assurance direction and guidance, including adoption of a comprehensive safety and mission assurance certification process to aid in assuring the safety and mission success of all activities.

2) Improving requirements, guidelines and training related to the identification, tracking, resolution and closure of problems/failures.

3) Developing guidance for the application of safety and mission assurance to non-contractual activities (for example grants and cooperative agreements that are being increasingly utilized by NASA).

There are other activities by other organizations that will also serve to enhance safety and mission success including increased emphasis on proper standards, procurement, and program and project education and training.

Program and Project Management:

The revision of NASA Procedures and Guidelines (NPG) 7120.5, NASA Program and Project Management Processes and Requirements is approaching completion, and it includes extensive changes/clarifications of the processes involved in program/project management. The NIAT Report was the driving force behind the extent of the changes. Several of the NIAT action plans are related to strengthening program/project management. Some of the action plans include more rigorous program/project formulation, continuous evaluation of mission risk profile and balance of scope and resources, and inclusion of management and stakeholders in mission risk acceptance process. Some specific areas of improvement include software development and assurance, the integrated review process, ensuring adequate resources, surveillance, verification and validation, and knowledge management.

Implementing FBC approach to Space Exploration Projects:

The specific actions delineated in the NIAT report focus on how NASA must approach execution of all programs and projects because the underlying principles of FBC, when properly applied, have applicability to all that the Agency does. The governing process by which the Agency guides execution of its programs and projects does not currently differentiate projects that are FBC and those that are not FBC. Instead, it relies upon a careful assessment on a case-by-case basis to establish the risk posture associated with a particular mission or endeavor. NASA's work is and will continue to be inherently high risk. Different NASA projects will have different risk profiles, depending on the criticality of the project to NASA's program goals, the amount invested in the project, and the nature of the project. For example, the acceptable technical risks on a small technology testbed may be substantially greater than those on a large science spacecraft or a human space flight mission. NASA's goal is to strive for a reduction of risk on every project that is commensurate with these factors. In this light, NASA has no differentiation of FBC projects. However, in all projects, individual competency, team functionality, utilization of technology, prudent risk taking, rigor of practice, and management awareness and consent are all key to properly identifying and managing risk. Through the actions of the report, the Agency will improve its approach to safety and prudent acceptance of mission risk as key criteria for proper project and program management.

Provide Aerospace Products and Capabilities
FY 2003 Performance Plan

Strategic Objective: Enhance Program safety and mission success in the delivery of products and operational services

	FY99	FY00	FY01	FY02	FY03
Annual Target and Target #	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. (P1)	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. (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. (1P1)	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. (2P1)	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. (3P1)
Target Assessment	Green	Red			

Strategic Objective: Enhance Program safety and mission success in the delivery of products and operational services

	FY99	FY00	FY01	FY02	FY03
Annual Target and Target #	Set up process to determine, on average, the operating time of NASA's spacecraft and ground facilities lost to unscheduled downtime. Establish a baseline in FY99. (P2)	Ensure the availability of NASA's spacecraft and facilities by decreasing the downtime relative to FY1999 spacecraft and facility performance. (0P2)	Ensure the availability of NASA's spacecraft and major ground facilities by keeping the operating time lost due to unscheduled downtime to less than 10% of scheduled operating time. (1P3)	Track the availability of NASA's spacecraft and major ground facilities by keeping the operating time lost due to unscheduled downtime to less than 10% of scheduled operating time. (2P2)	Track the availability of NASA's spacecraft and major ground facilities by keeping the operating time lost due to unscheduled downtime to less than 10% of scheduled operating time. (3P2)
Target Assessment	Green	Blue			

Strategic Objective: Enhance Program safety and mission success in the delivery of products and operational services

	FY99	FY00	FY01	FY02	FY03
Annual Target and Target #			Develop and approve NASA policy for Software Independent Verification and Validation, and conduct an evaluation of projects for its application through achievement of three indicators. (1P7)		
Target Assessment					

Strategic Objective: Improve NASA's engineering capability to remain as a premier engineering research and development organization

	FY99	FY00	FY01	FY02	FY03
Annual Target and Target #	Set up process to improve engineering skills and tools within the Agency. (P8)			Strengthen the NASA engineering capability through the completion of two indicators in FY02. (2P3)	
Target Assessment	Yellow				

Strategic Objective: Capture engineering and technological best practices and process knowledge to continuously improve NASA's program/project management

