The original documents are located in Box 26, folder "1975/06/19 HR4700 NASA Appropriations Authorization (2)" of the White House Records Office: Legislation Case Files at the Gerald R. Ford Presidential Library.

Exact duplicates within this folder were not digitized.

Calendar No. 98

94th Congress } SENATE { Report
1st Session } { No. 94-103

NASA AUTHORIZATION FOR FISCAL YEAR 1976 AND FOR TRANSITION PERIOD JULY 1, 1976—SEPTEMBER 30, 1976

REPORT

OF THE

COMMITTEE ON AERONAUTICAL AND SPACE SCIENCES UNITED STATES SENATE

ON

H.R. 4700

AN ACT TO AUTHORIZE APPROPRIATIONS TO THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION FOR RESEARCH AND DEVELOPMENT, CONSTRUCTION OF FACILITIES, AND RESEARCH AND PROGRAM MANAGEMENT, AND FOR OTHER PURPOSES

May 5 (legislative day, April 21), 1975.—Ordered to be printed

U.S. GOVERNMENT PRINTING OFFICE
47-396 O WASHINGTON : 1975

COMMITTEE ON AERONAUTICAL AND SPACE SCIENCES

FRANK E. MOSS, Utah, *Chairman*

STUART SYMINGTON, Missouri
JOHN C. STENNIS, Mississippi
HOWARD W. CANNON, Nevada
WENDELL H. FORD, Kentucky
DALE BUMPERS, Arkansas
BARRY GOLDWATER, Arizona
PETE V. DOMENICI, New Mexico
PAUL LAXALT, Nevada
JAKE GARN, Utah

ROBERT F. ALLNUTT, *Staff Director*
JAMES T. BRUCE, *Professional Staff Member*
JAMES J. GEHRIG, *Professional Staff Member*
GILBERT W. KEYES, *Professional Staff Member*
CRAIG M. PETERSON, *Chief Clerk/Counsel*
RALPH E. VANDERVORT, Jr., *Assistant Chief Clerk*
CRAIG VOORHEES, *Professional Staff Member*
DR. GLEN P. WILSON, *Professional Staff Member*

CHARLES F. LOMBARD, *Minority Counsel*
EARL D. EISENHOWER, *Professional Staff Member, Minority*

CONTENTS

Calendar No. 98

94TH CONGRESS } SENATE { REPORT
1st Session } { No. 94–103

AUTHORIZING APPROPRIATIONS TO THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MAY 5 (legislative day, APRIL 21), 1975.—Ordered to be printed

Mr. Moss, from the Committee on Aeronautical and Space Sciences, submitted the following

REPORT

[To accompany H.R. 4700]

The Committee on Aeronautical and Space Sciences, to which was referred the bill (H.R. 4700) to authorize appropriations to the National Aeronautics and Space Administration for research and development, construction of facilities, and research and program management, and for other purposes, having considered the same, reports favorably thereon, with an amendment striking out all after the enacting clause and inserting the committee amendment, and recommends that the bill be passed.

CONGRESSIONAL ADJUSTMENTS TO NASA REQUEST FOR FISCAL YEAR 1976 AND FOR TRANSITION PERIOD JULY 1, 1976—SEPT. 30, 1976—SUMMARY

Fiscal year 1976	Budget request	House action	Senate committee action
Research and development:			
Space Shuttle	$1,206,000,000	$1,206,000,000	$1,206,000,000
Space flight operations	207,100,000	203,100,000	203,100,000
Advanced missions	1,500,000	3,000,000	0
Physics and astronomy	155,800,000	156,800,000	162,800,000
Lunar and planetary exploration	259,900,000	258,900,000	259,900,000
Launch vehicle procurement	166,900,000	166,900,000	166,900,000
Space applications	175,030,000	181,530,000	183,930,000
Aeronautical research and technology	175,350,000	175,350,000	175,350,000
Space and nuclear research and technology	74,900,000	76,900,000	74,900,000
Energy technology applications	5,900,000	5,900,000	5,900,000
Tracking and data acquisition	243,000,000	240,800,000	240,800,000
Technology utilization	7,000,000	9,000,000	7,000,000
Total	2,678,380,000	2,684,180,000	2,686,580,000
Construction of facilities	84,620,000	125,693,000	82,130,000
Research and program management	776,000,000	776,000,000	776,000,000
Grand total	3,539,000,000	3,585,873,000	3,544,710,000
Transition period			
Research and development:			
Space Shuttle	321,000,000		
Space flight operations	55,100,000		
Advanced missions	500,000		
Physics and astronomy	46,600,000		
Lunar and planetary exploration	73,300,000		
Launch vehicle procurement	40,400,000		
Space applications	54,700,000		
Aeronautical research and technology	46,800,000		
Space and nuclear research and technology	22,300,000		
Energy technology applications	1,500,000		
Tracking and data acquisition	66,400,000		
Technology utilization	2,000,000		
Total	730,600,000	[1] 700,600,000	[2] 704,600,000
Construction of facilities	14,500,000	8,050,000	11,500,000
Research and program management	213,800,000	213,800,000	213,800,000
Grand total	958,900,000	922,450,000	929,900,000

[1] $30 million reduction not allocated.
[2] $26 million reduction not allocated.

PURPOSE OF THE BILL

The purpose of this bill is to authorize appropriations to the National Aeronautics and Space Administration totaling $3,544,710,000 for fiscal year 1976 and $929,900,000 for the Transition Period July 1, 1976–September 30, 1976, as follows:

Fiscal year 1976	Budget request	House action	Senate committee action
Research and development	$2,678,380,000	$2,684,180,000	$2,686,580,000
Construction of facilities	84,620,000	125,693,000	82,130,000
Research and program management	776,000,000	776,000,000	776,000,000
Transition period			
Research and development	730,600,000	700,600,000	704,600,000
Construction of facilities	14,500,000	8,050,000	11,500,000
Research and program management	213,800,000	213,800,000	213,800,000

LEGISLATIVE HISTORY

The budget request for fiscal year 1976 and for the Transition Period, July 1, 1976–September 30, 1976, for the National Aeronautics and Space Administration was introduced in the House under H.R. 2931, and in the Senate as S. 573. After holding hearings, the House Committee on Science and Technology reported out a clean bill, H.R. 4700, which was passed by the House, with one floor amendment, and subsequently referred to this Committee.

The Committee held hearings on S. 573 during February and March 1975. During its consideration of the bill, the Committee determined amendments were required.

The Committee has reported out H.R. 4700 with an amendment striking all after the enacting clause and inserting the Committee amendment.

SUMMARY

The budget estimates for the National Aeronautics and Space Administration are, for FY 1976, $3,539,000,000, for the transition quarter, $958,900,000, and for FY 1977, $3,625,000,000.

At the request of the Administration, S. 573 was introduced on February 5, 1975, to provide program authorization in these amounts and additional legislative authority requested for NASA.

In its actions on the authorization request, the Committee recommends increases totaling $15,900,000 and decreases totaling $39,190,000, for a net decrease of $23,290,000 below the budget estimates for FY 1976 and the transition quarter.

Most significant among the Committee actions are:

1. Removal from the bill of provisions authorizing a total of $3,625,000,000 for FY 1977. The FY 1977 authorization will be handled under normal procedures at a later date;
2. Addition of $11 million to the requested amount for NASA research, development, and monitoring activities designed to further the understanding of the physics and chemistry of the upper atmosphere in general and the possible inadvertent modification of the stratosphere in particular;
3. Incorporation in the bill of a legislative direction to NASA to undertake a program of research, development, and monitoring of the upper atmosphere and to coordinate its activities with other appropriate agencies of the Federal Government, with industry and the academic community, and with other governments;
4. Specific reductions in the amounts requested for Space Flight Operations, Advanced Missions, Tracking and Data Acquisition, and a Lunar Curatorial Facility, and specific additions in numerous Space Applications projects including earth resources, communications and weather satellites;
5. Approval of the FY 1976 program estimates for Space Shuttle, Lunar and Planetary Exploration, Launch Vehicle Procurement, Aeronautical Research and Technology, Space and Nuclear Research and Technology, Energy Technology Applications, Technology Utilization, and Research and Program Management.

As reported by the Committee, the bill authorizes a NASA program for FY 1976 with these key features:

—no new starts, for the first time in the history of the agency
—total cost requirements equal to less than 1% of the Federal budget
—an overall program plan more than $600 million below the "constant level" budget approved by the Congress in 1972
—agency purchasing power less than one-third the level of the peak NASA expenditures in the mid-1960's
—reduction of the NASA in-house workforce for the ninth consecutive year

Despite these harsh fiscal restraints, the NASA program continues to produce invaluable benefits—both direct and indirect—to the people of the United States and all mankind. In the 1970's, we have moved from the era of the promise of space research to the era of actual and frequently quantifiable benefits.

The program approved by the Committee strikes a balance between continuing work on the most challenging long-term goals and productive efforts to reap the harvest of past investments, meeting the pressing needs of today.

Fiscal Year 1976.—The NASA budget request for FY 1976 was for a total of $3,539,000,000, of which $2,678,380,000 was for Research and Development, $84,620,000 was for Construction of Facilities, and $776,000,000 was for Research and Program Management. The House approved an authorization total of $3,585,873,000, of which $2,684,180,000 was for Research and Development, $125,693,000 was for Construction of Facilities, and $776,000,000 was for Research and Program Management.

The Committee is recommending an authorization of $3,544,710,000, an amount $5,710,000 above the NASA request and $41,163,000 below that in the House-approved bill. Of the total amount the Committee recommends $2,686,580,000 for Research and Development, which is $2,400,000 above the House-approved amount and $8,200,000 above the NASA request for this appropriations category. The Committee recommends $82,130,000 for the Construction of Facilities, which is $43,563,000 below the House amount and $2,490,000 below the NASA request. Finally, the Committee recommends $776,000,000 for Research and Program Management, which is identical with the amount approved by the House and that requested by NASA. The reasoning accompanying the actions of the Committee is contained in this report under the various programs and items herein.

Transition Period.—The NASA budget request for the transition period to the new fiscal year, July 1, 1976, through September 30, 1976, was for a total of $958,900,000, of which $730,600,000 was for Research and Development, $14,500,000 was for the Construction of Facilities, and $213,800,000 was for Research and Program Management. The House approved an authorization total of $922,450,000, of which $700,600,000 was for Research and Development, $8,050,000 was for the Construction of Facilities, and $213,800,000 was for Research and Program Management.

The Committee is recommending an authorization of $929,900,000, an amount $29,000,000 below the NASA request and $7,450,000 above the amount in the House-approved bill. Of the total amount the Committee recommends $704,600,000 for Research and Development, which is $4,000,000 above the House-approved amount and $26,000,000 below the NASA request. The Committee is recommending $11,500,000 for the Construction of Facilities, which is $3,450,000 above the House amount and $3 million below the NASA request. Finally, the Committee recommends $213,800,000 for Research and Program Management, an amount identical with that approved by the House and requested by NASA. The description of the programs and the activities, together with any Committee comments applicable to the transition period are integrated with those similar items in the FY 1976 presentation.

As noted, the major Committee action on the transition period request was a reduction of $26,000,000 in Research and Development with a lesser cut of $3,000,000 in the Construction of Facilities. In view of the short duration of the transition period and recognizing the need for flexibility during this phase-in period, the Committee, in assessing its reduction in Research and Development, cut the total only and permits NASA the flexibility to apply the reduction against the various programs providing the total of any one program as specified in Section 7 of the bill is not exceeded.

RESEARCH AND DEVELOPMENT

Fiscal year 1976	Budget request	House action	Senate committee action
Research and development:			
Space shuttle	$1,206,000,000	$1,206,000,000	$1,206,000,000
Space flight operations	207,100,000	203,100,000	203,100,000
Advanced missions	1,500,000	3,000,000	0
Physics and astronomy	155,800,000	156,800,000	162,800,000
Lunar and planetary exploration	259,900,000	258,900,000	259,900,000
Launch vehicle procurement	166,900,000	166,900,000	166,900,000
Space applications	175,030,000	181,530,000	183,930,000
Aeronautical research and technology	175,350,000	175,350,000	175,350,000
Space and nuclear research and technology	74,900,000	76,900,000	74,900,000
Energy technology applications	5,900,000	5,900,000	5,900,000
Tracking and data acquisition	243,000,000	240,800,000	240,800,000
Technology utilization	7,000,000	9,000,000	7,000,000
Total	2,678,380,000	2,684,180,000	2,686,580,000
Transition period			
Research and development:			
Space shuttle	321,000,000		
Space flight operations	55,100,000		
Advanced missions	500,000		
Physics and astronomy	46,600,000		
Lunar and planetary exploration	73,300,000		
Launch vehicle procurement	40,400,000		
Space applications	54,700,000		
Aeronautical research and technology	46,800,000		
Space and nuclear research and technology	22,300,000		
Energy technology applications	1,500,000		
Tracking and data acquisition	66,400,000		
Technology utilization	2,000,000		
Total	730,600,000	[1] 700,600,000	[2] 704,600,000

[1] $30 million reduction not allocated.
[2] $26 million reduction not allocated.

SPACE SHUTTLE PROGRAM

FISCAL YEAR 1976	$1,206,000,000
TRANSITION PERIOD	321,000,000

OBJECTIVES

The Space Shuttle is the key element of an economical space transportation system that will provide a wide variety of national and international users with routine access to space beginning in the 1980's. The Shuttle will be the first reusable space vehicle and will be configured to carry many different types of payloads—applications, scientific, military, and technological—to and from low earth orbit. By offering versatility, economy, and ease of access to space, the Shuttle will open up new avenues of opportunity for expanding the returns from space and advancing the frontiers of science and technology. It will provide an economical transportation system for payload developers and users from United States Government agencies, private industry, universities, research organizations, and national and international organizations.

The Space Shuttle's design features and operational flexibility are the key to reducing the cost and complexity of payloads as well as space operations. The Shuttle will be able to retrieve as well as deploy satellites, to repair and redeploy them, to service or update them and to return them to earth for refurbishment and reuse. The Shuttle will also make rapid space rescue possible. In some instances, it may eliminate the need for space rescue by providing a means for timely delivery to orbit of replacement components.

The Shuttle system has four basic elements: the orbiter, the main engines, an external propellant tank and twin solid rocket boosters. The orbiter, with its large payload bay 60 feet long and 15 feet in diameter and cargo carrying capacity of up to 65,000 pounds, will permit payloads to be built to less stringent design constraints. Standard laboratory equipment, much of it off-the-shelf and relatively inexpensive, may be used in the construction of a payload. This key factor, reduction of payload complexity, will be a significant step in decreasing costs. The varied types of payloads that the orbiter can lift into orbit range from automated free flying satellites and space telescopes to fully equipped space laboratories with facilities for scientists and technicians to carry out orbital experiments and manufacturing processes in a comfortable shirt-sleeve environment.

The Space Shuttle orbiter will be boosted into orbit by the thrust of its three liquid oxygen/liquid hydrogen main engines, fueled by the external propellant tank, burning in parallel with the twin solid rocket boosters. Two minutes into the flight, at an altitude of about 22 nautical miles, the solid rocket boosters burn out, are separated and descend by parachute to a soft splashdown in the ocean about 130 nautical miles down range. They will be recovered, refurbished and reused. The orbiter, powered by its three main engines, will continue on into space for another six minutes after which the engines will be shut down. At this point, just prior to orbital insertion, the external tank will be jettisoned and it will fall in a remote ocean area about 10,000 nautical miles down range. The orbiter, firing its orbital maneuvering engines, will then enter earth orbit. After completing its mission, the orbiter will again fire its orbital maneuvering engines to deorbit and re-enter the atmosphere at a high angle (about 34°) in a shallow flight path to minimize frictional heating. At about 70,000 feet altitude, the orbiter will begin the final maneuvering, align its approach and land.

The Space Shuttle will have a flight crew of three: the commander, the pilot, and a mission specialist. On some missions a payload specialist will be added to check out complete payloads and deploy them in space. In normal operations the Shuttle can carry up to seven people, including the crew, for periods up to seven days. They will experience forces no more than three times that of gravity during launch and landing and can perform their work in shirt-sleeve comfort.

Summary of resources requirements

	Fiscal year 1976	Transition period
Orbiter	$877,300,000	$230,900,000
Main engine	135,500,000	36,000,000
Solid rocket boosters	76,200,000	18,000,000
External tank	66,100,000	15,100,000
Launch and landing	50,900,000	21,000,000
Total	1,206,000,000	321,000,000

BASIS OF FUND REQUIREMENTS

The program schedule for the Space Shuttle is as follows:

	Calendar year
Rollout of Orbiter No. 1	3rd quarter 1976.
Approach and landing tests	4th quarter 1977.
First manned orbital flight	2nd quarter 1979.
Development flights	3rd quarter 1979-mid 1980.
Operational Shuttle	mid-1980.

System Development Status

All Shuttle system elements are under contract and the development is proceeding as planned. Many components of the Shuttle system have already been completed and testing has been initiated. Funding for FY 1976 will permit the Shuttle prime contractors, the first and second tier subcontractors and their suppliers to continue manufacturing and testing components for the four basic elements of the Space Shuttle system. Fabrication of the major test articles, design of the launch processing system, and design of the solid rocket booster components and the recovery system are planned for FY 1976. Twenty-one subcontracts, valued at more than $10 million each, are now in effect and sixty subcontracts between $1 and $10 million each have been definitized. Even larger numbers of suppliers and small subcontractors will be part of the overall effort for FY 1976. The Shuttle is well into the hardware development and testing phase. The Space Shuttle total system development is proceeding on schedule to meet the program milestones set forth above.

Orbiter

The orbiter will be a reusable airplane-like vehicle, about the size of a DC–9 transport aircraft, with a versatile capability for multipurpose low earth orbital operations. It will have a payload bay measuring 60 feet in length with a diameter of 15 feet. With the two solid rocket boosters, the orbiter will be able to place up to 65,000 lbs. into a 100 nautical mile circular orbit, due east launch azimuth.

Orbiter No. 1 crew module fabrication has been completed and manufacture of the aft and mid-fuselage structures is nearing completion.

Fabrication of the main propulsion test article was begun in early FY 1975 and should be completed on schedule in FY 1977. Orbiter No. 2 will have its Preliminary Design Review in late FY 1975 to verify the design approach and to establish the basis for proceeding with detail design and fabrication of ground test and flight hardware for the first manned orbital flight. The Preliminary Design Review for the orbiter carrier aircraft modification was completed in FY 1975. Thermal protection system development has concentrated on obtaining high quality raw materials, such as carbon, for the leading edges and nose cap, sand for the silica tiles and frit for the protective outer coating, and methods of production and manufacturing procedures were also developed for the thermal protection system in FY 1975. The environmental control and life support system preliminary design has been completed and some development work and testing has been done on the components of this system.

During FY 1976 design, fabrication and assembly of Orbiter No. 1 will continue and manufacture of Orbiter No. 2 will begin. Orbiter No. 1 is being configured for the first approach and landing test to be conducted in 1977 at the Flight Research Center, Edwards AFB, California. Orbiter No. 2 will be configured for the first manned orbital flight, which is to be launched from the Kennedy Space Center in 1979. Fabrication of the mid-section, wings, vertical stabilizer, cargo doors, landing gear, nose section, leading edges for wing and vertical stabilizer, and the tail fairing will be completed and these components for Orbiter No. 1 will be shipped to the assembly plant at Palmdale, California.

The Critical Design Review which is held when detail design is essentially completed to verify compliance with the system and technical requirements for those systems required for the Shuttle approach and landing tests will be held in FY 1976. Ground support equipment and the test station at Palmdale, California, will be completed by the the last quarter of FY 1976 and ready for use in the checkout of Orbiter No. 1. Assembly of Orbiter No. 1 will be nearly complete by the end of FY 1976. The one-quarter scale model of the Shuttle will be completed in FY 1976 and subjected to ground vibration tests.

Final assembly of the crew module and basic airframe of the structural test article will be completed to allow test set-up activities and instrumentation installation to begin. In addition, fabrication and assembly will begin on the aft fuselage test article which will be utilized for vibro-acoustic testing.

The thermal protection system (TPS) for the orbiter is a major subsystem and a key development activity. This system is designed to attenuate the aerothermal heating on the external surface of the orbiter during ascent and reentry. During FY 1976, material characterization of both the low and high temperature reusable surface insulation will be completed. Development testing of representative pieces of the high temperature reusable surface insulation from critical areas, and reusable carbon-carbon from the leading edges and the nose will be subjected to repeated reentry heating and environmental testing in FY 1976. The thermal protection system production facility for reusable tiles will become operational in early 1976 and production runs of these materials will be delivered during that fiscal year.

Avionics provides the electrical power and electronics to guide and control the Space Shuttle. During FY 1976 the avionics hardware systems for the approach and landing test will be completed and installation will begin on Orbiter No. 1. These systems are: guidance and navigation, flight control, communications, display and control, instrumentation, data processing and electrical power distribution. Engineering integration of preproduction hardware and software will be performed in FY 1976. Software will continue to be developed and tested at Johnson Space Center and integrated with the avionics hardware systems for validation in the Center's Shuttle avionics integration laboratory.

In addition, FY 1976 funding will provide for developing software programs, modifying two Shuttle training aircraft and the Shuttle carrier aircraft, and updating automatic checkout equipment. Technical design support will continue to be provided for the avionics systems and the ground testing of subsystems and components will be continued at Government facilities in those cases where the tests cannot be performed cost effectively at the contractor's facilities. Funding in FY 1976 will also be used for Government-furnished equipment, which includes the astronaut life support assembly and spacesuits for extravehicular activity, the orbiter aeroflight simulator, the Shuttle mission simulator, and the Shuttle procedures simulator, as well as testing of the orbital maneuvering system engine at the White Sands Test Facility in New Mexico; the accomplishment of systems management tasks and environmental effects studies; and contract administration to be performed by the Defense Contract Audit Service.

During the transition period, installation and checkout of Orbiter No. 1 subsystems will be continued, leading to the rollout of the vehicle. Fabrication of the orbiter main propulsion test article will be continued, as will the structural fabrication and subassembly of Orbiter No. 2. Delivery of the Shuttle training aircraft is also expected to take place during this period.

Main Engine

A cluster of three high chamber pressure hydrogen/oxygen engines, each with a 470,000 pound vacuum thrust level, will be used on the orbiter. The high chamber pressure at which these engines operate is a major technological advancement which allows the use of a higher expansion ratio nozzle and results in a more efficient operating engine without increasing size. In addition, it will be the first large liquid rocket engine specifically designed to be reusable.

In FY 1975 the main engine fuel and oxidizer preburners were successfully tested at the Santa Susana, California test facility. Component testing of the turbopumps and thrust chamber are scheduled for the latter half of FY 1975. The integrated subsystem test activities to be performed at the National Space Technology Laboratories (NSTL), formerly the Mississippi Test Facility, will begin near the end of FY 1975 and will continue in FY 1976. The rack-mounted engine controller will be utilized for the integration tests at NSTL. Fabrication work on major components of the main engine is the primary effort in FY 1975.

During FY 1976 testing and fabrication of the major subsystems of the main engine will continue. Subsystems being tested at Santa Susana include the ignition system, thrust chambers, fuel and oxidizer turbopumps and the preburners. The first engine firing at rated power level will take place at NSTL in mid-FY 1976 and will be followed by the first throttling test over the rated power level range. The main propulsion test article will be in fabrication during FY 1976 to support the integrated test activity scheduled for FY 1977. Long lead time procurement of material and hardware for the flight engines will also be initiated in FY 1976 to allow manufacture to begin in FY 1977.

In addition, FY 1976 funds will provide for logistics support for the main engine efforts. This support will include procurement of propellants for test firing the engine and its various components, such as preburners and turbopumps.

In the transition period the fabrication of flight engine components is scheduled to begin following the main engine Critical Design Review.

Solid Rocket Boosters

The booster element of the Space Shuttle system consists of two reusable solid rocket boosters approximately 12.2 feet in diameter and 149 feet long, attached to the external tank. The solid rocket boosters, burning in parallel with the orbiter's main engines, will provide the combined thrust necessary from lift-off to booster staging. At staging, the solid rocket boosters will be released to descend by parachute into the ocean some 130 nautical miles from the launch site. They will be recovered and returned to land for refurbishment and reuse.

The solid rocket motors are under contract and the remaining booster system elements, such as the recovery system, the thrust vector control system and the aft skirt will be procured separately. The Marshall Space Flight Center will perform designated systems integration tasks and has the responsibility for total systems integration of the solid rocket booster effort.

In FY 1975 the incremental Preliminary Design Review (PDR) of structural drawings for the nose cap, frustrum, forward skirt and aft skirt was completed as was the solid rocket booster PDR. A technical problem of plume impingement on the orbiter thermal protection system during the firing of the solid rocket separation motors was corrected by moving the separation motors up on the frustrum, thus increasing their thrust and decreasing their firing time. Most of the tooling for fabrication of the solid rocket motor cases has been defined and procurement is underway. A prototype case segment was completed in mid-FY 1975 and has been used to demonstrate fabrication, heat treatment and machining processes for the production run. Selection of the subcontractors for the manufacturing of remaining components of the solid rocket booster will be completed in FY 1975 with the exception of the recovery system.

Fabrication of development motors will begin in FY 1976 to support first firings in FY 1977. Manufacture, heat treatment and machining of the solid rocket motor cases will proceed. A prototype flexible bearing for the thrust vector control (TVC) system will be fabricated and tested in FY 1976, and the design of the TVC actuators will also be completed. Fabrication of actuator development hardware and development testing will be initiated. Hardware fabrication for the separation motors will begin in FY 1976. Fabrication of major structural components, including the nose cap, forward skirt, aft skirt and attach system will begin in FY 1976. Separation motor testing will be conducted near the end of FY 1976.

Funding during the transition period will provide for continuing work on the solid rocket motor cases, including propellant processing, bonding studies, grain shaping and fabrication of structural components for the solid rocket booster.

External Tank

The external tank is a single assembly approximately 27.5 feet in diameter, and 154 feet long. It contains liquid oxygen and liquid hydrogen tanks and is mounted below the orbiter and between the solid rocket boosters in the launch configuration. Other major elements include propellant pressurization, external thermal protection and attachment hardware. The external tank will contain all the liquid oxygen and liquid hydrogen propellants consumed by the main engines of the orbiter from lift-off to main engine cut-off just prior to orbital insertion. Following main engine cut-off, the external tank will be separated from the orbiter and will coast through a ballistic trajectory to impact within a designated remote ocean area. The external tank is the only expendable element in the Shuttle system.

The design and development activities are conducted in the Government-owned Michoud Assembly Facility, New Orleans, Louisiana. Early in FY 1975, NASA conducted the external tank Preliminary Design Review and the thermal protection system was changed to meet the higher ascent temperatures predicted for the latest launch envelope. Several tests of the spray-on foam insulation applied to a 10-foot diameter test tank were completed to verify the application process. Procurement of tooling for the major test article was initiated and installation at the Michoud Assembly Facility is to begin near the end of FY 1975. Procurement of selected long lead time materials for flight tank production was also initiated.

The Critical Design Review for the external tank will be held in mid-FY 1976. Fabrication and assembly of the structural test articles (the intertank and the liquid oxygen and liquid hydrogen tanks) will begin in FY 1976, leading to delivery of the test article to the Marshall Space Flight Center testing facilities in mid-FY 1977. Fabrication of the main propulsion test article tank will begin during FY 1976 for subsequent integration and testing with the orbiter aft fuselage and the three propulsion test engines at the National Space Technology Laboratories. Welding facilities and equipment will be procured and installed at Michoud in the first half of FY 1976. Long lead time procurement of selected materials for the first increment of flight tanks will be continued during FY 1976. Tooling required for the fabrication and assembly of the flight tanks will be completed and certified before the beginning of fabrication in FY 1977. Funding for FY 1976 will also provide for the restoration and modification of existing fabrication equipment at the Michoud Assembly Facility and activation of structural test facilities at the Marshall Space Flight Center.

In the transition period, assembly of the intertank and the liquid oxygen tank for structural article tests will be completed. Fabrication and assembly of the main propulsion test article will also be continued.

Launch and Landing

New launch processing equipment and operational techniques are required to assure that the Shuttle ground operations are compatible with vehicle operational requirements, including turnaround times, launch rates and launch cost objectives. The launch processing system (LPS) will consist of two major subsystems, the checkout, control and minor subsystem (CCMS), and the central data subsystem (CDS). The CCMS will utilize a distributed processing scheme where consoles, each containing a small computer, will perform in parallel within their assigned function. The CDS will provide support to the CCMS and will consist of two large scale computers (primary and secondary) with shared access storage devices and related communications processors, interface and peripheral devices.

Design of the LPS that began in FY 1975 will be continued in FY 1976. The Preliminary Design Review will be conducted early in FY 1976 and will be followed later in the fiscal year by the Critical Design Review.

System engineering and integration for the LPS will be a major effort during FY 1976. Programming of computers and program validation will be conducted in the last half of the fiscal year. Procurement of software, mini-computers for the CCMS, peripheral devices such as cartridge disc systems, process data disc systems, line printers and readers, and consoles for this equipment is scheduled for FY 1976 as is the initial procurement of major components of the CDS large scale computers.

Fiscal year 1976 funding will also provide for accomplishing major engineering support services tasks including design, procurement and installation of unique ground support equipment (GSE) for the approach and landing tests; design and procurement of unique GSE for support of the first manned orbital flight; preparation of Space Shuttle launch and landing engineering specifications and standards; field surveys and field liaison engineering at the launch and landing site; preparation of preliminary engineering reports and conceptual engineering reports and other engineering data; systems engineering and integration support between ground support systems and other identified Space Shuttle operational requirements; and establishment of an engineering documentation center where technical documentation will be prepared, stored, and distributed.

During the transition period, work will be continued on the launch processing system, the installation of unique ground support equipment and operations of the engineering documentation center.

Space Flight Operations Program

Fiscal Year 1976	$203,100,000
Transition Period	55,100,000

OBJECTIVES

The Space Flight Operations program includes the developmental and supporting activities conducted under development, test and mission operations; space life sciences; mission systems and integration; and the Apollo Soyuz Test Project scheduled for completion in July 1975.

Development, test and mission operations encompasses the basic engineering, research and test operations conducted at the Johnson Space Center, the Kennedy Space Center, the Marshall Space Flight Center, and the National Space Technology Laboratories in support of manned space flight programs, together with the provisions for crew training, and launch, flight, and operational support required for space flight missions. Space life sciences complements ongoing and planned space activities through ground-based and flight research projects involving studies of man as an operator and controller of hardware in space. Space life sciences provides for the requisite advanced technology development of systems designed to support and protect the life of man or to extend his capabilities in space. Mission systems and integration encompasses work essential to the planning and preparation for future manned space flights. The principal areas of activity are: payload integration and mission analysis, Spacelab studies and concept verification testing, advanced development, and the definition studies for an interim upper stage and Space Tug to meet NASA requirements.

The United States and the USSR agreed in May 1972 to jointly implement the Apollo-Soyuz Test Project (ASTP) to develop and test a compatible system for rendezvous and docking of future manned spacecraft and stations that would be suitable for use as a standard international system. The ASTP is a flight experiment involving the rendezvous and docking of a manned Apollo spacecraft with a manned Soyuz spacecraft. The Soyuz spacecraft will be launched from the USSR. The Apollo spacecraft will then be launched from the United States and will rendezvous with the Soyuz spacecraft in orbit where joint docked operations, including crew transfer and in-flight experiments will be accomplished. The Apollo-Soyuz Test Project requires no FY 1976 new obligations authority.

Summary of resources requirements

	Fiscal year 1976	Transition period
Development, test and mission operations	$166,100,000	$43,200,000
Space life sciences	19,000,000	5,500,000
Mission systems and integration	22,000,000	6,400,000
Total	[1] 203,100,000	55,100,000

[1] The Committee cut the request for this program $4 million, however, allocation of the reduction to project elements is left to the discretion of NASA.

BASIS OF FUND REQUIREMENTS

Development, Test and Mission Operations

Development, test and mission operations (DTMO) provides the equipment, supplies and contractor support to maintain the basic capa-

47-396 O - 75 - 2

bilities necessary to conduct manned space flight research and development at the Johnson Space Center, the Kennedy Space Center, the Marshall Space Flight Center, and the National Space Technology Laboratories. The nucleus of all Manned Space Flight activities rests in the Centers with their complement of civil service personnel. This complement has been held to the minimum required to provide essential technical and management expertise. These capabilities are augmented through the use of more than 30 research and development support contractors, employing about 6,000 personnel in fiscal year 1976, to provide critical skills not otherwise available.

In-house research and development capabilities are those common to all Manned Space Flight programs being conducted or proposed, and provide early project definition, including conceptual design, project specifications, advanced development, and research and technology. These skills are also required to provide engineering support for in-depth technical examination of the work performed by the prime and major subcontractors on major programs, such as the Space Shuttle, and to provide backup design, testing and analysis in high technology areas of design and development. In addition to these basic overall capabilities, in-house efforts also support specific program needs such as providing end items that have not been placed under prime contract but are essential to the successful completion of the program.

	Fiscal year 1976	Transition period
Research and test operations	$55,400,000	$14,500,000
Data systems and flight operations	40,000,000	10,400,000
Operations support	44,300,000	11,500,000
Launch systems operations	26,400,000	6,800,000
Total	166,100,000	43,200,000

Research and Test Operations.—Research and test operations support a broad spectrum of technical engineering, scientific, medical, reliability and quality assurance and safety support operations. These activities complement the work of the major development contractors located in contractor-owned plants and Government facilities. FY 1976 funds will support the rapidly increasing Space Shuttle development activities, the efforts complementing the European Spacelab development and continued Space Shuttle and Spacelab utilization planning. Support will also be provided to the space life sciences, concept verification testing, and advanced development activities, as well as the advanced missions studies.

Specific examples of FY 1976 Space Shuttle support to be provided at the Johnson Space Center include: (1) the continuation of Shuttle orbiter technology and definition testing for propulsion systems, attitude control and translation systems, thermal protection systems, structural systems and materials, and Shuttle avionics integration; (2) in-house support to the Space Shuttle contractor by providing orbiter antenna test and evaluation, communications and tracking system ground testing, selected components test and evaluation, sensor studies and evaluation, and development of orbiter displays and controls, orbiter data processing system hardware, and orbiter performance monitoring systems.

At the Marshall Space Flight Center, FY 1976 funding provides for (1) analysis of the dynamics of re-entry of the solid rocket booster, studying recovery parachute aerodynamics, performing structural analyses/trade-off studies for design optimization, establishing procedures for solid rocket motor failure mode and effects analysis, and supporting the development of solid rocket motor design requirements; (2) support to the Shuttle main engine development through preparation and testing of materials, evaluation of ground handling and operation procedures, and establishment of a hybrid simulation of the engine controller/actuator system; and (3) support of the external tank program including performing stress analysis of structures, conducting trade-off studies to optimize structural design, and performing cost optimization trade-off studies of the propulsion systems.

In addition, the FY 1976 funds for the Johnson Space Center and the Marshall Space Flight Center will support (1) in-house efforts to demonstrate and verify various manned and automated shuttle payload designs and operational concepts, including Spacelab oriented trade-off studies, and performing man/systems integration and operations systems analyses; (2) biomedical activities related to shuttle spacecraft design, operational support to manned space flight operations such as flight crew health care, developing and implementing space flight medical studies, and conducting primary and basic research in space life sciences.

Transition period funding will provide continued engineering and technical support to Shuttle development analysis and testing, as well as support to in-house Spacelab and payload development and utilization activities.

Data Systems and Flight Operations.—This project, formerly titled Crew and Flight Operations, has been reconfigured to support the requirements of the Space Shuttle at the Johnson Space Center. It now includes the requirements definition, design, implementation, and checkout of hardware and software modifications for the Mission Control Center (MCC) and the Real Time Computer Complex (RTCC), and the operation and maintenance of these facilities during preparations for and during actual flight missions; the operation and maintenance of full-mission and part-task simulations for flight procedures development, as well as operation of the Central Data Computation Facility which is required to support center-wide activities in mission analysis, systems engineering, development and test functions for the Shuttle program; the development of Shuttle flight control and recovery plans and procedures, production of flight plans, flight data files, crew procedures, and other elements of the data base required for crew activities in space flight; operation and maintenance of space flight readiness training aircraft; and related flight data management.

FY 1976 funds will support preliminary definition of operational concepts and related MCC and RTCC requirements for the flight support and flight data management functions during the operational flight test period of the Space Shuttle program. This will include operation of the Software Development Laboratory, which is comprised primarily of existing RTCC systems and is used to develop and validate the Shuttle orbiter flight software.

Other operations activities which will be supported in FY 1976 are maintenance, modification, and engineering support services relating to the T–38 space flight readiness training aircraft and the KC–135 zero–G aircraft.

During the transition period, the funding will cover requirements for Space Shuttle support, including data processing plans, mission and systems design and performance studies, software modifications, and flight simulation activities.

Operations Support.—Operations support provides the contractor effort and related supplies and equipment to operate and maintain on-site technical services at the Johnson Space Center, the Marshall Space Flight Center, the Kennedy Space Center, the National Space Technology Laboratories, the White Sands Test Facility, the Michoud Assembly Facility, and the Slidell Computer Complex.

Fiscal Year 1976 funding will provide for the maintenance of highly technical facilities and equipment, chemical cleaning, engineering design, technical documentation, preparation of technical reports, telecommunications, component fabrication, photographic support and logistics support. A cross-section of specific services to be provided in FY 1976 includes: (1) preparing for final publication of the mission-related documents for ASTP flight control operational requirements; (2) operation of shops to do metal furbishing, anodizing, plating, stripping, and etching of selected items of in-house fabricated hardware; (3) engineering, installation, operation and maintenance of closed circuit fixed and mobile television required for support and surveillance of tests; (4) photographic services including film processing and photographic mission support; (5) fabrication of breadboards, scaled replicas of flight items and selected hardware for Shuttle technical efforts; (6) technical documentation services, telecommunications, and graphics; (7) technical services in support of center operations, including receipt, storage, issue of research and development supplies and equipment, and transportation services; and (8) management services in support of Center operations, including data management, microfilming, and distribution of technical documentation.

