Order Code RL30493

The National Aeronautics and Space Administration's FY2001 Budget Request: Description and Analysis

Updated June 9, 2000

Richard E. Rowberg
Senior Specialist in Science and Technology

Erin Hatch
Analyst in Space and Technology Policy
Resources, Science, and Industry Division

ABSTRACT

The National Aeronautics and Space Administration (NASA) is requesting $14.04 billion for FY2001. This report provides an overview of the NASA budget request by major program area. It includes a discussion of the general functions of each of those programs and highlights of activities planned for FY2001. The report also presents an analysis of key issues that could be considered by Congress as it reviews NASA's FY2001 request. The report should be useful for Members and staff in considering the NASA budget request as it moves through the authorization and appropriations process. The report will be updated as those budget-related actions take place.

The National Aeronautics and Space Administration's FY2001 Budget Request: Description and Analysis

Summary

For FY2000, Congress appropriated (P.L. 106-74) $13.60 billion for NASA, $22.4 million above the request. Funding for the International Space Station (ISS) was reduced $159.6 million from the request while funding for Aero-Space Technology was increased $118.4 million above the request. All other accounts were funded close to their requested levels. NASA is requesting a supplemental appropriation of $75 million for FY2000.

For FY2001, NASA requested $14.035 billion, an increase of 3.2% above the FY2000 appropriations. This is the first budget increase requested by NASA in seven years. Of the request, $9.73 billion is for R&D, an increase of 0.8% above the FY2000 level. Increases are being requested of $206 million for Space Science and $69.9 million for Aero-Space Technology. A decrease of $208.6 million is being requested for the International Space Station.

In its request, NASA is proposing a five-year, $4.4 billion effort to develop the technology base for a 2nd generation reusable launch vehicle (RLV). It is also proposing a 10-year, $1.7 billion program — Living With a Star — to study the origins of eruptions on the Sun's surface that can result in damage to Earth satellites. Another initiative in the request is a five-year, $1.9 billion effort for safety and supportability upgrades for the Space Shuttle.

The budget request highlights several issues that may arise during congressional consideration of the request. A perennial concern is U.S. reliance on Russia for construction of the ISS, and the problems Russia is having in meeting its commitments. An issue that intensified this past year is whether NASA's "faster, better, cheaper" policy about deployment of its scientific missions is resulting in too many failures and not enough attention to the scientific objectives of the mission. Concerns have also been raised about NASA's plans to develop a follow-on RLV to the Space Shuttle. While the RLV initiative announced in the FY2001 budget request is the most extensive effort to date, it still leaves many unanswered questions including the roll of earlier projects — the X-33, X-34, and Future-X — designed to help prepare for a next generation RLV. In the meantime, there has been growing concern about the safety and reliability of the shuttle, although the shuttle upgrade program proposed by NASA might address those concerns.

On June 7, 2000, the House Appropriations Committee recommended an appropriations of $13.714 billion for NASA for FY2001, 2.3% below the request but 0.8% above the FY2000 level. The reductions from the request occur in the Space Science and Aero-Space Technology programs. The Committee did not provide funds for the Living With a Star initiative and reduced the request for the 2nd generation RLV initiative by $290 million.

Contents

List of Figures

List of Tables

The National Aeronautics and Space Administration's FY2001 Budget Request: Description and Analysis

Introduction

The National Aeronautics and Space Administration (NASA) was created by the National Aeronautics and Space Act of 1958 (P.L. 85-568) to undertake civilian research, development, and flight activities in aeronautics and space. This report describes the various NASA programs and their FY2001 budget request. Included are discussions of key issues that might affect congressional actions on the budget. The report will be updated to include future congressional authorization and appropriations actions.

To begin the report, a brief review of NASA's budget history is presented including a description of the FY2000 budget request and congressional appropriations and authorization actions.

Historical Budget

Since its creation, NASA has experienced periods of budget growth and decline, some of which have been quite dramatic. In the early 1960s, as the nation strived to put an American on the Moon by 1969, NASA's budget increased rapidly, peaking at $5.25 billion in FY1965. Then, as other national priorities gained precedence, NASA's budget declined sharply from the FY1965 peak to about $3 billion in FY1974. After FY1974, NASA's budget once again began to increase steadily, peaking at $14.5 billion in FY1994. As efforts to restrain federal funding took hold under the pressure of the budget caps, NASA's budget again began to decline to its FY2000 level of $13.600 billion. Figure 1 (next page) displays the agency's budget history, both in current year dollars (unadjusted for inflation) and in 1998 dollars. (The one-year spike in 1987 was to build a replacement orbiter following the *Challenger* tragedy.) The sharpness of the budget growth and decline from 1958 to 1974 is quite clear when presented in 1998 dollars.

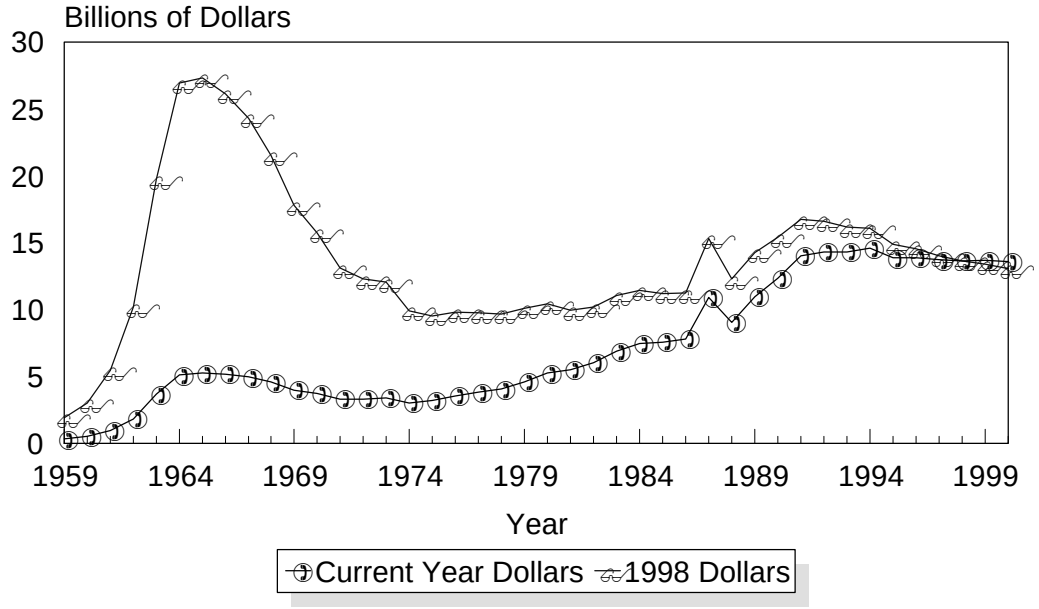
FY 2000 Budget[1]

Table 1 (see page 3) shows the FY1999 and FY2000 appropriations for NASA, along with the FY2001 request. For FY2000, NASA requested $13.578 billion, a reduction of $76.7 million from the FY1999 appropriation. The final FY2000

---

[1] Congressional Research Service, *The National Aeronautics and Space Administration's FY2000 Budget: Description and Analysis*, by Richard Rowberg, RL30154, Oct. 22, 1999.