	FY99	FY00	FY01	FY02	FY03
Annual Target and Target #				Improve program and project management through the completion of two of three indicators in FY02. (2P4)	
Target Assessment					

Strategic Objective: Capture engineering and technological best practices and process knowledge to continuously improve NASA's program/project management

	FY99	FY00	FY01	FY02	FY03
Annual Target and Target #	Set up a process in FY99 to capture a set of best practices/lessons learned from each Program, to include at least one from each of the four PAPAC subprocesses, commensurate with current program status. (P5)	Capture a set of best practices/lessons learned from each Program, to include at least one from each of the four PAPAC subprocesses, commensurate with current program status. Inputs will be used in PAPAC process improvement and in Program/Project Management training. (0P5)	Capture a set of best practices/lessons learned from each Program, to include at least one from each of the four PAPAC subprocesses, commensurate with current program status. Inputs will be used in PAPAC process improvement and in Program/Project Management training. (1P4)	Capture a set of best practices/lessons learned from each Program, to include at least one from each of the four PAPAC subprocesses, commensurate with current program status. Inputs will be used in PAPAC process improvement and in Program/Project Management training. (2P5)	
Target Assessment	Green	Yellow			

Strategic Objective: Facilitate technology insertion and transfer, and utilize commercial partnerships in research and development to the maximum extent practicable

	FY99	**FY00**	**FY01**	**FY02**	**FY03**
Annual Target and Target #	Set up a process to determine percent of Agency's R and D budget dedicated to commercial partnerships and establish a baseline. (P6)	Dedicate thepercentage of the Agency's R&D budget that is established in the FY00 processto commercial partnerships. (0P6)	Dedicate 10 to 20 percent of the Agency's Research & Development budget to commercial partnerships. (1P5)	Dedicate 10 to 20 percent of the Agency's Research & Development budget to commercial partnerships. (2P6)	Dedicate 10 to 20 percent of the Agency's Research & Development budget to commercial partnerships. (3P3)
Target Assessment	Green	Blue			

Strategic Objective: Enable technology planning, development, and integration driven by Strategic Enterprise customer needs

	FY99	**FY00**	**FY01**	**FY02**	**FY03**
Annual Target and Target #	Set up a data collection process to determine the amount of leveraging of the R and D budget with activities of other organizations. Establish a baseline in FY99. (P7)	Increase the amount of leveraging of the technology budget with activities of other organizations, relative to the FY99 baseline that is established during process development. (0P7)	Complete redefinition of the NASA Technology Plan to emphasize investments in the emerging strategic cross-Enterprise technology areas & include roadmaps for each Enterprise to show how Enterprise technology investments are linked to future mission needs. (1P6)		
Target Assessment	Green	Green			

PAPAC FY 2003 Annual Performance Goals	**Budget Category**	HEDS	Aero-Space Technology	Space Science	Earth Science
Annual Performance Goal					
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. (3P1)		X	X	X	X
Track the availability of NASA's spacecraft and major ground facilities by keeping the operating time lost due to unscheduled downtime to less than 10% of scheduled operating time. (3P2)		X	X	X	X
Dedicate 10 to 20 percent of the Agency's Research & Development budget to commercial partnerships. (3P3)		X	X	X	X

Communicate Knowledge

FY 2003 Performance Plan

Mission

NASA communicates knowledge by coordinating, managing and sharing information and experiences related to the content, relevance, results, applications, and excitement of NASA's mission. The Communicate Knowledge (CK) process facilitates the distribution of information on NASA's missions and discoveries. It ensures increased public understanding of science and technology, promotes the application of NASA-generated information, and inspires achievement and innovation. The process ensures that knowledge derived from NASA research programs is available to meet the specific needs and interests of constituent groups. It begins at the inception of a research project and increases in intensity as the effort reaches maturity to ensure the appropriate delivery, archiving, and future convenient access of all research results. The goal of the Communicate Knowledge Process is to ensure that NASA's customers (including scientists and technologists around the world, companies and innovators, educators, publishers, museums, the media, and every citizen) receive information derived from the Agency's efforts in a timely and useful form.