Fiscal Year 1976 funds will also provide a basic level of maintenance, operation, and support services at the White Sands Test Facility involving materials and components testing and orbital maneuvering systems test support for the Shuttle program; operation and maintenance of the computer systems at the Slidell Computer Complex; and a basic level of operation and maintenance of the Michoud Assembly Facility where the external tanks of the Shuttle are to be fabricated and assembled. In addition, the FY 1976 operations support funds will provide the basic level of support to the National Space Technology Laboratories, which is engaged in the integrated component testing of the Space Shuttle main engine, static test firing of the main engine, and qualification of the main propulsion test article.

Transition period funds will provide for a continuation of these technical support services.

Launch Systems Operations.—Launch systems operations provides for the operation of the checkout and launch facilities, complexes and associated ground support equipment as well as the highly technical services required to support the test, checkout and launch of space vehicles and payloads at the Kennedy Space Center.

Fiscal Year 1976 funds will provide for mechanical ground system activities involving maintenance and modification of launch complex

facilities and related equipment such as mobile transporters, mobile launchers, converter compressor facility, mobile service structure, altitude chambers, propellant loading systems, pneumatics, and Vehicle Assembly Building mechanical systems. In addition, launch related services, such as propellant handling, life support, technical shops, and chemical cleaning labs, will be maintained in an appropriate mode of readiness to support reconfiguration activities to meet the Space Shuttle requirements. Fiscal Year 1976 funds will also provide for the maintenance and modification of electrical/electronic and launch instrumentation systems such as automatic checkout equipment, operational voice and TV communications, computation, measurements, telemetrics, and other electrical/electronic systems.

Transition period funding will be devoted to maintaining, reconfiguring, and preparing launch facilities and systems to accommodate the Space Shuttle flight hardware and payload systems, including the installation of newly designed ground support systems.

Space Life Sciences

The Space Life Sciences program provides the understanding and technology necessary to determine human capabilities and limitations in the space environment and to develop a technology base for the various types of systems which will permit people to live and perform effectively in a space environment. With the advent of Space Shuttle operations and the inclusion of scientist passengers in the Shuttle/Spacelab program, new personnel selection criteria are necessary. Biomedical data to support these criteria must be obtained, as well as methods for the prediction of potential medical changes during flight. This multi-science and engineering technology program is a continuum which starts from ground-based research and is carried into flight experiments and verifications. Biomedical problems are studied in those organisms appropriate for each task which range from tissue cultures to the human body. Specialized instrumentation and unique accommodations necessary to conduct this work are developed and tested.

Life sciences also provides advanced technology and development related to life support, protective, and other systems required to support men and women and to extend their capabilities in space. Major program emphasis is directed toward the development of information which can be translated into design data and criteria for advanced space systems and mission operations. These data are to provide the criteria for choosing Shuttle crew members and scientist passengers.

	Fiscal year 1976	Transition period
Space life research	$8,900,000	$2,400,000
Life support and protective equipment	6,000,000	1,500,000
Bioinstrumentation and man-machine technology	3,100,000	1,150,000
Life sciences dedicated Spacelab mission common operating research equipment (CORE)	1,000,000	450,000
Total	19,000,000	5,500,000

Space Life Research.—Space life research activities focus on ground-based and space flight research designed to enhance the ability to function effectively and safely during space flight and to conduct research using the unique environment of space to support and advance earth-based science. This multi-disciplinary research program encompasses medical, behavioral and biological research, as well as definition of space flight biomedical experiments. The primary objective is to maintain a research base investigating all pertinent aspects of known and anticipated problems of human response to space flight and to provide rapid response to new problems as they arise.

During FY 1976, emphasis will be placed on ground-based, life sciences research related to the Space Shuttle. Studies of human beings and small animals will be conducted under various stress environments, including parabolic aircraft flights and centrifugation. These studies will include investigation of semicircular canal and otolith organ interactions and their relation to vertigo and motion sickness; body fluid shifts in response to different gravity forces; and loss of calcium and the structural integrity of bone under conditions of disuse or loss of gravitational force. Fiscal Year 1976 funding will also provide for the definition and evaluation of animal and plant experiments for flight in the Spacelab.

The transition period funds will support continued investigations in these key life sciences research areas.

Life Support and Protective Equipment.—The life support and protective equipment effort is designed to enhance the safety and performance of the crew and scientist passengers during Shuttle/Spacelab missions. Major areas of emphasis range from development and testing of improved life support and safety systems to development of more effective life support equipment. Improved reliability, maintainability, and operational characteristics are key goals in these efforts.

FY 1976 life support and protective equipment funding will support work in several critical areas: improved spacesuit joints and bearings to provide more mobility and comfort; new materials and fabrication techniques to provide increased strength and life at decreased costs; definition of a low-cost life support and waste management system for animal and specimen-holding facilities in the Spacelab; integration and testing of components of a Spacelab atmospheric contaminant sensor; and completion of testing of advanced concept breadboards of water reclamation and oxygen generation subsystems. Based on the results of this work, flight experiments will be prepared for future Shuttle payloads to demonstrate that these concepts will operate efficiently and reliably in space.

Funding during the transition period will be used for continuation of research, test and evaluation efforts for those life support subsystems and components approaching the design phase.

Bioinstrumentation and Man-Machine Technology.—Bioinstrumentation and man-machine technology provides for the development of technology and procedures for the measurement of physiological, medical and performance responses of human beings and other selected life species in the space environment. It also includes studies for advancement of technology in the use of people in man-machine systems; and for augmentation of human capabilities, through the use of devices such as teleoperators to service orbiting space vehicles, and to support experiments and space exploration.

FY 1976 bioinstrumentation program funding will emphasize the development of a urine volume measurement and sampling system, equipment for emergency intravenous injection of fluids and microminiaturized equipment to measure heart dynamics. Instrument design concepts will be studied and prototypes will be produced to measure cardiovascular, circulatory, metabolic, respiratory, musculoskeletal and other physiological functions where the data are important to the understanding of the body's adaptation to the weightless environment.

Man-machine technology activities to be supported in FY 1976 include the definition and enhancement of the human's role in payload support related space activities. Conceptual designs of mobility and restraint systems will be initiated for activities in the Shuttle payload bay and Spacelab. Technology efforts will continue on the remote control of manipulators. Also included will be the development of image enhancement, and touch and proximity sensing devices essential in the interface between the human and the remotely controlled machine. System simulation of a conceptual teleoperator mission will focus on resolution of man-machine problems associated with servicing tasks.

In the transition period, the funding will provide for the continuation of the evaluation of breadboard bioinstrumentation technology for application to biomedical studies and flight experiments to be considered for Spacelab.

Life Sciences Dedicated Spacelab Mission Common Operating Research Equipment (CORE).—This project will provide the laboratory equipment needed to outfit the ESRO-developed Spacelab for life sciences experimenters. In this manner their experimental requirements will be satisfied except for research specimens and any unique, specialized equipment. The laboratory will be outfitted and integrated in modular fashion on racks with essentially off-the-shelf equipment. It will consist of equipment commonly used by all life sciences researchers, along with other laboratory support capabilities, such as specimen-holding facilities, storage, power, and surgical operating capability. The design provides for easy and rapid change of research equipment, routine refurbishment, and easy transfer from one Spacelab to another. The proposed experiments will utilize subjects which range from tissue cultures to human beings, and are required to gain information on life sciences questions aassociated with manned space missions.

With FY 1976 funds, two parallel contractor definition studies will be undertaken to provide more indepth engineering data and refined cost data as the basis for management decisions on final design and development. During the transition period, funds will be used to maintain an orderly completion of sequential engineering and study efforts.

Mission systems and integration

	Fiscal year 1976	Transition period
Payload integration and mission analysis	$6,000,000	$1,800,000
Spacelab/concept verification testing	6,100,000	1,900,000
Advanced development	6,500,000	2,000,000
Interim upper state (IUS)/Space Tug	3,400,000	700,000
Total	22,000,000	6,400,000

Payload Integration and Mission Analysis.—This project is designed (1) to assure hardware and operational compatibility between payloads and the Space Transportation System (STS), which incorporates the Space Shuttle, the Spacelab and the IUS/Space Tug, (2) to obtain the most effective utilization and economical operation of the STS; and (3) to provide low cost, standardized and reusable equipment to interface with the wide range of payloads to be transported, deployed and serviced by the STS. The following principal task areas have been identified to achieve these objectives: defining and projecting user payloads to determine the requirements imposed on payload/carrier vehicle interfaces and on the manner in which the STS accommodates the payloads; coordinating with users to incorporate new payload design and operations concepts; formulating procedures and systems for handling payloads both in orbit and on the ground; examining hardware design variations and scheduling combinations to achieve the most economical mission plans; and defining and developing multiuse mission support equipment for use with diverse payloads during all phases of STS operations.

In FY 1976, study efforts to be supported will be concentrated on defining payloads operations and handling procedures to support Shuttle missions. Effort will be devoted to formalizing the early Shuttle missions plan, developing agency mission models and conducting cost tradeoff analyses to support the planning efforts. New approaches for mission planning will be developed, mission planning computer capabilities expanded and payload cost estimation capabilities extended. In the multiuse mission support equipment area, FY 1976 activities will include conducting cost tradeoff analyses and starting definition and design of selected items. A portion of the FY 1976 effort will be used to analyze the compatibility of payloads and the STS launch and recovery facilities resulting from further detailing of payload requirements and proposed changes to the design and operation of the launch and recovery facilities. By the end of FY 1976, the Shuttle reimbursable policy will be defined to a point where it will aid the early STS users in estimating their STS flight costs. Concepts for reducing the cost of space missions by servicing spacecraft in orbit will be refined, building on the operations and cost tradeoff studies performed during FY 1975. The FY 1976 effort will focus on the choice of a design approach for the various mechanisms and devices that comprise the servicing system and the development of plans and procedures for their use.

During the transition period, the following task areas will continue to be supported: (1) definition of payload processing and operational concept procedures, interfaces and hardware systems; (2) definition and design of selected multiuse mission support equipment; (3) studies to reduce the cost of space missions by servicing spacecraft in orbit; (4) refinement of STS mission model planning; and (5) definition of the reimbursable policy.

Spacelab/Concept Verification Testing.—The Spacelab will be a versatile payload carrier to be flown to and from space in the cargo bay of the Space Shuttle. Spacelab will allow researchers and scientists to conduct their experiments personally in a space environment, and, in some cases, to use their ground-based laboratory equipment in space to save additional cost. Spacelab is being designed and built for

NASA by the European Space Research Organization (ESRO). Ten European nations (of which nine are members of ESRO) have agreed to fund Spacelab hardware development and to deliver flight hardware and associated ground support equipment and software to NASA.

Fiscal Year 1976 funding will be used to continue ongoing engineering studies in support of Spacelab development and to define new approaches to operating the Spacelab system with its variety of experimental payloads including experiment integration, mission planning, payload specialist training, and payload operations. In addition, new studies will be initiated to determine the best logistics and ground operations procedures and to minimize on-board contamination which could be detrimental to the achievement of the scientific objectives of some experiments. Fiscal Year 1976 funds will also be used to initiate development of the crew transfer tunnel and procurement of a Spacelab high fidelity mockup. Transition period funds will be used to continue engineering and logistics studies, and to continue the development of Spacelab support hardware nad software. It is also expected that during this quarter the definition of the software and hardware necessary to operate the Spacelab with its planned payloads will be completed.

Spacelab Concept Verification Testing (CVT) is a ground simulation activity supporting the planning for effective utilization and operation of the Spacelab. Through breadboards and simulators, CVT provides the means for development of effective interfaces, testing of experiment payloads, and conducting total systems simulations, including software, so that final flight experiment hardware can be designed for effective research and applications at low cost.

Fiscal Year 1976 funds will be used for simulation activities in the CVT Data Management Subsystem Simulator, procured in FY 1975, and for partially equipping the CVT Spacelab Simulator and the CVT Shuttle Interface Simulator. Fiscal Year 1976 funding will also be used for testing key experiments in support of Spacelab operations development and for testing additional commercial equipment for Spacelab use. The transition period funds will complete the acquisition of the equipment and software for CVT, allowing the full system to be brought into operational capability in FY 1977.

Advanced Development.—This program is designed to develop and test new technology concepts, components and systems, and advanced operational software techniques for future program applications to reduce program costs and technical risks; and to initiate critical long-lead component and subsystem developments. Development activities are directed mainly toward future systems having multiple program application and a potential for high cost savings through increased reliability, longer life, and improved performance. Substantial savings or cost avoidance are achieved by early resolution of technical problems or substitution of alternative systems in critical areas before the program development phase.

Fiscal Year 1976 funds will support activities in the following areas: (1) Tug related design criteria; definition of cost and performance effective subsystems; breadboard testing to demonstrate high risk technology areas; and testing of components for advanced liquid oxygen-liquid hydrogen and storable engine propulsion systems. (2) Long lead subsystem developments for use with the Space Transportation System, including improved on-board contamination evaluation and control techniques, thermal control of sensitive equipment and structures, and payload support subsystems. (3) Advanced computer software to handle the increased number and complexity of missions in the 1980's; software development work on high speed data base handling; computer aided mission planning and payload integration; simplified logistics support and automatic ground and flight checkout. (4) Technical requirements of future mission options, such as manned orbital systems, assembly of large structures in space and geosynchronous stations of the future.

These activities will be continued during the transition period with particular emphasis on the design and testing of low cost, low power output fuel cells; light weight structures for stages that will handle high energy orbital placement, servicing, and retrieval of payloads; advanced liquid oxygen-liquid hydrogen engine components and improved radiator systems; inertial measuring unit incorporating laser gyros; electronically steerable antenna systems; rendezvous and docking systems; non-flammable materials; non-destructive testing techniques; data management systems and computer aided design.

Interim Upper Stage/Space Tug.—The Space Shuttle upper stage is an integral part of the Space Transportation System. It is required to provide the capability to deploy Shuttle launched payloads to high-energy, and escape orbits not attainable by the Shuttle alone. The NASA and DoD have agreed on a two-phased upper stage development program. In the initial phase, the U.S. Air Force will develop the Interim Upper Stage (IUS), a modification of an existing expendable stage, in time to fly during the early Shuttle missions. It will be able to deploy, but not retrieve, payloads and may or may not be reusable, depending on the results of IUS definition studies which the Air Force currently has under contract. In the second phase, NASA will define and prepare for the development of a Space Tug, with increased performance, which will be fully reusable and will have the capability of deploying, retrieving and possibly servicing, on-orbit payloads. NASA's current efforts consist of defining NASA and other non-DoD requirements for input to the IUS system definition studies being conducted by the Air Force; conducting an engine verification program for the Space Tug; identifying the IUS NASA-unique hardware and software requirements for earth orbital missions and automated planetary missions; and defining the NASA ground systems interface.

Funding for NASA activity in FY 1976 will be used to support the Air Force evaluation of the current IUS system studies for the selection of a concept for the validation and development phases. Studies to define NASA-unique IUS/Tug software requirements will be based on the operations studies currently in progress. NASA ground facility requirements and operation plans for use of the IUS will be determined. For some outer planetary missions, additional propulsion units—called auxiliary or "kick" stages—may be necessary. Specific characteristics of NASA's automated planetary missions will be investigated to determine the requirements for auxiliary stages. Space Tug activities will concentrate on potential long-lead time problem areas identified in previous studies, such as spacecraft rendezvous and docking, interface attachments, engine two-position

nozzle, and checkout procedures. These problem areas will be pursued in a simulation and demonstration program which will conduct candidate component testing and systems analyses of critical subsystems and operational procedures. Software and auxiliary stage studies for the IUS will also consider Tug requirements to insure an orderly transition from the IUS to the Tug.

In the transition period, definition of NASA-unique IUS software and ground facilities requirements will be continued and a study to define crew training requirements will be initiated. Preparations for the Tug Phase B definition effort will also be underway. Development of support documentation and verification of IUS and Tug Interfaces with the Shuttle Orbiter will commence in support of the Shuttle Critical Design Review.

COMMITTEE COMMENT

In anticipation of the completion of the Apollo-Soyuz Test Project early in FY 1976, the Committee expects NASA to use this opportunity to introduce the maximum efficiency and economy while organizing to support the essential on-going activities conducted under this program. In view of this expectation, the Committee agrees with the $4 million reduction in the NASA request for this program made by the House. The application of the cut to various program elements is left to the discretion of NASA.

ADVANCED MISSIONS PROGRAM

FISCAL YEAR 1976	0
TRANSITION PERIOD	0

OBJECTIVES

The objective of the Advanced Missions program is to examine the future direction of the nation's manned space flight program. New space systems, new operational concepts and advanced uses of existing systems evolve from studies conducted under this program. Emphasis is given to the utilization of existing systems to advance the Nation's space capabilities at a minimum cost.

COMMITTEE COMMENT

The Committee recommends the deletion of this line item, for which $1.5 million was requested by NASA.

In its report on the FY 1975 authorization bill, the Committee expressed the view that the activities encompassed by this program should be integrated with those similar and related functions in other NASA programs. This view was considered most appropriate with the advent of the shuttle era and the need to consider the shuttle in its proper role—that of a transportation system to support space science and applications activities. The Committee reiterates this view.

Accordingly, the Committee does not agree with the House action increasing this program amount to $3 million. Overall advanced mission planning should be consolidated and enhanced, and the Committee supports studies of the type proposed by NASA and the House. However, the maintenance of separate funding categories for different types of missions increases the risk of inadequate coordination and inefficient use of available planning resources. The time for arbitrary distinctions between "manned" and "unmanned" space flight has passed.

Physics and Astronomy Program

Fiscal Year 1976	$162,800,000
Transition Period	46,600,000

OBJECTIVES

The major objective of the Physics and Astronomy program is to increase man's knowledge and understanding of the Earth's space environment, the sun, stars, and other celestial bodies. Under this program, research is conducted to investigate the Earth's upper atmosphere and ionosphere, the magnetosphere, and the interplanetary medium. Space-based investigations of cosmic ray, gamma ray, X-rays, visible light, ultraviolet, infrared, and radio emissions, not possible from ground-based observatories because of the obscuring effect of the Earth's atmosphere, provide a unique opportunity to study the sun and other celestial bodies. These investigations are the basis for improved understanding of the fundamental laws of nature, especially those which control the environment of the Earth.

To achieve the objectives of the Physics and Astronomy program, NASA uses theoretical and laboratory research; aircraft, balloon, and sounding rocket flights; small Explorer spacecraft, large automated observatories; and manned spacecraft. Research teams involved in the program are located at NASA field centers, other Government laboratories, universities, and industrial laboratories. Foreign participation is encouraged with the participating country providing its share of the costs.

The information obtained and the technology developed in the program are made available to the scientific and technical community for applications and advancement of scientific research, education, and technology. Major advances in special purpose microelectronic devices and photoelectric sensors have been made under this program since 1965; these have significantly enhanced the cost effectiveness of spacecraft and have found broad-based applications outside the space program.

The Physics and Astronomy missions undertaken to date have been highly successful. These missions include: (1) the relatively low cost Explorer series of satellites commencing in 1959, which have made a number of very basic discoveries including the discovery of the Earth's radiation belts; (2) automated observatories such as the Orbiting Solar Observatory (OSO) series, and the High Energy Astronomy Observatories (HEAO) to be launched in 1977–79; (3) the Apollo Telescope Mount (ATM), launched on Skylab in 1973, the first of a new "second generation" of space observatories, where the skill of an on-board manned observer enhanced the capability of the largest observatory yet placed in orbit.

During 1974, there were four missions, all successful: Hawkeye, a Magnetospheric Physics Explorer launched in June, and three international cooperative astronomy Explorer-class spacecraft: San Marco C–2 (Italy) launched in February, the Netherlands Astronomical Satellite (ANS) launched in August, and United Kingdom 5 (UK 5) launched in October.

Calendar year 1975 will be a particularly active one with five launches scheduled as follows: Orbiting Solar Observatory I (OSO I), Dual Air Density Explorer, Atmospheric Explorer D and E, and Small Ostronomy Satellite C.

Work is continuing on the High Energy Astronomy Observatories designed to explore the X-ray, gamma ray, and cosmic ray emissions of the universe; most of the radiations in these regions of the electromagnetic spectrum are stopped by the earth atmosphere and so cannot be observed from the surface of the earth. These investigations will be carried out with three launches of HEAO in 1977, 1978, and 1979.

Advanced technological development and mission planning commenced on a Solar Maximum Mission (SMM) to take advantage of the next peak of the solar cycle.

Initial definition studies are underway to define a variety of Astronomy and Space physics payloads to capitalize on the capabilities of the Space Shuttle. One of these, the Atmospheres, Magnetospheres, and Plasmas-in-Space (AMPS) payload, would provide a large "laboratory in space" to conduct experiments utilizing the large volume and weight-carrying capabilities of the Shuttle. Advanced technological development is underway for a Shuttle-launched Large Space Telescope (LST), a multiple purpose telescope between two and three meters in diameter which will be able to observe galaxies at distances up to ten times farther than those which can be observed from the best ground-based observatory.

Summary of resources requirements

	Fiscal year 1976	Transition period
Large observatories	$62,000,000	$13,500,000
Orbiting explorers	33,000,000	11,000,000
Suborbital programs	24,800,000	7,500,000
Supporting activities	31,400,000	11,100,000
Spacelab science program	4,600,000	3,500,000
Total	[1] 162,800,000	[2] 46,600,000

[1] The Committee added $7 million to this program for an expanded upper atmospheric research, technology, and monitoring program.
[2] The Committee designated an additional $4 million of transition period funding to be applied to the upper atmospheric research activity.

BASIS OF FUND REQUIREMENTS

Large Observatories

	Fiscal year 1976	Transition period
Orbiting solar observatories	$2,600,000	$500,000
Orbiting astronomical observatories	2,800,000	1,000,000
High energy astronomy observatories	56,600,000	12,000,000
Total	62,000,000	13,500,000

The launch schedule for the Large Observatories is:

Mission:	Calendar year
OSO–1	1975
HEAO–A	1977
HEAO–B	1978
HEAO–C	1979

Orbiting Solar Obervatories (*OSO*).—The Sun plays a dominant role in the creation and maintenance of an environment necessary to sustain life on Earth. The objective of the OSO project is a better understanding of the basic physical processes of the Sun and of their interactions with the Earth's environment.

The OSO missions have provided for a systematic study of the Sun, both its cyclic variations and of specific phenomena observed on previous missions.

OSO–I, to be launched in 1975 near solar minimum, will attack the puzzle of the very large temperature difference between the outer atmosphere of the Sun (one million degrees) and the lower atmosphere (ten thousand degrees). OSO–I will have substantial increased capabilities over previous spacecraft in this series, for example, its resolvable field of view will be better by a factor of 900 and its spectral resolution by a factor of 100. A comprehensive Guest Investigator Program has been initiated for OSO–I with about 50 investigators from six countries including the USSR.

Fiscal Year 1976 and transition period funds will be used to support the orbital operations of OSO–I, and for the reduction and analysis of the scientific data returned from the experiments.

Orbiting Astronomical Observatories (*OAO*).—Since 1968, the OAO project has provided astronomers with accurately stabilized, automated spacecraft observatories for telescopic observations of celestial objects primarily in the ultraviolet region of the electromagnetic spectrum. The last of this series of observatories, OAO–3 (Copernicus), was launched in August 1972.

One of several totally unexpected results of these missions was the discovery of a high temperature component of the interstellar gas whose temperature is in the vicinity of one million degrees. This component may occupy up to 90 percent of interstellar space. The discovery will have a significant impact on the theory of star formation from interstellar clouds.

Fiscal year 1976 and transition period funds will be used for OAO–3 in-orbit operations and to provide for data processing and analysis of data obtained by the Princeton experiment. Support to the Guest Observer Program will be continued.

High Energy Astronomy Observatories (*HEAO*).—According to the best current theories, nearly one-third of the energy existing in the universe is in the form of X-rays, gamma rays, and cosmic rays. The basic scientific objective of the HEAO project is to further explore the universe through these emissions, most of which cannot penetrate the earth's atmosphere and therefore cannot be observed from the

ground. Using these observatories, scientists will study newly discovered energy processes and the creation of matter which might lead later to practical applications of these processes.

Specifically, this project is directed to obtaining better understanding of observed phenomena such as quasars, pulsars, novae, and supernovae. Various advisory bodies, including the President's Scientific Advisory Council, the Physics Survey Committee and the Space Science Board of the National Academy of Sciences, and the NASA Space Program Advisory Council, have given this project the highest priority.

The program consists of two segments or "Blocks". Block I consists of three satellites, currently under development, to be launched on Atlas/Centaur rockets from the Eastern Test Range. Block II will be considered as a future new start to be launched by the Space Shuttle and will carry heavier and larger instruments which Block I cannot accommodate.

About 80 percent of the HEAO subsystem components use existing flight hardware designs from ongoing projects such as OSO, ATM, SAS, and the Fleet Satellite Communications system. The first launch in 1977, HEAO–A, will be an X-ray survey mission. The second mission, HEAO–B, will carry a grazing incidence X-ray telescope and will make detailed studies of specific sources identified by HEAO–A. The third, HEAO–C, will carry a combination of gamma ray and cosmic ray instruments.

The FY 1976 and transition period funds will be used to complete the fabrication of the HEAO–A experiments and spacecraft. Subsystems testing will take place and the overall systems vertification will begin after integration of the observatory. Design of the HEAO–B observatory will be completed and fabrication will begin. The grazing incidence telescope mirrors will be polished. The HEAO–C design effort will be completed during FY 1976. Mission operation efforts will include preparation of software as well as preparation of the mission control center.

Orbiting Explorers

	Fiscal year 1976	Transition period
Space physics explorers	$22,547,000	$6,600,000
Astronomy and astrophysics explorers	10,453,000	4,400,000
Total, explorers	33,000,000	11,000,000

The Explorers provide the capability to conduct relatively low cost, quick response investigations from Earth orbit. As the name implies, these satellites are exploratory in nature and have made a number of basic contributions beginning with the discovery of the Earth's radiation belts.

The Explorer satellites normally focus on a specific problem or discipline area. Problems in X-ray, gamma ray and radio astronomy, atmospheric and ionospheric physics, radiation belts, magnetospheric boundaries, and interplanetary space are being investigated in this way. This project also provides a means for cooperative missions with other government agencies and other countries, where mutual program objectives can be met with the cooperating party paying its own costs.

Explorer spacecraft have been launched at a rate of about two to four missions per year, using both Delta and Scout launch vehicles.

Space Physics Explorers.—These Explorer satellites provide the means for conducting studies of the Earth's near-space environment. The activity requires a variety of satellites to investigate the lower reaches of the upper atmosphere, such as the Atmosphere Explorers, and the interplanetary medium beyond the Earth's magnetosphere, such as the Interplanetary Monitoring Platforms (IMP).

This activity is in transition between the early discovery and mapping phase conducted over the past decade to a phase in which the cause and effects of the solar wind on the Earth's environment will be studied by means of simultaneous measurements at different locations by projects such as the International Sun-Earth Explorers (ISEE).

The *Atmosphere Explorers* (AE) are launched by the Delta launch vehicle into elliptical earth orbits of different inclinations for the purpose of investigating the photochemical processes and other energy transfer mechanisms which occur as a result of solar energy absorption by the earth's upper atmosphere above 120 kilometers (about 74 miles). There are three Explorers in this series: AE–C was launched on December 16, 1973; AE–D and AE–E was scheduled to be launched during 1975.

The earth's upper atmosphere is an area of increasing concern relative to the earth's environment but has a substantial day-to-day variability. Therefore, it is essential to measure incoming solar radiation, the constituents of this part of the atmosphere, and the ionized particles resulting from the chemical and physical reaction between the constituents and the solar radiation.

The AE missions will make the first systematic investigation of this region which has previously been investigated only by sounding rockets. To do this each Atmosphere Explorer is equipped with an onboard propulsion system that permits variation in orbital altitude and to counteract air drag; this permits the AE on command to dip lower into the atmosphere than any previous satellite.

The *Dual Air Density (DAD) Explorers* are a continuation of the Magnetospheric Explorer series used to study the magnetosphere; which includes the uppermost layers of the earth's atmosphere, the Van Allen radiation belts and the electric and magnetic field surrounding the earth. The purpose is to study questions such as how charged particles enter and leave the earth's atmosphere and how changes in the energy output of the sun affect the near earth environment. The Dual Air Density Explorers consist of two spacecraft that will be launched by a single Scout launch vehicle during 1975 into co-planer elliptical earth orbits of 400 to 1500 kilometers and 700 to 1500 kilometers to obtain global density measurements and the vertical structure of the upper atmosphere as a function of latitude, season of the year and local time and to make composition measurements using a unique mass spectrometer system.

During 1974 a cooperative program was initiated with the European Space Research Organization (ESRO) which has been designated the

International Sun-Earth Explorers (ISEE). These Explorers are a continuation of the interplanetary and magnetospheric boundary Explorer series formerly called Interplanetary Monitoring Platforms. This activity was established for the purpose of observing over a long period the earth/sun relationship at the boundary of the earth's magnetosphere and the interplanetary medium and the interplanetary medium itself.

The ISEE project will consist of two launches in 1977 and 1978 of three spacecraft and will usher in a new phase of investigations. Specifically the ISEE is directed to investigating the real time cause and effect relationships between the incoming solar wind and its influence on the earth's environment. The first launch planned for October 1977 of ISEE–A and –B (frequently identified as mother/daughter spacecraft, respectively) will place these spacecraft into a highly elliptical earth orbit with an apogee of 18 to 23 earth radii. ISEE–C planned for launch in July 1978 will be placed into a heliocentric orbit about 1 million miles from earth. In this orbit ISEE–C will measure the solar wind fluctuations which are the input functions for some of the measurements by ISEE–A and –B. In addition, ISEE–C will continue the investigation of cosmic waves and solar flares. Together these three Explorer satellites will therefore provide the data necessary to understand the cause and effect relationships between the solar wind and the earth's magnetosphere.

The joint effort between NASA and ESRO is divided as follows: NASA will have responsibility for ISEE–A and ISEE–C, for selected U.S. experiments, will provide the launch vehicles and launch services and have responsibility for tracking and data acquisition; ESRO will have the responsibility for ISEE–B and selected ESRO experiments.

With respect to future Explorers, NASA issued during the fall of 1974, two Announcements of Opportunities, and a number of candidate experiments have been selected for inclusion in conceptual studies of spacecraft (to be conducted under Supporting Research and Technology). These include an Electrodynamic Explorer designed to systematically investigate the Earth' electric field for the first time and a Mesospheric Explorer to investigate this very critical region of the Earth's environment as it affects the transport of pollutants and the creation and stability of ozone layer.

During fiscal year 1976 and the transition period, the funds will be used for (1) in-orbit operation of AE–C and D, and analysis of data from AE-C and D experiments, and completion and launch of AE-E; (2) for the procurement of hardware, subsystem fabrication, assembly, and test of the U.S. ISEE spacecraft; (3) integration and launch of the DAD Explorers; (4) in-orbit operation of Hawkeye and analysis of data from Hawkeye experiments; (5) the continued operation and reduction of data from the IMP–J and H launched in 1972 and 1973, respectively; (6) the analysis of data from other previously launched missions; and (7) definition studies of proposed missions.

Astronomy and Astrophysics Explorers.—These Explorers provide the means for carrying out exploratory astronomical studies in various spectral regions of the sun, stars, galaxies, and planets which do not require, and prior to, the development of large, complex astronomical observatories. Included here are the Small Astronomy Satellites

(SAS); the Radio Astronomy Explorers (RAE); the International Ultraviolet Explorer (IUE), an international cooperative effort with the United Kingdom (UK) and ESRO; and other cooperative astronomy missions. The most recent cooperative missions, UK–5 and ANS (with the UK and The Netherlands, respectively), were successfully launched in October and August 1974, respectively.

The *Small Astronomy Satellite-C* (SAS–C) is scheduled to be launched in the Spring of 1975. The purpose of this satellite is to make measurements of the diffuse soft X-ray background in the spectral range from 0.2 keV to 80 keV. Earlier SAS Explorers provided sky surveys of celestial X-ray sources; however, SAS–C will have a greatly enhanced pointing capabilitiy so it will be able to locate X-ray source positions more accurately and provide very accurate measurements of X-ray intensity as a function of time.

The *International Ultraviolet Explorer* (IUE) is designed to obtain with high resolution the ultraviolet spectra of a wide variety of astronomical sources including galaxies, stars, comets and other intersteller objects so that the various processes occurring within and near the vicinity of these ultraviolet emitting objects can be studied. The IUE project has some unique features including international agreements under which the United Kingdom and the European Space Research Organization will provide respectively the imaging system and the solar panels for the NASA-built spacecraft. This equipment plus a planned ESRO ground station represents a European commitment of more than $18 million to the IUE project. The IUE also is being used to evaluate the performance of some subsystems and components that are being considered for the Large Space Telescope. Further, the IUE is being planned for extensive use by guest investigators as a precursor for operations with the Large Space Telescope operations. Consequently it will be operated very much like ground based observatories. It will be the first scientific satellite to operate in a facility mode and in which a large number of observers use the facility for a few days at a time. The IUE is scheduled for launch during the last quarter of 1976.

As in the case of Space Physics Explorers, a number of experiments have been identified as candidate payloads for inclusion in conceptual studies of several future Explorers being studied under the Supporting Research and Technology Program. During FY 1976, it is planned to proceed with detailed design of the Energetic Gamma Ray Explorer Telescope (EGRET), planned for flight on an early Shuttle mission. The spacecraft will be a large step forward in the field of gamma ray astronomy, including the ability to study the structure of our galaxy with a high statistical accuracy and structural resolution. The definition phase of EGRET will be completed during FY 1975.

Fiscal Year 1976 and transition period funds will support the analysis of data from SAS-C experiments; the continued acquisition, processing, and analysis of data from operational satellites previously launched (SAS-C and B, RAE-B, ANS, aund UK–5); the integration and test of the IUE preparatory to a mid-FY 1977 launch; the detailed design of EGRET; and the conduct of definition studies of proposed missions.

Suborbital Programs

	Fiscal year 1976	Transition period
Sounding rockets	$20,000,000	$6,200,000
Airborne research	3,800,000	1,000,000
Balloon programs	1,000,000	300,000
Total, suborbital program	24,800,000	7,500,000

Sounding Rockets.—Sounding rockets provide a low cost and versatile tool for scientific research in the suborbital space environment. They support all of the scientific disciplines, including the study of cosmic dust and interplanetary matter, magnetospheric physics, stellar astronomy, solar astronomy, and high energy astrophysics. The current level of activity is approximately 65 rocket flights per year.

The specific objectives of these Sounding Rockets are as follows:

1. To conduct a coordinated research program utilizing experiments with flight requirements which cannot be met by lesser performance vehicles and do not require long duration satellite observation. Specific areas of study include:

a. the nature, characteristics, and composition of the upper atmosphere, magnetosphere, and near space;

b. the effects of incoming energetic particles and solar and stellar radiation on the upper atmosphere and magnetosphere;

c. the nature, characteristics, and spectra of radiation of the Sun, stars, and other celestial objects.

2. To support the basic objectives of the Physics and Astronomy program by providing the means for obtaining measurements at altitudes too low for satellites but too high for balloons or airplanes; flight testing instruments and experiments being developed for flight on satellites, observatories, and space probes; and for calibrating or obtaining vertical profiles in correlation with currently orbiting spacecraft.

3. To support personnel in space science experimentation, both on a domestic and an international cooperative basis at minimum expense.

In the magnetospheric physics area, continued emphasis will be placed on lower ionospheric measurements (low altitude measurements which can only be done with sounding rockets) and vertical scans correlated with Atmosphere Explorer measurements. Correlative measurements of auroral phenomena are also being made with ATS–6 satellite. Increasing emphasis will continue on the coordination of near-simultaneous launching of several rocket payloads.

In the stellar astronomy area, continuing emphasis will be placed on measurement of stars and extended sources in both the UV and X-ray regions. Many Observations will follow up the earlier measurements on satellites such as UHURU, OAO–A2, and OAO–3. Special types of instrumentation will continue ot be flown in order to make measurements which cannot be made with existing satellites.

The Solar Physics Sounding Rocket program will continue. However, after the intensive activity related to Apollo Telescope Mount (carried on Skylab) calibration and collaborative investigations, the emphasis has shifted to similar activities in support of the OSO–I mission. In addition, new instrumentation for studies of both quiet and active solar features will be developed and tested.

The Gravity Probe–A project, which initiated in FY 1972 to confirm with improved accuracy the gravitational redshift (relativistic frequency shift) predicted by Einstein's Theory of Relativity, has proceeded through the design stage, and hardware is now under development and test. During FY 1976 and the transition period, environmental testing for the Gravity Probe–A will be completed, the flight performed, and data analysis initiated.

Airborne Research.—Research with instrumented jet aircraft has been an integral part of the overall NASA program in physics and astronomy since 1965. Aircraft provide a large payload capacity and facilities for extended observations and can easily be used at operational altitudes, near 15 kilometers (Km) (50,000 feet) to provide a cloud-free site for geophysics experiments and astronomical observations. Conducting experiments at this cloud-free altitude has been essential in opening to astronomy the infrared region of the electromagnetic spectrum from 10,000 Angstroms to one millimeter. The airborne platform has the further advantage of enabling scientists to participate directly in the space experiment.

Efforts have been concentrated in the infrared astronomy program, although geophysical investigations such as auroral studies and measurements of motions and fields in the upper atmosphere using photographs of chemicals released from rockets have been included.

The 91 centimeter (cm) IR telescope on the C–141A aircraft began operational flights in 1974. This Airborne Observatory is a full scale, manned facility. The 91-cm, f/13.5 telescope operates through an open port, with a pressure bulkhead giving the astronomers a comfortable, shirt sleeve environment in which to work. The telescope floats on a large air-bearing that permits hours of accurate stabilization within a few arc seconds. The weight of this observatory is about 16 tons (14.5 metric tons).

Infrared astronomers also have actively participated in Airborne Research for over three years utilizing a 30-cm telescope carried on a Lear Jet. The Lear Jet program involves, at present, about ten astronomical groups.

During FY 1976 and the transition period funds provided for Airborne Research will be used mainly to continue operations of the C–141A Airborne Observatory and the Lear Jet facility.