Figure 1. NASA Budget History – Budget Authority



Source: Aeronautics and Space Report of the President, FY1997 Activities: NASA*FY2001 Budget Request*

appropriations bill (P.L. 105-276, H.Rept. 105-749) provided $13.600 billion for FY1999, 0.16% above the request but 0.38% below FY1999.[2]

No NASA authorization bill was enacted last year, although bills passed the House and Senate. On May 19, 1999, the House approved the National Aeronautics and Space Administration Act of 1999 (H.R. 1654, H.Rept. 105-65). The bill authorizes $13.637 billion for NASA for FY2000. The House noted that the authorization was necessary to assure that the International Space Station reached its full scientific potential and to improve the health of the U.S. commercial and government space launch enterprise. On November 5, 1999, the Senate passed H.R. 1654 after amending the bill by substituting the text of S. 342 (S.Rept. 106-77), the National Aeronautics and Space Administration Authorization Act, FY2000, FY2001 and FY2002. The bill would authorize $13.883 billion for FY2000. The Senate urged NASA to meet the difficult cost challenges and enhance managerial control. The Senate noted that the authorization bill is to help provide for a "robust and balanced space program." Conferees have been appointed but have not met.

[2] A supplemental appropriation bill has been introduced in the House (H.R. 3908, H.Rept. 106-571) that would add $75 million to NASA's FY2000 appropriation. The bill would add $25.8 million to the Human Space Flight account, $29 million to the Science, Aeronautics, and Technology account, and $20.2 million to the Mission Support account.

NASA Programs and FY2001 Budget Request

Overview

NASA's budget[3] request is presented in four appropriations categories: Human Space Flight (HSF), Science Aeronautics and Technology (SAT), Mission Support (MS), and the Inspector General (IG).[4] For FY2001, NASA is requested $14.035 billion, an increase of 3.2% above the FY2000 appropriations (see Table I for details). This is the first increase requested by NASA in seven years. Of the request, $9.73

Table 1. NASA FY2001 Budget — Appropriations
(millions of dollars)

Funding Category	FY1999 (Appro.)	FY2000 (Appro.)	FY2001 (Request)	FY2001 (House)
HUMAN SPACE FLIGHT	**5,470.0**	**5,467.7**	**5,499.9**	**5,499.9**
Space Station	2,270.0	2,323.1	2,114.5	2,114.5
Space Shuttle	3,028.0	2,979.5	3,165.7	3,165.7
Payload Utilization and Operations	182.0	165.1		
Payload and ELV Support			90.2	90.2
Investments & Support			129.5	129.5
SCIENCE, AERO, AND TECH	**5,693.9**	**5,580.9**	**5,929.4**	**5,606.7**
Space Science	2,119.2	2,192.8	2,398.8	2,378.8
Life and Microgravity Sciences	263.5	274.7	302.4	329.0
Earth Science	1,413.8	1,443.4	1,405.8	1,405.8
Aero-Space Technology	1,338.9	1,124.9	1,193.0	859.0
Space Operations			529.4	529.4
Mission Communications Services	380.0	406.3		
Academic Programs	138.4	138.8	100.0	105.4
MISSION SUPPORT	**2,511.2**	**2,532.2**	**2,584.0**	**2,584.0**
Safety, Mission Assur, Eng & Adv Con	35.6	43.0	47.5	47.5
Space Communications Services	185.8	89.7		
Research and Program Management	2,121.2	2,217.6	2,290.6	2,290.6
Construction of Facilities	168.5	181.9	245.9	245.9
INSPECTOR GENERAL	**20.0**	**20.0**	**22.0**	**23.0**
TOTAL	**13,655.1**	**13,600.8**	**14,035.3**	**13,713.6**

Source: NASA *FY2001 Budget Estimate*

billion is for R&D, an 0.8% above the FY2000 level. Funding for the R&D programs contained within the SAT category would increase by 6.2% while funding for the International Space Station, in the HSF category, would decrease by 9%.

For FY2001, NASA states that its budget request is designed around four key priorities: operate the space shuttle safely; continue construction of the International

[3] For budget details, see, National Aeronautics and Space Administration, *Budget Estimates: Fiscal Year 2001*, [http://ifmp.nasa.gov/codeb/budget2001/].

[4] The NASA budget supports its four strategic enterprises: the Space Science Enterprise, the Earth Science Enterprise, the Human Exploration and Development of Space Enterprise, and the Aero-Space Technology Enterprise. See: NASA *Budget Estimates*, AS2-3.

Space Station; make progress toward reducing the cost of access to space; and perform outstanding science and technology. In addition, the budget request proposes two changes in the major account structure. First it converts the Payload Utilization and Operations account into two new accounts: Payload and ELV (expendable launch vehicle) Support, and Investments and Support. This action is designed to separate activities that support the shuttle and NASA's ELV program from those that provide broad support for all of NASA's human space flight (HSF) activities. The second action combines Mission Communication Services and Space Communications Services into one account, Space Operations. These two programs perform similar functions. NASA plans to combine their activities under the Consolidated Space Operations Contract (CSOC).

For FY2001, NASA is also proposing to increase its full-time equivalent workforce by 328 people following several years of decline. NASA states that it wishes to stabilize its workforce and rebalance the skill mix. This follows from growing concerns that the losses in personnel during the last several years of downsizing might be adversely affecting NASA's technical capabilities.

On June 7, 2000, the House Appropriations Committee recommended an appropriation of $13.713 billion for FY2001, 2.3% below the request but 0.8% above the FY2000 level. The bill recommended by the Committee contains a provision that prohibits NASA to engage in any joint aeronautics and space research efforts with the Air Force. In addition, the provision directs NASA to terminate any such activities currently underway.

Human Space Flight

The Human Space Flight account includes funding for the International Space Station, Space Flight Operations (space shuttle), Payload and ELV Support, and Investments and Support. Total request for the HSF account for FY2001 was $5.500 billion compared to $5.468 billion approved for FY2000.

International Space Station (ISS). The principal ISS mission is to establish permanent human presence in space.[5] The station will serve as a platform for a range of research activities in biology, physics, and materials science, as well as for Earth and astronomical observations. NASA also hopes that experience gained by using the ISS will facilitate decisions about the future of its Human Exploration and Development of Space enterprise. NASA considers the ISS as central to fulfilling that enterprise, including the commercial exploitation of space. The agency hopes that the ISS will attract a substantial number of commercial ventures, and that an increasing fraction of the ISS operational costs will be covered by the private sector.

For FY2001, NASA requested $2.114 billion for the ISS, 9% below the FY2000 appropriation, reflecting a planned decline as hardware for the station is completed. Currently, two elements of the space station are in orbit. The next scheduled element is to be the Service Module built by Russia. It was to have been launched last year.

---

[5] For a complete discussion of ISS issues, see Congressional Research Service, *Space Stations*, by Marcia Smith, CRS Issue Brief IB93017.

While the module itself is ready, Russia has encountered problems with the launch vehicle, the Proton-class rocket it will use to put the module in orbit, and the launch of the Service Module has been delayed. It is currently scheduled in mid-July, 2000.

NASA is requesting $442.6 million for the ISS vehicle, down from $890.1 million approved in FY2000. The ISS Vehicle program supports development of the hardware to be installed on the station. The assembly schedule for FY2001 is somewhat dependent on whether the Russian Service Module is launched in July. If not, NASA is readying the Interim Control Module for launch in December 2000. This facility is capable of providing attitude control and reboosting the station until the Service Module or the U.S. Propulsion Module can be placed in orbit. If the Service Module is launched in July, station assembly will continue in FY2001. Seven shuttle flights are now scheduled, including installation of truss assemblies for supporting photovoltaic arrays and six systems racks including the Human Facility Rack.[6] The latter will provide the station, for the first time, with the capability to support research. The first extended stay by a crew is also scheduled in FY2001. Installation of an airlock is also planned for FY2001. The FY2001 plans are subject to change if the Service Module is not launched in July.