Implementation Strategy

The Agency will work to expose more people to the activities of NASA's Aeronautics and Space programs by maintaining an exhibits loan service, supporting Visitor Center activities, and by providing live satellite interviews with astronauts, program managers, and other Agency officials. Through increased availability of documentation and digital images, the Agency will provide scientists and the public greater access to NASA generated knowledge. For example, the Scientific Technical Information (STI) program offers the public easy access to results from basic applied research. The STI Program was established to support the objectives of NASA's missions and research and is a unique resource to scientists, engineers, technicians, and managers. The Agency will also improve the utility of NASA World Wide Web pages and ease of locating areas of interest, based on the public's demand. NASA will increase the opportunities for transferring technology to private industry and the public through the Internet using the *NASA TechTracS database*, by producing a series of technology publications, and by attending industry specific conferences and trade shows. The Agency involves the educational community in its endeavors to inspire America's students, create learning opportunities, and enlighten inquisitive minds. This will be accomplished by providing opportunities for students and educators at all levels to become involved in our mission; providing excellent and valuable education programs and services as judged by our customer, the education community; increasing the number of sites that offer science and engineering curriculum to the underrepresented and minority students; and increasing the involvement of minority universities through sponsored research projects.

Changes from the FY 2002 to FY 2003 Plan reflect an effort to more accurately measure the Communicate Knowledge process. A few indicators were consolidated to avoid duplication and others were discontinued when we completed an activity.

The Objectives described in the NASA Strategic Plan for this cross-cutting process are:

- Share with the public the knowledge and excitement of NASA’s programs in a form that is readily understandable
- Disseminate scientific information generated by NASA programs to our customers
- Transfer NASA technologies and innovations to private industry and the public sector
- Support the Nation’s education goals

The Agency has defined 4 CK Annual Performance Goals for Fiscal Year 2003. Each goal has specific indicators that will provide a quantitative manner to measure performance. The goals are listed in the text that follows.

Strategic Goal: Ensure that NASA's customers receive information from the Agency's efforts in a timely and useful form.

Objective: Share with the public the knowledge and excitement of NASA’s programs in a form that is readily understandable.

Public Benefit: American citizens can experience NASA in ways that are meaningful and useful to them, by participating in NASA supported events.

Annual Performance Goal 3CK1: Share the experience of expanding the frontiers of air and space with the public and other stakeholders by meeting 4 of the 5 indicators for this goal.

Indicators:

- Provide public access to a minimum of 1,200 events featuring traveling exhibits that showcase NASA programs, research efforts and technological discoveries; in addition to more permanent attractions easily accessible to the public at the visitor centers located at many NASA Centers across the United States.
- Increase the NASA-sponsored, -funded, and/or -generated Scientific Technical Information (STI) available to NASA, the scientific community, and/or the public by 15,750 new items.
- Agency officials and astronauts will convey clear information on NASA activities through the most used media in America: television, through no less than 30 live shots per month on average.
- NASA’s activities and achievements will be chronicled and put into perspective for the American public through 10 new historical publications.
- Documents significant in the Agency’s history will be made available to a larger audience by at least one new electronic document – a CD/ROM.

Strategic Goal: Ensure that NASA's customers receive information from the Agency's efforts in a timely and useful form.

Objective: Disseminate scientific information generated by NASA programs to our customers.

Public Benefit: The public will have greater access to increased, relevant and understandable scientific information that will enable them to share in the excitement of discovery.

Annual Performance Goal 3CK2: Inform, provide status, enthuse, and explain results, relevance and benefits of NASA's programs by meeting 2 of the 3 indicators for this goal.

Indicators:

- Effective use of the NASA Home Page to communicate knowledge about NASA's scientific and technological achievements to the public. Effectiveness will be rated by placing at least 150 stories about breaking news on science and technology discoveries.
- The History Office will create one additional on-line exhibit on the NASA History Web page.
- The History Office will meet the need for a timely and effective response to the public by meeting or exceeding 90% of the time a 15-day response standard.

Strategic Goal: Ensure that NASA's customers receive information from the Agency's efforts in a timely and useful form.

Objective: Transfer NASA technologies and innovations to private industry and the public sector.

Public Benefit: General and targeted members of the public can benefit economically as well as intellectually through clear, effective communications concerning the Agency's activities.

Annual Performance Goal 3CK3: Enhance communication about and dissemination of technologies available for commercial use, technologies that have been commercialized by industry, and increase accessibility to targeted industry sectors by meeting 2 of 2 indicators.