Balloon Program.—For some purposes balloons provide the easiest, cheapest and most efficient method of flight. Some altitudes are not accessible to satellites nor for more than short periods to aircraft or sounding rockets. Nevertheless, there is important scientific research to be done at these altitudes; moreover, in the development of hardware and experiments for scientific space flights it is sometimes desirable to test the hardware in the hostile environment of the upper atmosphere. In these instances it is useful and efficient to fly these payloads on balloons. In particular, the new "super pressure" balloons offer unique opportunities for long duration missions.

Approximately $1 million has been spent annually to support 40 to 50 balloon flights per year. These funds provide for the balloons, the helium gas, launch and other services. Funding for the experiments flown is provided from Supporting Research and Technology projects.

For FY 1976 and the transition period NASA plans a level of effort about equal to that of FY 1975. However, there probably will be a decrease in the total number of balloon flights due to the emphasis on more complex payloads, higher altitude requirements and correspondingly larger balloons, and perhaps most important because of the effects of inflation.

Supporting Activities

	Fiscal year 1976	Transition period
Supporting research and technology (S.R. & T.)	$14,400,000	$4,000,000
Data analysis	5,000,000	1,300,000
Skylab data analysis	6,000,000	1,500,000
Large space telescope (LST) advanced technological development	5,000,000	3,000,000
Solar maximum mission (SMM) advanced technological development	1,000,000	1,300,000
Total	31,400,000	11,100,000

Supporting Research and Technology (SR&T).—This effort enhances the overall scientific and technological return from NASA flight projects and helps assure the continued viability of the future program in Physics and Astronomy. The objectives are in the following three broad categories: (1) enhancement of the value of current space missions by supplementary, simultaneous ground-based observations; (2) development of theories to explain observed phenomena and predict new ones; and (3) optimization of the return expected from future missions by problem definition, development of advanced experiments and concepts, and careful definition of proposed new missions.

The SR&T effort in space physics is largely devoted to support of research related to physics of the earth's environment. It includes study of the sun-earth environment factors, as well as extrasolar factors such as cosmic rays. Research supported in the field of astronomy involves the study of the sun and objects outside the solar system. Specific tasks related to the sun include studies of the solar atmosphere and the influence of the sun on interplanetary and planetary environments, instrument development, and laboratory and theoretical studies of basic physical processes peculiar to the sun. Research tasks related to objects outside of the solar system include observation by ground-based and balloon-borne telescopes; theoretical studies of stars, galaxies, interstellar and intergalactic matter; and advanced development work on experimental tests of the validity of Einstein's Theory of Relativity. About 225 tasks are being supported at universities, nonprofit and industrial research institutions, NASA centers, and other Government agencies in 26 states and the District of Columbia.

During FY 1976 and the transition period, NASA is planning continued support for those tasks which are critical to maintaining a firm base for a viable Physics and Astronomy program. Of special significance is the continuation of studies for advanced instrumentation involving image tubes and solid state devices which will increase sensitivity and resolution of detectors. Superfluid helium research will be continued for cryogenic systems for future application in cosmic ray, relativity, and infrared astronomy. Other technological problems in pointing and stabilization, onboard processing, onboard data storage, and background detection will be studied. In addition, studies will be made of advanced techniques for releasing tracers into the upper atmosphere and for introducing controlled perturbations into the space environment for study with such instruments as spaceborne radio transmitters and lasers. Basic studies will be continued to define future scientific objectives in astronomy and physics that will utilize the capabilities of Space Shuttle missions.

Data Analysis.—The purpose of this effort is to obtain the maximum return on the investment represented by the data gathered in the Physics and Astronomy program.

Controlled operation of spacecraft, beyond the times originally planned, has made additional data available for specific investigations with preference being given to correlative studies designed to illuminate physical problems, and to the exploitation of unusual opportunities such as unexpected encounters with comets. Further data analysis using existing data is also supported with emphasis on correlative studies.

The operation of the National Space Science Data Center is supported under this project. Further, under this project investigators prepare data, complete with calibrations, in a form suitable for deposit in the Center.

The funds provided for Fiscal Year 1976 and the transition period will support about 100 principal investigators at approximately 46 institutions, including NASA field centers.

Skylab Data Analysis.—Under this project the integration of data from ATM and other Skylab experiments, the ATM Guest Investigation Program, and the symposia and workshops on ATM results are supported.

The data acquired by the six major ATM instruments, together with that obtained by the worldwide program of complementary ground-based and rocketborne observations form the most comprehensive set of simultaneous high resolution solar data ever collected. Analyses of these data promise to advance man's knowledge of the structure and dynamics of the solar atmosphere, and of the coupling between the solar atmosphere, the solar wind and the terrestrial atmosphere, far beyond its present state. Studies of transient events such as flares are proving particularly fruitful. Not only is there evidence of possible precursors to these events but, for the first time, the interaction between this activity and solar wind structure can be studied. These results will prove invaluable in obtaining a better understanding of the earth's environment.

The preparation of atlases and high quality film copies for the National Space Science Data Center, the determination and application of instrument calibrations and the preparation of specialized computer software are important activities in this time frame. Preliminary analyses of the data obtained are also underway.

During Fiscal Year 1976 and the transition period, it is planned to shift the emphasis from the basic data reduction and preparatory tasks

to analysis. Also, the primary support for this activity will shift from the Office of Manned Space Flight to the Office of Space Science. The quantity of data and the complexity of its processing will require several years; it is expected that this period will be one of the most productive and exciting ever known in solar physics.

Large Space Telescope (LST)-Advanced Technological Development (ATD).—The LST, now under study, is a multi-purpose telescope, between two and three meters in diameter, that would be launched by the Space Shuttle. Its purpose is to provide the capability for making major advances in astrophysics.

It is expected that the LST would contribute significantly to the study of little-known energy processes in heavenly bodies, especially the early stages of star and solar system formation; to the observation of such highly evolved objects as supernova remnants and white dwarf stars; and to other studies related to the origin and physical extent of the universe. The LST would assist in the determination of whether or not our solar system is unique, whether there are other earth-like planets orbiting "suns" similar to ours and many other questions involving the nature and structure of the universe. Knowledge gained from such scientific investigations could well contribute to our continued preeminence as a high technology society.

In a new priority study just completed by the Space Science Board of the National Academy of Sciences, the LST was considered to be the highest priority new program in astronomy and was recommended for implementation starting in FY 1976; however, because of fiscal constraints, the hardware phase is not planned to begin before FY 1977.

During its consideration of NASA's FY-1975 budget, the Congress asked NASA to look at lower cost options for the LST and to investigate the possibility of international participation. In response to this request, the contractors who have been studying the Optical Telescope Assembly were directed to investigate and to recommend methods of reducing the total cost of the LST project.

In November 1974, three aerospace companies were selected to provide the definition studies. These three companies will examine LST primary optics ranging in size from 1.8 meters (5.91 feet) to 3 meters (9.85 feet).

Initial results from NASA in-house trade-off studies indicate that a telescope in the middle of this range appears to represent an appropriate compromise between performance and cost. The optical technology is well in hand and no new facilities are required to handle the primary mirror. The smaller overall spacecraft and the relaxation in performance means that lower cost subsystems can be used. While a mirror smaller than three feet means some reduction in performance, a telescope with a mirror on the order of 2.4 meters (7.9 feet) clearly would represent a significant advance in space telescopes.

Another way to lower the cost of the LST is to reduce the number of instruments. To help NASA examine this option, instrument definition teams have been established to examine the requirements and establish a priority list of candidate instruments.

NASA has reported to the Committee that in response to the desires of the Congress for lower cost options, ESRO and individual European countries have been contacted to explore the possibility of their participation on the LST. A practical area identified for their participation is the scientific instruments and such definition studies are underway in both ESRO and the United Kingdom.

During FY 1976 and the transition period, NASA plans to select the specific size and concentrate on the preliminary design for the LST. Studies to examine the requirements and establish a cost estimate will be made to insure that the LST can be developed, built and put into operation with use of only minimum resources and on the time schedule selected. Long-term development items such as the sensors and other advanced technological development will be continued to avoid costly problems later. All of the information necessary to provide a sound technical and financial basis on which to proceed with the implementation phase of the program will be available by the end of this period.

Solar Maximum Mission (SMM)-Advanced Technological Development (ATD).—The Solar Maximum Mission (SMM) is being planned to conduct specific problem-oriented solar scientific research during the next period of maximum solar activity, projected to occur near the end of this decade. The major scientific objectives of SMM will be to investigate solar flares and related phenomena over a broad spectral range with high time, spectral and spatial resolution.

The solar flares are perhaps the most dramatic and elusive of the observable solar phenomena. They have a profound impact on the solar-terrestrial system, but are difficult to study because they are transient in nature.

The SMM will provide the capability to make simultaneous measurements across the electromagnetic spectrum for the first time. The information to be developed will provide the potential for forecasting flares and their effects on Earth.

The SMM will play a pivotal role in a coordinated national program of satellite, sounding rocket, and ground-based observations of flares and their effects and is the most important solar mission proposed for this decade. The SMM will provide opportunities for international cooperation on the basis of mutual interest and benefit.

Mission definition studies were initiated in the spring of 1973. In 1974 NASA completed the conceptual design studies of the supporting spacecraft systems and associated ground operations facilities. The design concept provides for a spacecraft which capitalizes on common components and standardized subsystems to achieve a lower cost spacecraft system capable of meeting the required pointing accuracies for this mission. The spacecraft will be Shuttle-compatible, capable of rendezvous, retrieval, refurbishment, and return to orbit.

A preliminary science payload has been selected based on proposals from the solar physics community. This payload includes instruments for the observation and study of nuclear reactions in flares through gamma-ray emissions; the acceleration dynamics of charged particles to high (sometimes relativistic) energies through hard and soft X-rays; the temperature and density in flaring regions through soft X-rays and ultraviolet emissions; and the ejection of material from the sun through X-rays. It is planned that the final selection of the scientific payload will be made in mid-1975.

During FY 1976 and the transition period, NASA plans to complete the definition and preliminary design studies of the scientific

experiments and of the supporting spacecraft systems in preparation for the implementation phase of the program.

Spacelab Science Program

	Fiscal year 1976	Transition period
Spacelab science payload definition	$3,500,000	$900,000
Spacelab science payload development	1,100,000	2,600,000
Total	4,600,000	3,500,000

The Shuttle-launched Spacelab will offer new space flight opportunities to conduct Physics and Astronomy research with instrumentation and operations similar to those used in ground-based observatories. It is the purpose of this project to prepare for these opportunities building upon the experience and accomplishments of both previous and ongoing flight projects, including the extremely successful Skylab mission.

Spacelab Science Payload Definition.—To prepare for the scientific investigations to be undertaken during the Shuttle, era, Spacelab Science Payload studies are being conducted that will provide the information on which to base decisions for these future investigations. NASA believes that good planning now should lead to lower costs for payloads flown on Space Shuttle. Initial studies are being directed to facility-class payloads that would be flown from one to several times per year and would have an operational life comparable to traditional ground-based facilities. For example, NASA is studying a payload called Atmospheres, Magnetospheres and Plasmas-in-Space Spacelab (AMPS). The objective of AMPS is to help scientists understand the near earth environment and it is hoped that this space facility will be able to capitalize on the commonality of instrumention required for the several disciplines represented.

In Astronomy, similar definition studies have begun for a meter-class, cryogenically cooled, infrared telescope facility; a meter-class, high resolution optical/ultraviolet telescope facility; and a solar physics telescope cluster facility. For each of these studies, a scientific working group has been formed to provide the study with scientific definition appropriate to the objectives of the facility. To capitalize on the economy of common usage in the astronomy fields, a study to define the systems and subsystems required for astronomy-type payloads is in progress.

During Fiscal Year 1976 and transition period the funding provided will be used to complete the definition of the AMPS Space Laboratory and related facility instrumentation; for definition of a complement of High Energy Astrophysical instruments for the second Spacelab; for preliminary definition and design of a national Infrared Astronomical Spacelab Observatory and a national Solar Physics Spacelab in accordance with recommendations by the National Academy of Sciences; and for the continuing study of the scientific objectives and specifications of a one-meter-class high-resolution ultraviolet telescope.

Spacelab Science Payload Development.—The first Spacelab flight will be a joint effort with the European Space Research Organization and will carry a multi-disciplinary payload, with the emphasis on Atmospheric and Space Physics. It is expected the selection and development of scientific instruments for the first Spacelab mission will begin in FY 1976 and extend through the transition period. A flight readiness date of early FY 1980 is planned. Also, the incremental development of such instruments as an Electron Accelerator, used for controlled excitation of ionospheric and magnetospheric phenomena, and a laser radar (LIDAR) system for excitation and observation of the neutral atmosphere, will be initiated during FY 1976. These developments are building blocks for instruments that will be needed for the AMPS payload to be flown later. NASA expects that they will provide an early scientific return while building up to the more comprehensive AMPS flight.

COMMITTEE COMMENT

The Committee is concerned, as is the scientific community and the public, about the possible depletion of the protective ozone layer in the earth's upper atmosphere. Accordingly, the Committee held a hearing on January 29, 1975, to: (1) learn more about the upper atmosphere generally and the stratosphere ozone problems specifically; (2) explore what programmatic activity should be undertaken to understand the stratospheric ozone problem, and (3) identify corrective actions, if any, that should be initiated. These matters were further explored during the hearings on S. 573. The hearings demonstrated that there is much to be learned about the upper atmosphere and the problems of the stratosphere and that gathering and analyzing the data to provide the necessary understanding will be a complex and demanding task. As there are substantial variations in the ozone content of the stratosphere between the equator and the poles, and between the southern and northern hemisphere, it is clear that the task requires worldwide data so that NASA, with its space and related capabilities, is uniquely equipped to carry out a program to enhance our understanding of this important part of the earth's environment.

During the hearings NASA informed the Committee that it can identify about $7 million in its FY 1975 budget plan that relate to researching the suspected stratospheric ozone problem. No increase is proposed in the NASA level of effort for FY 1976; moreover, the total federal R&D funding in this area is actually decreasing. Yet this is clearly an important problem, as it involves a possible threat to life on earth.

The urgency to enhance the state of our knowledge on this problem demands that this activity be pursued vigorously by a lead agency. Accordingly, the Committee, in Section 8 of the bill, provides legislative authority which authorizes and directs the National Aeronautics and Space Administration to undertake a program of research, technology and monitoring of the earth's upper atmosphere.

The language of the amendment requires that NASA proceed in such manner that full coordination is maintained with other federal agencies involved in this activity, including those agencies which, unlike NASA, have regulatory responsibility, that the expertise of the academic community and industry in upper atmospheric research and technology is integrated into the planning for and carrying out of the program, that every effort be made to obtain international cooperation in this important research, technology and monitoring effort, and that all results of the program be made immediately available to the appropriate regulatory agencies and given the widest practicable public dissemination. Finally, the amendment requires that NASA submit to the President annually for transmittal to the Congress a report on the activities being carried out pursuant to the amendment, together with a description of the accomplishments achieved.

It is the intent of the Committee that the program authorized and directed to be carried out by the amendment have the long-term objective of clearly understanding the earth's upper atmosphere with near-term objectives centered on the problems of the stratosphere. Moreover, it is the intent of the Committee that this effort be effectively consolidated and organized within NASA and that it be properly coordinated with the NASA planetary atmospheric research activity.

For this new research, technology and monitoring activity on the upper atmosphere the Committee recommends adding $7 million to the Physics and Astronomy Program. This recommendation is $6 million above the amount approved by the House. For the transition period between FY 1976 and FY 1977 the Committee recommends that an additional $4 million be allocated to this activity.

Lunar and Planetary Exploration Program

Fiscal Year 1976	$259,900,000
Transition Period	73,300,000

OBJECTIVES

The objective of the Lunar and Planetary Exploration program is the scientific exploration of the moon, the planets and their satellites, asteroids, comets, and the particles and fields of interplanetary space. The goal of this exploration is to understand the origin and evolution of the solar system, the origin and evolution of life, and the dynamic processes that shape man's terrestrial environment. The program employs automated spacecraft which fly by, orbit, enter the atmosphere of, and/or land on other bodies, as well as ground-based observations to investigate our solar system. The lunar program utilizes ground-based observations, laboratory studies and data from the Apollo, Ranger, Lunar Orbiter, and Surveyor missions to investigate the composition and nature of lunar materials and phenomena.

The planetary and interplanetary fight missions undertaken to date have been highly successful, beginning with the first visit to another planet—the Mariner 2 flyby of Venus in 1962. The latest planetary mission, Pioneer 11, launched in April 1973, has completed its mission to Jupiter and is at present on its way to Saturn.

Two cooperative US/German spacecraft, Helios A, launched in 1974, and Helios B, to be launched in 1976, will investigate the properties in interplanetary space in close proximity to the sun.

Knowledge of Mars and its environment, including the possibility of life there, will be greatly advanced by the two Viking spacecraft, to be launched in 1975, which will orbit and land on the Martian surface in 1976.

In 1977, two Mariner spacecraft will be launched to fly by Jupiter and Saturn and their satellites, thereby further extending man's solar frontier.

The heavy veil of the planet Venus will be penetrated by instruments carried on two Pioneer spacecraft scheduled to be launched in 1978. The probe and orbiter missions will investigate the nature, dynamics and evolution of the Venusian atmosphere and will provide useful data to Earth meteorologists and atmospheric scientists.

Summary of resources requirements

	Fiscal year 1976	Transition period
Mariner Venus/Mercury 1973	0	0
Viking	$39,500,000	$14,000,000
Outer planets missions (Mariner Jupiter/Saturn 1977)	82,400,000	22,600,000
Pioneer/Helios	62,600,000	16,300,000
Supporting research and technology/advanced studies	14,300,000	3,600,000
Planetary astronomy	4,200,000	1,100,000
Planetary data analysis	1,400,000	400,000
Planetary quarantine	1,500,000	400,000
Planetary flight support	29,300,000	8,800,000
Lunar research program	24,700,000	6,100,000
Total	259,900,000	73,300,000

BASIS OF FUND REQUIREMENTS

Mariner Venus/Mercury 1973

No funds are required to complete this mission. This single Mariner spacecraft was successfully launched in November 1973. It has now successfully completed its swingby of Venus and three encounters with Mercury. The science data gathered to date by this mission has provided valuable insight into the circulation patterns of the upper Venusian atmosphere, yielded important experience in gravity assisted, multiplanet trajectories, and revealed the moon-like topography of Mercury.

Following the successful completion of the basic Mariner Venus/Mercury objectives, analysis indicated that through judicious gas management and utilization of "solar sailing" techniques, spacecraft stabilization could be maintained and enough gas made available for a further trajectory correction. With this small maneuver a third Mercury encounter became possible. The trajectory correction was successfully accomplished, and the third encounter was accomplished during March 1975.

Viking

	Fiscal year 1976	Transition period
Orbiter spacecraft	$9,200,000	$7,000,000
Orbiter science	2,100,000	1,200,000
Lander spacecraft	17,700,000	400,000
Lander science	4,600,000	1,900,000
Project management and project integration	5,900,000	3,500,000
Total	39,500,000	14,000,000

The objective of the Viking missions is to significantly advance man's knowledge of the planet Mars by means of observations from Martian orbit and direct measurements in the atmosphere and on the surface. Emphasis is on obtaining biological, chemical, and environmental data relevant to questions about the existence of life on the planet.

Two Viking spacecraft will be launched in mid-1975 by Titan/Centaur launch vehicles. Each spacecraft will consist of an Orbiter and a Lander. When the spacecraft arrive at Mars in the summer of 1976, each Orbiter will place itself and the attached Lander into an orbit around Mars. Each Lander will separate from its Orbiter on command and descend through the Martian atmosphere to the surface. After soft landing, the Lander will take panoramic color pictures and will conduct biological, geo-chemical, seismological, meteorological, and other scientific investigations. Instruments on the Orbiters will obtain data on dynamic planetary processes, view the surface in high resolution, and act as communications relay stations for both Orbiter and Lander scientific data.

During FY 1975, qualification testing of the Lander has been completed; the assembly and testing of two flight Orbiters and two flight Landers has been completed; and, software development, training and the spacecraft final preparations necessary for two launches in the first quarter of FY 1976 have proceeded as scheduled.

Additional funding to support FY 1975 activities was made available through reprogramming funds appropriated pursuant to the NASA Authorization Act, 1974 (P.L. 93–74). The Congress was apprised of this action in October 1974. The reprogrammed funds were required because of technical problems encountered in the guidance computer, biology instrument, and the proof test Lander capsule qualification program. These problems have been solved and by June 1975 four spacecraft (two Landers and two Orbiters) will be in final assembly and test operations at the Kennedy Space Center. Then, in July 1975, the two Landers will be sterilized by heat in large ovens. Afterwards, the Landers and Orbiters will be mated and then the mated spacecraft will be encapsulated, transported to Launch Complex 41, and each will be installed on its Titan IIIE/Centaur launch vehicle.

The launch window begins on August 11, 1975, and extends for roughly 40 days. During this period, both the Viking A and B spacecraft will be launched on the mission to Mars.

After launch, the mission will be directed by the flight team from the Space Flight Operations Facility (SFOF) at JPL. One part of the flight team will be involved in writing and testing software for the planetary phase of the flight. Another part of the flight team will be monitoring and controlling the two spacecraft during their 11-month journey to Mars. During this cruise phase, several mid-course propulsive maneuvers are planned to correct errors in the spacecraft trajectories.

Late in June 1976, the first spacecraft will arrive at Mars and be placed in orbit by a commanded propulsive maneuver. The planet will then be surveyed by the Orbiter's instruments which will return the science data to the waiting science and analysis teams at the SFOF. The preselected landing sites will be reviewed and the health of the Landers determined. After the spacecraft orbit is properly adjusted, and if everything checks as it is supposed to, the first Lander will be commanded from the SFOF to make its automatic landing on Mars on or about July 4, 1976. The second landing will occur about September 4. The nominal mission will end November 8, but NASA expects an extended lifetime.

Viking will require a flight team of more than 700 persons; the team is large because of the mission complexity. There will be four separate spacecraft to monitor, command, and receive science data from around the clock. Science data will be analyzed as rapidly as possible so that the mission sequences can be modified to achieve the maximum scientific return from the mission.

The funds recommended for FY 1976 and the transition period would be used for the following activities:

(1) *Orbiter Spacecraft*—for the final assembly and test of spacecraft hardware, and to support launch and flight operations.

(2) *Orbiter Science*—for final science tests and integration, science launch and flight operations, science team support, and science image processing and ground data handling.

(3) *Lander Spacecraft*—for final test and integration, launch preparation and operations, flight operations, and prime contractor periodic award and mission success fees.

(4) *Lander Science*—to support science launch and flight operations, lander investigation science teams and final assembly, integration, and testing of instruments.

(5) *Project Management*—to make final Radioisotope Thermo-Electric Generator payments to the Energy Research and Development Administration, to provide trajectory and software verification analysis, to provide for support service contracts, and to provide project reserve funds for problem resolution.

Outer Planets Mission (Mariner Jupiter/Saturn 1977)

	Fiscal year 1976	Transition period
Project management	$4,200,000	$1,600,000
Spacecraft design and development	58,800,000	14,800,000
Science	15,200,000	3,300,000
Mission operations	4,200,000	2,900,000
Total	82,400,000	22,600,000

In 1977, two Mariner-class spacecraft will be launched on a trajectory to Jupiter, and from Jupiter will continue on to Saturn on a space flight made possible by a special alignment of Jupiter and Saturn. This alignment permits a spacecraft launched to Jupiter to reach Saturn in less than four years after launch and eventually escape from the solar system through the acceleration provided by Jupiter's gravity. The opportunity to carry out such a fast gravity assisted swingby mission occurs approximately every 20 years. The spacecraft will encounter Jupiter in 1979 and Saturn in 1981. This important scientific mission will provide the data needed for comparative studies of the Jupiter and Saturn systems, including their satellites and the rings of Saturn, as well as to perfrom investigations in the interplanetary and interstellar media. The Saturn satellite Titan, which is comparable in size to the planet Mercury and is known to possess an atmosphere, is of special interest.

The use of a Mariner-class spacecraft with its higher power and precise pointing capability will permit the use of more sophisticated science packages than that used on Pioneer 10 and 11. The spacecraft will weigh about 750 kg (1,652 lbs.), will use the Energy Research and Development Administration's Multi-Hundred-Watt Radioiostope Thermoelectric Generators for power, and will carry approximately 95 kg (209 lbs.) of instruments. The spacecraft is being designed to make maximum use of residual Viking Orbiter hardware. The launch vehicle will be the Titan IIIE/Centaur D-IT, and the spacecraft will carry a propulsion module to provide the final increment of injection velocity.

The Pioneer 10 encounter of Jupiter in December 1973 revealed, within Jupiter's magnetosphere, fluxes of high-energy electrons several orders of magnitude greater than had been predicted. This discovery has had a significant effect on the MJS '77 spacecraft design; it will have increased shielding and parts designed with decreased sensitivity to radiation. Because of the increased scientific interest in the electro-magnetic processes occurring within Jupiter's magnetosphere, a plasama-wave experiment has been added to the MJS '77 science package replacing an ultraviolet photometer.

The funds recommended by the Committee for FY 1976 and the transition period are planned to be used as follows:

(1) *Project Management and Mission Design.*—To consist of the detailed trajectory navigation and maneuver design, precision ephemeris development, and development of mission profile alternatives, in preparation for final selection of the flight trajectories in FY 1977.

(2) *Spacecraft Design and Development.*—Prototype fabrication, testing and critical design reviews of subsystems, will be completed during the first quarter of FY 1976. Subsystem flight hardware will be fabricated and functionally tested with some flight acceptance testing being started. The Development Test Model, the Temperature Control Model and the Proof Test Model will be assembled and tested. Computer software for the Command Control Computer, Attitude and Articulation Control Subsystem and the Flight Data Subsystem will be completed, reviewed and accepted.

(3) *Science.*—Critical design reviews of all science instruments will be completed and the science instruments will be fabricated and tested.

(4) *Mission Operations.*—The design of the mission operations complex will be completed and implementation of that design will be started. The Mission Computing System (MCS) computers will be installed early in FY 1976 so that software implementation can be initiated. All launch and Earth-Jupiter cruise requirements on the Tracking and Data System and MCS will be completed.

Pioneer/Helios

	Fiscal year 1976	Transition period
Pioneer Venus	$57,600,000	$15,300,000
Pioneer 6–11	3,900,000	900,000
Helios A. & B	1,100,000	100,000
Total	62,600,000	16,300,000

Pioneer Venus.—The objective of the two Pioneer Venus missions—a probe and an orbiter—is to conduct scientific investigations of the planet Venus. The multiprobe mission will investigate: the nature and composition of the clouds; the composition and structure of the atmosphere, including the minor constituents; the general atmospheric circulation pattern; and the structure of the ionosphere. The orbiter mission will: determine the detailed structure of the upper atmosphere; investigate the solar wind/ionosphere interaction region; determine atmosphere and surface characteristics on a planetary scale by remote sensing; and measure the gravitational field harmonics.

The primary thrust of these missions is to determine the nature, dynamics, and evolution of the Venusian atmosphere. This goal has profound significance with respect to one of the objectives of the NASA Planetary program, namely that of "determining the dynamic processes that shape Earth's environment by investigation of other bodies of the solar system." Dynamic modeling of Earth's atmosphere for prediction of weather, climatic changes and pollution effects should be materially aided by the Pioneer Venus missions. The secondary thrust of this mission is to provide data to help understand the origin and evolution of the solar system by determining the relative abundances of the constituents of the Venus atmosphere and the mass properties of the planet.

NASA has testified that the program is structured to achieve its science objectives at the lowest possible cost. The basic spacecraft will employ many existing subsystems, and will be "standardized" for easy adaptation to both the probe and orbiter configurations. Also, ample weight margins are being allowed to minimize the need for new development.

It is planned to launch the orbiter mission with an Atlas/Centaur launch vehicle in May 1978. The orbiting spacecraft will weigh 320 kg (706 lbs.) in orbit and will carry 37 kg (81 lbs.) of scientific instruments. The multiprobe mission is planned for launch with an Atlas/Centaur in August 1978. The probe bus carrying 12 kg (26 lbs.) of scientific instruments will deliver one large probe with 28 kg. (62 lbs.) of scientific instruments and three small probes with 2.1 kg (4.6 lbs.) of scientific instruments into the Venus atmosphere. Both missions will encounter Venus in December 1978 to provide for a synergistic study of the planet.

FY 1976 and transition period funds are needed for: (1) testing and fabrication of flight subsystems (2) science support, design verification of instruments and to begin the fabrication of design verification units and flight instruments, (3) navigation and trajectory analysis and initiation of flight operations software tasks, and (4) mission design and definition and special mission parameter studies.

Pioneers 6–11.—The Pioneer 6, 7, 8, and 9 spacecraft, launched 1965–1968, are continuing to obtain valuable data on the nature of the interplanetary environment in the region 0.75 and 1.1 A.U. from the sun. (One Astronomical Unit, or A.U., is 93 million miles, the mean distance between Earth and the Sun.) These data are necessary to continue the study of the nature of the interplanetary environment near Earth as well as to provide a correlation with similar information obtained from the Pioneer 10 and 11 spacecraft, farther out in the solar system.

The Pioneer 10 and 11 missions are continuing to conduct exploratory investigations of the interplanetary medium beyond the orbit of Jupiter.

Pioneer 10 was launched in March 1972 and has now successfully traversed the Asteroid Belt and survived the radiation belts at Jupiter. Pioneer 11 was launched in April 1973, and has also completed its mission to Jupiter, measuring a new region of that planet. Excellent data have been obtained, from both spacecraft during the trips to Jupiter and in the vicinity of the planet. Results have revealed new information about Jupiter's magnetic field and intense radiation belts which are much different from those of Earth. Helium has been detected in Jupiter's atmosphere for the first time, and valuable new data on this planet's mass and shape characteristics and its energy balance have been obtained. New information concerning Jupiter's moons has also been gathered, considerably changing previous conceptions of their mass, density, and size.

Pioneer 10 will continue on into the interplanetary space beyond Jupiter, returning new information on the heliosphere and on low energy cosmic rays that transmit great amounts of energy from the stars but are too weak to reach earth.

Using the increase in velocity obtained during its Jupiter flyby, Pioneer II will extend its investigation of the outer planets by continuing its flight to the first encounter with Saturn in 1979.

FY 1976 and transition period funds are required to support the continued flight operations, mission analysis, data processing and the analysis of the scientific data from Pioneers 10 and 11.

Helios A & B.—The Helios project is an international cooperative project between the Governments of the United States and West Germany. Its scientfic objectives are to investigate the properties of, and processes in, interplanetary space in the region near the Sun, to within 0.3 A. U. The spacecraft, developed and built in West Germany utilizing consultants from the United States, weighs about 364 kg (800 lbs.) and carries about 55 kg (120 lbs.) of scientific instruments. Three of the ten scientific instruments are supplied by U.S. investigators. NASA provides the launch vehicle and the tracking and data support for the first phase of the mission. West German technical personnel conduct the spacecraft operations and will operate the tracking systems and acquire the data during the later mission phase.

Helios A was successfully launched on December 10, 1974 and will make its closest approach to the Sun in March 1975. Helios B will be launched in early 1976.

Most of the funds required for Helios A and B have been appropriated by the Congress; however, during FY 1976 and the transition period, a residual amount of funding is needed to continue the support for flight operations and data analysis for Helios A; for testing, and data analysis, of the U.S. scientific instruments to be carried on Helios B and for Helios B launch and flight operations planning.

47-396 O - 75 - 4

Supporting Research and Technology/Advanced Studies

	Fiscal year 1976	Transition period
Planetary science	$4,600,000	$1,200,000
Exobiology	3,300,000	800,000
Planetary advanced studies	1,200,000	300,000
Planetary advanced technical development	5,200,000	1,300,000
Total	14,300,000	3,600,000

Supporting Research and Technology and Advanced Studies furnish essential support to the planning and conducting of flight programs. It is through these activities that scientific objectives and mission concepts are defined, the scientific and technological readiness established and the initial planning accomplished for flight projects.

Planetary Science.—This project is subdivided into two major areas of research, planetary atmospheres and planetology. This research emphasizes the discovery and development of new techniques and experiments required for exploration and study of comets and the major planets in the late 1970's and early 1980's.

In pursuing the basic objective of obtaining an understanding of planetary atmospheres, considerable progress has been made in understanding the nature and dynamics of the Earth's atmosphere, and in describing the gross characteristics of the atmospheres of Mars and Venus. Experiments developed over the past five years are now assigned to or planned for flight missions to Mars, Venus, Jupiter and Saturn to obtain a more detailed understanding of their atmospheres. Similarly, the knowledge, techniques, instruments and experiments being developed now will form the basis for flight missions to comets and probes into the atmospheres of the planets in the early 1980's.

Tasks in planetology are directed at developing experimental concepts for determining formation history, composition and structure of planetary surface materials, and the nature and composition of planetary bodies.

During FY 1976, and the transition period, NASA plans to place emphasis on developing experiments to determine planetary surface composition by in-situ and remote sensing techniques as candidates for future missions and on the development of imagery experiments for investigations of Mars, Venus, and the outer planets, and Mars-Earth comparative geology studies. Efforts also will be directed toward Mercury-Mars-Earth-Moon analog studies to determine similarities between them.

Exobiology.—This activity is directed to producing the answers to fundamental questions of extraterrestrial life and the origin of life. In past years, the program brought to breadboard status some of the key instruments that were selected for flight on the Viking Mars landers. The gas chromatograph to fly on Pioneer Venus is also a product of this program. Work is now being directed toward follow-on exploration of Mars as well as toward investigation and analyses of the complex and potentially "organic" atmospheres of Jupiter and Titan. In addition, work has been initiated on problems associated with the analysis and study of returned samples from another planet.

During FY 1976 and the transition period, specific tasks will continue to be supported in approximately 60 universities and two NASA centers in the areas of organic chemistry, organic geochemistry, the biology of environmental extremes, and the development of techniques of life detection. These tasks will pursue the overall objective of studying other planets for evidence related to the presence of life and/or life related molecules. Feasibility demonstration instruments will be developed for future planetary missions and ground-based research will be directed to the interpretation of data returned from such investigations.

Planetary Advanced Studies.—The purpose of these studies are to define feasible mission concepts for the systematic exploration of the solar system and to develop rational schedule and resource requirements for conducting the missions in a logical, timely and cost effective manner. Advanced studies are performed both in-house at NASA centers and under contract. The studies cover the range from mission analysis and system feasibility to preliminary mission design and engineering.

The FY 1976 and transition period program is planned to include mission studies for the inner and outer planets, their satellites, and small bodies of the solar system (comets and asteroids) and general studies on adapting planetary spacecraft to the Space Shuttle/Tug.

Missions to be studied include: a Venus orbiter with synthetic aperture coherent radar to image and map the surface of Venus; a Jupiter orbiter to perform detailed studies of all of the Galilean satellites and of the temporal variations of the Jovian atmosphere and magnetosphere; Saturn orbiters, with the possibility of Titan probes; and missions to comets.

Planetary Advanced Technical Development.—This activity supports the new and improved spacecraft technologies that are critical to future planetary missions. Detailed technical planning for potential flight projects is performed and the technology readiness achieved to place them on a firm basis for the development of realistic schedules and cost estimates.

During FY 1976 and the transition period, efforts will be directed to a Jupiter Uranus mission opportunity in 1979. A spacecraft launch during that year can use the gravity of Jupiter as a springboard to Uranus and even Neptune. Other effort will be directed toward the technology for delivery of a probe into the upper atmosphere of either Jupiter or Uranus and the feasibility of standardizing probe design for utilization throughout the outer planets system. The Pioneer Venus probe will provide the technological point of departure for the outer planet probe. Additional activities will be concerned with the identification of and conceptual solutions for the technological problems peculiar to Jupiter orbital missions. At a lower level of effort, technical planning will continue on an out-of-the-ecliptic mission, an early Comet Enke flyby using spare Mariner hardware, and for future spacecraft utilizing solar electric propulsion.

Planetary Astronomy

This activity supports the scientific exploration of the solar system by observations of the planets and other solar system objects from the vicinity of Earth. New observation techniques, instruments, and platforms make it possible to acquire more information about the planets from the vicinity of Earth than previously possible. Observations are now made from airplanes, balloons, rockets, and earth-orbiting satellites as well as from ground-base observatories using the techniques of optical, infrared, radio and radar astronomy. Results from this Planetary Astronomy activity both supplement and complement the planetary flight programs. The objectives of Planetary Astronomy are accomplished through research projects carried out by astronomers and other scientists located at NASA center, universities, observatories, and other organizations.

During FY 1976 and the transition period, approximately 40 research projects are planned ranging in size from the work of a single investigator to large multifaceted projects at major observatories. Most of these research projects require a sustained effort over several years. Major emphasis will be on studies of the outer planets from Jupiter through Pluto to support upcoming flight programs. A recently completed NASA-supported addition to a high power radar system at the National Astronomy and Ionosphere Center at Arecibo, Puerto Rico (a National Science Foundation facility) will be used to study Saturn's Rings and for a high resolution mapping of the surface of Venus.

Planetary Data Analysis

This activity provides support for scientific analysis after the period funded by the flight project. It also supports the analysis of flight data by scientists who were not members of the flight investigation team. The long-term objective of Data Analysis is to fully analyze and interpret all the scientific data collected by flight projects and to insure the incorporation of these results into the growing body of knowledge about formation, history and characteristics of the planets, astroids and comets.

During FY 1976 and the transition period, the major emphasis in Planetary Data Analysis will be placed on conclusion of Mars geological mapping and analysis of other data obtained during the 11-month period in which Mariner 9 orbited Mars, and on the analysis of data obtained by the very successful Pioneer 10 and 11 spacecraft on their Jupiter flybys. Studies of Venus and Mercury also will be continued using the data obtained by the Mariner 10 spacecraft from its passage by Venus and its three passages past Mercury. Especially meritorious tasks analyzing the results of earlier Mariner and Pioneer missions to the planets and in interplanetary space will be continued as will tasks involving the interdisciplinary correlation and interpretation of collected data.

Planetary Quarantine

The objectives of this activity are to insure that no detrimental extraterrestrial life is introduced into the environment of earth, and that no other planet is detrimentally contaminated by terrestrial organisms through operations by U.S. spacecraft. The high priority of this activity has been repeatedly emphasized by the Space Science Board and the International scientific community. This activity also provides compliance with Article IX of the Space Treaty of 1966.