For space station operations capability, NASA is requesting $826.5 million for FY2001, up from $763.6 million approved for FY2000 . This activity's objective is to assemble and operate the space station. Space station operations includes operation of the station in flight and the associated ground operations. A major objective of operations capability is to ensure that all operations are safe, reliable, and sustainable. Currently, NASA envisions that FY2001 will be the first full year that the space station is permanently inhabited. Three different crews are planned to be on board the station during the year, and training will be carried out for the three crews scheduled for FY2002. Seven shuttle flights will be supported by operations during FY2001. In addition to the crews, these flights will transport additional research and stowage racks. The operations activity is also responsible for integrating all foreign contributions to the ISS. During FY2001, an Italian-built logistics module and a Canadian-built mechanical arm are planned for delivery to the station.

NASA is requesting $455.4 million for FY2001 for space station research, an increase of $61 million over the FY2000 appropriation. The objective of space station research is to develop the facilities — human research facility racks — and procedures to carry out research on the space station in the areas of biology, physics, and materials science. In addition, this activity supports research in those fields and will direct the transition from the current short-term focus of research now carried out on the space shuttle to a long-term focus made possible by the ISS. For FY2001, research using the first human research facility rack is planned to begin. Research will focus on understanding how humans adapt to living in space for long periods and the development of ways to mitigate undesirable effects. To assist with this research, NASA plans to deploy four smaller, focused racks — called EXPRESS racks — during FY2001. Also, NASA plans to continue fabrication and assembly of several other research racks and facilities permitting research on a variety of subjects.

---

[6] A rack is the assembly in which specific scientific experimental facilities, or associated equipment, will be mounted.

The final component of the space station program budget request is the Crew Return Vehicle (CRV) project, for which NASA is requesting $90 million for FY2001. This project's objective is the development of a vehicle that could return up to seven ISS crew to Earth in the event of an emergency. The first of four crew return vehicles will be required for the ISS by FY2004. For FY2001, NASA plans to continue Phase 1 of the CRV program which involves conversion of the X-38 design into a CRV design. The X-38 project is designed to develop the technology base for a CRV. A space flight test is planned for FY2002. Upon completion of Phase 1, NASA will decide whether to proceed with an X-38-based design of a CRV. Funding for that phase, Phase 2, would no longer be in the ISS account, but would be transferred to the Office of Aero-Space Technology. As a contingency, NASA plans to buy two Russian Soyuz vehicles, which would increase reliance on Russia.[7]

The House Appropriations Committee recommended appropriation of the entire request for the ISS for FY2001.

Perhaps none of NASA's programs has generated more controversy than the ISS. Despite the successful launch in 1998 of the first two major components of the station, the station continued to encounter problems during 1999. At present, the major concern is the reliability of Russia to meet its commitments to the ISS. In particular, can it launch the Service Module in time to avoid further serious delays in station assembly? One consequence of this uncertainty is that NASA is requesting $300 million for FY2001 to fund ISS efforts that might be needed in the event key Russian contributions are not forthcoming or are excessively delayed. For FY2001, NASA expects most of these funds to be used to continue development of the propulsion module that would be needed in the event that Russia is not able to provide reboost flights throughout station assembly. It is important to note that those funds would not be transferred to Russia, but would be used by NASA to procure substitute services and facilities. Even that amount, however, might not be sufficient, particularly if further commitments by the Russians are not met.

Space Flight Operations. The function of this program is to operate and maintain the Space Shuttle and carry out shuttle safety and performance upgrades.[8] NASA missions are the primary customer of the shuttle, although industry, academia, and international entities use shuttle services, usually on a reimbursable basis. Currently, the Space Shuttle program is designed for an average of seven launches per year.

For FY2001, NASA requested $3.166 billion for this program, an increase of $186.2 million from the amount approved for FY2000. Included in the FY2001

---

[7] Russian Soyuz spacecraft are planned be used for emergency escape for U.S. crews until a CRV is ready. Each Soyuz can only hold a three-person crew, however, limiting ISS crew size, and the Soyuz must be replaced every six months, increasing operations costs. Those limitations are the reasons why NASA is in the process of building a more capable CRV, which can hold up to seven crew and would need to be replaced only once every three years.

[8] For a more extensive discussion on space launch issues, see: Congressional Research Service, *Space Launch Vehicles: Government Requirements and Commercial Competition*, by Marcia Smith, CRS Issues Brief IB93062.

request are $2.006 billion for flight hardware, $555.1 million for ground operations, $273.6 million for flight operations, and $334.4 million for program integration. Nine flights are now planned for FY2001. In addition, upgrades to combat obsolescence — supportability upgrades — are to be funded in FY2001. NASA is also embarking on a major safety upgrade activity designed to improve reliability and ensure safe operations for the next decade. An independent review panel has been established by NASA to determine the priorities for these upgrades, which are now planned to be completed by 2005. The size of the Space Flight Operations (SFOC) contract is also expected to grow in FY2001 as more shuttle operations are added to that contract. The SFOC is designed to consolidate all shuttle operations under one contract and currently accounts for about one-half of the program's budget.

For FY2001, the House Appropriations Committee is recommending the funding the full request of $3.166 billion for space shuttle operations.

The major concerns about NASA's space shuttle operations center on shuttle safety. Since 1998, the Aerospace Advisory Panel's annual reports have expressed concern about future shuttle safety. In particular the reports note that personnel issues such as a growing shortage of skilled workers and aging of the shuttle workforce coupled with budget constraints and downsizing might lead to serious safety problems. More recently, NASA commissioned an independent review of shuttle systems and maintenance. That report was released on March 9, 2000.[9] The review expressed high regard for the dedication and skill of the shuttle workforce. At the same time the report presented nine issues providing broad guidance to NASA in managing shuttle operations and maintenance. In addition, the report noted a number of technical problems that needed addressing and provided NASA with 81 recommendations about steps to take between now and 2006 to improve shuttle safety and reliability. Four of these were highlighted for action prior to the next flight. NASA appears to be addressing these concerns in its FY2001 budget request and an FY2000 supplemental request to shift funds to hire more shuttle personnel and do additional upgrades. Because the shuttle is likely to be the primary means of human access to space for several more years, continued efforts to maintain safe shuttle operations are essential.

The House Appropriations Committee noted that NASA completed on time a report, directed by Congress, providing a comprehensive plan for Space Shuttle upgrades and had requested additional funds to meet the recommendations of that report. As a result of that study, the Committee recommended full funding of the request for the upgrades and urged NASA to proceed in an "expeditious manner" to carry out the report's recommendations.

Payload and ELV Support. The Payload and ELV Support program is charged with support and processing of shuttle payloads and of NASA payloads that use expendable launch vehicles (ELV). Included are the technical expertise and facilities for payload buildup, test and checkout, integration, servicing, transportation, and

---

[9] NASA, Space Shuttle Independent Assessment Team, *Report to the Associate Administrator; Office of Space Flight: October-December 1999,* "The MacDonald Report" March 7, 2000 [http://www.nasa.gov/newsinfo/publicreports.html].

installation in the shuttle prior to launch. In addition to funding for all NASA missions requiring ELVs, the activity provides advanced mission design and analysis, and integration services for future missions considering an ELV launch vehicle.

For FY2001, NASA requested $90.2 million for this program compared to $79.9 million approved for the comparable activities in FY2000. For FY2001, the program plans to support 20 major and secondary payloads for the shuttle including hardware for the ISS. For the ELV portion, the program is planning to support 11 missions and one secondary payload.

The House Appropriations Committee recommended the full request — $90.2 million — for this program for FY2001.

Investments and Support. For FY2001, NASA is proposing to separate the engineering and technical base (ETB) activity from payload and ELV support. In addition, NASA has included in the Investment and Support program rocket propulsion test support, technology and commercialization activities, and additional funding for academic programs. The ETB activity provides technical support for NASA's space flight laboratories and test beds.