Indicators:

- Publish and distribute program specific publications, including 1 industry specific publication, to encourage and increase partnerships with targeted industry sectors and develop an effective marketing campaign to increase accessibility to targeted industry sectors where NASA can promote its technologies available for commercialization and acquire new readership from the public.

- Provide public and industry access to the TechTracS database which features approximately 18,000 updated and evolving new technologies; as well as technical briefs, diagrams, and illustrations.

Strategic Goal: Ensure that NASA's customers receive information from the Agency's efforts in a timely and useful form.

Objective: Support the Nation's education goals.

Public Benefit: The general public will have increased learning opportunities in science and technology fields through NASA sponsored programs.

Annual Performance Goal 3CK4: Using NASA's unique resources (mission, people, and facilities) to support educational excellence for all, NASA will support the Nation's education goals by meeting 3 of the 4 indicators for this performance goal.

Indicators:

- Provide excellent and valuable educational programs and services, maintaining an "excellence" customer service rating ranging between 4.3 and 5.0 (on a 5.0 scale) 90% of the time.
- NASA will involve the educational community in its endeavors, maintaining a level of involvement of approximately 3 million participants, which include teachers, faculty, and students.
- Increase the amount of funding for and participation of Minority Universities.
- Increase the number of refereed publications by Investigators and the number of research papers and presentations by students at Minority Universities, using FY02 as a baseline.

Verification/Validation

Due to the broad nature of the Communicate Knowledge crosscutting process, there is a broad array of methods to verify and validate the reported metric data. These methods include the following:

1) Monthly reports from Field Centers.

2) Automatic built in statistics gathering software (web statistics).

3) On-air records and reports from NASA Field Centers television producers.

4) Field Center reports and commercially acquired video monitoring report from Burrelles.

5) Count of publications (History Office).

6) General and targeted distribution of *Aerospace Technology Innovation*, *SPINOFF* annual report, and *Tech Brief* publications. Monitoring of electronic subscription request file, recorded print distribution request and inventory, and downloads from Website. Sponsorship of NASA technology exhibitions at targeted industry trade shows and reports of prospective partnerships.

7) Education Computer-aided Tracking System (EDCATS) has a multi-layered process to verify the accuracy and quality of the data collected.

   a) 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.

   b) 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 access 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.

   c) 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. The EDCATS software developer also checks the data and informs the EDCATS Program Manager of anomalies or suspected problems.

8) *NASA TechTracS* - The authorization for release of new technology reports to the public is carried out by each Center's patent counsel and commercial technology office. A set of written procedures for this process is available upon request. The actual implementation of a release is controlled when the "release to public" data field in each Centers' *TechTracS* is set to "yes" by both the patent counsel and the commercial technology office. Access to this data field is tightly controlled by each Center.

9) The Contractor, as part of their report, collects metric data. A NASA representative of the STI Program Office, Principal Center for the STI Program, verifies improvements.

10) On-site visits.

11) 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 do not document why an individual accesses the web page.

12) 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.

13) Reports from the NASA Centers regarding their imagery additions for the year.

14) Data are collected from participants in Agency wide, Enterprise, and Center education programs via an on-line data collection system. Program participants have the opportunity to rate our programs by answering a series of questions including, would they recommend the program to others; how would they rate the staff; do they expect to apply what was learned; and was the program a valuable experience. The ratings provided on these questions are then used to create an "overall average for excellence."

MULTI-YEAR PERFORMANCE TREND

Communicate Knowledge

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00, and 01). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02, 03).

	FY 99	**FY 00**	**FY01**
Annual Performance Goal and APG #	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. (CK9)	Produce 12 new historical publications chronicling and placing NASA's activities and achievements in perspective for the American public. (0C3)	Share the experience of expanding the frontiers of air and space with the public and other stakeholders by meeting 5 of the 6 indicators for this target. (1CK1)
APG Assessment	Blue	Green	TBD

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00, 01).

	FY 99	**FY 00**	**FY01**
Annual Performance Goal and APG #	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 data base describing scientific and technical publications available to the American public.(CK10)		
APG Assessment	Blue		

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00, 01). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02, 03).

	FY 02	**FY 03**	
Annual Performance Goal and APG #	Share the experience of expanding the frontiers of air and space with the public and other stakeholders by meeting 4 of the 5 indicators for this goal. (2CK1)	Share the experience of expanding the frontiers of air and space with the public and other stakeholders by meeting 4 of the 5 indicators for this goal. (3CK1)	
APG Assessment	TBD	TBD	

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00, 01).