During FY 1976 and the transition period the Planetary Quarantine activities will continue to study the: (1) viability of terrestrial micro-organisms on the Mars surface, (2) use of the space environment to sterilize spacecraft during transit will be continued, (3) the problems that will be encountered in maintaining effective quarantine against any detrimental extraterrestrial life brought to earth from other planets by future return missions, and, (4) the Viking 1975 mission to provide the required support, biological monitoring, and certification for that mission.

Planetary Flight Support

Planetary Flight Support provides for the integrated tracking, telemetry, and command functions necessary to support all planetary flight projects. These functions require a highly sophisticated computer complex along with associated terminals, displays, and many other devices. This complex along with the general purpose scientific and engineering computing at the Jet Propulsion Laboratory also is supported with these funds.

During FY 1976 and the transition period, this activity will continue to support Pioneers 6 through 11, the Helios A mission, and the Viking A and B missions. Build-up to support the Mariner Jupiter/Saturn missions will continue. Also, the design of a new approach to mission support to make the total system more reliable and flexible will be completed and the implementation of this new approach will begin.

Additional activities which will be supported during FY 1976 and the transition period include: (1) support of the tracking system analytic calibration effort; (2) formulation of planetary programs data systems standards; (3) management of the Operations Support Coordinating Office at JPL which concentrates on system analysis and design, and support of off-lab projects; (4) general scientific and engineering computing requirements; and (5) selected project-peculiar studies.

Lunar Research Program

	Fiscal year 1976	Transition period
Lunar science S.R. & T.	$4,700,000	$1,300,000
Lunar data analysis and synthesis	9,600,000	2,300,000
Lunar sample analysis	5,600,000	1,400,000
Lunar science operations	4,800,000	1,100,000
Total	24,700,000	6,100,000

A concentrated scientific effort is underway to analyze and interpret fully the large amount of data available from the past lunar flight programs, ground-base studies of the moon, and laboratory investigations. The analytical work that has been carried out to date has revolutionized prior theories about the moon, yet the analysis is still in its early stages.

Lunar Science SR&T.—This activity emphasizes scientific studies that, provide a broad, sound base for the scientists engaged in analysis and synthesis of lunar data. In addition to the still-operating Apollo Lunar Surface Experiment Packages (ALSEP) and the Laser Ranging Project, this SR&T is the only source of significant new lunar data. SR&T activities emphasize studies in the following science areas: (a) earth-based observations, (b) analog studies, (c) theoretical studies, (d) laboratory simulations, and (e) extraterrestrial materials (primarily meteorites) studies.

New techniques and equipment have been developed for collecting lunar data by earth-based, multispectral, telescopic studies of the lunar nearside. Particularly rewarding are studies of the lunar surface reflection spectrum at near ultraviolet, visible and near infrared wave lengths which allow the determination of certain compositional properties of the surface material. This work is particularly enhanced by laboratory measurements of the optical properties of returned lunar samples and by our detailed geochemical knowledge of the Apollo landing sites.

The Lunar Science Institute (LSI) operated by the Universities Space Research Association is also supported under this project. The LSI serves as an important data repository facility open to all qualified scientists, and enables these scientists to utilize the extensive scientific equipment at the Johnson Space Center (JSC).

Advanced mission studies are concerned with studying the high priority unanswered scientific questions about the moon and defining optimum flight systems needed to collect the addition data needed to answer these questions. Some of these questions are concerned with major lunar geologic formations and significant gravity and magnetic anomolies. Much additional data could be obtained by mapping from lunar polar orbit both the radioactive and major rock-forming elements and the gravity and magnetic fields over the 80 percent of the moon not covered by Apollo, especially the critical farside and polar regions. Several approaches to such mapping have been examined in recent years.

During Fiscal Year 1976 and the transition period funds will be used for continued support to Lunar Science ground-based efforts, including telescopic observations and Lunar Science Institute activities. Definition studies will continue to examine mission parameters, requirements and constraints of lunar polar orbit mapping missions, including possible Shuttle-launched automated lunar missions to be flown in the 1980's.

Lunar Data Analysis and Synthesis.—The immediate objective of this activity is the continued interpretation of the large and still growing body of data acquired by lunar missions and SR&T research and, by integrating these results, the enhancement of man's knowledge of the origin, history and present characteristics of the moon. The long term objective is to integrate lunar knowledge with the terrestrial, planetary and solar studies, so as to gain a better understanding of the earth and the solar system.

During the Appollo phase of the lunar program, the primary scientific effort was directed to reducing and analyzing the results of individual experiments. However, the vast body of acquired Apollo data, additional data from the still-operating Apollo lunar experiments, and data from the past automated lunar flight programs now require a major effort of interdisciplinary analysis and synthesis to obtain the maximum scientific benefit from the lunar flight programs.

This Lunar Data Analysis and Synthesis activity is receiving enthusiastic support from researchers with broad scientific backgrounds in attacking the important problems of lunar origin and history.

During FY 1976 and the transition period, the scientific research of nearly 100 Principal Investigators will be supported; many of these projects will require several years to reach fruition. Because many new and outstanding scientists are expressing their desire to enter this program, the total program is expected to show steady improvement at a relatively constant funding level.

The ALSEP Principal Investigators, who are still reducing and analyzing the data received from the five ALSEP's operating on the lunar surface, also are supported under this activity as are scientists at JSC who constitute NASA's focal point for lunar science.

Finally, work will continue in the reduction and analysis of the photos from the lunar mapping cameras flown on Apollos 15–17. The results of this work are the cartographic products needed to support the present and future lunar scientific efforts.

Lunar Sample Analysis.—Among the most important scientific information so far obtained from the moon is the extensive set of data on the chemical, isotopic, and physical characteristics of the lunar rocks and soil samples. These samples have already provided the essential elements of an absolute lunar chronology, and had led to models of lunar composition and evolution quite different from those anticipated prior to the return of lunar samples. In addition, data on the interactions of solar and interstellar products with lunar surface materials is leading to a far better understanding of the history of the sun and stellar processes in general.

During FY 1976 and the transition period, it is planned that this activity will continue to support the current level of 109 domestic Principal Investigators and 37 foreign investigators, as well as over 700 co-investigators. The teams are highly qualified and located at institutions where unique research capabilities and skills have been developed. The funds will provide for salary support, computer efforts, supplies, and instruments for U.S. investigators.

Lunar Science Operations.—The full scientific potential of the Apollo lunar landing missions is being realized with the continued operation of the five long-lived ALSEPS and the three laser ranging retro-reflectors emplaced at the Apollo 11, 14 and 15 landing sites. The ALSEP instruments, most of which were designed for a maximum lifetime of 12 months have continued to operate far beyond expectations. The Apollo 12 ALSEP passed its fifth anniversary of continuous operation on November 19, 1974. NASA plans to continue to operate these lunar systems as long as they furnish valuable scientific data but annual reviews of all instruments are conducted to verify the scientific validity and merit of each experiment. Continued observations under this task require support: (1) to operate these instruments and to record and format raw data for Principal Investigators, (2) for Principal Investigators, who are familiar with instrument characteristics, to reduce raw data from these instruments to useful scientific observations, and (3) for these data to be placed in data banks where they will be available to all responsible scientific investigators.

The Lunar Sample Curatorial Facility at the Johnson Space Center is a major component of the post-Apollo scientific effort. Its operation requires support for handling, storing, preparing and distributing lunar materials as well as documenting the history and data obtained on each sample and assuring their security. Only a small fraction of the material returned from the moon has been expended for scientific research to date. This practice will continue in order to preserve these unique materials for study by new and innovative techniques which may be developed in the future as well as for second generation analyses.

During FY 1976 and the transition period, the laser ranging program will continue at McDonald Observatory. The new observatory at Mt. Haleakala in Hawaii will begin test runs in FY 1976. With the two stations producing range data, analysis will continue to develop new information on the dynamics of the earth-moon system. The primary objectives include the study of physics of the moon, gravitation and relativity, and the physics of the earth. This will increase our understanding of the wobbles of the earth's axis of rotation, which could enhance our capacity for earthquake prediction; and, provide measurements of the relative motions between the continental United States and Hawaii, which would refine our theories on continental drift.

Continued support to the operating ALSEP's and of the Lunar Sample Curatorial Facility, will also be provided during this period. As a precaution a selected portion of the lunar material will be placed in an especially prepared, secondary storage site, remote from the primary curatorial facility.

COMMITTEE COMMENT

The Committee recommends acceptance of the Lunar and Planetary program request as presented, and accordingly, it does not concur with the House cut of $1 million in this program.

Launch Vehicle Procurement Program

Fiscal Year 1976	$166,900,000
Transition Period	40,400,000

OBJECTIVES

The objective of the Launch Vehicle Procurement Program is to provide launch vehicles for automated space missions. The program includes procurement of vehicle hardware, launch services, engineering and maintenance support, in addition to providing for the product reliability improvement of vehicle and auxiliary ground support equipment. The program also includes a Supporting Research and Technology/Advanced Studies effort to analyze future mission requirements and to investigate new technological developments. The vehicles currently being procured are: Scout, Delta, Atlas–F, Atlas Centaur, and Titan IIIE/Centaur. Launches under this program are conducted from the Eastern Test Range in Florida, the Western Test Range in California, the Wallops Island Range in Virginia and the San Marco launch site off the east coast of Africa.

Summary of resources requirements

	Fiscal year 1976	Transition period
Scout	$12, 100, 000	$3, 400, 000
Centaur	113, 800, 000	26, 400, 000
Delta	36, 600, 000	10, 300, 000
Atlas-F	3, 400, 000	0
Supporting research and technology/advanced studies	1, 000, 000	300, 000
Total	166, 900, 000	40, 400, 000

BASIS OF FUND REQUIREMENTS

Scout

The Scout vehicle is the smallest launch vehicle employed by NASA. It is a four stage, all solid propellant launch vehicle, approximately 22.4 meters in length (73 feet). The first stage booster has a diameter of 1.14 meters (3.75 feet). It is capable of placing a 180 kilogram (400 pound) payload in a 555 kilometer (300 nautical mile) orbit. The Langley Research Center, located near Hampton Roads, Virginia, has managed the Scout project since its inception in 1959.

Scout vehicles are launched from the Western Test Range, California; from Wallops Island, Virginia; and from the San Marco Platform off the African coast near Kenya.

During FY 1976 and the transition period funds will be used as follows: (1) to continue hardware procurement to support the Dual Air Density Mission, the Heat Capacity Mapping Mission, and the Stratospheric Aerosol and Gas Mission; and (2) for engineering and technical support, vehicle test and checkout, launch operations, and maintenance of launch facilities and ground equipment to support the launch schedule.

Centaur

The Centaur program provides for the procurement and launch of two booster stages, the Atlas and Titan, and an upper stage, the Centaur. Centaur is a high performance upper stage, the most powerful used by NASA for automated missions. It is currently being used with the Atlas booster for high energy missions, particularly planetary, and synchronous orbit. The Atlas Centaur vehicle is 40 meters (131 feet) in length and has a diameter of 3.1 meter (10 feet).

A new configuration, the Titan Centaur, has been developed to support the Viking mission, and for other heavy payloads or high energy missions beyond the lifting capability of the Atlas Centaur. A Titan Centaur successfully launched the Helios-A mission on December 10, 1974. This flight demonstrated satisfactorily the full performance capabilities required for the Viking and Mariner Jupiter/Saturn missions. The Titan Centaur is 49 meters (160 feet) high and has a payload shroud diameter of 4.3 meters (140 feet).

During FY 1975 additional engineering support was required for the design effort associated with the failure of the Titan/Centaur Proof Flight, and corrections to electronic components of the Centaur inertial guidance system.

During FY 1976 and the transition period funds will be used: (1) to continue incremental procurement of hardware for the launch of

Helios-B, Viking-A and -B, Mariner Jupiter/Saturn-A and -B, High Energy Astronomy Observatory (HEAO) -A, -B, and -C, and the Pioneer Venus-A and -B missions; and, (2) for management and engineering support effort, launch support operations, field services, and to maintain facilities and ground equipment.

Delta

The Delta launch vehicle is the most used vehicle in the NASA launch vehicle family. Since its first use in 1960, this vehicle has been utilized in 106 launches and has a success record of 90 percent. It is presently operational in two and three stage configurations and a multiburn second stage capability. The first stage is an elongated Thor booster with 3, 6, or 9 strap-on solid motors for thrust augmentation.

The second stage Delta, which has a multiple restart capability, uses an inertial guidance system for guiding the first stage booster and the second stage Delta. The third stage utilizes the Thiokol TE-364 solid motor which is spin stabilized. This vehicle in its three stage configuration is approximately 35.05 meters in length (115 feet) and has a diameter of 2.44 meters (8 feet). It is capable of placing a 1,772 kilogram payload (3,900 pound) into a 555 kilometer (300 nautical mile) orbit.

This launch vehicle system experienced a failure during the launching of the Skynet IIA mission in January 1974. Subsequently, vehicle anomalies occurred during the launches of Westar A in April and SMS–A in May, 1974. Consequently, all launch activity was stopped until October 1974 while an overall technical and management review of the project was conducted. The review committees recommended a series of hardware modifications which have been implemented. In addition, the committees recommended changes in project management, practices, staffing levels for certain key activities, and operating procedures to improve the reliability of the Delta. Launch activity has been resumed, and a number of missions have been successfully launched. During FY 1975 $4.1 million in additional funds were made available to this project for the corrective actions.

A major improvement activity planned for FY 1975 was not carried out due to the use of the funds for activities associated with the recommendations of the failure review committees.

During FY 1976 and the transition period funds will be used: (1) to continue the hardware procurement contracts in support of the International Ultraviolet Explorer (IUE), Nimbus-G, International Sun-Earth Explorer A/B and C (ISEE), and the LANDSAT-C missions; and (2) for necessary technical and engineering support, to sustain vehicle test and checkout and launch operations and to support maintenance of launch facilities and ground equipment.

Atlas–F

The Atlas–F is a one and one-half stage vehicle which uses liquid oxygen and kerosene as propellants. The vehicle is a refurbished surplus Intercontinental Ballistic Missile (ICBM) used for space missions. It is managed by the Air Force.

Funds are needed for FY 1976 to refurbish and modify an Atlas–F to launch the Tiros-N meterological satellite in early CY 1978. No funds are required for the transition period.

Supporting Research and Technology/Advanced Studies

The objective of the Supporting Research and Technology/Advanced Studies project is to provide preliminary information and alternatives to management so that decisions concerning the space transportation systems may follow a well defined, integrated course in future years.

The FY 1975 funding plan was decreased $3 million; these funds were reprogrammed to meet the more urgent requirements of carrying out corrective actions on Centaur and Delta.

During FY 1976 and the transition period funds will be used as follows: (1) Solar electric propulsion advanced studies will be continued and launch vehicle phase out studies will be initiated in order to insure an orderly transition from current vehicle usage to the Space Shuttle; (2) solar array technology for solar electric propulsion and research in solar electric propulsion system capabilities will be continued; (3) development, test, and evaluation of strap down guidance system components consisting of inertial sensors and computer technology will be continued; and (4) investigation of atmospheric effects resulting from effluents produced during vehicle launching activities will be continued.

Space Applications Program

Fiscal Year 1976	$183,930,000
Transition Period	54,700,000

OBJECTIVES

The major objective of the Space Applications program is to conduct research and development activities that demonstrate the application of space-related technology for the benefit of mankind. Generally, these activities are grouped in the following areas: Weather and Climate, Pollution Monitoring, Earth Resources Survey, Earth and Ocean Physics Applications, Space Processing, Communications, Data Management, and Applications Experiments and Studies.

Reliable short- and long-term weather forecasts mean savings of life, property, and money through effective disaster warning systems and proper planning in many activities such as agriculture and transportation. Therefore, the Weather and Climate program has as its major thrusts the application of satellite data to vital problems in the detection, prediction, and early warning of severe storms; the improvement of the capability for long range weather prediction; and the development of advanced sensors and satellite systems for utilization by the National Oceanographic and Atmospheric Administration (NOAA) to achieve the foregoing objectives. These activities will build on the achievements and contributions of meterological satellite systems and sensor developments in previous years.

Pollution monitoring is directed to applying space technology and remote sensing from space to the problems of determining the concentrations and distributions of atmospheric constitutents and monitoring changes in atmospheric composition which might prove annoying and/or harmful to man, the biosphere or other aspects of the earth's environment. The data acquired will provide a basis for limiting and controlling environmental damage. Additional significant data will also be obtained by the second Application Explorer Mission—the Stratospheric Aerosol and Gas Experiment (SAGE)—which will fly a single instrument to direct and map statospheric aerosols and gas concentrations. The informatoin derived will complement that obtained by the Nimbus-G program currently under development.

The effective utilization of the world's natural resources requires that their extent be surveyed, their changes monitored and systems for wisely mangaging their exploration be constructed. Toward this end the Applications Systems Verification Tests (ASVT) program is continuing to demonstrate to the user community that remotely obtained information (from satellite and aircraft) provides new capabilities to supplement existing data gathering systems. In FY 1975 and FY 1976, as part of this program, the Large Area Crop Inventory Experiment (LACIE) utilizes Landsat data to establish the feasibility of using such data on an operational basis to determine wheat production over the North American continent with possible extension to the entire world. In addition Landsat-C, an Earth Resources Technology Satellite just getting underway, will have a resolution twice that of the earlier Landsat 1 and 2 and its multispectral scanner will incorporate a new thermal sensing capability.

The Earth and Ocean Physics Applications program (EOPAP) is designed to use space and space derived techniques for very precise monitoring of the earth's crustal motions (tectonic plate movement, fault motions, polar wobble and rotation rate) to develop an understanding of earthquakes, their origin and the ability to forecast their occurrence, and to monitor ocean phenomenon such as sea state, currents, surface winds and general ocean circulation on a global basis which is of particular importance to the maritime industries. With respect to the monitoring of the earth's crustal motions, accurate ground measurements will soon be aided by the LAGEOS satellite to be launched in 1976. With respect to monitoring ocean phenomena, development of an Ocean Dynamics Satellite (Seasat–A) is being continued this year as an outgrowth of a program plan for oceanographic research and ocean dynamics forecasting defined by NASA and user organizations (Departments of Defense, Transportation, and Commerce and research institutions). The satellite will provide data on wave height, wind speed, wind and wave direction, ocean temperature, and ocean surface topography which will be used for scientific studies and ocean state forecasts.

The objective of the Space Processing program is to exploit the unique characteristics of space flight to prepare and process materials in ways that are not possible or economically practical on earth. The eventual benefits of the program are expected to include new knowledge of materials and technology improvements directly applicable to industrial processes on the ground as well as unique high-technology products produced in space for use on earth. Skylab experimentation has demonstrated the possibilities and advantages of manufacturing crystals for earth-based applications in the gravity-free environment of space.

The current NASA effort in the field of satellite-based communications systems is directed toward the development of advanced technology and toward providing expert advice and consultation on satellite communications to various Government departments and agencies. The highly successful series of Applications Technology Satellites (ATS–1, 3, 5 and the recently launched ATS–6) will continue to be used by various domestic and international experimenters. Two important experiments involving ATS–6 are the Health and Education Television Experiment being conducted with the Department of Health, Education and Welfare and the Satellite Instructional Television Experiment in cooperation with the Government of India.

Data Management activities are directed toward the study, design, development and demonstration of the technology for improving the flow of data from onboard satellite systems to user terminals and/or facilities to accommodate the steadily increasing volume, complexity, and exceedingly high rates of data involved; to reduce origin-to-user data transmission times; and to provide improved capabilities for the rapid storage, maintenance and retrieval of data products.

To avoid premature commitment of new technology the Advanced Applications Flight Experiments program provides for the early design and development of sensors and experiments prior to committing them to flight on a mission. Applications studies and systems analyses are undertaken to assure that the research and development activities of the Applications program are practical, cost-effective, and based on user needs and requirements. Special emphasis is placed on user-oriented economic analyses and assessments of ongoing and proposed new programs. A major consideration is to establish need and economic justification. Such studies are performed as early in the life of a program activity as possible and updated through follow-on analyses.

Summary of resources requirements

	Fiscal year 1976	Transition period
Weather and climate	$34,600,000	$11,700,000
Pollution monitoring	19,200,000	8,700,000
Earth resources survey	66,930,000	15,000,000
Earth and ocean physics	26,400,000	7,800,000
Space processing	3,700,000	1,200,000
Communications	9,500,000	2,000,000
Data management	4,000,000	1,500,000
Shuttle payloads	4,000,000	1,500,000
Advanced applications flight experiments	4,700,000	1,300,000
Applications systems analyses	5,000,000	1,400,000
Applications explorer missions	5,900,000	2,600,000
Total	183,930,000	54,700,000

BASIS OF FUND REQUIREMENTS

Weather and Climate

	Fiscal year 1976	Transition period
All weather atmospheric sounding experiment satellites (Nimbus 5 and F)	$3,500,000	$900,000
Operational temperature sounding satellite (Tiros-N)	9,000,000	2,100,000
Operational satellite improvements	5,000,000	2,400,000
Global atmospheric research program (GARP)	7,000,000	3,000,000
Meteorological sounding rocket program	1,900,000	600,000
Severe storm observations satellite (Stormsat) definition studies	2,500,000	300,000
Advanced techniques in observing and forecasting	5,700,000	2,400,000
Total	34,600,000	11,700,000

Nimbus (5 and F).—The Nimbus spacecraft series was originally developed as a flying test bed for developing advanced instrumentation for meteorological satellites. Nimbus 5, launched in December 1972 into a 600 nautical mile polar orbit with a Delta launch vehicle, and Nimbus F, to be launched in late FY 1975, flight test advanced infrared and microwave sensors to provide atmospheric soundings on a global basis which are needed for a better understanding of the atmospheric processes and interactions to improve long-term weather forecasting. Nimbus 5 provided the first vertical profile of temperature and moisture from cloud covered surface to the upper reaches of the atmosphere.

Nimbus F will provide data on incoming solar radiation, on the earth's outgoing radiation, and on tropical and southern hemisphere wind and temperature structures. During FY 1976 and in the transition period, primary emphasis will be placed on collection and analysis of data from Nimbus-F, including the Tropical Wind, Energy Conversion and Reference Level Experiment, a Carrier Balloon System Test, relay of data from globally-distributed remote relay sites, and other experiments.

Tiros–N.—Tiros-N, a third-generation polar orbiting operational satellite to be launched in 1978 into a 906 nautical mile polar orbit with a Delta launch vehicle, is being developed for NOAA. It will incorporate recent advances in infrared and microwave sounders for the high-resolution, all-weather measurement of temperature and moisture profiles. Microwave soundings in the 5mm band present the only means of penetrating cloud fields which cover much of the earth's surface. The ability to sound the lower troposphere during extensive cloudiness is of utmost importance for diagnosing and forecasting the evolution of severe weather because clouds always prevail around a storm system during its entire life cycle. Tiros–N will also include an operational data-collection system for the acquisition of in-situ data from buoys, balloons, aircraft, and remotely-located ground stations. The capability to track constant-density super-pressure balloons provides very important support to the Global Atmospheric Research Program since there is no other feasible way to obtain meteorological measurements in tropical and Southern Hemisphere ocean regions.

Operational Satellite Improvements.—Through the Operational Satellite Improvements Program (OSIP), NASA conducts research and development for the improvement of sensors, equipment and subsystems associated with operational satellite programs to insure that advances in technology related to solving critical problems, such as severe storm detection, are available for incorporation into the operational weather satellites.

Current developments include modifications on: the Vertical Temperature Profile Radiometer (VTPR) to improve the accuracy and utility of this sensor, Advanced Very High Resolution Radiometer (AVHRR) to provide improved sea-surface temperatures for operational use, and the Visible Infrared Spin-Scan Radiometer (VISSR) to provide an atmospheric sounding capability. All these efforts are coordinated with the National Oceanic and Atmospheric Administration (NOAA) and will be continued in FY 1976.

An all-weather microwave sounding capability for follow-on satellites of the Tiros-N series will be initiated to give better numerical weather prediction. Also, the development of local user terminal ground equipment for readout of data from both polar-orbiting and geostationary weather satellites will be continued in response to long unfilled user community needs for such low cost equipment.

Development will also be initiated on a sounder for a 3-axis stabilized geostationary spacecraft to provide data which are improved in both resolution and accuracy for use in severe storm detection and forecasting.

Global Atmospheric Research Program.—The Global Atmospheric Research Program (GARP) is an international program designed to (1) improve the accuracy and time extent of global numerical weather predictions; (2) assess the feasibility of large-scale weather modifications; and (3) determine the long-term effects of pollutants on the earth's atmosphere.

In early FY 1975 NASA participated in the first large-scale international GARP experiment—the GARP Atlantic Tropical Experiment. In May 1974, a Data Systems Test was conducted that produced the first global real time data set. The Data Systems Test focused attention on problems related to the acquisition and processing of global data from many data sources, as will be the case in the 1977–79 period of the First GARP Global Experiment. In FY 1975, the U.S. plan for the First GARP Global Experiment will be completed and distributed for comment. Testing and evaluation of the Carrier Balloon System will continue during this period.

In FY 1976 and the transition period, further Data Systems Test periods are scheduled to provide global data sets during summer and winter weather conditions; these tests will use data obtained from the Nimbus-F and SMS–B weather satellites and also the data relayed from ocean buoys and carrier balloons through Nimbus-F. Planning and associated research will be accelerated in preparation for the First GARP Global Experiment. Research in numerical methods weather forecasting will concentrate on the development of new technologies to use meteorological satellite data in atmospheric circulation and operational weather forecast models. Global data sets of higher quality than those previously obtained will be produced and used in experiments.

Meteorological Sounding Rockets Program.—Research is urgently needed on what effects, if any, man's activities have had on the composition and chemistry of the upper atmosphere, in particular on the ozone layer in the stratosphere. In FY 1976 and during the transition period, Nike Cajun, Arcas, and boosted dart-type meteorological sounding rockets will be launched from various sites to obtain data on the distribution and concentrations of minor stratospheric constituents. Also, optical ozone soundings will be made to obtain the vertical profile of ozone during daylight, and chemi-luminescent soundings will be made to obtain the vertical profiles of ozone during night time. To examine the effects of high-flying aircraft on the upper atmosphere, nitric oxide soundings will be taken. A balloon payload will measure solar spectral irradiance profiles, and other rocket payloads will seek to determine the Bremstrahlung ozone source.

Agreements between the U.S. and U.S.S.R. for space cooperation include an agreement on the establishment of an Eastern and Western Hemispheric Meridional Network of meteorological rocket stations and the exchange of data and investigation of the processes characterizing the state of the stratosphere and mesosphere. During FY 1976 and the transition period about 300 improved rockets will be launched as part of this program.

Data from meteorological sounding rocket flights are also used to calibrate data obtained from satellite systems and in supporting studies of the total atmospheric effects on man and machines.

Severe Storm Observations Satellite (STORMSAT).—The objective of the STORMSAT definition studies to be conducted during FY 1976 and the transition period is to define the needed characteristics of an advanced sensing device termed the Advanced Atmospheric Sounding and Imaging Radiometer (AASIR) for the observation of the short-lived and violent meterological features which describe and are associated with severe storms. Stormsat will remain stationary over the North American continent and its sensors will be pointed continuously toward the earth giving nearly continuous data that will be used to provide significant improvements in severe storm forecasting. Stormsat could be launched in 1980 if undertaken as a FY 1977 new initiative.

Advanced Techniques in Observing and Forecasting.—The objectives of this program are the establishment of the physical principles upon which remote sensors can be developed and employed, the development of the techniques for the acquisition of environmental data by remote sensors, and the application of the data to the definition of the earth's atmosphere and the prediction of its changes.

During FY 1976 and the transition period, the severe storms research program will include detailed studies of geostationary satellite photographs, of possible improvements to satellite systems, special aircraft overflights of severe storms, and joint studies with NOAA, other Government agencies, and university scientists. Research emphasis will also be placed on small scale, short-lived but destructive weather phenomena, including not only thunderstorms, tornadoes and hurricanes, but also flash floods, heavy frosts and winter storms. This program will expand the current state of knowledge about severe storms to aid in the development of systems to detect, monitor, and forecast severe storms.

Using Nimbus satellite data, new investigations will also be initiated to improve numerical weather prediction. Climate research will be focused on studying the relatively slow changes of global weather or climate that bring about large scale/long-term changes reflected in droughts, series of severe or mild winters, monsoon patterns, and motion of polar ice. Concurrently, research is being conducted to adapt and refine short-term numerical prediction models to accept long-term parameters related to the laws of climatic behavior.

Pollution Monitoring

	Fiscal year 1976	Transition period
Oceanographic and air pollution observing satellite (Nimbus-G)	$15,000,000	$7,500,000
Sensor definition and feasibility evaluations, modeling, operational methodology	4,200,000	1,200,000
Total	19,200,000	8,700,000

The primary objective of the Pollution Monitoring program is the development and demonstration of systems capable of identifying and measuring pollutants in the air and water on global and regional scales.

A major new concern over atmospheric pollution is the possibility that certain manmade chemicals may be depleting the ozone in the stratosphere. These chemicals include fluorocarbons used in aerosol spray propellants and refrigerants, nitrogen compounds produced for agriculture, and exhaust gases from high-flying aircraft and spacecraft. Data on the trace gases in the stratosphere are now being obtained from instruments flown on aircraft and the global space observation capability that is needed is now being initiated.

Nimbus G.—The Nimbus G mission, initiated in FY 1974, will provide the first capability for global acquisition of well integrated repetitive, synoptic, remotely-sensed data required for atmospheric pollution and oceanography investigations. The prime mission objectives are twofold: (1) to measure the types, quantities and distributions of gases and particulates in the troposphere and in the stratosphere and (2) to measure the color, temperature and ice conditions of the ocean. In support of these objectives, other experiments will study the interface of the atmosphere with the oceans and the land, and the earth's energy budget. Data acquired will be applied to studies on the concentration, distribution, and time-variations of atmospheric and oceanographic contaminants and their impact on the total environment.

The Nimbus G spacecraft, adapted from the Nimbus/ERTS spacecraft developments and to be launched by a Delta launch vehicle in 1978, will operate from a near polar, sun synchronous orbit viewing the earth at the same local sun time everywhere. Nine experiments have been selected to date. Four directly address the problem of atmospheric pollution and will measure gases and particulates. The gases to be measured are directly related to pollution problems such as the use of fossil fuels and the effect of high altitude aircraft operations in the stratosphere. Three experiments are directed to oceanography and the air/sea interface including sea ice and surface temperatures and water color sensing all of which is important for ocean food and pollution surveys and for assessing chlorophyll, sediment and other substances in coastal waters. The final two experiments will measure incoming solar radiation and outgoing-reflected and emitted-radiation in a study to increase the understanding of the earth's radiation budget, and to establish thermal baselines and to detect changes therefrom, particularly those attributable to human activities.

Specifications for the spacecraft and experiments are now being completed, and design and construction of hardware will be supported with FY 1976 and transition period funding.

Sensor Definition and Feasibility Evaluations.—This effort is the foundation for the NASA program of applying aerospace technology for assessing the quality of the environment and evaluating the impact of candidate strategies for enhancing the quality of the air, water, and land. The primary emphasis is on remote sensing techniques; however, the need is also recognized for application of in-situ sensing and analysis as a means for validating and calibrating remote sensors.

47-396 O - 75 - 5

During FY 1976 and the transition period, increased emphasis on global monitoring of the stratosphere will require coordinated programs in: sensor development; fundamental physical and chemical processes; modeling for establishing sensor requirements (to aid in data analysis and to assess the impact of aerospace operations); and measurements to establish global baselines.

The remote sensing of water quality has received less emphasis than that for air quality, and, consequently, more fundamental research is required. New techniques need to be developed and tested with regard to both remote and in-situ sensing of water pollutants. These investigations should be valuable for application to the detection, identification, and differentiation of municipal and industrial wastes, as well as understanding the chemical reactions involved in creating new pollutants and toxic substances. This technology will also be of value in conjunction with urban and regional water quality surveys. There will be a continuation in the activity for remote sensing of water quality. In addition, it is expected that the cooperative effort with NOAA in the New York Bight region (Marine Ecosystem Analysis program) will be initiated.

Earth Resources Survey

	Fiscal year 1976	Transition period
Earth resources technology satellite (Landsat 1 and 2)	$5,300,000	0
Multispectral scanner 5th band development	2,000,000	0
Earth resources technology satellite (Landsat-C)	11,000,000	$3,500,000
Applications airborne research program	13,330,000	3,600,000
Earth resource experiment package (EREP) investigations	1,500,000	0
Applications systems verification tests (ASVT)	10,800,000	2,900,000
Data interpretation techniques, special investigations and data analyses	23,000,000	5,000,000
Total	66,930,000	15,000,000

Earth Resources Technology Satellites (Landsat 1 and 2).—The first Earth Resources Technology Satellite (Landsat–1), carrying a multi-spectral scanner and a return beam vidicon camera system and launched in July 1972, has been a most successful development. It has proven effective in the identification and acreage measurement of major crops on a global basis. "Photo-maps" have been made at scales of 1:250,000 from Landsat–1 imagery thereby exceeding National Map Accuracy standards, and classification of land use has been accomplished for 18 national and regional categories proposed by the U.S. Department of the Interior for National Land Use Mapping (Circular 671); previously unrecognized major faults have been identified and correlated with earthquake epicenters from conventional data; mineral alteration halos have been enhanced near Goldfield, Nevada; and pollution plumes, strip mining and reclamation efforts have been identified. Mapping of floods (including the entire Mississippi River), snow-covered areas, and regional water resources, has been accomplished. The location of menhaden fish schools has been precisely correlated with coastal water turbidity imaged by Landsat–1 and sea ice affecting ocean shipping has been detected and its movement mapped.

More recent accomplishments include the continued successful operation of Landsat–1, exceeding two and a half years in orbit, the flight of the Earth Resources Experiment Package (EREP) on Skylab, and the successful launch of the second experimental earth resources satellite, Landsat–2 in January 1975. Data from these missions have successfully demonstrated the capabilities of space-based remote sensing data and its application to both immediate and long-range user community requirements. These include such areas as the identification of potential oil bearing formations in Alaska, the computer classification of crop types in Nebraska with better than 90 percent accuracy and the assessment of flood extent and damage by the Missouri and Mississippi Rivers. Comprehensive actions are in progress to exploit those applications which require further development of analytical techniques and assessment of cost effectiveness for operational use. Follow-on ERTS investigations to develop these operational applications will be conducted during late FY 1975, FY 1976 and the transition period.

The primary effort in FY 1976 and the transition period will be directed toward the flight operations of the Landsats and continuation of the approximately 100 follow-on investigations. Flight operations will include mission planning and the operations of the spacecraft control center on a 24 hour-per-day basis.

Multispectral Scanner.—The addition of a thermal infrared channel to the Multispectral Scanner on an ERTS-type spacecraft will provide for comparison of thermal data with that simultaneously obtained at visible or near infrared wavelengths. Such information has high utility for locating, mapping, and measuring thermal pollution of large lakes, bays and estuaries; and for providing information about the heat capacity of soils and geological structures. It should, in addition, provide important information on stresses in vegetation. Observations of ocean currents from their temperature differences will provide data needed for investigations of ocean shoreline changes and effects upon coastal land and water uses.

In FY 1976 and the transition period, fabrication and test of flight components, including the scan mirror assembly, scanner, and data multiplexer, will be completed. These major components and the passive radiative cooler will be integrated into the flight model of the five-channel multispectral scanner; systems test will be conducted; and the flight model will be delivered to the Landsat-C prime contractor for integration into the spacecraft.

Earth Resources Technology Satellite (Landsat–C).—The principal objective of Landsat–C is to continue the research and development of medium-resolution, multispecial remote sensing systems to be used from space for global data acquisition. The performance of the instrumentation will be significantly improved over the sensors used on Landsat–1 and –2. Landsat–C will include a fifth channel on the Multispectral Scanner to measure the thermal infrared pattern of phenomena characterized by temperature, and the Return Beam Vidicon (RBV) camera system will allow an improvement of a factor of two in the spatial resolution. Current planning calls for a launch in the third quarter of 1977.

During FY 1976 and the transition period, the spacecraft design will be completed and fabrication will be initiated. The Multispectral Scanner will complete its development, assembly and test, and will be ready for integration into the spacecraft. The Return Beam Vidicon cameras will be designed, assembled, and will undergo subsystem tests. Delivery of the RBV's is anticipated early in 1977. In addition, the necessary modifications to the ground data processing facilities to accommodate the sensor changes will be initiated, along with the detailed ground operations planning and the software.

Applications Airborne Research Program.—NASA remote sensing aircraft focus on developing measurement and interpretive techniques, defining and evaluating new space sensors, and demonstrating the application of remote sensing.

During FY 1976 and the transition period, severe storm research and environmental quality activities will be supported by numerous aircraft efforts which are characterized by stratospheric sampling flights with the U–2's and thermal mapping with high altitude aircraft in relation to Nimbus–G studies. Several multispectral scanner flights are also planned in conjunction with the Environmental Protection Agency to support their efforts in water quality research. Sensor definition flights will focus on the development of instruments for Nimbus–G, the Ocean Dynamics Satellite (Seasat) and the Heat Capacity Mapping Mission.

Modifications to the replacement CV 990 aircraft will be completed to restore the full capability of the research facility lost in an accident in April 1973. Upcoming expeditions for the CV 990 now under review include the Arctic Ice Dynamics Experiment, Severe Environmental Storms and Meso Scale Experiment and Project Stormfury which deals with hurricane seedings to modify high-energy patterns.

Earth Resources Experimental Package (EREP) Investigations.—The EREP, launched aboard Skylab I on May 24, 1973, was used to acquire data during the three manned Skylab missions for 140 applications investigations. The 140 investigations include studies related to agriculture, range land, and forestry; geological applications; continental water resources; oceans; atmospheres; coastal zones, shoals and bays; regional planning and development; cartography; and remote sensing technique development. Data in the form of measurements in the visible, infrared, and microwave portions of the spectrum have been acquired using a variety of sensor techniques. During FY 1975 approximately one fourth of the EREP Investigations were completed.

During FY 1976 and the transition period, the remainder of the 140 investigations will be completed. The results of the EREP investigations will be published in individual reports and will be summarized in a report which will include an assessment of the relative value of spatial and spectral resolution, additional spectral bands, and microwave techniques in the various application disciplines.