For FY2001, this program requested $129.5 million, including $73.5 million for the ETB activity. The latter is $11.7 million below that approved for ETB in FY2000. The Investments and Support program will be the home of the Human Exploration and Development of Space Technology and Commercialization initiative in FY2001. This initiative is designed to foster innovative technology for future human exploration of space and enable commercial development of such technologies. For FY2001, the NASA Space Flight Centers will be converted to full cost accounting and all ETB activities and budgets will be assigned to specific customers resulting in the phasing out of a specific ETB budget. Also in FY2001, NASA's rocket propulsion test capabilities will be consolidated to ensure effective management and maintenance. Important facility upgrades are also planned for FY2001 along with investments in new technology for testing.

The House Appropriations Committee recommended the full request — $129.5 million — for this program for FY2001.

Science, Aeronautics, and Technology

The Science, Aeronautics, and Technology account of the NASA budget funds the bulk of its research and development activities. Included are the Offices of Space Science, Earth Science, Life and Microgravity Science and Applications, Aero-Space Technology, Space Operations, and Academic Programs. The Offices of Space and Earth Science focus on increasing human understanding of space and the planet, and make use of satellites, space probes, and robotic space craft to gather and transmit data. The Office of Life and Microgravity Science and Applications funds research in biological areas important for human exploration of space. The Office of Aero-Space Technology supports aeronautics research that continues a long tradition dating back to NASA's predecessors, the National Advisory Committee on Aeronautics. It also funds advanced space transportation R&D aimed at lowering the cost of access to space. Space Operations is a new program for FY2001, combining the activities

of the current Mission Communications Services and Space Communications Services. The new program will be responsible for communications activities of all of NASA's space missions.

Space Science. The Office of Space Science (OSS), which is responsible for NASA's Space Science Enterprise, has four missions: understanding the universe, exploration of the solar system, discovering planets around other stars, and searching for life beyond Earth. Using primarily space-based telescopes and other sensing probes, the NASA OSS programs study the nature of stellar objects to determine their formation, evolution, and fate. Robotic probes are sent to other bodies in the solar system, searching for information about their makeup and whether the conditions for life exist. To accomplish these tasks, NASA supports a number of activities: a series of large, focused missions such as the Space Infrared Telescope Facility (SIRTF) and the Hubble Space Telescope (HST); the Explorer program to provide low-cost access to space with small, single purpose satellites; the Discovery program to support small planetary missions; and a Mars exploration activity. The OSS also funds an extensive supporting research and technology (SR&T) effort. The research component focuses on data analysis and theoretical studies to understand space-based observations, and supports complementary ground-based and laboratory activities. Universities and NASA centers are the principal performers of supporting research. The supporting technology component of the SR&T program is designed to provide enabling technologies for the next generation of space science missions, cross-cutting technology development that can be used on a number of NASA missions, and flight testing of new technologies that can be used on future NASA science missions.

Through its Supporting Research and Technology program, the NASA OSS is putting more emphasis on developing enabling technology for future missions. By expending more effort at this stage, NASA hopes to reduce the cost and increase the reliability of its future missions. A principal example of this technique is the Next Generation Space Telescope (NGST) currently in the planning stage. NASA has set stringent cost requirements for the project even though its goal is to perform more extensive science than the Hubble Space Telescope. About 30% of the NGST's cost will be for enabling technology development.

For FY2001, NASA requested $2.399 billion for the OSS, an increase of $206 million above the amount approved for FY2000. Included in the FY2001 request are $168.1 million for HST development, $117.6 million for the SIRTF, $138.8 million for Explorer development, $326.7 million for the Mars Surveyor Program, $196.6 million for the Discovery program, $1.30 billion for SR&T, and $13.2 million for education.[10] For FY2001, NASA plans to continue work on Servicing Mission 4 for the HST, now scheduled for June 2003.[11] Three missions are planned for launch under the Explorer program in FY2001, along with continued development of several others scheduled for launch in FY2002 through FY2004. For the Discovery program, launch is planned for the Genesis mission, designed to return charged particles from

---

[10] These two subprograms are located within Academic programs. For FY2001, NASA, for the first time, has assigned the portions funded by the OSS and OES to those offices.

[11] Service mission 3B is now scheduled to take place no earlier than June 2001, and may slip into FY2001.

the solar wind to Earth. In addition, startup of a new activity is planned, Discovery Micromissions, which will focus on ways to carry out inexpensive solar system science. NASA is currently undertaking a major review of the Mars Surveyor program. Once complete, a new plan for the program for FY2001 will be announced. It is expected that Mars Micromissions and a Mars telecommunications network will be important parts of the new plan.

For FY2001, NASA is planning to focus on activities in four areas of the technology portion of the Supporting Research and Technology program for FY2001. These are technology, including the Next Generation Space Telescope, for the astronomical search for origins; technology for advanced deep space systems including the Europa orbiter and the Pluto/Kuiper Express mission; technology for study of the structure and evolution of the universe; and technology for the Sun-Earth Connections program. The last element includes the Living With a Star initiative that will focus on understanding the origin of solar disturbances and how they affect human-made space and terrestrial technology.[12] This initiative, which is projected to cost about $433 million from FY2001 to FY2005, is requesting $20 million for FY2001. In addition, NASA requested an additional $5 million for FY2001 to expand research in nanotechnology as part of the Administration's National Nanotechnology Initiative. Within the research portion of SR&T, NASA is planning to continue funding a broad range of space science data analysis and basic research to understand observations from various space science missions. In addition, funding is planned of a series of high-priority studies in the Astrobiology Institute,[13] and the launch of 25 sounding rockets.

For FY2001, the House Appropriations Committee is recommending $2.379 billion for Space Science, 0.8% below the request but 8.5% above the FY2000 level.

The Space Science Enterprise has perhaps the most ambitious mission of any activity within NASA. Until recently, efforts toward fulfilling that mission made use primarily of costly, highly sophisticated and complex missions. NASA successes have been substantial, significantly advancing our understanding of the universe and our knowledge of the solar system. At the same time, those missions have had a history of cost overruns and schedule delays. In some cases, technical problems have developed that have cost NASA a great deal to fix, when a fix was possible. To continue towards its space and Earth science goals, NASA adopted a policy of "faster, better, cheaper"(FBC) in the early 1990s to guide the design of future space missions. This policy would not eliminate the risks just mentioned, but it was hoped that it would reduce the consequences of such risks. Those risks became quite visible

---

[12] Solar variability describes changes in the sun's burning activity over time. Those changes can be rather violent — solar storms — and result in significant variation in solar radiation and eruptions from the Sun's surface that can send a stream of energetic electrons to the Earth. When these electrons strike the Earth's magnetic field, significant disruptions can occur — geomagnetic storms — that can interfere with radio communications and long-range radar, and disrupt electric power transmission. In addition, the energetic particles can damage sensitive electronics in space systems and may be a threat to human space activity.

[13] The Astrobiology Institute is a partnership between NASA and academic institutions to study the origin, evolution, distribution, and destiny of life in the universe.

last year with the consecutive loss of the two Mars missions mentioned above, following the loss of the Lewis and WIRE missions.[14] Since 1992, NASA has launched 16 robotic space exploration missions under its "faster, better, cheaper" policy and seven of them either failed or had serious technical problems post launch.[15] That record has raised concerns among some observers.