	FY 02	**FY 03**	
Annual Performance Goal and APG #			
APG Assessment			

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02, 03).

	FY 99	FY 00	FY01
Annual Performance Goal and APG #		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. (0C12)	
APG Assessment		Green	

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00, and 01). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02, 03).

	FY 99	FY 00	FY01
Annual Performance Goal and APG #		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. (0C13)	Captured in APG (1CK1).
APG Assessment		Green	TBD

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00, 01). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02, 03).

	FY 02	**FY 03**	
Annual Performance Goal and APG #			
APG Assessment			

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00, and 01). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02, 03).

	FY 02	**FY 03**	
Annual Performance Goal and APG #	Captured in APG (2CK1).	Captured in APG (3CK1).	
APG Assessment	TBD	TBD	

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00, and 01). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02, 03).

	FY 99	FY 00	FY01
Annual Performance Goal and APG #		Maintain a baseline for live satellite interview programs of no less than 10 live shots per month. (0C19)	Captured in APG (1CK1)
APG Assessment		Blue	TBD

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00, and 01). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02, 03).

	FY 99	FY 00	FY01
Annual Performance Goal and APG #		Maintain a baseline of 5 Video File elements per week, issuing raw video and animation daily on NASA TV. (0C20)	
APG Assessment		Blue	

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00, and 01). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02, 03).

	FY 02	**FY 03**	
Annual Performance Goal and APG #	Captured in APG (2CK1).	Captured in APG (3CK1).	
APG Assessment	TBD	TBD	

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00, and 01). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02, 03).

	FY 02	**FY 03**	
Annual Performance Goal and APG #	Captured in APG (2CK1).	Captured in APG (3CK1).	
APG Assessment	TBD	TBD	

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00 and 01). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02, 03).

	FY 99	FY 00	FY01
Annual Performance Goal and APG #		Increase the NASA-sponsored, funded, or generated report documents for the scientific community and public from 11,600 to 13,920. (0C4)	Captured in APG (1CK1).
APG Assessment		Blue	TBD

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00 and 01). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02, 03).

	FY 99	FY 00	FY01
Annual Performance Goal and APG #		Increase the nontraditional NASA-sponsored scientific and technical information through the NASA Image eXchange (NIX) digital image database from 300,000 in FY98 to more than 470,000 in FY00. (0C16)	Captured in APG (1CK1).
APG Assessment		Green	TBD

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00 and 01). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02, 03).

	FY 02	FY 03	
Annual Performance Goal and APG #		Captured in APG (3CK1).	
APG Assessment		TBD	

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00 and 01). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02, 03).

	FY 02	FY 03	
Annual Performance Goal and APG #			
APG Assessment			

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00 and 01). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02, 03).

	FY 99	FY 00	FY01
Annual Performance Goal and APG #		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. (0C14)	
APG Assessment		Red	

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00 and 01). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02, 03).

	FY 99	FY 00	FY01
Annual Performance Goal and APG #		The Office of Scientific and Technical Information Program plans to improve the NASA Image eXchange (NIX) meta-search engine accessing all NASA digital image databases, adding Quick-Time, video, animation, and browse categories on NASA's key topics of interest to customers. (0C6)	
APG Assessment		Green	

Strategic Objective: **:** Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00 and 01). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02, 03).

	FY 02	**FY 03**	
Annual Performance Goal and APG #			
APG Assessment			

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00 and 01). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02, 03).

	FY 02	**FY 03**	
Annual Performance Goal and APG #			
APG Assessment			

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00 and 01). Disseminate scientific information generated by NASA programs to our customers (FY02 and 03).

	FY 99	**FY 00**	**FY01**
Annual Performance Goal and APG #		Increase the number of searched pages in NASA Web space by 5% per year, relative to the FY99 baseline. (0C17)	Inform, provide status, enthuse, and explain results, relevance and benefits of NASA's programs by meeting 2 of the 3 indicators for this target. (1CK2)
APG Assessment		Blue	TBD

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00, 01). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02). Disseminate scientific information generated by NASA programs to our customers (FY03).

	FY 99	**FY 00**	**FY01**
Annual Performance Goal and APG #		Increase the capacity of the NASA Home Page to meet public demand by providing for a 5% per year increase in download capacity, using FY99 figures as a baseline. (0C18)	Captured in APG (1CK2).
APG Assessment		Blue	TBD

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00, 01). Disseminate scientific information generated by NASA programs to our customers (FY02, 03).