Application Systems Verification Tests (ASVT).—The objective of this program is to take the most promising research investigations using the Landsat data and to define, demonstrate, and document the practical capability of remote-sensing information systems.

One ASVT project, initiated in FY-1975, is the Large Area Crop Inventory Experiment (LACIE) which is determining whether remote sensing data from Landsat–1 and –2 can improve the timeliness and accuracy of major crop forecasts, first for North America and then for other regions. Wheat is the test crop.

Another project is a joint Lake Ice program between NASA, the Coast Guard (USCG) and NOAA. The objective is to develop a system to provide accurate ice distribution maps to ships in order to expand the shipping season on the Great Lakes.

Other ASVT projects include an automated natural resources system for the State of Mississippi, an automated natural resources system for the wet lands of southern Louisiana, and a snow melt monitoring for water management in several states. These projects will be transferred to the respective user organizations as soon as the application is proven and reaches mature status.

Data Interpretation Techniques, Special Investigations and Data Analyses.—This effort forms the research and technology base for the Earth Resources Survey program and as such is fundamental to the continuing development and extension of remote sensing techniques and their application to practical problems.

In FY 1976 and during the transition period, research will continue on quantifying remote sensing data and presenting the data in a format that is most understandable and useful to resource managers. Specifically, work will continue on developing techniques to increase identification and measurement accuracies in agriculture. Work will also continue on improving remote sensing capabilities for soil moisture detection and measurement and to validate and demonstrate advanced remote sensing techniques in forestry applications. In mineral resources, efforts will concentrate on further refinement of digital enhancement techniques for identifying and determining the significance of surface alterations caused by underlying mineral and petroleum deposits, on the development of spatial filtering techniques, and on evaluating the utility of infrared sensors. In land use, work will continue on developing techniques for automatic classification and change detection. Development of snow survey and watershed models required for the utilization of remote sensing data will be pursued in the water resources area while further work will be done to develop quantitative measures of chlorophyll, salinity and surface temperatures in marine resources.

In technology development, emphasis will be in the development of automatic data processing techniques to improve accuracies and the development of methods for remote sensing signature extension with the goal of minimizing the need for ground truth in data analysis. In the area of new flight instruments, selection and award of a contract for detailed design of the Thematic Mapper will be made, and basic technology work will continue on microwave instruments to overcome cloud cover limitations.

Earth and Ocean Physics Applications Program (EOPAP)

	Fiscal year 1976	Transition period
Laser geodynamics satellite (Lageos)	$1,000,000	$300,000
Ocean dynamics satellite (Seasat–A)	17,000,000	5,000,000
Tectonic plate motion	2,600,000	800,000
Measurement systems, forecasting techniques and modeling/advanced studies	3,100,000	900,000
Experiment data analysis	2,700,000	800,000
Total	26,400,000	7,800,000

Lageos.—The Lageos program (employing a dense sphere satellite with 400 laser reflectors) will provide the capability for making extremely accurate determinations of the earth's crustal and rotational motions by means of laser tracking techniques. It will be a major advance over GEOS–C and other current capabilities in this respect. Lageos will be employed to observe a number of phenomena associated with earthquakes, including fault motion, regional strain fields, dilatancy, tectonic plate motion, polar motion, earth rotation, and solid earth tides, as well as to determine accurate station locations for use in other efforts such as the EOPAP ocean dynamics program.

The program includes the building and launching of the satellites, with a Delta launch vehicle, the development and use of accurate laser ground tracking stations, and the application of the laser data in connection with the generation of models of the earth's crustal and dynamic motions.

The satellite qualification model was completed in early FY 1975 and it proved to be acceptable for flight, precluding the necessity of a separate flight satellite. During FY 1976 and the transition period, the last increment of retroreflectors will be delivered. The final assembly of the satellite and optical performance vertification will be accomplished. The qualification testing of the satellite-to-launch vehicle interface adapter and satellite ejection mechanism will be completed. The satellite will be integrated with the launch vehicle third and fourth stages and spin-balanced. This assembly will then be integrated with the first and second stages and launched in the first quarter of CY 1976.

Seasat–A.—This project was a new start in FY 1975 and consists of one satellite to be launched into a high inclination orbit by a Delta launch vehicle in 1978. It will carry ocean dynamics instrumentation to measure wave heights, wind speeds, wind and wave direction, ocean temperature, and ocean surface topography.

The monitoring of the oceans from space will provide oceanographers for the first time with the kind of global, synoptic coverage for scientific analyses which have already been supplied by TIROS and Nimbus satellites to meteorologists investigating the atmosphere, and by the ERTS spacecraft to scientists studying the land. A sound foundation of scientific knowledge of the oceans as global systems, based on the Seasat–A data, will constitute an indispensable base upon which to build new ocean dynamics forecasting capabilities having major scientific and economic potential, particularly to the fishing and shipping industries and in the development and protection of our coastal regions.

Seasat will make a major contribution to the study of air-sea interactions, which is perhaps the most significant "interface" science involving our planet. Oceangraphers, meteorologists, and climatologists will be able to use Seasat information on wave height and direction, surface winds and ocean temperatures obtained globally in virtually all weather conditions. They will have a global view, but will also be able to scrutinize local systems, such as hurricanes, in detail.

Geodesists are also among the scientists who will take a major step forward by analyzing Seasat data. The fine structure of the geoid which they will determine with much greater accuracy in the

Seasat data will be studied keenly by the tectonic physicists as they search for clues about the structure of the earth's crust. The science of orbit determination will also benefit from the use of the new type of satellite position data provided by the Seasat altimeter.

Based on the results of the Seasat–A data analyses and the improvements they will allow in ocean and weather forecasting models, it should be possible to define and develop forecasting systems which will provide ocean conditions, as well as ocean influence inputs, necessary for 14–day worldwide weather forecasting.

During FY 1975, procurement of the spacecraft module, launch vehicle selection, and sensors was finalized. During FY 1976 and the transition period, the manufacture and test of the spacecraft bus and the development of the sensors and sensor module will be in process. The fabrication of a sensor module test model will begin and sufficient testing will be completed to start sensor module fabrication during the transition period.

Tectonic Plate Motion.—One of the keys to understanding and predicting earthquakes is the ability to measure the movement of the giant tectonic plates which make up the earth's crust. The Tectonic Plate Motion project was implemented in FY 1975 in the form of three different experiments.

The San Andreas Fault Experiment (SAFE), conducted in California with the U.S. Geological Survey and the Geophysical Observatory of Columbia University, will demonstrate the feasibility of using satellite-tracking lasers to determine surface motions along an active fault over a period of several years. As an alternative, the feasibility of using distant stars as a reference will be demonstrated in California by the Astronomic Radio Interferometric Earth Surveying (ARIES) project. Finally, the Pacific Plate Motion Experiment (PPME), entering into the initial phases this year, will aid in the determination of the relative motions of the Pacific, North American and Eurasian plates by extending the experiment to Alaska and Hawaii. The objective of this coordinated set of experiments is to obtain a consistent picture of the motions, both in the plate boundary region extending from southern California to Alaska and over the plate as a whole.

During FY 1976 and the transition period new equipment will be added, other equipment will be evaluated and a second series of observations and intercomparisons will be completed.

Measurement Systems and Forecasting Techniques and Modeling.—The objectives of Measurement Systems and Forecasting Techniques are to establish a base of analytical and experimental techniques and feasibility investigations which are required for the orderly development and implementation of the Earth and Ocean Physics Applications program.

Universities, institutions, and other Government agencies will be funded to perform scientific studies of fundamental phenomena in earth and ocean dynamics as a basis for the detailed requirements for experimental and analytical techniques.

Efforts will include studies utilizing space techniques which will lead to a better understanding of the mechanisms governing the dynamics of the solid earth and the world's oceans.

Experiment Data Analysis.—Experiment Data Analysis provides the funding to analyze all data obtained in the Earth and Ocean

Physics Applications program, including data obtained from earth-based experiments and earth/satellite experiments, and to apply these data to particular end objectives, such as mapping and modeling ocean currents; monitoring and forecasting sea state, other ocean dynamics effects, and the interactions between ocean and atmosphere; and assessing earthquake hazards.

In FY 1976 and the transition period, the analysis of data from GEOS–C experiments involving radar altimetry, laser ranging, satellite-to-satellite tracking, and other techniques will be continued. Data from such experiments, will be analyzed to validate and improve scientific and user theories and to demonstrate the feasibility and limitations of the various space and ground systems to contribute to the solution of scienitfic and user problems. Data from intercomparison experiments will be analyzed to establish the relative merits of alternate techniques and the applications of acquired data to the development and assessment of analytical models for ocean currents, transport and circulation, and other earth and ocean dynamics effects.

Space Processing

	Fiscal year 1976	Transition period
Ground-based investigations, analyses and studies	$3,100,000	$900,000
Sounding rocket missions	600,000	300,000
Total	3,700,000	1,200,000

The space processing program is designed to investigate the utility of space flight for work in materials science and technology and ultimately for the commercial manufacturing of unique high-technology products in space for use on earth. Under Ground-based Investigations, Analyses and Studies, work is undertaken both to define the technical and economic potential for useful applications of space processing and to develop the technology required to implement actual space processing operations on future space missions.

Under the Sounding Rocket Missions category, funding is provided to carry out sounding rocket flight tests of promising space materials processing methods that cannot be adequately performed in aircraft flights and drop-tower operations.

In FY 1976 and the transition period emphasis will continue on products and processes having potential for early application. Processes of current interest include cell separation, crystal manufacturing, metal purification, and production of new types of optical glass. The economics of space processing operations will also be examined.

Communications

	Fiscal year 1976	Transition period
Cooperative applications satellite (CAS–C)	$1,100,000	$100,000
Experiment coordination and operations support	3,900,000	800,000
Technical consultation and support studies	2,100,000	600,000
Advanced communications research	2,400,000	500,000
Total	9,500,000	2,000,000

Canadian Cooperative Satellite (CAS–C).—In April 1971, the Canadian Department of Communications (DoC) and NASA entered into an agreement to launch a synchronous orbit Cooperative Applications Satellite (CAS–C), also referred to as Communications Technology Satellite (or CTS) in late 1974. The overall objective of this project is to develop a technical capability for satellite communications with small ground stations in the newly allocated 12 GHz frequency band. The investigation of the use of frequencies above 10 GHz is considered urgent in view of forthcoming domestic satellite systems further crowding the spectrum below 10 GHz.

Canada is responsible for design, development and fabrication of the spacecraft, and for post-launch spacecraft operations with the U.S. and Canada equally dividing the experiment time. NASA is responsible for the principal technology development on the satellite, the Transmitter Experiment Package (TEP), and for providing and launching the Delta launch vehicle. Launch is now scheduled for late 1975, with the delay due to thermal control and overweight problems with the spacecraft and to shortages of materials and electronic parts for both the spacecraft and experiments.

Experiments Coordination and Operations Support.—NASA made an offer to the general public in 1969 to use in-orbit Application Technology Satellites (ATS) 1, 3, and 5 for communications experiments after the NASA experiments were completed. Under this offer, which received a large response, the experimenter provides funding support for the experiment. NASA funds the operation of the satellite, provides experimenter time on the spacecraft and gives technical consultation to the experimenters. ATS–6, launched in May, 1974, is operated under the same guidelines as ATS–1 through –5 as will be the Cooperative Applications Satellite–C (CAS–C) when it is launched in late CY 1975.

Operations of ATS–6 will continue through the transition period. As part of its experiments the satellite will be moved in May, 1975, from its position over the U.S. to a position over the Eastern Hemisphere for the Satellite Instructional Television Experiment (SITE) with India and then returned to the U.S. late in FY 1976 for more experiments over the United States.

Technical Consultation and Support Studies.—This program consists of special studies, measurements and consultation services providing support in spacecraft technology and telecommunications to NASA itself, to fulfill NASA's statutory responsibilities to other Government agencies, and to others, on a reimbursable basis as appropriate.

In FY 1976 and the transition period NASA will continue orbit and frequency utilization studies which deal with the problems of frequency sharing, spacing criteria, propagation phenomena, and interference as related to satellites. Also, preparation will begin for the 1977 World Administrative Radio Conference (WARC) on broadcast satellites and for the 1979 WARC on space and terrestrial communications services.

Advanced Communication Research.—The objective of this program is to develop technology and concepts in advance of current and planned state of the art communications technology. It is designed to maintain NASA's competence in the field.

Efforts initiated in FY 1975 in this program, to be continued in FY 1976 and the transition period, are in four major areas: improved and expanded utilization of the radio frequency spectrum; techniques for antenna beam shaping; development of improved modulation and data compression techniques; and more efficient transmitting and receiving devices.

In FY 1976 and the transition period, this effort will concentrate on developing methods for better utilization of microwave frequencies, and on performing research to open up new bands in the spectrum, such as in the infrared and visible, for space research and applications. These efforts include the development of both components and spacecraft technology to produce more efficient and reliable communications.

Data Management Program

The objective of this program is to improve the management of the data acquired through NASA's programs. As data from new sensors threaten to overwhelm existing data management facilities, two approaches show promise. One is to increase the capacity of the data handling system; the other is to reduce the amount of data collected to match the information requirements of the data users.

The FY 1976 and transition period effort in Data Management will build on the systems approach initiated in FY 1975. Definition of user needs will be expanded by conducting additional regional surveys and by having information users define their requirements more precisely by using simulation techniques. User-system information extraction experiments will assist in the formulation of better interactive techniques. Systems analyses will be performed to produce integrated sensor-to-ground-data-handling system models and analyze tradeoffs to improve procedures. Other activities undertaken will include extensive investigations of high data rate transmission and processing systems, including laboratory models to identify system characteristics and limitations.

Shuttle Payloads

The objective of Shuttle Payloads Program for Space Application is to develop the required instruments and the associated spacecraft technology for high priority experiments to be performed on shuttle sortie missions utilizing the Spacelab.

The initial design and development of these experiments must be commenced in FY 1976 and the transition period in order to have them ready for flights in 1980–81. The experiment selected can be grouped into three categories: communications, earth observations, and space manufacturing.

Advanced Applications Flight Experiments

The Advanced Applications Flight Experiments (AAFE) program plays a very important role in developing instrumentation for future missions in earth resources survey, pollution monitoring, weather and climate, earth and ocean physics, and space processing. The ability to develop instruments closely approaching their flight configuration but not yet committed to flight, as is done in the AAFE program, is an effective way to provide for low cost development of such instruments. The experiments in the AAFE program are pursued until their feasibility has been established through testing of an engineering model or some other equivalent testing procedure. When the experiments are selected for incorporation on an approved mission, the construction of the appropriate instrumentation will be funded by the flight mission or the instrumentation program.

During FY 1976 and the transition period, portions of the AAFE funding will be used to continue experiments initiated in each of the applications discipline areas. This will include an Active/Passive Multispectral Scanner to measure atmospheric path characteristics, water depth, turbidity, and vegetation canopy height. A High Resolution Laser Radar will be developed to measure vertical profiles of aerosol distribution, humidity, and alkali metal vapor.

In the areas of bathymetry, algae detection and mapping and oil slick detection, a High Pulse Repetition Rate Lidar will be developed. In addition to continuing these ongoing tasks, new experiments will be solicited for FY 1976.

Applications Systems Analyses

The Applications Systems Analyses program has two primary objectives: (a) user oriented systems and economic analysis and assessment of the applications programs and (b) the identification of systems feasibility analysis of new applications initiatives.

An integral activity of the Applications program is the determination that the programs being carried out and proposed have real potential for economic and social return to the public.

In FY 1975, cost benefit studies were conducted on agricultural forecasting, land use planning, and the potential value of the SEASAT systems to the user community. Also, undertaken were an economic assessment of commercial space processing, and a study of carbon wastewater treatment.

During FY 1976 and the transition period some of these activities will be continued and a number of new studies will be initiated.

Applications Explorer Missions

The objective of the Applications Explorer Missions program is the development and launch of low cost, Scout-launched missions to support research in earth resources surveys, environmental quality, weather and climate, ocean studies, and space communications. Each mission is tailored to the specific area of research and to the orbital requirements.

The first mission, the Heat Capacity Mapping Mission, a new start in the Earth Resources Survey program in FY 1975, involves the launch, in 1977 with a Scout launch vehicle, of a small 3-axis stabilized spacecraft with a Surface Composition Mapping Radiometer into a 600 kilometer sun synchronous orbit. The Radiometer is an existing backup instrument from the Nimbus 5 project which will be modified for this application.

The mission is designed to make thermal inertia measurements of the earth's surface which will lead to the identification of surface rock types, the monitoring of ocean currents and aid in the development of a capability to inventory potential geothermal sources. The identification of rock types is of major value in locating oil and gas fields since the exploration for these resources relies substantially on the identification of reservoir rock and local structure which might provide a trap for petroleum. Major civil works like highway and canal construction are critically dependent upon the type of surface rock that will be encountered along alternative routes.

The second mission, the Stratospheric Aerosol and Gas Experiment, will use a photometer to develop monitoring techniques for the detection and mapping of stratospheric aerosols and ozone concentrations and distributions. This mission will be launched in 1979 into a fifty degree inclined orbit and will provide bi-weekly coverage of aerosols and ozone for latitudes seventy-two degrees north to seventy-two degrees south. A similar instrument will be launched in 1978 as a part of the Nimbus–G payload to measure aerosols at polar latitudes.

COMMITTEE COMMENT

The Committee recommends the addition of $8.9 million to this program as follows:

Weather and Climate.—The Committee concurs with the House in adding $1 million to the severe storm observation satellite project.

Earth Resources Survey.—The Committee notes with satisfaction that the Landsat–C follow-on earth resources satellite is now in the program with the launch projected for 1977. This should provide continuity of data for users through 1979 or 1980, depending on satellite lifetime, thereby supporting an increasing number of experiments and allowing a sufficient opportunity to fully exploit and evaluate the potential of this space system.

The Committee supports the "pilot plant" approach to applications systems verification testing, as represented by the LACIE experiment, and encourages the initiation of more of this type of activity. Accordingly, the Committee recommends the addition of $1.5 million to this program, which is identical to action taken by the House.

While the Landsat–C will provide on-going earth resources coverage with an improved (5th or thermal band added) multispectral scanner and an enhanced vidicon system, the launch schedule does not allow introduction of additional instrument capability. The Committee believes it is most important to initiate promptly the development of advanced systems for greater payoffs from satellite surveys. Therefore, it has added $3.4 million to support full scale development of the thematic mapper, an advanced scanning instrument. This amount is $2.4 million above that added by the House for the same purpose.

Communications.—The House added $2 million to the NASA communications request for FY 1976, $1 million to provide satellite services to support additional users for the ATS and the CAS–C satellites, and $1 million for research on higher frequencies for communications satellites. The Committee agrees with these additions to the funding for this program.

Shuttle Payloads.—The Committee believes it is timely to proceed with those activities necessary for transition to the space shuttle system in order to maximize the advantages offered by that system. Accordingly, the Committee concurs with the House addition of $1 million to this activity.

The Committee further recommends that the Administrator of NASA continue to provide for an independent review of the remote sensing technology development program such as carried out by the Committee on Remote Sensing Programs for Earth Resource Surveys, Commission on Natural Resources, National Academy of Sciences. Included in these reviews should be an analysis of the processing and information management techniques and an assessment of the program as related to the needs of those working in the earth resources and environmental fields. Further, these reviews should identify where possible technological opportunities that may lead to improved remote sensing capabilities.

AERONAUTICAL RESEARCH AND TECHNOLOGY PROGRAM

FISCAL YEAR 1976	$175,350,000
TRANSITION PERIOD	46,800,000

OBJECTIVES

The Aeronautical Research and Technology program is directed at improving the performance and reducing the energy requirements and undesirable environmental effects of civil and military aircraft. Maintaining the Nation's superiority in civil and military aviation is essential to the economic well-being and military security of the United States. NASA's role is the development of advanced technology to address specific areas of concern, and the general advancement of aeronautical technology to ensure the superiority of our military aircraft and a strong competitive position for the U.S. civil aviation industry in the international marketplace.

A strong research effort is maintained in the disciplinary areas of materials, structures, avionics, propulsion, aerodynamics and man-vehicle interactions to provide advanced technology to meet the future needs of civil aviation. The program includes a major effort aimed at reducing aircraft energy consumption and the undesirable environmental effects of noise and pollution. This effort is directed at providing the technology for quiet, clean and efficient propulsion systems; the reduction of aerodynamic drag; the application of active control concepts, and advanced materials and structural concepts to aircraft to reduce weight and improve operating efficiencies; and a characterization of nonpetroleum based fuels for aircraft. Another major area of program emphasis is concerned with improving aircraft terminal area operations and safety through the development of technology in areas such as avionics systems, operating procedures, crash-worthy aircraft structures, and fire resistant aircraft interior materials.

These technology efforts are integrated with additional focused technology efforts to provide the technology for advanced long haul and short haul air transportation system concepts for the future. The short haul program focuses on Short Takeoff and Landing (STOL), Vertical Takeoff and Landing (VTOL) and rotorcraft systems; while the long haul program focuses on Conventional Takeoff and Landing (CTOL) subsonic systems with a modest effort aimed at developing supersonic and hypersonic technology to provide options for aircraft of the future.

The Aeronautics program also supports the military by providing an advanced technology base which may be uniquely applicable to military aircraft or applicable as well to civil aircraft, and by providing technical problem solving support for current military aircraft development.

Summary of resources requirements

	Fiscal year 1976	Transition period
Research and technology base	$85,100,000	$23,800,000
Systems studies	3,000,000	700,000
Systems technology programs	46,550,000	15,800,000
Experimental programs	40,700,000	6,500,000
Total	175,350,000	46,800,000

The structure of the Aeronautics program has been modified to reflect the logical flow of the research and technology effort. The activities carried out in the Research and Technology Base are oriented toward establishing a solid foundation embracing all of the relevant disciplines and a wellspring of ideas for advanced concepts; the System Studies activity provides a basis for decisions regarding emphasis and priorities in the Research and Technology Base program and identifies and evaluates potential applications of advanced concepts; the Systems Technology Programs are technology demonstration/proof-of-concept activities for concepts which have matured under the Research and Technology Base and are ready for systems integration and demonstration, or the project definition phase of potential future Experimental Programs; and the Experimental Programs involve multidisciplinary concept demonstration and major research vehicle development.

BASIS OF FUND REQUIREMENTS

Research and Technology Base

	Fiscal year 1976	Transition period
Materials research and technology	$6,200,000	$1,700,000
Structures research and technology	6,250,000	1,800,000
Propulsion environmental impact minimization research and technology	11,410,000	3,200,000
Propulsion components research and technology	9,050,000	2,700,000
Air breathing engine systems research and technology	8,150,000	2,000,000
Fluid and flight dynamics research and technology	10,200,000	2,900,000
Avionics research and technology	3,580,000	1,000,000
Aircraft operations and safety research and technology	3,900,000	1,100,000
Low speed vehicle aerodynamics and flight dynamics research and technology	12,500,000	3,500,000
High speed vehicle aerodynamics and flight dynamics research and technology	8,830,000	2,500,000
Aeronautical man-vehicle research and technology	5,030,000	1,400,000
Total	85,100,000	23,800,000

Funds for Research and Technology Base projects are to sustain NASA activity in its role of conducting basic research and developing the technology that will be the building blocks for new future capabilities and missions that today cannot be precisely defined.

Materials Research and Technology.—This program involves the study of advanced materials with the objectives of improving the safety, performance, and economy of civil and military aircraft. Emphasis is on high temperature turbine engine materials and low weight, high strength airframe materials which are also fire resistant.

Structures Research and Technology.—This program provides technology to improve the safety, durability, and economy of commercial, military, and general aviation aircraft by advancing the state-of-the-art in airframe structures. The specific activities undertaken are selected to provide the maximum benefits in critical areas and are coordinated with related efforts in other agencies to avoid unnecessary duplication.

Propulsion Environmental Impact Minimization Research and Technology.—The propulsion environmental impact minimization research and technology program will provide through basic research, applied technology, and experimental engineering the knowledge and understanding necessary to reduce propulsion system noise and exhaust pollutant emissions to help meet national environmental objectives. In addition, the program will provide improved methods for predicting noise and pollution impact on the environment, and for assessing the interaction of aircraft emissions in the atmosphere.

Propulsion Components Research and Technology.—The propulsion components research and technology program objectives are to increase efficiency, increase operating range, improve specific fuel consumption and reduce the weight of the many interactive components making up aircraft engines and propulsion system installations.

Air Breathing Engine Systems Research and Technology.—The air breathing engine systems research is directed toward the attainment of technology for reducing both the costs and time required for new engine development programs through improved engine systems design and analysis techniques, and to investigate potential new system concepts.

Fluid and Flight Dynamics Research and Technology.—The fluid and flight dynamics program objective is the advancement of our understanding and predictive capability of aerodynamic pheonomena to permit increased proformance optimization for more efficient, fuel-conserving advanced aircraft, and to ensure reduced environmental effects and improved safety of advanced aircraft in early design stages.

Avionics Research and Technology.—The avionics research and technology program is focused on the design, development and test of improved aircraft guidance, navigation, control, display and communication subsystems for general aviation, short haul, vertical take-off and landing, and long haul transport aircraft.

Aircraft Operations and Safety Research and Technology.—Aircraft operations and safety research and technology programs provide a research and technology base which can be used to solve a wide variety of aeronautical safety and safety-related operational problems. Three program elements provide a focus for individual research efforts: (1) expansion of basic knowledge of atmospheric processes; (2) aircraft safety technology; and (3) aircraft system operational efficiency improvement.

Low Speed Vehicle Aerodynamics and Flight Dynamics Research and Technology.—The objective of this program is to develop and demonstrate the advanced technology required for improvements in the integrated aerodynamic performance, noise, stability, control, handling qualities and flight dynamics of four low-speed aircraft categories, i.e., general aviation, advanced rotorcraft, advanced vertical take-off and landing and powered-lift.

High Speed Vehicle Aerodynamics and Flight Dynamics Research and Technology.—The high speed aerodynamics program is directed toward generating advancements in design and prediction techniques for economy, safety, and reliability in civil aircraft and superiority in military aircraft.

Aeronautical Man-Vehicle Technology.—The aeronautical man-vehicle technology program provides a research and technology base for providing solutions to the human problems impeding the growth and safety of air transportation. Major foci are to understand the relationships between aircraft noise and human response and to enhance the safety, economy, and effectiveness of new air transportation systems through development of automated flight management cockpit technology.

Systems Studies

The program objective of aeronautical systems studies is to determine the technology requirements, costs, benefits and impacts of advanced civil and military aeronautical systems based on mission, systems and conceptual studies. Advanced aeronautical concepts are identified, analyzed and evaluated. The System Studies program for FY–1976 has been restructured from the program presented last year under the same title with many of the studies now part of the Systems Technology Program.

In the FY 1976 and the transition period, civil air transportation systems studies will be conducted to identify technology requirements, evaluate concepts and tradeoffs, and clarify National needs in support of improved near-term and future civil air transportation systems, including both commercial and general aviation. Studies will also be conducted to identify technology requirements and evaluate concepts and tradeoffs in support of future military aviation systems, coordinating closely with the Department of Defense in their identification of future military needs and missions.

With respect to both civil and military applications, studies will be conducted to identify and evaluate promising approaches for reducing the fuel/energy consumption of future aviation systems.

Systems analysis methods for program assessment will continue to be developed and implemented as routine elements of the budget formulation process. In addition, studies examining alternatives for future overall program direction will be executed during FY 1976 and the transition period.

Systems Technology Programs

	Fiscal year 1976	Transition period
Materials and structures systems technology	$8,100,000	$4,400,000
Propulsion systems technology	2,500,000	1,200,000
Avionics systems technology	6,000,000	2,000,000
Aircraft operating systems technology	11,900,000	2,600,000
Aerodynamic vehicle systems technology	4,650,000	1,200,000
Advanced civil aircraft systems technology	12,500,000	4,300,000
Man-vehicle systems technology	200,000	100,000
Military aircraft systems technology	700,000	0
Total	46,550,000	15,800,[illegible]

The Aeronautics program for FY 1976 and the transition period contains several planned program augmentations in the Systems Technology programs area. The design, construction, and testing of propulsion system subassemblies and components for an advanced energy conservative turbofan, and the integration and evaluation of fuel conservative aircraft technologies are directed at energy conservation and improving aircraft operating economy. The development of long time technology related to flight weight cryogenic tanks and insulation required to utilize hydrogen as an aircraft fuel represents a significant step forward in the search for an abundant alternative to hydrocarbon fuels. Common components for variable cycle engines which show great promise for efficient operation over a wide range of subsonic and subsonic/supersonic flight conditions will be designed, developed and tested. Propulsion, structures and aerodynamics technology will be developed for future hypersonic applications. An effort to develop solutions to offset the increase in "human error" caused commercial aircraft accidents, and the identification of new fire resistant, low toxicity materials for use in aircraft will make significant contributions to improving air transportation safety. NASA technology will be applied to reduce the undesirable environmental effects of noise and pollution from general aviation turbofan engines. An effort will also be initiated to improve capability for understanding and avoiding aeroelastic instability in turbine engine fan blades.

Materials and Structures Systems Technology.—The objective of this effort is to accelerate the transfer of advanced materials and structures technologies to application in design of airframe structures and engines. Accomplishment of the objective involves development of prototype components for laboratory testing and long term operational service evaluation, and, where necessary, development of more efficient analysis and design techniques.

Propulsion Systems Technology.—The aeronautical propulsion systems technology programs will demonstrate advancements in technology through system design and test of subassemblies incorporating results of advanced component research. Improved engine development, environmental effects or a combination of these parameters are the criteria governing systems technology programs.

Avionics Systems Technology.—The avionics systems technology program applies the fundamental knowledge gained in the Research and Technology Base to develop and demonstrate the technical readiness and encourage the transfer of advanced systems to the aircraft industry through experimental testing and verification in a realistic environment.

Aircraft Operating Systems Technology.—This program will provide proven system concepts, technology, operational flight procedures and techniques on which logical decisions can be based for improvements in airborne systems (avionics and air vehicle) which will solve the interface problems between the aircraft and its operating environment. It concentrates on the terminal area performance characteristics of aircraft to increase air traffic system productivity within the constraints of safety, passenger comfort, pilot workload, community noise and emissions, and minimum time and fuel expenditures.

Aerodynamic Vehicle Systems Technology.—This program is focused primarily on flight evaluation and demonstration of selected

47-396 O - 75 - 6

aerodynamic concepts directed at improving aircraft performance, efficiency, safety, handling qualities, maneuverability and other important aircraft characteristics while at the same time striving to improve overall operations in regard to factors such as fuel consumption, community acceptance, and direct operating cost.

Advanced Civil Aircraft Systems Technology.—The objective of this program is to provide a technology base for transport vehicles in the short haul and long haul categories with emphasis on fuel conservation, noise reduction, economics, and their interactions in aircraft design, using promising technologies generated in the research and technology base programs.

Man-Vehicle Systems Technology.—The aeronautical Man-Vehicle Systems Technology program is designed to reduce the incidence of approach and landing accidents attributable to human error and to develop technology and operational procedures that will insure optimum crew coordination in multipilot aircraft.

Military Aircraft Systems Technology.—This program provides the means of enhancing and fostering new aeronautical technologies, especially applicable to military needs, through cooperative and joint programs between the various agencies of the Department of Defense and NASA. These aircraft and missile technologies are validated through flight testing and supported by wind tunnel model tests.

Experimental Programs

	Fiscal year 1976	Transition period
Highly maneuverable aircraft technology	$4,900,000	$1,800,000
Quiet, clean, short haul experimental engine	10,000,000	2,000,000
Supersonic cruise aircraft research	8,900,000	2,000,000
Tilt rotor research aircraft	1,900,000	300,000
Rotor systems research aircraft	3,100,000	0
Quiet propulsive lift technology	11,900,000	400,000
Total	40,700,000	6,500,000

Highly Maneuverable Aircraft Technology.—The objective of this program is to provide low cost flight research vehicles to promote and stimulate the application of new high risk (laboratory) technology for the design of future military combat vehicles. Reductions in the cost of the experimental flight tests to explore the new technology of aproximately 50 percent over comparable manned test vehicles will be realized through flight test of subscale vehicles utilizing the relatively new Remotely Piloted Research Vehicle test technique.

Quiet, Clean, Short Haul Experimental Engine.—The objective of this program is to consolidate and demonstrate the technology needed for very quiet, clean and efficient propulsion systems for economically viable and environmentally acceptable powered lift short haul aircraft.

Supersonic Cruise Aircraft Research.—This program will provide the technology for future civil and military supersonic cruise aircraft by means of an integrated program in the key areas of propulsion, structures, aerodynamics, and stability and control. The research will assess the environmental and economic impacts of new supersonic aircraft and provide data for future decisions relative to the development of this type aircraft by the United States.

Tilt Rotor Research Aircraft.—This joint NASA/Army program will provide proof-of-concept and perform advanced flight research investigations utilizing two tilt rotor research aircraft presently being designed and fabricated as part of this program. A primary objective of this program is to evaluate the potential benefits of applying tilt rotor technology, developed over the last twenty years, to various Army, Air Force, Navy and commercial missions which require the unique capabilities of the tilt rotor concept.

Rotor System Research Aircraft.—This joint Army/NASA program will provide a unique flight test capability for advanced rotor research to expedite and improve rotorcraft research through the use of a specially designed flight test vehicle.

Quiet Propulsive-Lift Technology.—The Quiet Propulsive-Lift Technology program will generate and verify through ground-based and flight research a technology data base for design and certification criteria for practical and efficient quiet propulsive-lift short haul transports. The program consists of: (1) an effort directed to flight research utilizing the Air Force Advanced Medium Short Takeoff and Landing Transport prototype aircraft; and (2) an effort directed to flight research utilizing a Buffalo aircraft modified at low cost into a Quiet Short Haul (propulsive-lift) Research Aircraft.

Space and Nuclear Research and Technology Program

Fiscal Year 1976	$74,900,000
Transition Period	22,300,000

OBJECTIVES

The objective of the Space and Nuclear Research and Technology program is to provide a technology base which will support the exploration and exploitation of space. The program concentrates on advancing the technologies used in systems required to transport, protect, power, control and communicate with the spacecraft and scientific instruments needed to achieve the objectives of current and future NASA space missions. Much of the basic technology developed in the program is applicable to a broad range of terrestrial problems in fields such as energy and communications.

Materials and structures technology are developed to provide advanced materials and structural concepts to reduce spacecraft weight; as well as seals, lubricants, and optical and high temperature materials for use in the hostile environment of space and spacecraft applications. The propulsion technology effort is aimed at expanding mission capabilities by increasing propulsion systems performance and life, and at lowering propulsion system costs. The effort focuses on liquid and solid fuel chemical systems, electric powered thrusters, and on the development of nuclear propulsion technology for the future. Power technology will be developed to reduce the cost and weight while increasing the power, efficiency, life and reliability of spacecraft power systems to meet the more stringent requirements of future space missions. The generation, conversion, storage, transmission and conservation of energy are all addressed by this effort. The effort focuses on long life batteries, fuel cells, thermionic converters, isotope power sources, magnetohydrodynamic generators, gaseous fueled nuclear reactor technology and high powered lasers for power transmission. A fundamental electronics effort is aimed at providing the advanced electron devices, high resolution sensors and long life reliable circuit arrays required for low cost electronic systems. Low cost guidance and control components, advanced spacecraft navigation techniques and autonomous control systems for robot vehicles will be developed as part of the guidance and control technology effort. Technology will be advanced in the areas of transmission, reception, processing and storage of information to help meet the demands of increasingly complex space missions at lower cost with increased reliability. Aerothermodynamic technology will be developed to insure the effective design of entry spacecraft for various planetary atmospheres.

Work will also be done on the development of space laboratory research facilities and supporting technology to enable NASA and other Shuttle and Spacelab users to conduct research and technology investigations in space in an economical manner.

In May of 1974, NASA established the new Office of Energy Programs and consolidated under it the energy related functions previously performed by other NASA Program Offices. In the FY-1976 budget, these programs are all reflected under the Energy Technology Applications program. Accordingly, the major portion of the former Energy and Environmental Systems Technology program was transferred from this program to the Energy Technology Applications program.

Summary of resources requirements

	Fiscal year 1976	Transition period
Research and technology base	$61,300,000	$18,500,000
Systems studies	1,600,000	400,000
Systems technology programs	2,200,000	800,000
Experimental programs	3,700,000	1,100,000
Low cost systems program	6,100,000	1,500,000
Total	74,900,000	22,300,000

The structure of the Space and Nuclear Research and Technology program has been modified to reflect the logical flow of the research and technology effort. The activities carried out in the Research and Technology Base are oriented toward establishing a solid foundation embracing all of the relevant disciplines and a wellspring of ideas for advanced concepts; the System Studies activity provides a basis for decisions regarding emphasis and priorities in the Research and Technology Base program and identifies and evaluates potential applications of advanced concepts; the Systems Technology programs are technology demonstration/proof-of-concept activities for concepts which have matured under the Research and Technology Base and are ready for systems integration and demonstration; or the project definition phase of potential future Experimental Programs; and the Experimental Programs involve multidisciplinary concept demonstration and major research vehicle development.

BASIS OF FUND REQUIREMENTS

Research and Technology Base

	Fiscal year 1976	Transition period
Materials research and technology	$8,900,000	$2,700,000
Structures research and technology	5,420,000	1,600,000
Fundamental electronics research and technology	5,300,000	1,600,000
Guidance and control research and technology	3,400,000	1,000,000
Information systems research and technology	5,190,000	1,600,000
Chemical propulsion research and technology	8,290,000	2,600,000
Electric propulsion research and technology	4,200,000	1,200,000
Space energy systems research and technology	7,290,000	2,200,000
Nuclear energy research and technology	2,200,000	700,000
High power lasers and energetics research and technology	5,410,000	1,600,000
Entry research and technology	5,700,000	1,700,000
Total	61,300,000	18,500,000

Materials Research and Technology.—This program provides, through state-of-the art advancement, materials for highly efficient, low cost spacecraft structures, thermal protection systems, and propulsion and power systems for future orbiting and planetary vehicles, and supports the development of the Space Shuttle with unique expertise and facilities. Its aim is to provide the means to reduce the costs and further improve the reliability and lifetime of all space transportation systems.