At the same time, the number of satellite and spacecraft launches, many of which fall under the FBC rubric, has increased dramatically. The cost of those 16 missions is still less than the single Cassini probe, which was the last robotic mission NASA launched under the old policy. In addition, the launch rate is much greater now than prior to 1992. Still, concerns remain about this policy. In particular, some believe that technical risk has increased too much even if the financial consequences of failures might be less. In particular, the emphasis on cost may be too great, leading to shortcuts taken by NASA and its contractors that increase the risk of failure for those missions to unacceptable levels. It is possible that the basic FBC policy is not flawed, and that a relatively small increase in funds for and time spent on each mission could reduce the failure rate. A recent review commissioned by NASA of the FBC policy also concluded that the problem lay in too much emphasis on cost and schedule reduction and not enough on oversight by NASA officials.[16]

A related concern is whether such missions are compromising the achievement of scientific goals. In other words, are there scientific issues that cannot be addressed using small, inexpensive satellites? In 1998, Congress requested that NASA contract with the National Research Council (NRC) to study this question. That study was recently completed and concluded that while the FBC mission policy was sound, its implementation too often "jeopardized the scientific objectives of these missions."[17] The NRC recommends that NASA should make sure that the driving force behind its missions be the desired scientific outcomes and not the mission cost. According to the study, while some missions can be performed with small, less costly spacecraft, others will require larger systems to achieve their scientific goals.

Another issue that might arise is concern about the value of the Living With a Star initiative. While requesting only a small amount of funds for FY2001 for the project, NASA estimates that annual project costs will grow to about $200 million annually (in FY2000 dollars) over the period FY2006 to FY2009 and then begin to decline. Total project cost through FY2010 would be about $1.7 billion. The project

---

[14] The Wide-field Infrared Explorer (WIRE) mission was designed to detect infrared radiation from certain types of galaxies. The Lewis and Clark missions were funded by the Office of Earth Science and were designed to demonstrate different land imaging capabilities. The Clark mission was cancelled because of cost overruns.

[15] Robert Lee Hotz, "Are Failed Mars Probes the Price of Cost-Cutting?" *Los Angeles Times,* December 26, 1999. [http://www.latimes.com/cgi-bin/print.cgi].

[16] National Aeronautics and Space Administration, *NASA FBC Final Report,* March 14, 2000, [http://www.nasa.gov/newsinfo/publicreports.html]

[17] National Research Council, Space Studies Board, *Assessment of Mission Size Trade-offs for Earth and Space Science Missions,* March 14, 2000 [http://www.nap.edu/catalog/9796.html].

plan is quite complex, involving the launch of numerous satellites over the next several years, including one that will orbit the Sun and another that will be placed in a fixed position on the opposite side of the Sun from Earth. A primary goal of the project is to be able to predict the onset of potentially damaging solar eruptions with greater lead times than is possible now. NASA claims that the benefits could be substantial noting that the nation and the world are increasingly dependent on satellite systems that are vulnerable to solar disturbances. In addition, as human presence in space is expected to increase substantially with habitation of the ISS, dangers to that presence from solar activity are also likely to increase. As a result, the ability to avoid a significant amount of the potential damage from solar disturbances could be quite beneficial.

It is not clear, however, just how much the knowledge that might be gained from the Living With a Star program will allow any significant mitigation of that risk. Some believe that an increase of a few hours in warning time of the arrival of particles erupting from the Sun's surface will provide enough time to shut down vulnerable systems. Whether such actions would be sufficient to protect sophisticated electronics systems aboard satellites is not clear. Furthermore, the program is quite costly and might result in a substantial reduction of resources available for other important space science projects over the next several years. In that context, NASA does not appear to have made it clear why its existing Sun-Earth Connections program would not be able to meet the goals of the new program.

The House Appropriations Committee noted the rapid escalation in projected program costs in future years. In addition, the Committee directed the NASA Inspector General to review the Living With a Star program to make sure that NASA maintained "full and open competition" for any contracts awarded under it. Until such a review was completed, the Committee stated that it would not recommend any funding for the program.

Life and Microgravity Sciences and Applications. The Office of Life and Microgravity Sciences and Applications (OLMSA) funds and directs biomedical and health research in support of the Human Exploration and Development of Space enterprise. It carries out a number of programs that investigate the biomedical effects of space flight and the effects of gravity on biological processes, develop technologies to support humans living in space, enhance space crew health and safety, and address medical care requirements for human space flight. The office also supports research on biological, chemical, and physical processes in a microgravity environment. An important function of OLMSA is to assist the private sector to make use of space for product development, primarily in the life sciences. Research activities sponsored by OLMSA are now carried out in space on robotic vehicles, in ground-based laboratories, and on space shuttle missions. The International Space Station is intended to serve as a site for OLMSA research beginning in FY2001.

For FY2001, NASA requested $304.4 million, up from $274.7 million approved for FY2000. Included in the request are $76.9 million for biomedical research and countermeasures, $39.2 million for fundamental biology research, and $129.26 million for microgravity research. NASA proposed a Bioastronautics initiative for FY2001 that would accelerate R&D on various means — diagnostics, preventatives, therapy, etc. — to maintain the health of humans on long-duration space flights. In FY2001,

OLMSA plans to expand research operations on the ISS and fund 164 separate investigations in the fundamental biology area. NASA is also planning to continue preparation for using the ISS for microgravity research and will continue such research on suborbital missions and one shuttle flight during FY2001. In addition, in FY2001, OLMSA plans to fund research on biology-based technology that could support biological computing and materials research.

The House Appropriations Committee recommended $329.0 million for the OLMSA for FY2001, 8.8% above the request and 19.9% above the FY2000 level. The Committee directed that the increase be used for ground-base research — emphasizing the life sciences — to support future space flights.

The Committee noted its concern about the lack on life and microgravity research being performed on shuttle flights flown for that purpose during construction of the ISS. It stated that delays in station assembly along with the absence of those flights have resulted in a backlog of relevant experiments and is harming the long-term health of the academic and commercial interests that wish to make use of the station. As a consequence, the Committee directed NASA to prepare a detailed report on its plans for shuttle-based life and microgravity research following shuttle flight STS-107. The report is also to provide Congress with information about any schedule changes in the research plans for the station as a result of delays in assembly.

Earth Science. The Office of Earth Science (OES), which is responsible for NASA's Earth Science Enterprise (ESE), supports programs that focus on the effects of natural and human-induced changes on the global environment. The ESE is the largest federal agency program studying the Earth and its environment. The program aids scientific understanding of environmental issues, particularly global climate change. NASA uses a combination of space-based, airborne, and ground-based instruments to acquire long-term data on the Earth climate system. OES supports research and analysis programs that assist scientists in converting these data into knowledge of the Earth system. At the same time, OES operates a data and information management system to capture, process, archive, and distribute data to the scientific community and the public. A final cross-cutting objective of OES is the development of enabling remote sensing technologies, which can be used to reduce the cost and increase the reliability of future missions. A significant objective of OES is to enhance predictive capabilities about potential global environmental risks. In support of this objective, NASA is a significant contributor to the United States Global Change Research Program (USGCRP), the International Geosphere-Biosphere Program (IGBP), and the World Climate Research Program (WCRP).