	FY 02	**FY 03**	
Annual Performance Goal and APG #	Inform, provide status, enthuse, and explain results, relevance and benefits of NASA's programs by meeting 2 of the 3 indicators for this target. (2CK2)	Inform, provide status, enthuse, and explain results, relevance and benefits of NASA's programs by meeting 2 of the 3 indicators for this target. (3CK2)	
APG Assessment	TBD	TBD	

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY99, 00, 01). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02). Disseminate scientific information generated by NASA programs to our customers (FY03).

	FY 02	**FY 03**	
Annual Performance Goal and APG #			
APG Assessment			

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY00).

	FY 99	FY 00	FY01
Annual Performance Goal and APG #		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. (0C7)	
APG Assessment		Red	

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY00, 01). Transfer NASA technologies and innovations to private industry and the public sector (FY02, 03).

	FY 99	FY 00	FY01
Annual Performance Goal and APG #		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 *Innovations*, (12,000), *Spinoff* (50,000), and *Tech Briefs* (205,000), whose effectiveness will be measured by monitoring readership and frequency of use as a sources of reference. (0C21)	Ensure consistent, high-quality, external communication by meeting 2 of the 3 indicators for this target. (1CK3)
APG Assessment		Green	TBD

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY00).

	FY 02	**FY 03**	
Annual Performance Goal and APG #			
APG Assessment			

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY00, 01). Transfer NASA technologies and innovations to private industry and the public sector (FY02, 03).

	FY 02	**FY 03**	
Annual Performance Goal and APG #	Ensure consistent, high-quality, external communication by meeting 3 of the 4 indicators for this goal. (2CK3)	Enhance communication about and dissemination of technologies that have been commercialized by industry and increase accessibility to targeted industry sectors by meeting 2 of the 2 indicators. (3CK3)	
APG Assessment	TBD	TBD	

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY00, 01). Transfer NASA technologies and innovations to private industry and the public sector (FY02, 03).

	FY 99	**FY 00**	**FY01**
Annual Performance Goal and APG #		Publish at least 1 industry specific *Aerospace Technology Innovation* issue per year. (0C22)	Captured in APG (1CK3).
APG Assessment		Blue	TBD

Strategic Objective: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY00, 01). Transfer NASA technologies and innovations to private industry and the public sector (FY02, 03).

	FY 99	**FY 00**	**FY01**
Annual Performance Goal and APG #		The Office of Aero-Space 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 annual tradeshow in Detroit, Michigan. (0C15)	
APG Assessment		Red	

<u>Strategic Objective:</u> Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY00, 01). Transfer NASA technologies and innovations to private industry and the public sector (FY02, 03).

	<u>FY 02</u>	**<u>FY 03</u>**	
Annual Performance Goal and APG #	Captured in APG (2CK3).	Captured in APG (3CK3).	
APG Assessment	TBD	TBD	

<u>Strategic Objective</u>: Improve the external constituent communities' knowledge, understanding, and use of the results and opportunities associated with NASA programs (FY00, 01). Transfer NASA technologies and innovations to private industry and the public sector (FY02, 03).

	<u>FY 02</u>	**<u>FY 03</u>**	
Annual Performance Goal and APG #	Captured in APG (2CK3).		
APG Assessment	TBD		

Strategic Objective: 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 (FY99, 00, 01). Transfer NASA technologies and innovations to private industry and the public sector (FY02, 03).

	FY 99	FY 00	FY01
Annual Performance Goal and APG #	Increase new technology opportunities from 19,600 to 19,700. These will be made available to the public through the NASATechTracs database and will be measured by monitoring a controlled data field that indicates the number of new technologies communicated to the public. (CK12)	Increase new opportunities to transfer technology developed at NASA to private industry from 19,600 to 19,800. These opportunities will be made available to the public through the NASATechTracs database and will be measured by monitoring a controlled data field that indicates the number of new technologies communicated to the public. (0C9)	Captured in APG (1CK3).
APG Assessment	Blue	Green	TBD

Strategic Objective: 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 (FY99).

	FY 99	FY 00	FY01
Annual Performance Goal and APG #	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 98. (CK1)		
APG Assessment	Green		

Strategic Objective: 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 (FY99, 00, 01). Transfer NASA technologies and innovations to private industry and the public sector (FY02, 03).