Structures Research and Technology.—Advanced technology is being provided for structures to meet the needs of future space systems. This technology provides improved capability for systems designers to meet stringent structural weight limitations, plan for large space erectable structures, and reduce the cost of hardware qualification procedures.

Fundamental Electronics Research and Technology.—Research and technology activities in fundamental electronics provide new devices and techniques for sensing, measuring and displaying information, and long life electronic circuits necessary for the design and synthesis of reliable, low cost electronic systems.

Guidance and Control Research and Technology.—The space guidance and control research and technology program seeks to define and develop components and techniques which will lower the cost of spacecraft attitude control and stabilization systems, provide precise pointing of experimental payloads, increase the accuracy and efficiency of planetary navigation and guidance systems, and provide sensors and logic systems which enable the autonomous operation of unmanned vehicles in alien environments.

Information Systems Research and Technology.—The objective of the space information systems research and technology program is to provide advanced components and techniques which permit a greater return of knowledge from space science and application missions by speeding the transmission, processing and reduction of space derived data.

Chemical Propulsion Research and Technology.—The chemical propulsion program is structured to meet the continuing need for higher propulsion performance, longer system life, lower costs and critical problem solving. To achieve these objectives, the program is focused on the following areas: (a) reusable oxygen-hydrogen systems for reduced transportation system operating costs, (b) long life space storable propulsion for future unmanned planetary exploration, (c) improved low cost solid propulsion for upper stage and orbit insertion applications, and (d) the problem of effects on the atmosphere by rocket exhaust products. These focused efforts are supported by a broadly based research program which explores the fundamental chemical and physical processes common to all chemical propulsion systems.

Electric Propulsion Research and Technology.—The objective of this program is to provide the research and technology for high specific impulse (greater than 1,000 seconds) electric propulsion systems needed for advanced capabilities in near-earth and planetary/interplanetary applications. Specific areas of investigation include: (1) auxiliary electric propulsion technology for station keeping and attitude control of long life application type satellites, (2) primary solar electric propulsion technology for use with the Shuttle and Tug to augment their performance capability for accomplishing high energy missions in the 1980's and 1990's and, (3) basic research in fundamental processes involved in electric propulsion to extend reliability and life, and to explore the full potential of electric propulsion.

Space Energy Systems Research and Technology.—The objective of the Energy Systems Research and Technology program is to make available low cost, long-lived, reliable, high power density and high-energy density components and energy systems for spacecraft.

Nuclear Energy Research and Technology.—Research and technology investigations will be conducted in areas related to advanced applications of nuclear energy in space. Building upon the extensive space nuclear programs of the past decade, these activities will maintain a viable, long-range capability in nuclear research for space power and propulsion while providing important benefits to the Nation in its concerns for future energy sources.

High Power Laser and Energetics Research and Technology.—The high power laser and energetics program provides, through basic research and experimental engineering, major advances in power generation, conversion, and transmission which will be the basis for future capabilities in space and which will apply to the long-range energy need on earth.

Entry Research and Technology.—The entry research and technology program provides the technology base required to improve entry space craft design, operation, safety, and reliability.

Systems Studies

The overall objective of this activity is to identify and evaluate the technology requirements of advanced space systems and to assess the effects of technology advances on space program alternatives.

The effort to determine long-term program enabling technology needs will continue to receive major emphasis during FY 1976 and the transition period. In order to provide more comprehensive research and technology planning recommendations, the studies will be broadened to include Earth and Ocean Physics programs, Physics and Astronomy programs and Lunar programs. The long-term investigations of advanced Planetary, Earth Observations and Transportation Systems will continue examining system alternatives and their impact on technology needs. It is intended to pursue further technology oriented studies such as the communications and the environment control tasks. Instrument development and detector research will be studied with the goal of acquiring or generating comprehensive forecasts of both technology development trends and total (scientific and applications) program needs. Study efforts will give increased attention to projected software requirements.

Future mission, concept feasibility studies will continue as a basis for providing technology focus. Interstellar Communications, Single-Stage-to-Orbit, Advanced Planetary Spacecraft, and Titan (Saturn Moon) Exploration studies are in progress. Advanced concepts such as those which may derive from the "Outlook for Space" results will be considered for study.

Technology readiness studies will continue for selected candidate new programs. The study of candidate Mariner change recommendations for the Saturn Orbiter mission will be completed, as will the evaluation of technology alternatives for the recoverable NASA Space Tug.

Systems Technology Programs

	Fiscal year 1976	Transition period
Materials and structures systems technology	$500,000	$300,000
Guidance, control and information systems technology	700,000	300,000
Entry systems technology	1,000,000	200,000
Total	2,200,000	800,000

Materials and Structures Systems Technology.—This activity is directed to accelerating the transfer of advanced materials and structures technologies to application in the design of space vehicle systems. Critical system applications are selected and components are designed, fabricated and tested in the laboratory to demonstrate the validity of the predicted improvements. If necessary and appropriate, space flight testing will also be performed.

Guidance, Control and Information Systems Technology.—The purpose of this systems technology program is to demonstrate the capabilities of advanced electronic devices and system concepts to provide improved performance, increased reliability and/or reductions in cost of spacecraft guidance, control and information systems.

Entry Systems Technology.—The objective of the program is to perform and evaluate manned and unmanned experiments in flight that demonstrate or validate ground based entry research and technology to improve spacecraft design, operation, and reliability; to carry out studies to investigate spacecraft system feasibility and to provide direction and timely execution of supporting ground-based research and technology.

Experimental Programs

Experimental programs includes Space Technology Shuttle Payloads and will define and develop space facilities which enable researchers to utilize in an economical manner the capabilities provided by the Shuttle and Spacelab systems. These facilities will extend the capabilities of the ground-based research facilities, permitting research and technology investigations to be conducted in space where the unique attributes of vacuum, weightlessness, radiation, and/or location are essential. Experiments in specific discipline areas and which require shuttle capabilities are supported to establish the feasibility of the effort and to determine the technical and programmatic resources required for a subsequent flight program.

The Advanced Technology Laboratory, which utilizes the Spacelab to support technology experiments that require man interaction in space, is also being supported as is the Long Duration Exposure Facility, a low cost, free-flying, completely passive, reusable payload which will expose large numbers of experiments to the space environment.

Experiments which have been adequately defined as to technical scope and resource requirements are being supported for hardware development in preparation for an early Spacelab mission. The research module in which basic fluid physics and drop dynamics experiments will be conducted is one such effort. During FY 1976 the design packages for these experiments will be completed.

Low Cost Systems Program

The objectives of the Low Cost Systems Program are to prescribe approaches to reducing the overall costs of space systems by the standardization of components and systems and improvement of business and programmatic practices.

This program consists of two major elements. First, standard space equipment development which involves the use of standardized capabilities to reduce the costs of designing and developing unique equipment for different missions thereby realizing unit cost reductions from quantity production, improvement in reliability and quality assurance and the shortening of delivery schedules. The effort on standard equipment and components for spacecraft is concerned with the areas of power, auxiliary propulsion, stabilization, guidance and control, communications and data handling, and ground support equipment. The second element of this program is the study of business and program practices to identify opportunities for effecting cost savings in current and future projects. This addresses activities such as the acquisition process, contract execution, business data processing, the development and maintenance of a proved component inventory, lower cost methods of testing, and the investigation of other areas of support operations which influence the cost of development, production, assembly and test of spacecraft.

COMMITTEE COMMENT

The Committee believes that the amount requested for this program, $74,900,000, an increase of about $3.5 million over the FY 1975 budget plan, is adequate for these activities. The Committee further believes that there is sufficient flexibility provided to NASA to accommodate those areas identified by the House as needing additional effort, and accordingly, it does not concur with the House addition of $2 million to this program.

ENERGY TECHNOLOGY APPLICATIONS PROGRAM

FISCAL YEAR 1976 $5,900,000
TRANSITION PERIOD 1,500,000

OBJECTIVES

The objectives of the Energy Technology Applications Program, established as a separate, identifiable line item with this bill, are to apply NASA capabilities to assist in attaining national energy self-sufficiency. These are achieved by (1) providing support in advanced research, technology and development to other Federal agencies; (2) defining and, if appropriate, implementing programs in areas related to energy which require the broad application of aerospace systems technology and management techniques; (3) providing support to Federal, state and local government agencies in the application of aerospace technology; and (4) evaluating the potential of various elements of aerospace technology in a comprehensive energy matrix through the application of the techniques of systems analysis and analytical modeling.

Summary of resources requirements

	Fiscal year 1976	Transition period
Energy research and technology	$2,200,000	$550,000
Energy applications	3,000,000	750,000
Systems analysis	700,000	200,000
Total	5,900,000	1,500,000

BASIS OF FUND REQUIREMENTS

Energy Research and Technology

Energy Research and Technology is aimed at effective utilization of the existing NASA capabilities and experience in relation to the national energy research and development program being pursued by the agencies having primary energy program responsibilities. A part of the effort to relate experience to problems is accomplished by the direct NASA participation in the continuing energy research and development planning activity. The balance of this effort must be accomplished by direct support of both in-house and contractual efforts to refine, translate and adapt the wide range of aeronautics and space technologies to the appropriate energy program activities.

The process being developed to bring the technological strength of NASA to bear in support of the energy programs involves two discrete, but related, elements: technology identification and verification, and critical technology advancement. Technology identification and verification involves a continued search for technology existing in aeronautics and space disciplines which could solve energy problems as well as experimental verification of known aerospace technology to terrestrial energy problems. Critical technology advancement includes the definition of assumptions regarding technology levels which can be achieved in systems proposed for solving energy problems, as well as understanding the technology advancements required to achieve predicted levels of performance within specified time periods. In addition to using this general process to assure that competent NASA recommendations are made to ERDA and the other organizations directly authorized to fulfill the energy research and development program responsibilities, it is also being used to define comprehensive technology programs in specific areas directly related to the most relevant NASA experience and capabilities.

The funding for FY 1976 and the transition period will support identification and verification in areas that will include materials for high temperature energy conversion systems and thermal, mechanical and electro-chemical energy storage techniques; the analysis of critical technological aspects of systems design concepts and technical proposals and approaches to energy problems utilizing aerospace related technology; and completion of selected program definition efforts initiated during FY 1975 in the following technology areas: multipurpose gas turbine, terrestrial (commercial) fuel cells, advanced surface propulsion and hydrogen energy technology.

The hydrogen injection concept to achieve a higher efficiency, low pollution, internal combustion engine has been successfully demonstrated in an engine test stand. The next phase planned will be a demonstration of the engine and the on-board hydrogen generator in an automobile. To support this, a vehicle demonstration plan is being prepared for consideration by ERDA.

Energy Applications

During FY 1976 and the transition period investigations of potential advancements in methods of producing and conserving energy that can benefit from the integrated application of aerospace technology will be conducted including a study of the technical and economic feasibility of satellite solar power and satellite power relay systems, studies and research of systems and subsystems which are part of integrated utility systems, and studies of the focused application of remote sensing and rapid data handling techniques to energy resource assessment and environmental effects.

Funding for the satellite power systems program will be used to investigate the economic, environmental, and operational aspects of the space-based collection, conversion, and relay of solar energy concepts and continue to pursue technological areas pertinent to such concepts. Program definition studies will be undertaken to identify and prioritize the critical technologies that presently constrain the technological, operational, and economic assessment of satellite power concepts, to identify ongoing research and technology within NASA related to satellite power concepts, and to structure an orderly program leading to feasibility decisions regarding the concepts.

Support of the utility systems technology program will apply aerospace-derived technology, systems integration engineering, and management techniques to the analysis and design of community services of power, water, liquid and solid waste management. The program is oriented toward short term (pre-1985) energy and environmental conservation via integrated utility systems for residences and small communities. This program, conducted partly in cooperation with the Development of Housing and Urban Development at the Johnson Space Center modular integrated utility system (MIUS) integration and subsystem test (MIST) facility, will be dedicated to the development, integration and testing of waste water and solid treatment concepts, production of electrical and thermal energy from these waste products, low cost heating and cooling, energy storage devices, humidity control, and water quality monitoring.

In the area of resource assessment, funding will be focused on the applicability of rapid turn-around data handling as a means of increasing the efficiency of oil and gas exploration in frontier areas, such as the outer continental shelf. Remote sensing technology appears to require further development in most cases before becoming a large scale operational approach. However, in those areas where the technology appears to be sufficiently mature, chiefly in the area of hydroelectric power, studies will be instituted to determine the impact of a systems approach, including remote sensing, on the problem of managing the Nation's energy supply.

Systems Analysis

Systems studies and analysis covers the systematic identification and maintenance of existing energy project data bases in order to support the broad analyses involving clearly defined boundaries with respect to technical, economic, environmental, political and social assumptions. FY 1976 and transition period funding will be utilized to continue to build a data base of existing energy project information, to develop the capability to evaluate the interaction of individual energy systems with the total environment in which each system must develop and operate, and to continue the aim to make this information available prior to implementation of individual projects set forth in other portions of the energy program.

Tracking and Data Acquisition Program

Fiscal Year 1976	$240,800,000
Transition Period	66,400,000

OBJECTIVES

The purpose of this program is to provide the tracking and data acquisition support necessary to meet the requirements of all NASA flight projects. In addition to NASA flight projects, support is provided, as mutually agreed, for projects, of the Department of Defense, other Government agencies, and other countries and international organizations engaged in space activities.

Support is provided for manned and unmanned spacecraft flights, sounding rockets, and research aircraft.

Types of support provided include: (a) tracking to determine the position and trajectory of vehicles in space; (b) acquisition of scientific data from onboard experiments; (c) acquisition of engineering data on the performance of spacecraft and launch vehicle systems; (d) transmission of commands from ground stations to spacecraft; (e) communication with astronauts and acquisition of biomedical data on their physical condition; (f) communication of information between the various ground facilities and central control centers; and (g) processing of data acquired from the launch vehicles and spacecraft. Such support is essential for achieving the objectives of all flight missions, for executing the critical decisions which must be made to assure the success of these flight missions, and, in the case of manned space missions, to insure the safety of the astronauts.

Tracking and data acquisition support is provided by a world-wide network of NASA ground stations and an instrumentation ship, supplemented by appropriate instrumented aircraft. These facilities are interconnected by a network of ground communications lines, undersea cables, and communication satellite circuits which are leased from domestic and foreign carriers and which provide for the instantaneous transmission of data and critical commands between spacecraft and the control centers in the United States from which the flights are directed. Facilities also are provided to process into meaningful form the large amounts of scientific, applications and engineering data which are collected from flight projects. In addition, instrumentation facilities are provied for support of sounding rocket launchings and flight testing of aeronautical research aircraft.

The funds authorized to be appropriated by this bill will be used for: (a) the operation and maintenance of the worldwide facilities; (b) the engineering and procurement of equipment to sustain and modify the systems to support continuing, new, and changing flight project requirements; (c) the investigation of advanced tracking and data acquisition techniques; and (d) the development of advanced tracking and data acquisition instrumentation.

Summary of resources requirements

	Fiscal year 1976	Transition period
Operations	$191,400,000	$51,200,000
Systems implementation	41,400,000	12,900,000
Advanced systems	8,000,000	2,300,000
Tracking and data relay satellite system	0	0
Total	240,800,000	66,400,000

BASIS OF FUND REQUIREMENTS

Operations

	Fiscal year 1976	Transition period
Spaceflight tracking and data network	97,000,000	26,000,000
Deep space network	38,400,000	10,200,000
Aeronautics and sounding rocket support	4,100,000	1,100,000
Communications	27,900,000	7,000,000
Data processing	24,000,000	6,900,000
Total	191,400,000	51,200,000

The FY 1976 funding recommendation reflects a leveling off in the funding requirements for network operations. Savings associated with the closing of stations are being offset to some degree by significant cost escalation because of inflation in all areas, especially in the over-The primary function of the Spaceflight Tracking and Data Network and the Deep Space Network the support workload will remain relatively high with the Apollo Soyuz Test Project and Viking being the two new major increments in tracking and data acquisition support during FY 1976 and the transition period.

Spaceflight Tracking and Data Network (STDN) Operations.—The primary function of the Spaceflight Tracking and Data Network is to support manned and unmanned spaceflight missions. The majority of these missions have near earth orbits; however, the network does support missions through lunar distances. In addition, the network provides launch support to NASA's planetary missions as well as to the spaceflight missions of the Department of Defense, other U.S. agencies, other countries and international organizations.

This network must be responsive to the tracking and data acquisition requirements of a large variety of flight projects from the time of launch to the completion of flight project objectives. In many instances the period of support required by flight projects extends to several years.

STDN presently consists of sixteen geographically dispersed land stations (two less than last year), two transportable facilities, advanced instrumentation aircraft, one instrumented ship, and a control center complex at Goddard Space Flight Center. These facilities have the capability to track the spacecraft, send commands for spacecraft and experiment control purposes, receive engineering and scientific data from the spacecraft, and in the case of the astronauts maintain voice communications for safety and other project related purposes. In addition to the electronic systems, the Spaceflight Tracking and Data Network is supplemented by laser tracking systems to meet the extremely precise needs of NASA's geodetic investigations.

The sixteen land stations are located at Fairbanks, Alaska; Goldstone, California; Merritt Island, Florida; Kauai, Hawaii; Rosman, North Carolina; Guam; Ascension Island; Canberra, Australia; Bermuda; Canary Islands; Santiago, Chile; Quito, Ecuador; England; Madagascar; Johannesburg, South Africa; and Madrid, Spain. A transportable station located near St. John's, Newfoundland, for early Skylab support has been put in caretaker status and will be reactivated in FY 1975 for the Apollo–Soyuz Test Project. A second transportable facility has been relocated to Madrid to support Applications Technology Satellite No. 6.

The station at Corpus Christi, Texas, was closed after completion of Skylab in February 1974 and the station at Carnarvon, Australia, was closed in December 1974, after supporting the Helios 1 launch. The Canary Island station will close in mid-1975 and the station near Johannesburg, South Africa, will close in late 1975 after supporting the launch phase of Viking.

STDN is currently supporting on a continuing basis an average of approximately 40 unmanned scientific spacecraft including such missions as the first and second Earth Resources Technology Satellites (LANDSAT), several Applications Technology Satellites and Interplanetary Monitoring Platform satellites, Synchronous Meteorological Satellites 1 and 2, Orbiting Solar Observatory 5, Radio Astronomy Explorer 2, Atmosphere Explorer 3, and Nimbus 4 and 5. The network is also supporting the Apollo Lunar Surface Experiment Packages (ALSEP) left on the moon's surface by the Apollo 12, 14, 15, 16, and 17 missions. Upcoming missions to be supported include Nimbus F, Geodynamic Experimental Ocean Satellite (GEOS) C, Orbiting Solar Observatory (OSO) I, and the Apollo–Soyuz Test Project. In addition, Atmosphere Explorer D and Atmosphere Explorer E with widely differing orbits will require simultaneous support by the network for a six month period in FY 1976. The overall workload of the Spaceflight Tracking and Data Network is expected to continue to average approximately 40 spacecraft.

Funds required for the Spaceflight Tracking and Data Network operations in FY 1976 and the transition period will support the maintenance and operation of the network facilities as well as the related logistics, network support and computer programming costs associated with the around-the-clock operation of the network. The amount reflects the decreases associated with the station closures noted above.

Deep Space Network (DSN) Operations.—The primary function of the Deep Space Network is to support planetary and interplanetary space flight missions. The recently launched Helios 1 mission is on a trajectory that will take the spacecraft within forty-five million kilometers of the Sun. The Pioneer 11 flyby of Jupiter occurred December 2, 1974, and the spacecraft is scheduled to reach Saturn in the last half of 1979. Future missions to Saturn and beyond will involve distances measured in billions of kilometers.

As missions become more complex and flight distances continue to increase, equipment designs and computer program techniques are required in this network which continue to push the state-of-the-art in interplanetary communication. The Deep Space Network provides the vital two-way communication link to these distant spacecraft by which the spacecraft are controlled and scientific data are obtained.

The DSN stations are located in Goldstone, California; Canberra, Australia; and Madrid, Spain. The stations consist of one 64-meter and two 26-meter antennas at each location. The DSN station near Johannesburg, South Africa, was closed in June 1974. The checkout facility at Cape Canaveral, Florida, has been consolidated with the Spaceflight Tracking and Data Network station on Merritt Island, Florida.

During this funding period, the Deep Space Network support workload will consist of six ongoing Pioneer spacecraft, the Helios 1, Mariner 10, and the Viking 1975 A and B missions which will be launched in the first quarter of FY 1976. The Viking missions will be the most complex the DSN has ever supported. Helios B is also scheduled for launch during FY 1976 and will add to the ongoing network workload.

The DSN facilities are utilized also for ground-based measurements in support of experiments in the field of radio astronomy to learn more about such phenomena as Quasar energy sources and the possibility of dying massive stars generating black holes in space. Support of these experiments will continue on a noninterference basis to the flight missions in FY 1976 and the transition period.

The FY 1976 funds required for operation of the Deep Space Network facilities are greater than were required in FY 1975 due to cost escalation and the increasing workload associated with Viking and Helios. In addition to mission support, funds are required for the engineering activities that are necessary to implement new equipment and sustain the network to meet the requirements of the Mariner Jupiter/Saturn 1977 and the Pioneer Venus 1978 missions.

The funds for the transition period are needed to continue to operate the Deep Space Network during the period from July 1 through September 30, 1976.

Aeronautics and Sounding Rocket Support.—Instrumentation systems are maintained and operated in support of the sounding rocket, small satellite and aeronautical programs conducted by Wallops Flight Center and for the flight research programs of the Flight Research Center. These instrumentation systems include general purpose fixed tracking, telemetry, data handling, recording, timing, plotting, and communications systems as well as special purpose optical equipment.

The sounding rocket program will continue to be very active with approximately three hundred launches in FY 1976. These launches range from the smaller meteorological rockets to the larger Scout rockets. In addition to its continuing sounding rocket and aeronautical program support activities, Wallops will provide specialized tracking, evaluation and calibration services for the GEOS–C project.

The Flight Research Center operates the Aerodynamic Test Range, consisting of facilities at Edwards Air Force Base and the up-range site at Ely, Nevada. These facilities have precision radar tracking, telemetry, and communications equipment which are used to support high performance aircraft research and development programs of both NASA and the Air Force. Programs supported by the Aerodynamic Test Range include various aircraft and lifting body projects, including the F–111, F–104, X–24–B, and F–15. The Flight Research Center will also be responsible for supporting the approach and landing tests for the Shuttle Orbiter.

The funds requested for FY 1976 and for the transition period are required to continue the operational activities discussed above during these periods.

Communications Operations.—NASA's global communications network (NASCOM) interconnects the NASA tracking and data acquisition facilities to support all NASA projects and projects of other agencies that are supported by NASA. It interconnects by means of leased voice and data circuits such facilities as telemetry and command control sites, launch areas, test sites, and mission control centers. The major NASCOM control center is located at the Goddard Space Flight Center. In the interest of economy, reliability, and full utilization of trunk circuitry, subswitching centers have been established at both domestic and overseas locations.

To an increasing extent the NASA flight projects are requiring higher data transfer rates between the mission control centers and the tracking sites due to the need for real time control of spacecraft and the onboard experiments. In addition, requirements for wideband communications are increasing.

To meet the higher data transfer rates new communications technology has been implemented in the NASCOM such as electronic circuit switching and the capability for sending increased amounts of data over a normal voice circuit. Another development allows for the transmission of data over a lesser number of circuits through the use of digital techniques and specially modified voice channels. This capability will continue to be added to those NASCOM facilities which need this data handling capability.

While technology developments have reduced data transmission unit costs, some additional circuits are required to meet the increasing workload brought about by extended mission life-times and higher data rate transfer requirements of the new flight programs. It also is necessary to augment the normal network configuration to support special mission needs such as the Apollo-Soyuz Test Project, Helios, Viking 1975, and the Atmospheric Explorers D and E.

The funds for NASCOM Operations for FY 1976 are less than required for FY 1975 due to the closure of the Carnarvon, Australia, Canary Island and Johannesburg, South Africa, stations along with the continuing application of technology improvements. The funds for FY 1976 and the transition period will be used for the procurement of the communications circuits and services required to continue the operation and maintenance of NASCOM.

Data Processing Operations.—Tracking and telemetry data from the various spacecraft must be processed into a form useful to both those persons controlling the day-to-day spacecraft operations and those responsible for analyzing the scientific and applications data acquired by the spacecraft.

Tracking data are processed to provide orbital elements which are used to prepare the predictions of future spacecraft positions necessary for the real time control of spacecraft, for knowing when the spacecraft will be passing over the stations so data can be acquired, and to provide precise information that can be used by the scientific experimenters to determine where in the trajectory of the spacecraft for the scientific measurements were made. Telemetry data must be processed to: (a) separate the information obtained from various scientific experiments aboard the spacecraft, (b) consolidate information from each experiment, (c) determine spacecraft attitude, and (d) correlate these measurements with the position data mentioned above. Processed data are the primary product of the spacecraft missions, and it is through reductions and analyses of these data by the experimenters that a better understanding of earth and space is achieved.

Upcoming missions require extensive pre-mission orbit studies, including spacecraft position and attitude predictions. Studies are also required to work out operational methods and procedures to be used during the actual mission operations of these complex spacecraft.

The request for FY 1976 and the transition period is based upon the requirement to process data from previously launched satellites, plus additional satellites that are scheduled to be launched during the period. The scientific requirements for the acquisition and processing of data from the older satellites are under continuing review, and support is terminated or curtailed for older missions as mission objectives are achieved. These reductions make possible the support of some new spacecraft, without major increases in data processing capability. However, often new missions dictate major changes in the type of support provided. For instance, the Atmosphere Explorer 3 spacecraft, launched in December of 1973, has an orbit change capability which necessitates real time orbit and attitude determination. The low altitudes reached by this spacecraft also require the near real time analysis of experiment data. This mode of operation requires that data received at stations around the world be transmitted to the control center at Goddard Space Flight Center, fed directly into interconnected computers, processed, and placed in computer memory units,

then used in near real time as the basis for determining commands to be sent to the spacecraft for orbit adjustment and further experiment operation. Two additional spacecraft of this type will be launched in 1975, and simultaneous operation of two or more such spacecraft will be required during FY 1976.

The Image Data Processing Facility, established for the support of the first Earth Resources Technology Satellite (LANDSAT-1), will continue operation in support of the LANDSAT-2 spacecraft during FY 1976 and the transition period. This facility is expected to continue operations for several years, after that period, at approximately the same level of effort, to support a continuing Earth Resources program.

Systems Implementation

	Fiscal year 1976	Transition period
Spaceflight tracking and data network	$17, 400, 000	$5, 100, 000
Deep space network	14, 300, 000	5, 400, 000
Aeronautics and sounding rocket support	2, 700, 000	700, 000
Communications	3, 000, 000	800, 000
Data processing	4, 000, 000	900, 000
Total	41, 400, 000	12, 900, 000

The objectives of the Systems Implementation program are to maintain the existing ground support capabiltiy at a high level of proficiency and reliability to meet the needs of the many and varied missions, and to augment this capability, as necessary, to meet the special requirements of individual projects. These support systems consist of the NASA tracking and communications networks, control centers, data processing facilities and aeronautics and sounding rocket-instrumentation.

The Systems Instrumentation program encompasses the engineering design and procurement of the necessary equipment, subsystems and systems in response to the requirements of the various flight missions and other research projects. It includes related documentation and development of initial computer programs as applicable, the provisioning of initial and large module spares, and associated services such as acceptance testing, integration and checkout of subsystems and systems.

Funds are used to maintain operational performance and reliability of network systems by providing for the replacement of obsolete and worn-out equipment, the modification and augmentation of existing systems to maintain compatibility with changes in associated onboard spacecraft communications systems and the improvement of support utilization and efficiency of network systems.

Funds are required in FY 1976 and the transition period for the implementation of new capabilities including those necessary for network system augmentation for the Mariner Jupiter/Saturn 1977, Pioneer Venus, Shuttle, International Ultraviolet Explorer and High Energy Astronomy Observatory missions. In addition, funds are required for the modification and augmentation of the data processing facilities to provide increased accuracy and resolution in image processing for such missions as NIMBUS-G, SEASAT-A, and Heat Capacity Mapping Missions.

47-396 O - 75 - 7

Spaceflight Tracking and Data Network Systems Implementation.—The STDN systems implementation program encompasses the procurement of equipment, systems and services necessary to sustain the network's capability to provide reliable support to the ongoing scientific and applications satellite missions, to provide network capabilities to assure efficient and multipurpose tracking, command, and data acquisition support for all manned and unmanned earth orbital and synchronous missions, and to meet new support requirements for spacecraft to be launched in the near future.

FY 1975 funding was adjusted downward from the budget estimate because of the requirement to reduce the operating level for the agency to the appropriated amount and to provide funding for the Phase I contract effort ,for Tracking and Data Relay Satellite System. To accommodate these requirements it was necessary to stretch out procurement of the laser systems planned for support of LAGEOS and other elements of the Earth and Ocean Physics Applications Program. The impact of deferring the lasers is to delay the investigation of earth surface phenomena, thereby delaying the understanding of any correlation between earth surface motion and earthquakes.

During FY 1976 equipment modification is required to maintain the network's required high level of performance for support of its diverse and demanding workload and to assure the quality and reliability of the network's systems and subsystems. Accordingly, funds are requested for: (1) replacement of wornout systems with more reliable units; (2) equipment modifications to correct operational deficiencies; (3) equipment to be used in operational control of the network; (4) subsystems spares; (5) provision and modification of test equipment; and (6) equipment modifications related to changes in support requirements from one mission to the next.

Network system augmentations are planned to support the orbital flight test phase of the Space Shuttle program. Digital voice demodulation systems will be provided at core network stations for voice communications between the Space Shuttle and the mission control center. In addition, command, telemetry and voice communications equipment will be procured for installation at the Space Shuttle primary landing sites to support the terminal phase of each flight.

Funds are also required for: (1) implementation of the displays, consoles, and computer peripherals necessary to complete the control center for the International Ultraviolet Explorer; (2) control center modifications to the existing Orbiting Astronomy Observatory control center for the High Energy Astronomy Observatory which include console replacements, display and computer modifications, and additional communcations interface equipment; and (3) improvements and augmentation to laser tracking systems necessary to support LAEGOS satellite and other elements of the Earth and Ocean Physics Applications program.

Transition period funding is required to sustain the STDN and to continue the implementation of the additional capabilities to support the approved programs.

Deep Space Network Systems Implementation.—The Deep Space Network systems implementation program provides for the procurement of equipment and related services to sustain the network's capability to support the ongoing planetary spacecraft missions and to procure the necessary equipment required to support the planned launches of approved planetary flight missions.

Due to the extreme distances from earth at which planetary spacecraft operate, very large antennas and extremely sensitive and complex receiving and data handling equipment must be used at the ground stations to provide communications with the spacecraft. Consequently the network requires a continuing effort of replacement, modification and augmentation to maintain its high degree of reliability and operational integrity. State-of-the-art improvements, which are the key to achieving and maximizing the scientific return from these missions, will continue to be made.

To achieve the improved reliability required by the ongoing planetary missions, such as Pioneer 10, Pioneer 11 (now targeted to fly by Saturn in 1979) and Helios, network system modifications and equipment replacements will be necessary. These missions are characterized by time critical support demands on the network involving spacecraft attitude maneuvers, mid-course trajectory changes, and encounter sequences which dictate an extremely high level of system reliability that can only be achieved with a continuing program of module and component replacement and readily available spare modules and components. Therefore, FY 1976 funds are required for replacement hardware and spares so that the network systems can provide uninterrupted support to these extended ongoing missions and to incorporate changes necessary to maximize the scientific return of these missions.

Preparations for Viking support are underway and in FY 1976 the network will be supporting the cruise phase of the mission. Concurrently, final preparation of the DSN system will be completed to support the Mars Orbiter and Lander Phase of the mission. Viking will be the most complex mission ever supported by the network, therefore extremely high precision and performance levels must be met by the network.

In preparation for the dual Mariner missions to Jupiter and Saturn in 1977, long lead time development of prototype equipment has been initiated. Equipment changes include those needed to accommodate the increased command transmission data rate required by the spacecraft computer to update the many critical stored programs. These programs are used not only to control the numerous spacecraft functions but also to change the telemetry data rate and data content in accordance with variations in mission operations sequences.

Other equipment changes necessary in FY 1976 include those required to receive the new X-band (8400 megahertz) telemetry transmissions from the spacecraft and handle a new coded telemetry system capable of transferring the large quantities of vital scientific and engineering data with minimal error during the planetary flyby phases which will occur at distances beyond 1½ billion kilometers (9.5 A.U.) from earth.

In addition, to precisely control the spacecraft trajectory for close flyby of the planets and their selected satellites, increased ground system navigation capabilities are required. These will be provided by augmenting the tracking equipment with special recording, processing and timing systems to allow measurement of spacecraft position and velocity over the great distances involved from two widely spaced earth stations simultaneously. As part of a time-phased implementation program, it is planned to provide equipment to stations of the DNS which will be used for early prelaunch testing with the spacecraft and for launch and early cruise support. Accordingly, funds are required to initiate systems implementation for support of the early phase of the Mariner Jupiter/Saturn missions.

The transition period funding is required to sustain the network during that period for ongoing mission support and to continue upgrading the network for the Mariner Jupiter/Saturn mission.

Aeronautics and Sounding Rocket Support System Implementation.—The funds recommended for this project provide instrumentation support to the aeronautics and sounding rocket programs of Wallops Center; both fixed and mobile ground support equipments are used. To maintain these equipments, spare and replacement parts are required as well as some non-recoverable flight hardware such as onboard antennas and transponders. To meet specific test requirements, modifications and augmentations of selected telemetry, communications, tracking, command, and data handling systems are required. In addition, the mobile equipment must be periodically refurbished and modified to meet remote site requirements such as the ongoing meteorological program in cooperation with several foreign nations including Argentina, Brazil and Spain.

The ground aeronautical support systems at the Flight Research Center consist of stations at Edwards, California, and Ely, Nevada. High precision radar, telemetry, data handling, and associated timing, communications and command systems will be maintained and modified to meet the changing requirements of the approved flight projects.

The funds for FY 1976 and the transition period will provide for the equipment and modifications necessary to support the sounding rocket and aeronautics programs.

Communications Systems Implementation.—Funds recommended for communications systems will be used for the procurement of hardware for the NASA communications network to meet new program requirements, to increase the efficiency of the network and to sustain the network at a high level of reliability.

During FY 1976 and the transition period, modifications will be made to the existing systems as part of a continuing program to increase the amount of data that can be transmitted over existing circuits, and to provide the capability for transmitting bulk data over a specially modified voice circuit.

To maintain system reliability the procurement of replacement parts, spares, test and monitoring equipment will continue.

Data Processing Systems Implementation.—The FY 1976 and the transition period funds will be used to modify and augment the existing NASA image data processing facility at the Goddard Space Flight Center in order to meet the accuracy and resolution requirements of upcoming approved missions. Initially, this facility was established for the Earth Resources Technology Satellite (Landsat) missions and operated as an analog system doing most of data manipulation within the photographic process itself. The accuracy requirements for experiments on future spacecraft including Nimbus-G, Seasat-A, and

the Heat Capacity Mapping Mission are such that the data must be processed in digital form.

With the augmented system, data acquired by the network stations will be processed and corrected in digital form. This will improve the quality of the data by a factor of two to three over the present approach. The output of this process will be high density digital tapes. The augmented facility will be general purpose in nature, meeting the processing requirements of the above mentioned missions and possibly the extended phases of the Landsat 2 mission.

In addition, funds are required in FY 1976 and the transition period to maintain the existing scientific data processing systems. Typical of these activities are (1) modifications to the existing computer complex to facilitate interconnection with the many peripheral equipments associated with its operation including drums, displays and line printers; (2) the addition of power source monitors; and, (3) the purchase of routine and special spare components and hardware.

Advanced Systems

The Advanced Systems program, formerly called Supporting Research and Technology, includes studies and developments of tracking and data acquisition systems and techniques required (1) to provide new and improved network and data processing capabilities to meet the needs of approved missions and new starts; and (2) to improve the cost-effectiveness and reliability of the overall T&DA support for the total mix of NASA flight missions. This effort includes spacecraft and ground system trade-off studies aimed at optimizing space-to-ground telecommunications links.

The program for FY 1976 and the transition period is divided into four basic activities: (1) tracking, orbit determination and ground-based navigation; (2) spacecraft/ground communications, telemetry and command; (3) network control and operations technology; and (4) data handling and processing.

Studies and developments will proceed in the area of tracking and ground-based navigation for support of future planetary missions. New and improved tracking techniques, using simultaneous data from more than one station in a Very Long Baseline Interferometry (VLBI) mode, will be investigated.

Techniques also will be studied to determine spacecraft position against a background of extraterrestrial radio sources, such as quasars, to greatly reduce errors that now limit the accuracy achievable in spacecraft tracking. Time synchronization among network stations with atomic timing standards will continue to be investigated in order to meet the extremely accurate tracking requirements of future missions. Development effort will also continue on a general purpose approach to meet spacecraft attitude determination and control system requirements, in order to utilize common software and achieve greater efficiency in the data processing function than is now obtained with the present systems.

Future planetary missions will require data rates in excess of 100 kilobits per second from the vicinity of Jupiter, approximately 900 million kilometers away. Therefore, studies will continue on the influence of transmission media, such as the sun's corona, planetary atmospheres and space charged particles, on such deep space communications. Also, the improvement of the capabilities of the large aperture antennas will be further investigated using higher frequencies, developing techniques for arraying several antennas, studying dish-surface shaping, and by developing low radio noise elements coupled with receivers having improved sensitivities.

Future earth orbital missions require an order of magnitude improvement in the rate at which data must be acquired and handled, i.e., approximately 300 million bits per second for high resolution image data. Therefore, work will be done on ground antenna feed systems, telemetry receivers, and on network station techniques for handling high data rates. Network support analyses will be made to plan the support of future missions such as the Large Space Telescope and the Earth Observation Satellite.

Effort will continue on developing techniques for centralized control and monitoring of tracking and data acquisition support operations both at the stations and their respective network control centers. The objective is to obtain greater efficiency and effectiveness in the utilization of the overall network systems. Automated monitoring and control techniques will be examined and developed for those applications which are determined to be cost effective and necessary to meet real time operations requirements. The multiple use of minicomputers to monitor and control network functions and to improve logistical support and reduce manual operations in the network will continue to be pursued. Development and application of new techniques necessary to maintain low cost, reliable software will be continued.