There are three major program areas within OES. The centerpiece is the Earth Observing System (EOS) spacecraft series. The series consists of several polar-orbiting and low inclination satellites of various sizes, many of which include international contributions. The EOS program also supports research designed to analyze data and develop models that might explain the spacecrafts' observations. The first EOS satellite was launched in 1999, and launches will continue through 2003. OES is in the process of developing a science implementation plan that will drive the selection of follow-on missions to this first phase of EOS spacecraft. To process EOS flight data into useful information, NASA has also created an EOS Data Information System (EOSDIS). The agency characterizes EOSDIS as evolutionary,

including the phased deployment of the EOS satellites and their enabling data transmission technology. Though significant technical difficulties delayed the deployment of the second and third versions of EOSDIS, the agency reports that both are now performing successfully. Also complimenting EOS is the Earth Probes program, which NASA defines as consisting of unique, specific, and highly-focused missions. This set of missions includes those opportunities presented by international cooperative efforts, small satellites, and advanced technologies. Earth Probes can investigate processes requiring special orbits or short development cycles of one to three years. One Earth Probes project is Triana, a spacecraft that would be located at the Earth-Sun LaGrange-1 (L1) point, and which has been the subject of significant congressional controversy.[18]

For FY2001, NASA requested $1.406 billion for the Office of Earth Science, a decrease of 3.4% below the FY2000 appropriation. Of this amount, $819.5 million is for Major Developments, including $447.1 million for EOS, $252.0 million for EOSDIS, and $120.4 million for the Earth Probes program. NASA is also requesting $533.3 million for Research and Technology, including $353.2 million for Earth Science Program Science, $69.2 million for Applications, Commercialization and Education, and $110.9 million for Technology Infusion.[19] Finally, the agency requested $42.7 million for Operations, and $10.3 million for Investments, the latter of which includes $8.8 million for the Minority University Research and Education subprogram and $1.5 million for the Education subprogram.[20] OES plans to launch eight spacecraft in FY2001, including Triana and three EOS satellites.[21] OES expects that FY2001 will be a very important year for EOSDIS, especially given expected increases in the volume of archived climate data, and the demand for timely delivery of archived products. The next phases of EOSDIS deployment are scheduled for December 2000 and April 2001, respectively.

---

[18] The Earth-Sun L-1 (LaGrange-1) point is the location in space where the Earth's gravitation field just balances the Sun's gravitation field. A satellite placed at that point would remain stationary with respect to the Earth, allowing a continuous, full disk sunlit view of the Earth. For more information, see: Congressional Research Service, *NASA's Triana Spacecraft: An Overview of Congressional Issues*, by Erin Hatch, CRS Report RS20252, March 29, 2000.

[19] According to NASA's FY2001 budget justification documents, the agency has restructured the FY2001 OES budget to display Research and Technology budgetary allotments in a manner more readily understood by NASA's customers. As a result, the former Research and Technology budget has been subdivided into three categories: Earth Science Program Science, Applications Commercialization and Education (ACE), and Technology Infusion. In addition, Technology Infusion allotments formerly contained within the EOS budget are now budgeted within Research and Technology. The agency contends that this restructured format aligns the Research and Technology budget requirements with the manner in which they are managed within the agency.

[20] See note 10.

[21] The three planned FY2001 EOS launches are JASON-1 (a follow-on mission to TOPEX/Poseidon), Aqua (formerly known as EOS PM-1), and IceSat (Ice, Clouds and Land Elevation Satellite).

For FY2001, the House Appropriations Committee is recommending an appropriation of $1.405 billion for Earth Sciences, equal to the request and 2.6% below the FY2000 level.

Substantial criticism of the Office Earth Science over the last several years has resulted primarily from delays in the EOS program and the controversial nature of many of the subjects being studied by the EOS program (e.g., global climate change). These issues have led some to question the value of NASA's Earth science program as a whole. Some EOS program delays are attributable to difficulties in developing data management and satellite control software for the EOSDIS program. NASA has been forced to scale back the program more than once from its original design. Agency officials now assert that the new EOSDIS time line is both incremental and realistic. In FY2002, some EOSDIS operations will become part of the Consolidated Space Operations Contract (see below), and the agency plans for EOSDIS to be fully operational by the end of FY2003. OES also has received criticism from the National Research Council regarding the lack of a "fully integrated science plan" for missions following completion of the first EOS series.[22] As a result, OES is in the process of developing a targeted research program—including a set of specific science questions—for missions in 2003 and beyond. Another area of congressional interest is the impact of OES missions on the emerging commercial remote sensing industry. Potential congressional issues in this area include: competitive pricing procedures for government remote sensing data, federal resolution restrictions on civilian data sets, government-mandated satellite imagery black-out zones ('shutter control'), consistency in data standards and licensing procedures, and guidelines for building satellites versus purchasing data from commercial providers.[23]

The House Appropriations Committee noted the agency's need to obtain global wind profile data to better understand the Earth's climate, and encouraged NASA to obtain these data through commercial sources.[24]

Aero-Space Technology. The Office of Aero-Space Technology, which is responsible for the Aero-Space Technology Enterprise, supports NASA's Aeronautical Research and Technology and Advanced Space Transportation Technology programs. The Office is divided into the Research and Technology Base and the Focused programs. For FY2001 NASA is proposing to integrate the

---

[22] National Research Council, Task Group on Assessment of NASA Plans for Post-2002 Earth Observing Missions, *NASA's Plans for Post-2002 Earth Observing Missions*, April 26, 1999, 4 [http://www.nas.edu/ssb/post2000menu.htm].

[23] Due to national security concerns, current law and administration policy allow U.S. companies to sell commercial satellite imagery data only at 1-meter or lower resolution. The U.S. government also prohibits the sale of satellite imagery to rogue countries such as Iraq and North Korea. Furthermore, the U.S. government can prohibit a U.S. company from selling satellite images of a specific geographic area; this policy is known as 'shutter control.'

[24] This is not the first time Congress has directed NASA to purchase earth science data from commercial providers. In addition to language in other congressional reports and hearing discussions with NASA officials, the *Commercial Space Act of 1998* (P.L. 105-303) directed NASA to acquire remote sensing data, services, distribution, and applications from a commercial provider to the maximum extent possible.

aeronautics and space transportation activities of the Office. The Technology Base programs are responsible for developing new technologies, processes, and computational tools that can enhance development of new aero-space technologies. The programs support both the aeronautical and the space transportation activities of the Office. The programs that make up the Technology Base are information technology, intelligent synthesis environment, vehicle systems technology, propulsion and power technology, flight research, operations systems, rotorcraft, and space transfer and launch technology.

The Focused programs examine specific civilian aviation and space transportation technical issues through separate projects. The Focused programs include NASA's high-performance computing and communications effort, the aviation system capacity project, the aviation safety program, the ultra-efficient engine technology program, the future X-pathfinder project, the X-34 project, and the enabling space launch initiative.

A major goal of the Office of Aero-Space Technology is the development and demonstration of next-generation technology for access to space. Such technology could serve as the basis for commercial space transportation systems. Consequently, this work is often done in partnership with industry. The prime NASA goal is a dramatic reduction in launch costs, while improving reliability and safety. The final responsibility of the Office is NASA's Commercial Technology Programs. These programs included NASA's technology transfer activities and the Small Business Innovative Research Program.

For FY2001, NASA requested $1.193 billion for Aero-Space Technology, up from $1.125 billion approved for FY2000. Included in the request are $539.4 million for the Research and Technology Base programs and $507.4 million for the Focused programs. NASA is proposing three initiatives for the Office for FY2001. The first is the small aircraft transportation system initiative that plans to develop and demonstrate technologies permitting greater use of small, public-use airports. The purpose of the initiative is to allow those airports, most of which are under utilized, to make a greater contribution to improving the efficiency of the nation's transportation system. The second initiative, quiet aircraft technology, is aimed at achieving a dramatic reduction in airport noise. The third is the 2nd generation RLV program. Between now and 2005, NASA is planning to spend about $4.4 billion to develop the technology base for the shuttle replacement. It is NASA's hope that after this expenditure, the risk of developing a second generation RLV will be reduced to the point where the commercial sector will continue development toward an operating system to provide launch services to NASA and other potential customers. Included in the 2nd generation RLV initiative are programs to develop alternative access and 3rd generation RLV technology. The former is designed to support the use of existing and emerging commercial launch capabilities that could meet NASA requirements for access to the ISS. The latter program, which is now operating under the Spaceliner-100 designation, is focusing on technology that could make a substantial leap in cost reduction beyond more conventional RLV systems.