	FY 02	**FY 03**	
Annual Performance Goal and APG #	Captured in APG (2CK3).	Captured in APG (3CK3).	
APG Assessment	TBD	TBD	

Strategic Objective: 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 (FY99).

	FY 02	**FY 03**	
Annual Performance Goal and APG #			
APG Assessment			

Strategic Objective: 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 (FY99).

	FY 99	FY 00	FY01
Annual Performance Goal and APG #	Increase the number of students reached through NEWEST/NEWMAST program to 42,000 students from 33,600 in FY 98. (CK2)		
APG Assessment	Green		

Strategic Objective: 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 (FY99, 00, 01). Support the Nation's education goals (FY02, 03).

	FY 99	FY 00	FY01
Annual Performance Goal and APG #	Maintain the participation level in Agency-wide educational programs at more than 1 million teachers and students. (CK3)	Seek to maintain a level of participation involvement of approximately 3 million with teachers, faculty, and students in the education community. (0C1)	Use NASA's ability to support meeting the Nation's education goals by meeting 3 of the 4 indicators for this target. (1CK4)
APG Assessment	Blue	Blue	TBD

Strategic Objective: 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 (FY99).

	FY 02	**FY 03**	
Annual Performance Goal and APG #			
APG Assessment			

Strategic Objective: 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 (FY99, 00, 01). Support the Nation's education goals (FY02, 03).

	FY 02	**FY 03**	
Annual Performance Goal and APG #	Using NASA's unique resources (mission, people, and facilities) to support educational excellence for all, NASA supports the Nation's education goals by meeting 3 of the 4 indicators for this performance goal. (2CK4)	Using NASA's unique resources (mission, people, and facilities) to support educational excellence for all, NASA will support the Nation's education goals by meeting 3 of the 4 indicators for this performance goal. (3CK4)	
APG Assessment	TBD	TBD	

Strategic Objective: 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 (FY00, 01). Disseminate scientific information generated by NASA programs to our customers (FY02, 03). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02, 03).

	FY 99	FY 00	FY01
Annual Performance Goal and APG #		Assist customers who use the STI Help Desk and the NASA Image eXchange (NIX) digital image database within a specific turnaround period. (0C10)	Captured in APG (1CK2).
APG Assessment		Green	TBD

Strategic Objective: 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 (FY00, 01). Disseminate scientific information generated by NASA programs to our customers (FY02, 03). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02, 03).

	FY 99	FY 00	FY01
Annual Performance Goal and APG #		Support no less than 800 portable exhibit loans and send portable exhibits to a minimum of 175 targeted events per year. (0C11)	
APG Assessment		Blue	

Strategic Objective: 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 (FY00, 01). Disseminate scientific information generated by NASA programs to our customers (FY02, 03). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02, 03).

	FY 02	**FY 03**	
Annual Performance Goal and APG #			
APG Assessment			

Strategic Objective: 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 (FY00, 01). Disseminate scientific information generated by NASA programs to our customers (FY02, 03). Share with the public the knowledge and excitement of NASA's programs in a form that is readily understandable (FY02, 03).

	FY 02	**FY 03**	
Annual Performance Goal and APG #		Captured in APG (3CK1).	
APG Assessment	TBD	TBD	

Communicate Knowledge FY 2003 Budget Link Table	**Budget Category**	Space Science*	Earth Science*	Biological and Physical Research*	HEDS*	Aero-Space Techology*	Academic Programs
Share the experience of expanding the frontiers of air and space with the public and other stakeholders by meeting 4 of the 5 indicators of this goal. (3CK1)		x	x	x	x	x	
Inform, provide status, enthuse, and explain results, relevance and benefits of NASA's programs by meeting 2 of the 3 indicators for this goal. (3CK2)		x	x	x	x	x	
Enhance communication about and dissemination of technologies available for commercial use, and technologies that have been commercialized by industry and increase accessibility to targeted industry sectors by meeting 2 of the 2 indicators. (3CK3)		x	x	x	x	x	x
Using NASA's unique resources (mission, people, and facilities) to support educational excellence for all, NASA will support the Nation's education goals by meeting 3 of the 4 indicators. (3CK4)		x	x	x	x	x	x
* The Enterprises also have specific APGs and indicators dealing with Communicating Knowledge.							