Studies and development will continue on improved data handling and data processing systems and techniques to meet the increasing requirements for real time mission control and user-interactive information systems. Studies during this period will be concerned particularly with the problems of high rate, on-line data handling, storage, and retrieval, and also with techniques and systems for a fully digital approach to handling of imaging data from earth observation satellites.

Tracking and Data Relay Satellite System

Although no funds are requested for it, a major aspect of the Tracking and Data Acquisition Program in future years will be the proposed Tracking and Data Relay Satellite System (TDRSS).

The TDRSS will consist of two relay communications satellites and a ground terminal in the continental United States, and will serve to relay data, commands and voice to and from mission spacecraft and the ground control center. The two relay satellites will be positioned in geosynchronous orbit, one over the mid-Atlantic Ocean and the other over the mid-Pacific Ocean. A spare relay satellite will be positioned in orbit midway between the two active spacecraft.

The TDRSS will support essentially all earth orbital spacecraft missions and will greatly improve NASA's earth orbital tracking and data acquisition capabilities. Since the TDRSS will support essentially all earth orbital spacecraft missions, it will permit the elimination of 6 of the ground stations in the present Spaceflight Tracking and Data Network with resulting cost savings.

NASA is planning to acquire this capability through a contract-for-services arrangement: that is by entering into a contract under which the contractor will establish the system and provide NASA with service for a period of ten years. Under this arrangement, NASA funding for TDRSS services will not be required until service actually commences.

The schedule for development and construction of the TDRSS is based upon having a fully operational system by early 1980, in time for support of the Space Shuttle operational flights.

Since last year, NASA has decided to use a competitive two-phase procurement approach to acquire TDRSS service. Phase I will involve the award of multiple study contracts for system design and to provide technical and cost proposals for Phase II. Phase II will involve the competitive selection of a single contractor for final design, implementation and operation.

During FY 1975, $3.6 million was reprogrammed within T&DA to fund the Phase I contracts. While these funds are a part of the NASA deferral actions included in the President's Special Message on Budget Restraint (November 26, 1974), they will be available for the Phase I contracts in early FY 1976. No additional funding requirements are anticipated until FY 1979.

COMMITTEE COMMENT

The Committee recognizes the support nature of the tracking and data acquisition program, and that quick response and overall flawless program performance is essential to the conduct of successful space and aeronautical flight missions. Nevertheless, the Committee notes that this function is experiencing a reduction in manned space flight demands and will be approaching the transition period to the TDRSS system. The Committee also notes that deferrals ordered by the President result in limiting FY 1975 funding to $238 million. Accordingly, the Committee believes that NASA should seek economies in the program, and therefore, it agrees with the overall reduction of $2.2 million made in the request for this program by the House in its action on this bill.

TDRSS.—Section 6 of the bill would authorize NASA, when so provided in an appropriation act, to enter into a contract to lease tracking and data relay satellite services. The government would incur no costs under the contract prior to the time that such services were furnished except that the contract could provide for payment of contingent liability by the government which could accrue in the event the government decided for its convenience to terminate the contract before the end of the contract period.

The proposed Tracking and Data Relay Satellite System (TDRSS) is described above. By greatly increasing the percentage of time during which data can be received from and commands sent to most of NASA's earth orbiting satellites a TDRSS would enhance the productivity of such satellites. It also would substantially reduce space program operating costs since the TDRSS would permit closing many of the ground stations of the Space Flight Tracking and Data Network. Accordingly, the Committee has supported the concept, development and deployment of a TDRSS.

However, it has not been clear and it is not clear now to the Committee whether NASA should contract for the development and operation of a government-owned TDRSS or whether, as proposed, NASA should contract to lease the service from a privately-owned TDRSS.

In its report last year, the Committee recommended that NASA be authorized to proceed with a TDRSS in such a manner as to provide the Congress with an accurate assessment of the probable costs of a leased TDRSS service and a NASA-owned TDRSS. The Committee stated in its report that it had no objection to NASA leasing the TDRSS service provided that method of procuring the service was found to be the most advantageous to the government, cost and other factors considered. Specifically, the Committee requested that NASA (1) report to the Committee, prior to entering into a contract, on the projected cost of a lease arrangement as compared to the cost of an equivalent NASA-owned TDRSS service, and (2) expedite the TDRSS service procurement process so as to be able to report to the Committee on those costs during the consideration of the FY 1976 authorization request.

NASA was unable to comply with the Committee's request.

During the past year, the Committee has continued to express its views on this cost question in letters from the Chairman to the Administration; these letters are printed in the hearing record along with the Administration's responses on pages 328–332, Part 1 of the hearings.

The Committee believes that a Tracking and Data Relay Satellite System would be a major step forward for the NASA Tracking and Data Aquisition program; it believes that the TDRSS should be available to support the first manned orbital flight of the space shuttle; the Committee would have no objection to NASA leasing the service if the data show that that is the course most advantageous to the government when cost and other factors are considered.

NASA has testified that it is now planning to proceed during FY 1977 with the contract arrangement for leasing the TDRSS service. This will require that the Committee again review the NASA proposal for aquiring the TDRSS service during its consideration of the FY 1977 authorization bill. To do that it will be necesary for the Committee to have definitive cost estimates for obtaining the TDRSS service on a leased basis vs. from a NASA-owned system.

Technology Utilization Program

Fiscal Year 1976	$7,000,000
Transition Period	2,000,000

OBJECTIVES

The primary objectives of the Technology Utilization program are to increase the return on the national investment in aerospace research and development by encouraging additional uses of the knowledge gained in those programs; to shorten the time gap between the discovery of new knowledge and its effective widespread use; to aid the movement of new knowledge across industry, disciplinary, and geographical boundaries; and to contribute to the development of better means of transferring technology from its points of origin to its points of potential use.

Summary of resources requirements

	Fiscal year 1976	Transition period
Industrial applications	$3,220,000	$850,000
Technology applications	3,025,000	950,000
Program control and evaluation	755,000	200,000
Total	7,000,000	2,000,000

BASIS OF FUND REQUIREMENTS

This program supports the establishment and operation of systems and mechanisms, including an evaluation of program effectiveness, to identify, evaluate, publish, and transfer the technological innovations developed in the aeronautics and space programs to the general public.

Technology Utilization Officers at NASA installations identify new technology developed by NASA and its contractors which has potential utility for non-aerospace application and use. New advances identified in such diverse fields as materials research, communications, bioengineering, and fabrication/manufacturing technology, are evaluated and published in NASA Tech Briefs, Compilations, Handbooks, and other dissemination media. Special emphasis is being given to increased market relevance of the technology and improved distribution methods to broaden availability and use.

In FY 1976, it is planned to broaden the capability to transfer aerospace technology to meet technological needs in certain U.S. geographical areas which have heretofore been difficult to serve. Since the current six NASA Industrial Application Centers (IAC) (formerly known as Regional Dissemination Centers) are somewhat limited geographically due to travel cost constraints and operational considerations, it is proposed to institute an "outreach program" that will add a number of IAC Divisional offices to the existing IAC network to extend technology transfer efforts in a cost effective manner to highly industrialized urban areas. This is a major step in developing a national network of technology transfer centers to serve the technological needs of U.S. industry as well as State and local governments. These Divisional Offices in conjunction with parent Industrial Application Centers will provide an operable framework and structure to facilitate the use of established and proven transfer mechanisms for selected user groups located in strategic geographic areas.

In the technology applications effort seven NASA-sponsored Applications Teams are supported to assist in defining and solving problems through the adaptation of NASA technology. Public sector problems, identified in cooperation with user agencies, are matched with existing aerospace technology via the Application Teams, Industrial Application Centers, and NASA Field Centers. The matching process gives rise to specific applications projects designed to adapt, modify, or otherwise re-engineer existing NASA technology to meet performance requirements specified by Federal, state or local user organizations. Currently, over seventy active applications engineering projects are underway.

The major emphasis of the engineering projects has been placed in biomedical applications in the specific areas of detection, diagnosis and treatment, instrumentation, rehabilitation, and biomedical systems analysis and health planning. In fact, four of the seven Applications Teams specialize in the biomedical area. The areas of urban construction, fire safety, environmental pollution and transportation will continue to receive attention via the sponsorship of applications engineering projects. In response to identified needs in the public sector, projects concerned with mine safety and public safety were initiated during FY 1975 and it is expected that continued emphasis will be placed on these endeavors in FY 1976.

Evaluation activities will be continued to determine program effectiveness including studies to more precisely determine the impact and effect of such factors as time lag, technology characteristics and industrial structure on the transfer process. Documentation of instances of transfer will be constructed so as to augment and increase the public understanding of technology transfer activities. Other studies to analyze and document impacts and benefits of NASA research and development programs will be conducted assessing impacts on technology in current industrial practice as well as the implications of aerospace technology on increased national capabilities stated in terms of productivity and economic growth and change. These activities also will include development of exhibit materials, conference coordination, and development of material for use by the communications media.

COMMITTEE COMMENT

The Committee concurs with the NASA request of $7 million for this program, an increase of $1.5 million, or 27 percent, above FY 1975, in order to expand the mechanisms and the facilities for transferring technology developed in NASA programs to the public sector. The Committee believes, however, that such a large expansion in one year must be carefully initiated and controlled to assure success and avoid the pitfalls of too rapid growth. Accordingly, the Committee does not agree with the House action which added another $2 million to the already planned program expansion, resulting in a proposed 63 percent increase in one year.

In the expansion of the network of Industrial Applications Centers through the establishment of IAC Divisional offices, NASA should assure that the selected locations are in areas not now geographically or otherwise realistically accessible to an existing NASA facility, in order to maximize the total area served throughout the nation.

More specifically, in view of the numerous industrial areas of the nation that are relatively remote from any NASA Center or technology utilization dissemination center, no IAC facility should be located in an area coincident with the reasonable geographic service capability of an established NASA Center.

Transition Period

COMMITTEE COMMENT

The Committee noted that the amounts requested for each Research and Development program for the transition period to the next fiscal year, July 1, 1976 through September 30, 1976, exceeded the quarterly

equivalent requested for that program for FY 1976. While the Committee appreciates that the transition period is a one-time occurrence and that fund availability for contract renewals and other requirements may ordinarily be somewhat higher in the early part of a new fiscal year, the Committee also recognizes that it is recommending a permanent authorization even though it is only for a three-month period. Therefore, to accommodate these factors and in recognition of the aggressive program recommended on upper atmospheric research in the Physics and Astronomy program, the Committee has made a net reduction of $26 million in the total Research and Development request, from $730.6 million to $704.6 million. This represents a reduction from approximately 27% of the FY 1976 authorization to an amount more closely approaching a quarterly equivalent, with the addition of $4 million for the upper atmospheric research activity. This action parallels that taken by the House, a cut of $30 million, without additional funding for the upper atmospheric research effort.

As set forth in Section 7 of the bill, the Committee has adopted the individual program levels requested by NASA as authorization ceilings for the transition period, with the exception of the Advanced Missions line item. NASA is provided the flexibility to conduct its activities on any individual program up to the originally requested amount provided the total of all such program amounts does not exceed the reduced total of $704.6 million for Research and Development. The House also inserted the individual program ceiling amounts with the same flexibility in its action on the authorization bill, however, the House specified that the Aeronautics and Space Technology program cannot be reduced to support other programs. The Committee cannot concur with this action without further action to save harmless the many other high priority programs in this budget.

CONSTRUCTION OF FACILITIES

The Construction of Facilities authorization recommendation is for $93,630,000 of which $11,500,000 is for the transition period, July 1, 1976–September 30, 1976.

The fiscal year 1976 recommendation for $82,130,000 consists of 6 line items, the largest item being one with ten projects for the Space Shuttle program estimated to cost $47,220,000. Except for $9,275,000 in the line item for Facility Planning and Design activities, the recommended funds will support facilities projects that are characterized by the extent to which they represent the modification of, rehabilitation of, or additions to existing facilities as compared with the construction of new facilities thereby maximizing utilization of the investment in existing facilities to support changing NASA mission requirements.

No individual line item facility projects are scheduled for initiation during the transition period. The funding recommended for this period, $11,500,000, will support the ongoing type of facility activities, more specifically, smaller rehabilitation and modification projects, minor construction and/or additions to existing facility projects and facility planning and design work.

The table below identifies each facility item recommended, together with the estimated cost thereof, which is followed by a brief description of each project and the justification therefor.

Summary

FISCAL YEAR 1976

Item	*Amount*
1. Modification of 11- by 11-foot transonic wind tunnel, Ames Research Center	$2,695,000
[Addition to lunar sample curatorial facility, Lyndon B. Johnson Space Center	0]
2. Addition for composite model and metal finishing shops, Langley Research Center	1,940,000
3. Space shuttle facilities at various locations as follows:	
(a) Modifications to launch complex 39, John F. Kennedy Space Center	13,110,000
(b) Construction of Orbiter processing facility, John F. Kennedy Space Center	8,160,000
(c) Modifications for solid rocket booster processing facilities, John F. Kennedy Space Center	5,240,000
(d) Modifications for hypergolic checkout and refurbishment facilities, John F. Kennedy Space Center	6,940,000
(e) Modifications for launch equipment test facilities, John F. Kennedy Space Center	1,960,000
(f) Construction of Orbiter approach and landing test facilities, Flight Research Center, and Air Force Plant Number 42, Palmdale, California	1,680,000
(g) Construction of Shuttle/Carrier aircraft mating facilities, Flight Research Center, and Air Force Plant Number 42, Palmdale, California	3,890,000
(h) Modifications for crew training facilities, Lyndon B. Johnson Space Center	830,000
(i) Modification of the vibration and acoustic test facility, Lyndon B. Johnson Space Center	2,410,000
(j) Modifications for solid rocket booster component manufacturing and assembly facilities, undesignated location	3,000,000
4. Rehabilitation and modification of facilities at various locations, not in excess of $500,000 per project	16,000,000
5. Minor construction of new facilities and additions to existing facilities at various locations, not in excess of $250,000 per project	5,000,000
6. Facility planning and design not otherwise provided for	9,275,000
Total—fiscal year 1976	82,130,000

TRANSITION PERIOD

Item	*Amount*
1. Rehabilitation and modification of facilities at various locations, not in excess of $500,000 per project	$7,000,000
2. Minor construction of new facilities and additions to existing facilities at various locations, not in excess of $250,000 per project	2,000,000
3. Facility planning and design not otherwise provided for	2,500,000
Total	11,500,000

1. MODIFICATION OF 11- BY 11-FOOT TRANSONIC WIND TUNNEL, AMES RESEARCH CENTER, $2,695,000

This project involves (1) replacement, on a turn key basis using off-the-shelf modules where possible, of the present wind tunnel data acquisition system consisting of a flexible, high performance data gathering processor, a real time processor, and associated peripheral devices; (2) enlargement and rehabilitation of the existing wind tunnel control room to accommodate the new data system including construction of a new air-conditioned computer room equipped with a power conditioning system for the computer equipment and the installation of additional air-conditioning and electrical power for the control room equipment; and (3) the general rehabilitation of the wind tunnel building, Building N–227A, including elements such as restroom facilities, interior partitions, roof, and the repainting of interior and exterior walls. Equipment and construction costs are estimated at $2,270,000 and $425,000, respectively.

This project is designed to increase the operational efficiency of this transonic wind tunnel, a major element of the Ames "Unitary Wind Tunnel," by providing for increased data acquisition speed, improved data system accuracy, reduced test setup time, increased reliability, and decreased maintenance. This tunnel supports experimental investigations on advanced aircraft and missiles for the Department of Defense, on commercial transports for the aircraft industry on a reimbursable basis, and on a broad range of advanced aircraft and aerospace projects for NASA and other government agencies. Due to the workload this facility is normally operated 24 hours per day, 6 days per week. The existing static data acquisition system and strain gage signal conditioning equipment is essentially obsolete with some necessary repair parts no longer manufactured. Reliability is deteriorating and maintenance requirements are increasing thereby requiring more time to achieve test objectives. In addition, the existing dynamic data acquisition system does not provide on-line data reduction, a feature essential to more safe and efficient conduct of certain wind tunnel investigations. It is estimated that the increased operational efficiency to be provided by the proposed data system will permit relatively the same test loading as is now being conducted within a given year and in addition, will make available some added 600 occupancy hour capability. About 350 hours of the added capability is realized from increased data acquisition speed, about 200 hours would be achieved from reduced test setup times and improved monitoring and approximately 50 hours from decreased maintenance requirements. From a monetary standpoint the added available hours, if not used, could be translated into annual savings of about $600,000 of which $440,000 would be in electrical power costs. However, with a continued emphasis on aeronautics, especially in the transonic speed range, it is believed that the increasing demand for experimental investigations in NASA transonic facilities will make full use of the added capability.

ADDITION TO LUNAR SAMPLE CURATORIAL FACILITY, LYNDON B. JOHNSON SPACE CENTER, $0

This project provided for the construction of a 2-story, 15,000 sq. ft. addition to the existing Lunar Curatorial Facility, Building 31. The addition included a two-section, ultraclean and highly secure vault at the 40 foot level, one section of which would be for storage of pristine lunar samples and one for samples that had been investigated. Also, small sample processing laboratories for visiting scientists, an equipment elevator, support rooms, data storage, and a security alarm system would be provided. Utilities would be extended from the existing service for Building 31.

47-396 O - 75 - 8

COMMITTEE COMMENT

The Committee has been concerned about the adequacy of protection afforded to the lunar samples, acquired at a substantial cost to the Nation during the Apollo program. It has also reviewed the history of facilities provided for the lunar sample program, and it has weighed the present request for additional curatorial facilities against alternative approaches, program status, and budgetary requirements in general.

The Committee has some difficulty in accepting the fact that subsequent to the substantial investment in the Lunar Receiving Laboratory, Building 37, NASA is currently converting this building to support another function utilizing FY 1975 and anticipated FY 1976 funds. The question is immediately raised as to why provision for the lunar sample activity should not have a priority claim on existing facilities. This question has not been answered so as to persuade the Committee that the proper order of priorities has been established at this Center.

Against this background, the Committee is deleting this facility from the FY 1976 request. In so doing, it is recommending that NASA take such interim actions as necessary to assure that the lunar samples are appropriately protected, and study alternative measures to the facility expansion presented in the FY 1976 budget request.

NASA should report to the Committee on the interim measures and the study of alternatives in a timely fashion, and in no event later than October 15, 1975, indicating the actions it has taken and proposes to take.

2. ADDITION FOR COMPOSITE MODEL AND METAL FINISHING SHOPS, LANGLEY RESEARCH CENTER, $1,940,000

This project provides for the construction of a one-story L-shaped 36,000 sq. ft. building with a high bay ceiling encompassing a 30,000 sq. ft. composite model shop and a 6,000 sq. ft. metal finishing shop. The facility will house fabrication operations for constructing precise and complex research test models of wood, ceramics, fiberglass and advanced composite materials as well as provide for the chemical processing of metals. It will contain a lumber conditioning room, storage area, fiberglass spraying and grinding area, clean fabrication area, clean room and dust collection area, together with offices for about 12 personnel, restrooms, and all necessary utilities. Construction costs are estimated at $1,915,000 with the relocation of existing equipment estimated to cost $25,000.

This project, to provide shop space to support composite model development shop and metal finishing shop operations, will replace existing facilities built in 1940-41 which have deteriorated beyond economical rehabilitation and which are not sufficiently adaptable to meet current program requirements. The growth of aeronautical research activities over the years and the changes in the designs and materials used in the programs have increased the number and size of models and equipment to be produced or worked on in these shops. Therefore, in addition to the deteriorated conditions, the existing space largely improvised over the years is also functionally inadequate.

The addition recommended in this project will also permit consolidation of scattered shop operations into one shop complex at this Center thereby improving efficiency and workload coordination, as well as reducing safety hazards and improving the cleanliness and quality of the production of these shops.

3. SPACE SHUTTLE FACILITIES, $47,220,000

(*a*) *Modifications to Launch Complex 39, John F. Kennedy Space Center, $13,110,000.*—This project consists of two major elements. (1) Completion of the project initiated in fiscal year 1975 involving extensive modifications to two high bays in the Vertical Assembly Building (VAB), to one mobile launcher, and to Launch Pad A. The current project will support the required changes in the environmental control, pneumatic, and high pressure gas systems in the VAB, the environmental control, propellant, and pneumatic systems in the mobile launcher, and the environmental control, pneumatic, fuel, and high pressure gas systems on Pad A. (2) Modifications to the second floor and two firing rooms on the third floor of the existing Launch Control Center. The second floor will house the central launch processing computer system, the one firing room will directly support major integrated shuttle vehicle checkout and control, and individual shuttle vehicle ground support activities, and the second firing room will be used for controlling non-direct vehicle systems, including control of the facility systems at Launch Complex 39, the Orbiter Processing Facility, and the Solid Rocket Booster processing facilities. An area also will be provided for management control functions. The work consists of removing and/or modifying instrument racks including associated underfloor cables, wireways and receptacles, rearranging partitions, walls and doors, modifying raised floors for the instrument consoles and computer equipment, relocating and installing air-conditioning equipment and making extensive electrical service changes. Modifications to the emergency power system will also be made to support the consoles and air-conditioning system to insure uninterrupted operation during a power failure. The chilled water system will also be modified to provide adequate equipment cooling in the event of a power failure. The area adjacent to firing room number 1 will be modified to provide an electronically shielded communications security work room and equipment room for Department of Defense missions. This involves removal of doors and permanent closure of wall openings, installation of additional partitioning with electromagnetic shielding for the floors, walls, and ceiling of the rooms, and the installation of double entry shielded doors. In addition, the present fire detection and alarm systems will be expanded to include a fire extinguishing system in each area or room as it is modified. This system will provide total freon flooding of areas above ceilings, under raised floors and inside racks and consoles, thus permitting continuity of operations.

The first element of this project is a continuation and extension of the fiscal year 1975 project to modify two high bays in the existing VAB, one mobile launcher and Pad A to support integration of the shuttle elements—orbiter, external tank, and solid rocket boosters—on the mobile launcher in the VAB, the transport of the flight configuration to the launch pad and the actual launch operation. While the total work requirement was identified in fiscal year 1975, the full authorization was not granted inasmuch as it appeared that work progress would not require all the funding at that time. Accordingly, $10,300,000 of the amount recommended in this project is to complete the work originally outlined for these three facilities and to provide for the escalation in construction costs that has prevailed. The second element in this project, for which $2,810,000 is recommended, will provide funding to modify the Launch Control Center, originally built and configured for the Apollo program, to accommodate the Space Shuttle launch processing system. This system will accomplish the electronic checkout, monitoring and control functions during prelaunch operations, as well as launch control of the Shuttle system during countdown and through liftoff.

(*b*) *Construction of Orbiter Processing Facility, John F. Kennedy Space Center, $8,160,000.*—This project is a continuation and extension of the fiscal year 1975 Orbiter Processing Facility project which provided for the construction of a structure with a 29,100 sq. ft. high bay and a 25,000 sq. ft. low bay, and for site work and partial foundations for a second high bay. This project provides for construction of the 29,100 sq. ft. second high bay structure equipped with two 30-ton bridge cranes with a 70-foot hook height. The basic utility systems, including water, electrical power and lighting and a deluge fire protection system will also be provided. However, outfitting of the second high bay with a special air-conditioning, hydraulic and propellant systems, and the high pressure gas and fuel systems required to support program requirements are not included in this project. Construction and equipment costs in this project are estimated at $7,370,000 and $790,000, respectively. Outfitting of the second high bay is estimated to cost $5–$6 million and will be included in subsequent year budget requests.

The Orbiter Processing Facility will support orbiter safing, maintenance, and checkout operations following return from a space mission and during preparations for the next flight. The major operations include draining and purging of all fuel systems, removal of ordnance, removal of payloads brought back from space, inspection of the vehicle, repair and replacement of damaged components and refurbishment of the thermal protection system. The hypergolic modules that make up the reaction control system, the orbital maneuvering system and components of the auxiliary power unit are removed, serviced and checked out in a separate facility and then returned for reinstallation in the orbiter. After these operations are completed, the payloads for the next mission are inserted and the orbiter undergoes integrated system checkout before transfer to the Vertical Assembly Building for integration and checkout with the external tank and the booster. Shuttle program plans require the use of the two high bays in this facility interchangeably; however, certain operations, particularly the safing operations, are very hazardous. Others, such as thermal protection system refurbishment, are somewhat "dirty" and therefore incompatible with the clean environment required for the removal and insertion of payloads into the orbiter payload bay. The

facility is being designed to handle these complex tasks; however, in order to fully train personnel and to develop the detailed operational procedures required to do these functions safely and efficiently, it is necessary to have both high bays available during the development phase of the shuttle program.

When completed, the first bay is scheduled to receive the orbiter and carry out the normal safing, maintenance, and checkout operations as well as the payload inspection, insertion, and removal functions. In the event these operations are found to be significantly incompatible, particularly for the initial developmental missions, the second bay will provide the capability to separate these functions until a long term solution and/or vehicle maturity evolves. This approach will allow sufficient time to train personnel and develop procedures to permit each bay to carry out the total processing functions to support the more frequent flights projected for 1981 and beyond. The first high bay must be operationally ready by the third quarter 1978 to support the orbiter flight schedule. The second high bay must be operational in the second quarter of 1979 to support the first manned orbital flight and the shuttle developmental flights that follow. Accordingly, construction of the second high bay must start in 1975. Initiating that construction in this time frame will preclude the potential interference between the construction of the second high bay and operations in the first; it will allow for consistency and standardization of facility construction thereby optimizing the operation and it provides the most economical means of completing the facility. The outfitting of the second high bay can be accomplished on a non-interference basis, consistent with the schedule, with subsequent year funding.

(*c*) *Modifications for Solid Rocket Booster Processing Facilities, John F. Kennedy Space Center, $5,240,000.*—This project provides for the modification of three existing Air Force Titan III solid rocket motor (SRM) facilities at Cape Canaveral to receive, inspect, store and assemble space shuttle solid rocket booster (SRB) components before movement to the Vertical Assembly Building for stacking and integration with the external fuel tank and the orbiter. (1) Approximately 10,000 sq. feet of the 230-foot high bay area in the Solid Motor Assembly Building will be modified by removing the Titan III stands and providing four new work stands configured to assemble the forward and aft sections of the SRB. Each of the aft work stands will be equipped with four 5-ton hoists for subassembly operations. The existing 300-ton bridge crane in the high bay area will be modified to adapt it for SRB assembly functions by increasing the vertical travel capability from 20′ to 80′ and by adding a second 300-ton hoist, and hoist trolley. Appropriate extension of electrical and mechanical utilities services will also be accomplished. (2) Approximately 14,000 sq. feet of the 140-foot high bay support area in Solid Motor Assembly Building will be modified for the processing and assembly of smaller components such as nozzles, nose cones and parachutes and to provide a work area, tool crib and administrative and engineering space. Work in the support area involves construction of four subassembly workstands, strengthening of floors, modification of utility systems, installing a new compressed air system, extending the fire protection system, and the modifications to provide office space for the administrative and engineering functions. (3) Relatively minor modifications with a total estimated cost of $330,000 are required in the Missile, Inspection, and Storage Building and the Segment Arrival Storage Area to support subassembly and storage of the inert SRB components. (4) Approximately 8 miles of the existing road system will be repaired and upgraded, and 3,000 feet of new 24-foot wide roadway will be constructed to provide access between the Titan III facilities and the Vertical Assembly Building. Construction and equipment costs are estimated at $3,300,000 and $1,940,000, respectively.

Each SRB is composed of four solid rocket motor (SRM) segments, forward and aft skirts, a nose cone, a nozzle, a thrust vector control mechanism, separation motors, parachute recovery system, and attachment structure. These components will be manufactured in other geographic areas of the country and shipped to the Titan III facility. The Solid Motor Assembly Building will support two major assembly operations—first, the forward subassembly section including the nose cap, frustrum, parachute pack, forward thrust structure, forward skirt and forward SRM segment, all of which is about 57 feet long and weighs approximately 168 tons; second, the 179 ton aft subassembly section consisting of the aft skirt, thrust vector control mechanism, separation rockets, nozzle extension, aft attachment ring, the aft SRM segment, and the nozzle. The assembled sections will be moved by transporter over the road systems included in this project to the Vertical Assembly Building. The Missile Inspection and Storage Building and the Segment Arrival Storage Area will, in addition to inspection and storage functions, be used for minor assembly operations. In addition to supporting the space shuttle program, 6,000 square feet of the modified Solid Motor Assembly Building high bay area will continue to be used to support Air Force programs. The use of these existing facilities, with these modifications, is considered to be the most efficient and economical way of providing support facilities for SRB processing.

(*d*) *Modifications for Hypergolic Checkout and Refurbishment Facilities, John F. Kennedy Space Center, $6,940,000.*—This project involves modifying five existing buildings—M7–961, M7–1212, M7–1061, M7–1410, and M7–1412—in the fluid test complex to checkout, maintain, refurbish and store the hazardous hypergolic propellant pods used on the orbiter vehicle. The work in Building M7–961, for processing the Orbital Maneuvering System (OMS) and aft Reaction Control System (RCS) modules, and Building M7–1212, for processing the payload bay kit and the forward RCS module, includes refurbishing all interior and exterior surfaces, overhead cranes, and door seals; modifying and extending utility systems; removing existing piping and equipment; installation of a new hypergolic piping system and associated spill drains; and procurement and installation of compressed air, and high pressure gaseous nitrogen and helium systems. Building M7–1061, to accommodate and house launch processing system control consoles, self contained atmospheric protective ensemble support, and to support administrative and logistics functions, requires relocation of existing prototype shops to another facility; refurbishment of all interior and exterior surfaces and the erection of partitions; modification of utility systems; removal of existing piping and equipment; roof replacement; installation of a new fire protection system and installation of a pneumatic system.

The work in Buildings M7–1410 and M7–1412, scheduled to provide environmentally controlled storage for the payload bay kit, forward RCS, OMS, and aft RCS modules, includes rehabilitation of the utility systems, high bay roof, vertical sliding doors, and interior and exterior surfaces; replacement of the low bay roof; procurement and installation of a pneumatic system; modification of the plumbing, ventilating and air-conditioning systems; and upgrading of the lighting. This project will also provide service pads for hypergolic equipment, propellant disposal ponds, spill drains and associated gravity feed piping system, and a 222 sq. yd. concrete apron.

The orbiter OMS, RCS, auxiliary power unit systems and the payload bay kit use extremely hazardous hypergolic propellants and, therefore, special and remote facilities are required for their decontamination, maintenance, testing, and storage following a flight and prior to reuse. The hypergolic pods will be removed from the orbiter in the Orbiter Processing Facility after each flight, and transferred to these remote facilities for the sensitive test and refurbishment operations including functional integrity checks such as electrical continuity and leak checks for each module and for the system as a whole. In addition, these operations include decontamination of the modules, engine pressure and functional checks excluding firings, and verification and calibration of the OMS/RCS instrumentation and control systems. The modifications provided for in this project will convert existing facilities to provide the necessary facilities to accomplish these functions after which the various modules will be returned to the Orbiter Processing Facility for reinstallation on the orbiter vehicle.

COMMITTEE COMMENT

The Committee advocates full funding for a facility project in order to promote the maximum efficiency and economy during the facility acquisition process. Exceptions to this approach are recognized when good and sufficient reason exists to phase a project such as self-sustaining entities in a large total dollar, multi-year undertaking. Accordingly, the Committee recommends full FY 1976 funding of this project to provide Hypergolic Checkout and Refurbishment facilities for the shuttle at the Kennedy Space Center, and it does not concur with $637,000 deferral in this project made by the House.

(*e*) *Modifications for Launch Equipment Test Facilities, John F. Kennedy Space Center, $1,960,000.*—This project provides for modifications to the Supply. Shipping and Receiving Facility, Building M7–505, and the adjacent exterior area to provide the capability for testing and modifying critical launch support equipment such as umbilical-type launch accessories, holddown arms and swing arms. The work involves modifying a room for a data acquisition and control center for acquiring test data and for controlling the test operations and consists of the extension of electrical service, air-conditioning modifications, procurement and installation of cabling and the upgrading of existing lighting. The exterior area work involves construction of a pile foundation and erection of a 58-foot high test tower; installing four existing hydraulic pumps to operate motion simulators at the base of the tower; construction of heavy foundations for the solid rocket booster holddown arms, random motion and liftoff simulators and a pad for the tail service masts; and construction of a foundation and a structure to support development and testing of the orbiter emergency egress arm. Supporting instrumentation lines, gaseous nitrogen and hydraulic piping and electrical power service will also be provided to these facilities. Instrumentation and control equipment and steel for the test tower are available from existing inventory.

The orbiter crew access swing arm, the orbiter tail umbilical masts, the external tank gaseous-hydrogen vent umbilical, the orbiter environmental control and life support system umbilical, the solid rocket booster holddown arms and related ground support equipment must be developed, tested, and certified before installation in the launch complex to insure launch integrity and reliability, as well as reusability and maintainability throughout the span of the shuttle program. These launch accessories are subjected to stringent forces and loads before and during the launch and the equipment must operate flawlessly and precisely to insure a successful launch. Therefore, each swing arm and umbilical must be separately subjected to similar loadings in a test facility, and since the various accessories must swing, retract and/or fall away from the shuttle vehicle at an exact point in the countdown or at the precise moment of launch, these motions must be simulated for the individual items to certify that the equipment is capable of performing its exacting task. This facility is designed to provide the capability to carry out the structural testing and simulation tests involved.

(*f*) *Construction of Orbiter Approach and Landing Test Facilities, Flight Research Center and Air Force Plant Number 42, Palmdale, California, $1,680,000.*—This project provides for (1) the construction, at Edwards Air Force Base, of 4 air-conditioned buildings approximately 16′ x 20′ x 10′ high to house a microwave scanning beam landing system with two located at each end of the main runway, and each having an uninterruptible power supply system for the operation of equipment and associated utilities; (2) the construction, at Flight Research Center (FRC), of hazardous storage facilities consisting of two remotely located 120′ x 200′ concrete slabs with catch basin, sump pumps, fire protection systems, explosion-proof electrical systems for lights and power, and security fencing for the handling and storing of hazardous fuels and ground support equipment; and, (3) the construction, at Palmdale, California, of a 4,000 square foot masonry building to house acceptance checkout equipment, complete with raised flooring for computer installation, a suspended ceiling, a fire detection and protection system, a 100-ton air-conditioning system with associated cooling tower and two 50-ton chillers to handle the heat loads from the computer equipment, and with a supporting 1,000-KVA power substation. This part of this project also includes provision for a microwave transmission system to transmit data between this acceptance checkout equipment building at Palmdale and the FRC.

This project is a continuation and extension of the fiscal year 1975 project to provide orbiter horizontal flight test facilities. The microwave scanning beam landing system is required to provide the automatic landing capability for the unpowered orbiter during the flight test program which includes verifying the vehicle's stability and control, basic aerodynamics, and automatic landing system, and the development of checkout and flight procedures. This landing system is a vital and necessary system since there is no "go-around" capability for the orbiter as there is with a conventional aircraft. The orbiter will provide its own on-board electric and hydraulic power to operate the crew cabin systems and the vehicle's control surfaces from a hydrazine-fueled auxiliary power unit, hydrogen/oxygen fuel cells, and an ammonia coolant system. These hazardous materials require special handling and extra safety measures, and, therefore separate facilities are required to safely store and handle the hazardous fluids and associated ground support equipment. A computerized checkout and control capability is required to monitor, evaluate, and control preflight checkout of each orbiter subsystem—guidance and navigation, communication, power, hydraulic, and environmental control—to insure flight worthiness. Similar checkout operations will also be conducted after the orbiter lands and during the safing and post-flight testing that follow. These requirements will be met by modifying and installing Apollo program automatic checkout equipment in the facility provided by this project at Palmdale. The facility will be located at Palmdale to obtain mutual personnel support from the automatic checkout equipment used in orbiter final assembly and to permit equipment redundancy between the assembly equipment and the flight test equipment. The automatic checkpoint equipment will be connected to the FRC via a microwave transmission system.

COMMITTEE COMMENT

The Committee recommends full funding of this project for the reason stated in connection with the hypergolic facilities at the Kennedy Space Center. Accordingly, the Committee does not agree with the $300,000 deferral in this project made by the House.

(*g*) *Construction of Shuttle/Carrier Aircraft Mating Facilities, Flight Research Center and Air Force Plant Number 42, Palmdale, California, $3,890,000.*—This project is the second phase of the project initiated during fiscal year 1975 to provide shuttle orbiter/Boeing 747 carrier aircraft mating facilities at the NASA Flight Research Center, (FRC), and at the orbiter assembly plant at Palmdale, California. The project involves (1) construction of a 60-foot wide, 4,300-foot long concrete towway from the existing main runway and taxiway system at Edwards Air Force Base, to the site of the new mating facilities and the shuttle orbiter hangar located about 1200 feet north of the nearest occupied facility at the FRC in accordance with established safety criteria; (2) the construction of safing facilities consisting of a 7,000 sq. yd. concrete pad with associated trenches, utilities, fluid and gaseous piping systems, electrical power, hypergolic fuels catch basins, and an 11,000 gallon holding tank; (3) construction of the mating/demating facilities at the FRC and Palmdale, consisting of structural-steel, cantilevered crane type structures approximately 100 feet high with a hoisting device capable of lifting about 225,000 lbs.; and, (4) extension of existing electrical power, water, sewer and communications systems, including provision for a compressed air system, to the mating/demating facilities and the hangar.

The fiscal year 1975 project provided for the towway, the safing facilities and the utilities at the FRC, and for the long-lead procurement of steel, hoist, and other materials for the mating facilities at both the FRC and Palmdale. This fiscal year 1976 project provides for the completion of the mating/demating facilities at both locations and includes fabricating and erecting the steel structure and installing the hoist mechanism, movable platforms, elevators, and various piping systems to support the safing, deservicing, mating and demating operations at FRC, and includes site preparation, utilities installation, foundation work, erection of the steel structure, and installation of hoist mechanisms and movable platforms at Palmdale.