The House Appropriations Committee is recommending an appropriation of $859.0 million for Aero-Space Technology for FY2001, 28.0% below the request and 23.6% below the FY2000 level. The reduction included $49.1 million from the

request for the aviation system capacity program and $290 million from the 2nd generation RLV initiative. The Committee also did not provide any funds for the Small Air Transport System initiative. Finally, it recommended an additional $15 million for the ultra-efficient engine technology program.

The development of the next generation RLV has been under consideration at NASA for several years. The Agency has known for some time that a replacement to the shuttle would be necessary eventually, and that lowering the cost of access to space would be essential to continuing human exploration and development of space. The plan NASA has announced this year appears to take a new approach to that effort. While it includes the X-33, X-34 and Future-X programs, the main focus is on a new, competitive program to reduce the risk of RLV development. Indeed, NASA's contribution to those three "X" programs is expected to be completed by the end of FY2002. There are many unanswered questions about the new NASA approach, however, that may be raised during consideration of the request. It is not clear, for example, what role if any the three "X" programs will have in the risk reduction effort. Also, there are no assurances that at the end of the risk reduction program, the space-launch industry will feel confident that it can proceed with development of an operating launch system without additional NASA funds beyond those needed for NASA-unique requirements. Nevertheless, a new approach to next generation RLV development might be needed. The existing efforts, while making progress, do not seem to be offering a promising outcome. And NASA believes that it will need to replace the shuttle, as it is currently configured, within 10 to 12 years, although upgrades could make it last longer, perhaps to 2030 if necessary.

The House Appropriations Committee expressed concern about the effect of the decline in NASA funding directed at assisting the development of technologies aimed at quieter, safer, and more affordable commercial air travel. The additional funds for the ultra-efficient engine technology program is in part to shore up NASA's long-term commitment to aeronautics R&D. With respect to the Aero-Space Technology program's efforts on aviation system capacity, the Committee argued that the Federal Aviation Administration was the more appropriate agency. The Committee commended NASA for its efforts to develop new space launch technology in order to reduce the cost of access to space, although it was unable to provide any funds for that program at this time. The Committee noted that it would continue to "monitor the proposals" and see if it will be possible to find additional funds before enactment of the appropriations bill.

Space Operations. The Space Operations program provides command, tracking, telemetry, and data services between ground facilities and all of NASA's missions. Satellite links, ground networks, mission control, data processing, and related facilities comprise the elements of this program. Services are provided for every NASA mission, including deep space probes, Earth-orbiting satellites, research aircraft, and sub-orbital flights. High-speed telecommunication links are provided to connect industry, university, and laboratory scientists participating in NASA missions with tracking, data acquisition, mission control, and data processing facilities. Mission support services and mission planning and analysis are also provided by the Space Operations program.

For the last few years, NASA has attempted to cut costs by contracting for communications and operations services, and consolidating these contracts. The largest example of this effort is the Consolidated Space Operations Contract (CSOC), which was awarded to Lockheed Martin Space Operations Company on September 25, 1998, and began operations on January 1, 1999. The agency asserts that when fully implemented, CSOC will provide end-to-end space operations mission and data services to both NASA and non-NASA customers.[25]

For Space Operations in FY2001, NASA requested $529.4 million, not including program office contributions, which is an increase of 6.7% over the FY2000 appropriation. Of this amount, $422.0 million is for Mission Communications Services (formerly contained in the Mission Support account), including $158.6 million for Ground Networks (e.g. the Deep Space Network), $254.6 million for Mission Control and Data Systems, and $8.8 million for Space Network Customer Services. NASA also requested $107.4 million for Space Communications Services (formerly contained in the Science, Aeronautics, and Technology (SAT) account), including $4.8 million for Space Network Services, $55.0 million for the Tracking and Data Relay System (TDRS) Replacement Spacecraft and Launch Services, and $47.6 million for the NASA Integrated Services Network. Including contributions from other program offices, the total Space Operations FY2001 request is $672.2 million, $358.5 million of which is for CSOC services and $314.2 million for non-CSOC services.[26]

The House Appropriations Committee is recommending an appropriation of $529.4 million for Space Operations for FY2001, equal to the request and 6.7% above the FY2000 level.

In an attempt to streamline accounting and management processes, NASA recently reorganized its space operations and communications budgets. Previously, the NASA space operations effort was split between the Mission Communications Services program in the SAT account, and the Space Communications Services program in the Mission Support account. The Space Communications Services program operated the space-based portion of the network, while the Mission Communications Services program supported the ground-based portion. Beginning in FY2001, NASA's Space Operations effort is consolidated in the SAT account. NASA states that these two programs are to be combined so as to more directly link space communications activities with the programs that use these facilities and services. Moreover, the agency contends that this new budget configuration will enable more effective management of the Space Operations program as a whole.

NASA intends to continue this reorganization trend by moving towards a 'fee for service' accounting system for space operations services. The agency has already begun this transition by designing an on-line space operations and management catalog of all related services available to NASA missions. This catalog will

---

[25] NASA's contract with Lockheed Martin allows for excess operations and communications capacity to be marketed and sold by the contractor, which would also keep any fees received.

[26] For CSOC, NASA's FY2001 request includes $215.2 million from Space Operations and a combined total of $143.3 million from four program offices.

eventually enable NASA programs to order standard space operations mission and data services. During FY2001, agency officials plan to identify all operations costs for each NASA office.[27] This will allow offices, and potentially individual programs, to directly account for operations expenses. Eventually, perhaps as early as FY2003, the agency intends to budget for all space operations costs directly within the account for the program office receiving the services.

In 1999, NASA reported that anticipated cost savings from CSOC would be delayed because initial cost reductions due to management consolidation would be used for a new system architecture.[28] In addition, in anticipation of CSOC savings, some FY1999 funds for space operations and communications were shifted to other NASA programs; these funds were primarily transferred from the Space Communications program to the International Space Station (ISS) account. Along with other technical and management difficulties experienced by the contractor in implementing CSOC, these decreases in available funds have delayed full implementation of the system. NASA still expects to save $1.4 billion from CSOC over the ten years of the contract, but now says that the majority of these savings will be realized in the last five years. Challenges are anticipated in developing the appropriate CSOC capacity for the anticipated future demand. In addition, the agency expects to experience difficulties in increasing the outsourcing of operations and communications services, and in achieving the CSOC small business goals.[29]

The House Appropriations Committee expressed concern about NASA's Sounding Rocket Operations Contract (NSROC), and specifically with the NSROC contractor. The Committee stated it understands that this contractor may be considering funding the development of a new, non-U.S. sounding rocket system with the use of NASA funds. The Committee directed NASA to not expend any funds for a competing rocket system, but to instead utilize a privately developed system.

Academic Programs. Academic programs include a broad array of activities designed to improve science education at all levels. They include programs that directly support student involvement in NASA research, train educators and faculty, develop new educational technologies, provide NASA resources and materials in support of educational curriculum development, and involve higher education resources and personnel in NASA research efforts. In addition, a separate set of programs is devoted to minority education issues. Academic programs supply NASA mission and research experience to students in grades K-12, and support for graduate students in NASA-related disciplines. Teachers at the K-12 level receive training from NASA to enhance math and science teaching skills and the application of NASA

---

[27] For example, NASA plans that all communications and operations costs of Office of Space Science's programs and projects will be assigned to that office rather than be assigned to Space Operations as is now the practice. The same would be done for the Office of Earth Sciences, the Office of Life and Microgravity Sciences and Applications, the Office of Space Flight, and the Office of Aero-Space Technology.

[28] "Rohrabacher Worried CSOC Won't Produce Promised Savings," *Aerospace Daily*, March 15, 1999, p. 384.

[29] NASA's CSOC contract with Lockheed Martin and its industry partners includes a goal of procuring 25% of services from small businesses.

research results in the classroom. In both cases, efforts are made to reach underrepresented populations. Efforts to improve K-12 and higher education are supported through the Aerospace Education Services and National Space Grant College and Fellowship programs. NASA also funds an Experimental Program to Stimulate Competitive Research (EPSCoR) to help develop research capabilities of states that have been less successful in obtaining NASA research grants. Programs are also funded to develop new teaching technologies based on NASA developments, apply those technologies to the classroom, and involve educators in NASA missions.

Programs devoted to minority education focus on expanding participation of historically minority-dominant universities in NASA research efforts. Working with NASA enterprises, these programs develop opportunities for participation by researchers and students from those institutions in NASA activities. Five competitive, peer-reviewed research award categories have been set up for those institutions. The objectives are to improve research quality in those universities, and increase the number of underrepresented investigators supported by NASA.

For FY2001, NASA requested $100 million for Academic programs, a reduction of $38 million from the amount approved for FY2000. The reduction is primarily due to NASA's decision not to continue funding congressionally mandated programs in the FY2000 appropriation, which amounted to $38 million. Included in the FY2001 request is $54.1 million for the Education subprogram and $45.9 million for the Minority Research and Education subprogram. In the latter, NASA plans to select, through merit review, additional Science, Engineering, Mathematics, and Aerospace Academies at minority institutions. NASA also plans to involve its Strategic Enterprises more fully in partnership awards with minority institutions, which will be run through the NASA Centers. Under the Education subprogram, NASA plans to continue efforts at much the same level as in FY2000.

The House Appropriations Committee is recommending an appropriation of $105.4 million for Academic Programs for FY2001, 5.4% above the request but 24.1% below the FY2000 level. The increase is for EPSCoR program to bring total funding for that program to $10 million.

Mission Support

The Mission Support account provides funds for the principal support activities for NASA missions. It includes funding for NASA civil service employees, assurance of mission safety and quality, development of engineering policies and standards, and facility construction.

Safety, Mission Assurance, Engineering, and Advanced Concepts. The Safety, Mission Assurance, Engineering, and Advanced Concepts (SMAEAC) budget has three components: the safety of NASA missions and personnel, oversight of NASA's crosscutting technology development activities, and coordination of NASA-wide technology goals. The Office of Safety and Mission Assurance (OSMA) sets agency-wide safety and mission assurance policy and strategy, sets standards, and oversees compliance. It also supports research on new methods to assure safe and successful missions. The Office of Chief Engineer (OCE) is responsible for development of policies and standards to enhance NASA engineering practices. The

Office of the Chief Technologist (OCT) is responsible for development of a NASA-wide investment strategy for innovative technology, and oversight of NASA technology policies and capabilities.

For FY2001, NASA requested $47.5 million, up from $43 million approved for FY2000. The SMAEAC program is planning to support 8 shuttle and 11 expendable launch vehicle missions in FY2001. In addition, the NASA electronics program, which performs radiation testing and readiness assessments of advanced electronic packages, plans to develop new methods in FY2001 for qualifying technologies and assessing their readiness. Other activities will continue at FY2000 levels.

The House Appropriations Committee is recommending an appropriation of $47.5 million for this program, equal to the request.

Research and Program Management. Research and program management provides the salaries, benefits, travel, and administrative support for all of NASA's civil service employees. It also provides all travel funds, and funds for facilities and technical services, and for management and operations supplies and equipment.

For FY2001, NASA is requesting $2.291 billion for research and program management, an increase of $73 million over that approved for FY2000. NASA plans to increase its workforce in FY2001 to a total full-time equivalent level of 18,741 from 18,413 at the end of FY2000. The increase is in response to concerns that NASA's downsizing effort, begun in FY1993, has resulted in staffing levels below that needed in mission critical and safety-related areas.

The House Appropriations Committee is recommending an appropriation of $2.291 billion for research and program management, equal to the request.

Construction of Facilities. Construction of facilities provides funding for individual projects needed to maintain NASA's basic infrastructure and its institutional facilities.

For FY2001, NASA is requesting $245.9 million for this activity, an increase of $64 million above the amount approved for FY2000. The increase is a result of plans to construct several new utilities and support structures at various NASA Centers and an increase in minor revitalization and small facility construction projects at those Centers.

The House Appropriations Committee is recommending an appropriation of $245.9 million for construction of facilities, equal to the request.

Outyear Budget Projections

Along with its FY2001 budget request, NASA supplied estimates of its requests for the succeeding four years. That five-year budget outlook is provided in Table 2. Although the outyear estimates are subject to change, the trends they provide indicate the general directions that NASA is headed at this time. The table shows that NASA

projects increased spending for the next five years. Significant increases are projected in the Science, Aeronautics, and Technology account, slower growth is projected for the Mission Support account, and the Human Space Flight account is projected to decline. This outyear budget forecast is a substantial departure from the one presented last year, where NASA had projected that its total budget request would stay flat between FY2001 and FY2004. This year's outyear budget forecast projects a FY2004 budget that is 11.3% higher than the one projected in last year's NASA budget justification.[30]

For the Human Space Flight account, funding for the ISS is projected to decline by nearly 40% between FY2001 and FY2005 as the station is completed. In addition, NASA plans to transfer work on the Crew Return Vehicle to the Office of Aero-Space Technology, further reducing outyear ISS funding requirements. Funding for the shuttle is projected to remain relatively flat over that period. Funding would peak in FY2002 as a result of the safety and supportability upgrades scheduled over the next five years.

Table 2. NASA FY2001 and Outyear Budget Estimate
(millions of current-year dollars)

Category	FY2001	FY2002	FY2003	FY2004	FY2005
Human Space Flight	5,499.9	5,347.8	4,939.0	4,817.4	4,686.3
Science, Aero, and Tech	5,929.4	6,388.9	6,993.9	7,571.3	7,913.5
Mission Support	2,584.0	2,666.2	2,812.7	2,892.2	2,945.1
Inspector General	22.0	22.7	23.6	24.5	25.4
Total	**14.035.3**	**14,465.3**	**14,769.2**	**15,305.4**	**15,570.3**

Source: NASA *FY2000 Budget Estimate*

NASA proposes that funding for the Office of Space Science would grow by about 45% between FY2001 and FY2005. The growth is to be focused in the Supporting Research and Technology (SR&T) programs, primarily the Astronomical Search for Origins and the Sun-Earth Connection programs. The latter includes the Living With a Star initiative. A modest increase in funding for the SR&T core program is projected. Increases are also projected for the Explorer Development and Discovery programs. Included in the Explorer Development program is an outyear wedge of $110 million reserved for future projects to sustain a presence in exploration of the solar system. Funding for the Hubble Space Telescope is projected to decline sharply as the telescope nears the end of its useful life.

Increased funding is also projected for the Office of Aero-Space Technology. NASA is proposing a 93% increase in funding for the Office between FY2001 and

[30] Congressional Research Service, *The National Aeronautics and Space Administration's FY2000 Budget: Description and Analysis*, by Richard Rowberg, RL30154, Oct. 22, 1999.

FY2005. All of the increase would be for the 2nd Generation RLV initiative. Funding for that initiative is projected to grow by 360% over FY2001–FY2005. The Aero-Space Base and Focused programs would remain essentially flat for that period.

Funding for the Office of Life and Microgravity Science and Applications and the Office of Earth Sciences would change little during the FY2001–FY2005 time period. The former would grow slightly, in part to accommodate outyear funding for the Bioastronautics Initiative. Funding for the Office of Earth Sciences is projected to decline about 7% over that period. Funding for the Research and Technology programs would grow while funding of the Earth Observing System would decline as the system's satellites are deployed. Funding for Space Operations is projected to decline by about 43% as savings from the CSOC consolidation begin to emerge.