Following the decision to delete the removable air-breathing engines from the space shuttle orbiter vehicle, a piggyback arrangement with the orbiter mounted on a Boeing 747 aircraft was adopted for atmospheric flight testing and for transport of the non-powered orbiter vehicle. This arrangement requires facilities for mating/demating the orbiter with the Boeing 747 carrier aircraft for the orbiter flight test program at the FRC and for movement of the orbiter between assembly, recovery, and launch sites. The mating facility will be designed to permit disassembly and relocation by air of these structures for use at other sites in support of the shuttle program. Basic provision will also be made in this project to accommodate mating the shuttle external fuel tank to the carrier aircraft for transport should this capability be required in the future. This project will complete the mating/demating requirements at FRC and Palmdale. However, an additional requirement will exist for comparable facilities at the Kennedy Space Center launch site.

(*h*) *Modifications for Crew Training Facilities, Lyndon B. Johnson Space Center, $830,000.*—This project, a continuation of a fiscal year 1975 shuttle facilities project, provides for modifications to 15,200 sq. ft. in the Mission Simulation and Training Facility, Building 5, to house the shuttle mission simulator and its associated high and low altitude image generation systems. This work includes strenghening the floors for equipment foundations, changes to interior walls, extensive modification of the electrical power distribution system, procurement and installation of a 3,000-KVA substation with three transformers and associated switch gear, provision of approximately 4,000 sq. ft. of computer flooring, modification to the air-conditioning system, procurement and installation of a sprinkler system, provision of special lighting for the visual generation equipment, and removal of various items of equipment and structures.

The fiscal year 1975 project provided for the initial modifications to this facility to accommodate the orbiter aero-flight simulator, designed to provide crew training for orbiter approach and landing testing in the atmosphere, and the shuttle mission simulator computer, required to initiate software development for simulated flight missions. This project provides for those further modifications to the same facility required to support the shuttle mission simulator itself, which is the principal flight crew ground trainer for the shuttle program. This simulator will operate in conjunction with the Mission Control Center to train ground controllers and flight crews in the operation of all orbiter systems. It will simulate the shuttle flight in launch, ascent and abort modes, as well as during all orbital and recovery maneuvers. In addition, the crew and payload specialists will train in operating the payload manipulator used for capturing or releasing payloads during the mission.

(*i*) *Modification of Vibration and Acoustic Test Facility, Lyndon B. Johnson Space Center, $2,410,000.*—This project provides for modifying the acoustic reverberant chamber of the Vibration and Acoustic Test Facility, Building 49, to increase the sound generation capability within the chamber to approximately 169 dB. The work involves procurement and installation inside the chamber of 24 acoustic horns and 20 noise generators, replacement of the interior chamber walls with stronger walls below the 30-foot level, and installation of a compressed gaseous nitrogen system. The project also includes the erection of sound retarding rooms around noisy test equipment within the existing vibration laboratory in order to meet noise criteria applicable to the exposure of test personnel. Construction and equipment costs are estimated at $1,840,000 and $570,000, respectively.

This project is complementary to projects in the fiscal year 1973 and fiscal year 1975 facilities programs to upgrade the capability of this facility to support the space shuttle program. Those projects included a sonic fatigue test cell addition for fatigue testing on full scale sections of the orbiter, modifying the existing acoustic reverberant chamber to provide a 160 dB test capability for the orbiter fuselage sections, and rehabilitation of existing amplifiers to increase their efficiency and reliability. The most recent orbiter development data predicts a 164 to 165 dB exposure for the aft fuselage section, therefore an increased acoustic test capability, as provided in this project, is required to simulate the flight environment now anticipated for this section of the orbiter vehicle.

(*j*) *Modifications for Solid Rocket Booster Component Manufacturing and Assembly Facilities, Undesignated Location, $3,000,000.*—The solid rocket boosters (SRB) for the Space Shuttle consist of the solid rocket motors (SRM) and the booster components—aft and forward skirts, nose cone, external tank/SRB attachment structures and various brackets. The contractor has been selected and work is underway on the SRM; however, the selection process for the SRB components contract has not been completed. Since the shuttle schedule dictates the availability of this hardware in 1977, funds for the facilities are required in fiscal year 1976.

The proposed SRB components contract anticipates the use of existing facilities, either government-owned or privately-owned, whichever is most advantageous, modified as necessary to support SRB component manufacturing and assembly operations. In the absence of a specific facility selection this project description and the cost estimate are baselined on a potential facility that could accommodate the work requirements. The project would require the modification of approximately 190,000 sq. ft. of existing manufacturing and assembly space involving work such as constructing concrete foundations for tooling, relocating and extending utility systems, modifying the air-conditioning system, relocating and rerouting overhead cranes and railings, reinforcing cranes and structural trusses, making minor modifications to the plant, and rearranging and upgrading the overall lighting system. The project also anticipates the procurement and installation of additional collateral equipment, including a heat treat oven, a cleaning booth, pumps, and a paint spray booth to support the manufacturing operations. Construction and equipment costs are estimated at $2,700,000 and $300,000, respectively.

4. Rehabilitation and Modification of Facilities at Various Locations, Not in Excess of $500,000 Per Project

Fiscal Year 1976	$16,000,000
Transition Period	7,000,000

This Construction of Facilities line item provides a lump sum amount of $16,000,000 for 51 individual facility rehabilitation and modification projects at various NASA installations ranging in estimated cost from $100,000 to $495,000 each and for a group of small (under $100,000 each) miscellaneous unidentified projects. The latter group accounts for $1,540,000 of the total amount recommended for this line item. Approximately forty-seven percent of the recommended amount is for work on technical facilities, twenty percent for general purpose buildings, and sixteen percent for upgrading utility systems with the remainder scheduled for fire protection, building exterior and paving and drainage projects. While the budget documentation identifies the larger, individual projects recommended herein, the Committee recognizes that the priority of need for this type of work at the many NASA installations may change during the fiscal year and, therefore, understands that changes or substitutions in the projects may be necessary.

These facility rehabilitation and modification projects are part of a continuing program required to offset the accumulative effects of wear and deterioration on the NASA plant (with an estimated value of about $5.9 billion) to assure the availability and reliability of these facilities and their capabilities to support NASA functions, to improve the capabilities and the usefulness of existing facilities to accommodate new technologies and offset obsolescence, and to achieve more efficient energy utilization by updating utility systems and using elements thereby reducing energy demand. This work is of such a nature and magnitude that it cannot be accomplished by routine day-to-day facility maintenance, and it excludes major rehabilitation and modification projects estimated to cost more than $500,000 each which are presented as individual line items in this section of the bill. This line item also excludes new facility construction or additions to existing facilities which are provided for separately in the bill.

Transition Period—The funds for the transition period will support the initiation of several individual facility rehabilitation and modification projects at various NASA installations ranging in estimated cost from $100,000 to $490,000 each, and provide for a group of small miscellaneous unidentified projects under $100,000 each. These projects are of the same nature and are required for the same purposes as for those projects recommended for fiscal year 1976.

COMMITTEE COMMENT

The House cut the NASA request for the transition period $4,750,000, from $8,750,000 to $4,000,000. While the Committee is aware that

the transition period request significantly exceeded a quarterly equivalent of the FY 1976 request, it recognizes that the line item does not represent a "level of effort" type activity, but rather it consists of individual projects with accompanying justifications and cost estimates. Further, the Committee recognizes that there is a significant backlog of such projects requiring accomplishment, all of which have a bearing on the capability of the NASA plant to support its research and development programs. Based upon the foregoing, the Committee believes that some additional support above a direct quarterly equivalent is warranted for this line item and accordingly, it is recommending $7 million, a reduction of $1,750,000 in the NASA request.

5. Minor Construction of New Facilities and Additions to Existing Facilities at Various Locations, Not in Excess of $250,000 Per Project

Fiscal Year 1976	$5,000,000
Transition Period	2,000,000

This Construction of Facilities line item provides a lump sum amount of $5,000,000 for 24 individual minor construction and/or facility addition projects at the several NASA installations ranging in estimated cost from $50,000 to $245,000 each and for a group of small (under $50,000 each) miscellaneous unidentified projects. The latter represents $750,000 of the total amount recommended. These projects support construction of new freestanding structures or the expansion of existing facilities as opposed to the rehabilitation and modification of existing facilities, without the expansion thereof, as provided for in item 5 above. Projects of this nature estimated to cost more than $250,000 are recommended as individually authorized line items in the bill.

The projects for which this authorization is recommended are necessitated by changing technology and missions and by ongoing research, development, and test activities, and support therefor. Examples of these projects are construction of an underground control room at the Ames Research Center to support a static test facility used for aeronautical research, particularly V/STOL research, construction of a pre-engineered metal warehouse building for aircraft parts storage at the Flight Research Center, and installation of commercial power service to the Rosman, N. C. tracking and data acquisition station to provide a redundant power source to increase reliability and reduce operating costs. The Committee recognizes that flexibility in the use of these funds is necessary to accommodate changing needs during the year and, therefore, authorizes NASA to make changes to and/or substitutions for the specific work items set forth in the budget justification on a priority-of-need basis.

Transition Period—The funds for the transition period will support the initiation of several individual minor construction and/or facility addition projects ranging in estimated cost from $50,000 to $245,000 each and a group of small (under $50,000 each) miscellaneous unidentified projects. These projects are of the same nature, i.e., freestanding structures or expansion of existing facilities, and are required for the same purposes as for those projects recommended for fiscal year 1976.

COMMITTEE COMMENT

In its action on the bill, the House cut the NASA request for this item from $2,950,000 to $1,250,000, a reduction of $1,700,000. The transition period request for this line item as in the case of that for the rehabilitation and modification of facilities substantially exceeded a quarterly equivalent of the FY 1976 request. The Committee recognizes the individual project nature of this line item and for reasons stated previously, believes that there is justification for some additional funding during the transition period. Accordingly, the Committee is recommending $2 million for this line item, a reduction of $950,000 in the NASA request.

6. Facility Planning and Design

Fiscal Year 1976	$9,275,000
Transition Period	2,500,000

These funds will provide for two general categories of work. First, the regular, continuing, planning and design activities for facilities projects such as the conduct of studies and investigations, the preparation of preliminary engineering reports, cost estimates, and construction schedules for proposed projects, the preparation of final construction contract plans, specifications, schedules and cost estimates for approved projects, and the development and updating of master plans for field installations. Secondly, these funds will support facility planning and design activities for large, complex projects or specific programs which require longer range and more detailed engineering effort. Projects of this type to be supported in fiscal year 1976 are Space Shuttle facilities, and the initial facilities to support the Spacelab and Shuttle payload programs.

Transition Period—The work program for the transition period will be a continuation of that described for the full fiscal year 1976 in support of presently authorized and proposed facilities projects.

COMMITTEE COMMENT

Fiscal Year 1976—The House increased the budget request for this item by $4,500,000, from $9,275,000 to $13,775,000 to provide funds for design activities in support of the two aeronautical research facilities added to the Constuction of Facilities request. The Committee recommends approval of the original request, $9,275,000, in view of the fact that it has not included these aeronautical research facilities in the bill.

Transition Period—The Committee is recommending $2,500,000 for Facility Planning and Design for the transition period, a reduction of $300,000 in the NASA request. The House approved the full amount requested by NASA for this item, $2,800,000.

COMMITTEE COMMENT

Aeronautical Research Facilities.—The House added two aeronautical research facility projects, Section 1(b), (4) and (5) of the House

bill, totaling $40,000,000, to the FY 1976 Construction of Facilities request.

The first project, for $12,500,000, consists of the first phase of a three phase project to upgrade the 40′ x 80′ subsonic wind tunnel at the Ames Research Center with a total estimated cost ranging from $57.5 million to $72.5 million. This project was not requested by NASA in its presentation to the Office of Management and Budget or to the Congress.

The second project, for $27,500,000, involves the first phase of a two phase project to provide a new transonic research tunnel at the Langley Research Center with a total estimated cost ranging from $65 million to $70 million. This project also was not included in the NASA FY 1976 budget presentation.

Both of these facilities have been and still are an integral part of a joint Department of Defense-NASA study to provide the nation with the appropriate research capabilty to maintain its leadership in aeronautics. Testimony before the Committee indicates that initially DOD and NASA agreed on the need for separate transonic tunnels—the research tunnel to be provided by NASA and the development tunnel by the DOD. However, further study, partially dictated by rising costs for separate facilities and in part by technology developments in wind tunnel operation, has resulted in agreement that both capabilities can be achieved in one facility of a new design and that acquisition actions on the separate facilities should be discontinued.

The Committee fully understands the need for new and upgraded facilities to support future aeronautical research and development activities. However, in view of the developments on the transonic tunnel and the fact that neither facility was requested by NASA in FY 1976, the Committee does not concur with the action of the House in including these facility projects in the bill at this time.

RESEARCH AND PROGRAM MANAGEMENT

SUMMARY

Fiscal year 1976	Budget request	House action	Senate committee action
Personnel compensation	$543,566,000		
Personnel benefits	50,551,000		
Benefits for former personnel	178,000		
Travel and transportation of persons	17,001,000		
Transportation of things	3,754,000		
Rent, communications and utilities	51,604,000		
Printing and reproduction	4,211,000		
Other services	90,041,000		
Supplies and materials	11,733,000		
Equipment	2,469,000		
Lands and structures	475,000		
Grants, subsidies and contributions	50,000		
Insurance claims and indemnities	7,000		
Total	776,000,000	776,000,000	776,000,000
Transition period			
Total	213,800,000	213,800,000	213,800,000

The Research and Program Management appropriation includes funding for research in Government laboratories, management of programs, and other activities of the National Aeronautics and Space Administration. Principally, it is intended to (1) provide the civil service staff to conduct in-house research, and to plan, manage, and support the Research and Development programs, and (2) provide other elements of operational capability to the laboratories and facilities such as logistics support (travel and transportation, maintenance, and operation of facilities), and technical and administrative support.

Approximately three-fourths of the appropriation for fiscal year 1976, or $597,513,000, is required to pay the salaries and related personnel costs of NASA employees during the fiscal year. This amount will support 24,316 permanent positions, of which approximately 65 percent will be assigned to scientific, engineering and supporting technician personnel. During fiscal year 1975 NASA employment was reduced an additional 300 below the authorized total, for an overall reduction of 654. This was the ninth consecutive fiscal year in which NASA employment has been reduced with the cumulative effect of about a one-third reduction from its peak employment. In view of the foregoing, the slight increase in program activity in fiscal year 1976 and the fact that a small, but gradually increasing number of NASA technical personnel are being assigned, on a non-reimbursable basis, to assist in the solution of complex, technical problems of other agencies, no further reduction in the permanent work force is recommended for fiscal year 1976. While total employment has declined, total personnel costs have increased primarily due to the 5.5 percent federal pay raise in October 1974 which had an impact of $19,975,000 in fiscal year 1975 and a projected impact of $28,000,000 in fiscal 1976.

The remaining funding within this appropriation is, for convenience, grouped into the functional budget categories of travel, facilities services, technical services, and administrative support for which a total of $178,487,000 is recommended. These categories show an increase of approximately $5,000,000 above the current estimate for fiscal year 1975, fifty per cent of which is in the facilities services category. This increase reflects the large increase in electric power rates throughout the country, offsetting significant conservation efforts made by NASA, and the labor and material cost increases experienced in the support service contracts at the several NASA installations.

COMMITTEE COMMENT

The Committee noted that the request for Research and Program Management for the Transition Period was approximately $20 million higher than the direct quarterly equivalent of the amount recommended for the full fiscal year 1976. While this may appear to be a significant unbalancing of the budget requirements, the Committee also notes the fact that a large workmen's compensation payment is due in the transition quarter and that selected contracts for support services, limited to a one-year term, require renewal during this period. Accordingly, in view of these factors and to assure the availability of sufficient authorization while transitioning to the new fiscal year, the Committee is recommending adoption of the NASA request of $213,-800,000 for the transition period for this appropriations category.

COST AND BUDGET DATA

NASA's budget plan and request for authorization of appropriations for fiscal year 1976 is $3,539,000,000, and for the transition period to the new fiscal year, July 1, 1976 through September 30, 1976, is $958,900,000. This bill, H.R. 4700, as recommended by the Committee, authorizes appropriations to the National Aeronautics and Space Administration for fiscal year 1976 in the amount of $3,544,710,000 and for the transition period in the amount of $929,900,000. The amount for fiscal year 1976 is $5,710,000 more than the Administration's budget request and the amount for the transition period is $29,000,000 below the budget request. The differences are explained in this report.

While the requirements of Section 308(a) of the Congressional Budget and Impoundment Control Act of 1974 are not mandatory this year, estimates for the next five years of NASA budget (obligational) authority and outlays are provided for informational purposes without the benefit of inputs from the Congressional Budget Office. Further, since Section 403 of the Congressional Budget and Impoundment Control Act of 1974 has not been implemented, the Committee has received no data from the Congressional Budget Office pertaining to the amounts recommended in this bill and, therefore, is not including any comparison between this bill and such data.

[In billions of dollars]

	Budget authority		Outlays	
	NASA estimate	Committee estimate	NASA estimate	Committee estimate
Fiscal year:				
1976	3.539	3.545	3.498	3.503
Transition period	.959	.930	.905	.902
1977	3.625	3.658	3.600	3.620
1978	3.400	3.430	3.440	3.470
1979	3.010	3.030	3.110	3.134
1980	2.550	2.565	2.715	2.732

The above estimates are future year funding requirements for the continuation or completion of the NASA programs (including the development of the space shuttle) provided for in the bill. These estimates do not provide for the initiation of any new programs or projects after fiscal year 1977, contain no provision for the impact of future inflation, and do not provide for any administrative adjustments that may be required.

The Committee used the NASA estimate as a starting point to prepare its estimate. For fiscal year 1976, the Committee made selective reductions and increases in programs and projects with the net result of an increase of $5,710,000. The Committee future year estimates are higher than the NASA estimates primarily due to the acceleration of activity on the severe storm weather satellite and the advanced earth resources survey instrument, and to the Committee's recommendation that NASA aggressively pursue the upper atmospheric research program authorized in Section 8 of the bill. The Committee added $7 million to the fiscal year 1976 request to support the expansion of this

47-396 O - 75 - 9

latter activity and additional amounts will be required in subsequent years to support the program anticipated.

The estimates given in this report are not an estimate of what the NASA budget will be in future years. As existing programs and projects are phased out new programs and projects may be requested. The Congress will have an opportunity to exercise its judgment on these new programs and projects when authority and funds are requested to proceed with them. The Committee does expect, however, that the budgets for fiscal years 1979 and 1980 will approximate $3.4 billion, in current year dollars, based upon the concept of a constant level budget adopted by the Congress and the Executive Branch in 1972. This $3.4 billion concept through this decade has been outlined in detail in the Committee's presentation to the Senate Budget Committee in connection with the fiscal year 1976 concurrent resolution.

There are no funds authorized in this bill for financial assistance to State and local governments.

LEGISLATIVE CHANGES

The Committee considered four legislative amendments in its action on this NASA authorization bill.

Section 6 authorizes the National Aeronautics and Space Administration, when so provided in an appropriation act, to enter into a contract (or contracts) for tracking and data relay satellite services. The House, in its action on the fiscal year 1976 NASA authorization request, inserted a provision in Section 6 of its bill requiring that any such contract include a provision under which the government may acquire title, upon termination of the contract, to facilities, equipment, and spacecraft which were acquired in the performance of the contract under terms and conditions agreed upon in the contract. The Committee believed that this additional language unnecessarily restrained NASA's negotiation freedom in contracting for the service and that it is inconsistent with a dual purpose (NASA and commercial) satellite which might be proposed to provide the desired service. Accordingly, the Committee did not include an equivalent provision in Section 6.

Section 7 authorizes funds for the National Aeronautics and Space Administration for the transition period, July 1, 1976 through September 30, 1976, the purposes for which are discussed elsewhere in this report in conjunction with activities for fiscal year 1976. The bill, S. 573, specified total amounts only for the three appropriations categories—Research and Development, Construction of Facilities, and Research and Program Management. The Committee, in addition to reducing the amounts proposed for research and development and the construction of facilities, deleted the Advanced Missions program in R&D and inserted individual ceilings for the programs and activities funded under these two categories consistent with Section 1 of the bill pertaining to the authorization for fiscal year 1976. The House adopted a similar provision precluding however any reduction in the amount specified for the Aeronautical Research and Technology Program, and authorizing funds for the Advanced Missions program.

The Committee deleted Section 8 of S. 573 which would have authorized total amounts for each appropriations category for NASA for fiscal year 1977. Since separate legislative action will be undertaken on the fiscal year 1977 authorization request, no action is necessary at this time. There is no provision for fiscal year 1977 authorization in the House bill.

The Committee added a new Section 8 to the bill amending the National Aeronautics and Space Act of 1958, as amended, through the addition of a Title IV entitled, Upper Atmospheric Research, which would authorize and direct the National Aeronautics and Space Administration to develop and carry out a comprehensive program of research, technology and monitoring of the phenomena of the upper atmosphere. It is the view of the Committee that NASA is singularly equipped with the capabilities to initiate, coordinate and carry out the program necessary to acquire the data to provide the understanding for intelligent informed decisions on activities that may or may not have an adverse impact upon the upper atmosphere. The Committee believes that there is no coordinated and aggressive program now underway to provide the necessary data and it is the intent of this amendment to place responsibility for positive action on a significant national need for scientific data. It would not assign NASA any regulatory responsibility related to product usage and control. A hearing was held on this matter on January 29, 1975, and subsequently a bill addressing this need, S. 851, was introduced in the Senate on February 26, 1975, and referred to this Committee. This amendment incorporates the substance of S. 851. There is no equivalent provision in the House bill. (Additional background on this amendment appears under Committee Comment on the Physics and Astronomy Program.)

CHANGES IN EXISTING LAW

In compliance with subsection 4 of rule XXIX of the Standing Rules of the Senate changes in existing law made by the bill are shown as follows (existing law proposed to be omitted is enclosed in black brackets, new matter is printed in italic, existing law in which no change is proposed is shown in roman):

NATIONAL AERONAUTICS AND SPACE ACT OF 1958
Public Law 85–568 (72 Stat. 426)

* * * * * * *

TITLE IV—UPPER ATMOSPHERIC RESEARCH

PURPOSE AND POLICY

"*SEC. 401. (a) The purpose of this title is to authorize and direct the Administration to develop and carry out a comprehensive program of research, technology and monitoring of the phenomena of the upper atmosphere so as to provide for an understanding of and to maintain the chemical and physical integrity of the Earth's upper atmosphere.*

"*(b) The Congress declares that it is the policy of the United States to undertake an immediate and appropriate research, technology, and monitoring program that will provide for understanding the physics and chemistry of the Earth's upper atmosphere.*

"DEFINITIONS

"SEC. 402. For the purpose of this title the term 'upper atmosphere' means that portion of the Earth's sensible atmosphere above the troposphere.

"PROGRAM AUTHORIZED

"SEC. 403. (a) In order to carry out the purposes of this title the Administration in cooperation with other Federal agencies shall initiate and carry out a program of research, technology, monitoring and other appropriate activities directed to understanding the physics and chemistry of the upper atmosphere.

"(b) In carrying out the provisions of this title the Administration shall—

"(1) arrange for participation by the scientific and engineering community, of both the Nation's industrial organizations and institutions of higher education, in planning and carrying out appropriate research, in developing necessary technology and in making necessary observations and measurements;

"(2) provide, by way of grant, contract, scholarships or other arrangements, to the maximum extent practicable and consistent with other laws, for the widest practicable and appropriate participation of the scientific and engineering community in the program authorized by this title; and

"(3) make all results of the program authorized by this title available to the appropriate regulatory agencies and provide for the widest practicable dissemination of such results.

"INTERNATIONAL COOPERATION

"SEC. 404. In carrying out the provisions of this title, the Administration, subject to the direction of the President and after consultation with the Secretary of State, shall make every effort to enlist the support and cooperation of appropriate scientists and engineers of other countries and international organizations.

"REPORT

"SEC. 405. The Administration shall submit to the President, annually, for transmittal to the Congress, a report on the activities being carried out pursuant to this title, together with a description of accomplishments achieved in the implementation of this title."

TABULATION OF VOTES CAST IN COMMITTEE

Pursuant to Section 133(b) of the Legislative Reorganization Act of 1946 as amended, the following roll call vote is reported. During the Committee's mark-up of S. 573, a motion was made by the Senator from Arizona (Mr. Goldwater), and seconded by the Senator from Nevada (Mr. Laxalt), that the Committee adopt the amendments to S. 573 recommended by the Chairman; that the Committee amend H.R. 4700 by striking everything after the enacting clause and substitute therefor the amended Senate Bill, S. 573; and that the Committee report H.R. 4700 as amended to the Senate. The roll call vote on the motion was unanimous as follows:

YEAS—10

Mr. Moss—Chairman	Mr. Goldwater
Mr. Symington	Mr. Domenici
Mr. Stennis	Mr. Laxalt
Mr. Cannon	Mr. Garn
Mr. Ford	
Mr. Bumpers	

SPACE BUDGETS OF OTHER AGENCIES

(The following table, the source for which is the Office of Management and Budget, shows new obligational authority of all Government agencies:)

SPACE ACTIVITIES OF THE U.S. GOVERNMENT—HISTORICAL SUMMARY AND 1976 BUDGET RECOMMENDATIONS FEBRUARY 1975[1]

[In millions of dollars (may not add due to rounding)]

	NASA		Department of Defense	ERDA	Commerce	Interior	Agriculture	NSF	Total space
	Total	Space[2]							
1955	56.9	56.9	3.0						59.9
1956	72.7	72.7	30.3	7.0				7.3	117.3
1957	78.2	78.2	71.0	21.3				8.4	178.5
1958	117.3	117.3	205.6	21.3				3.3	347.9
1959	305.4	235.4	489.5	34.3					759.2
1960	523.6	461.5	560.9	43.3				.1	1,065.8
1961	964.0	926.0	813.9	67.7				.6	1,808.2
1962	1,824.9	1,796.8	1,298.2	147.8	50.7			1.3	3,294.8
1963	3,673.0	3,626.0	1,549.9	213.9	43.2			1.5	5,434.5
1964	5,099.7	5,046.3	1,599.3	210.0	2.8			3.0	6,861.4
1965	5,249.7	5,167.6	1,573.9	228.6	12.2			3.2	6,985.5
1966	5,174.9	5,094.5	1,688.8	186.8	26.5			3.2	6,999.8
1967	4,967.6	4,862.2	1,663.6	183.6	29.3			2.8	6,741.5
1968	4,588.8	4,452.5	1,921.8	145.1	28.1	0.2	0.5	3.2	6,551.4
1969	3,990.9	3,822.0	2,013.0	118.0	20.0	.2	.7	1.9	5,975.8
1970	3,745.8	3,547.0	1,678.4	102.8	8.0	1.1	.8	2.4	5,340.5
1971	3,311.2	3,101.3	1,512.3	94.8	27.4	1.9	.8	2.4	4,740.9
1972	3,306.6	3,071.0	1,407.0	55.2	31.3	5.8	1.6	2.8	4,574.7
1973	3,406.2	3,093.2	1,623.0	54.2	39.7	10.3	1.9	2.6	4,824.8
1974	[3] 3,036.9	2,758.5	1,766.0	41.7	60.2	9.0	3.1	1.8	4,640.3
Budget:									
1975 estimate	[3] 3,228.8	2,920.3	2,011.0	40.2	64.6	8.3	3.9	2.0	5,050.3
1976 estimate	[3] 3,536.6	3,222.4	2,191.0	43.8	73.7	8.3	5.8	2.4	5,547.4

[1] Historical amounts are estimates based on best data available.

[2] Excludes amounts for aircraft technology in 1959 and succeeding years. Amounts for NASA–NACA aircraft and space activities not separately identifiable prior to 1959.

[3] Adjusted for net offsetting receipts.

EXECUTIVE COMMUNICATIONS

The following documents constitute the departmental data received by the Committee with reference to the provisions of this bill.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION,
Washington, D.C., February 3, 1975.

Hon. NELSON A. ROCKEFELLER,
President of the Senate,
Washington, D.C.

DEAR MR. PRESIDENT: Submitted herewith is a draft of a bill, "To authorize appropriations to the National Aeronautics and Space Administration for research and development, construction of facilities, and research and program management, and for other purposes," together with the sectional analysis thereof. It is submitted to the President of the Senate pursuant to Rule VII of the standing rules of the Senate.

Section 4 of the Act of June 15, 1959, 73 Stat. 73 (42 U.S.C. 2460), provides that no appropriation may be made to the National Aeronautics and Space Administration unless previously authorized by legislation. It is a purpose of the enclosed bill to provide such requisite authorization in the amounts and for the purposes recommended by the President in the Budget of the United States Government for fiscal year 1976. For that fiscal year, the bill would authorize appropriations totaling $3,539,000,000 to be made to the National Aeronautics and Space Administration as follows:

(1) for "Research and development" amounts totaling $2,678,380,000;

(2) for "Construction of facilities" amounts totaling $84,620,000; and

(3) for "Research and program management," $776,000,000.

In addition, the bill would authorize appropriations totaling $958,900,000, to be available July 1, 1976, the beginning of the three-month transition period between fiscal year 1976 and fiscal year 1977, the latter of which will begin October 1, 1976, under the provisions of the Congressional Budget Act of 1974, 88 Stat. 297. The bill would also authorize appropriations totaling $3,625,000,000, to be available October 1, 1976, i.e., in fiscal year 1977.

The enclosed draft bill follows generally the format of the National Aeronautics and Space Administration Authorization Act, 1975 (Public Law 93–316). However, the bill differs in substance from the prior Act in several respects. First, subsections 1(a), 1(b), and 1(c), which would provide the authorization to appropriate for the three NASA appropriations, differ in the dollar amounts and the line items for which authorization to appropriate is requested.

Second, as authorized in subsection 1(g) of the prior Act, funds appropriated pursuant to subsections 1(a) and 1(c) may be used for facility projects involving minor construction and additions to existing facilities as well as facility rehabilitation and modification projects, with a per project limit of $10,000 and $25,000, respectively. In recognition of the increases in construction costs which have been experienced since these limits were initially established, the bill increases these amounts to $25,000 and $50,000, respectively, to maintain the operating flexibility that was originally intended.

Third, section 2 of the bill has been modified. In addition to authorizing an upward variation of 10 per centum in the amounts perscribed in the "Construction of facilities" line items, in the discretion of the Administrator or his designee, to meet unusual cost variations, section 2 would also authorize an upward variation of 25 per centum in such line items to meet such cost variations, but under this added authority the upward variations could not exceed 10 per centum unless NASA submits a report to the Committee on Science and Technology of the House of Representatives and the Committee on Aeronautical and Space Sciences of the Senate on the circumstances of such action. This authority has been necessitated by widening fluctuations in the costs of construction projects.

Fourth, section 6 of the prior Act, which amended the National Aeronautics and Space Act of 1958 and is, therefore, permanent law, has been omitted.

Fifth, section 6 of the bill would authorize NASA, when so provided in an appropriation Act, to enter into a contract for tracking and data relay satellite services. Such services will greatly improve our earth-orbital tracking and data acquisition capabilities and, at the same time, permit closing of most of the ground stations in our present worldwide tracking and data acquisition network now dedicated to spacecraft in near-earth orbit. Section 6 was enacted in a slightly modified form as section 7 of the National Aeronautics and Space Administration Authorization Act, 1975.

Sixth, as noted above, in addition to providing authorization of appropriations in the amounts recommended by the President in his Budget for fiscal year 1976, the bill also would provide authorization for appropriations to be available in the three-month period between fiscal years 1976 and 1977, and in fiscal year 1977. The additional authorization of appropriations for these fiscal periods would be provided in sections 7 and 8 of the bill. It is specified that all of the limitations and other provisions of the bill applicable to amounts appropriated pursuant to section 1 shall apply also to amounts appropriated pursuant to sections 7 and 8.

Finally, the last section of the draft bill, section 9, has been changed to provide that the bill, upon enactment, may be cited as the "National Aeronautics and Space Administration Authorization Act, 1976", rather "1975".

Where required by section 102(2)(C) of the National Environmental Policy Act of 1969 (42 U.S.C. 4332(2)(C)), environmental impact statements covering NASA installations and the programs to be funded pursuant to the bill have been furnished to the Committee on Aeronautical and Space Sciences.

The National Aeronautics and Space Administration recommends that the enclosed draft bill be enacted. The Office of Management and Budget has advised that such enactment would be in accord with the program of the President.

Sincerely,

JAMES C. FLETCHER,
Administrator.

Two enclosures.

A bill to authorize appropriations to the National Aeronautics and Space Administration for research and development, construction of facilities, and research and program management, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there is hereby authorized to be appropriated to the National Aeronautics and Space Administration:

(a) For "Research and development," for the following programs:

(1) Space Shuttle, $1,206,000,000;

(2) Space flight operations, $207,100,000;

(3) Advanced missions, $1,500,000;

(4) Physics and astronomy, $155,800,000;
(5) Lunar and planetary exploration, $259,900,000;
(6) Launch vehicle procurement, $166,900,000;
(7) Space applications, $175,030,000;
(8) Aeronautical research and technology, $175,350,000;
(9) Space and nuclear research and technology, $74,900,000;
(10) Energy technology applications, $5,900,000;
(11) Tracking and data acquisition, $243,000,000;
(12) Technology utilization, $7,000,000;

(b) For "Construction of facilities," including land acquisition, as follows:

(1) Modification of 11- by 11- foot transonic wind tunnel, Ames Research Center, $2,695,000;

(2) Addition to lunar sample curatorial facility, Lyndon B. Johnson Space Center, $2,490,000;

(3) Addition for composite model and metal finishing shops, Langley Research Center, $1,940,000;

(4) Space shuttle facilities at various locations as follows:

(A) Modifications to launch complex 39, John F. Kennedy Space Center, $13,110,000;

(B) Construction of Orbiter processing facility, John F. Kennedy Space Center, $8,160,000;

(C) Modifications for solid rocket booster processing facilities, John F. Kennedy Space Center, $5,240,000;

(D) Modifications for hypergolic checkout and refurbishment facilities, John F. Kennedy Space Center, $6,940,000;

(E) Modifications for launch equipment test facilities, John F. Kennedy Space Center, $1,960,000;

(F) Construction of Orbiter approach and landing test facilities, Flight Research Center, and Air Force Plant No. 42, Palmdale, California, $1,680,000;

(G) Construction of Shuttle/Carrier aircraft mating facilities, Flight Research Center, and Air Force Plant No. 42, Palmdale, California, $3,890,000;

(H) Modifications for crew training facilities, Lyndon B. Johnson Space Center, $830,000;

(I) Modification of the vibration and acoustic test facility, Lyndon B. Johnson Space Center, $2,410,000;

(J) Modifications for solid rocket booster component manufacturing and assembly facilities, (Location to be designated), $3,000,000;

(5) Rehabilitation and modification of facilities at various locations, not in excess of $500,000 per project, $16,000,000;

(6) Minor construction of new facilities and additions to existing facilities at various locations, not in excess of $250,000 per project, $5,000,000;

(7) Facility planning and design not otherwise provided for, $9,275,000.

(c) For "Research and program management," $776,000,000, and such additional or supplemental amounts as may be necessary for increases in salary, pay, retirement, or other employee benefits authorized by law.

(d) Notwithstanding the provisions of subsection 1(g), appropriations for "Research and development" may be used (1) for any items of a capital nature (other than acquisition of land) which may be required at locations other than installations of the Administration for the performance of research and development contracts, and (2) for grants to nonprofit institutions of higher education, or to nonprofit organizations whose primary purpose is the conduct of scientific research, for purchase or construction of additional research facilities; and title to such facilities shall be vested in the United States unless the Administrator determines that the national program of aeronautical and space activities will best be served by vesting title in any such grantee institution or organization. Each such grant shall be made under such conditions as the Administrator shall determine to be required to insure that the United States will receive therefrom benefit adequate to justify the making of that grant. None of the funds appropriated for "Research and development" pursuant to this Act may be used in accordance with this subsection for the construction of any major facility, the estimated cost of which, including collateral equipment, exceeds $250,000, unless the Administrator or his designee has notified the Speaker of the House of Representatives and the President of the Senate and the Committee on Science and Technology of the House of Representatives and the Committee on Aeronautical and Space Sciences of the Senate of the nature, location, and estimated cost of such facility.

(e) When so specified in an appropriation Act, (1) any amount appropriated for "Research and development" or for "Construction of facilities" may remain available without fiscal year limitation, and (2) maintenance and operation of facilities, and support services contracts may be entered into under the "Research and program management" appropriation for periods not in excess of twelve months beginning at any time during the fiscal year.

(f) Appropriations made pursuant to subsection 1(c) may be used, but not to exceed $35,000, for scientific consultations or extraordinary expenses upon the approval or authority of the Administrator and his determination shall be final and conclusive upon the accounting officers of the Government.

(g) Of the funds appropriated pursuant to subsections 1(a) and 1(c), not in excess of $25,000 for each project, including collateral equipment, may be used for construction of new facilities and additions to existing facilities, and not in excess of $50,000 for each project, including collateral equipment, may be used for rehabilitation or modification of facilities: *Provided*, That of the funds appropriated pursuant to subsection 1(a), not in excess of $250,000 for each project, including collateral equipment, may be used for any of the foregoing for unforeseen programmatic needs.

SEC. 2. Authorization is hereby granted whereby any of the amounts prescribed in paragraphs (1) through (6), inclusive, of subsection 1(b)—

(1) in the discretion of the Administrator or his designee, may be varied upward 10 per centum, or

(2) following a report by the Administrator or his designee to the Committee on Science and Technology of the House of Repre-

sentatives and the Committee on Aeronautical and Space Sciences of the Senate on the circumstances of such action, may be varied upward 25 per centum,

to meet unusual cost variations, but the total cost of all work authorized under such paragraphs shall not exceed the total of the amounts specified in such paragraphs.

SEC. 3. Not to exceed one-half of 1 per centum of the funds appropriated pursuant to subsection 1(a) hereof may be transferred to the "Construction of facilities" appropriation, and, when so transferred, together with $10,000,000 of the funds appropriated pursuant to subsection 1(b) hereof (other than funds appropriated pursuant to paragraph (7) of such subsection) shall be available for expenditure to construct, expand, or modify laboratories and other installations at any location (including locations specified in subsection 1(b)), if (1) the Administrator determines such action to be necessary because of changes in the national program of aeronautical and space activities or new scientific or engineering developments, and (2) he determines that deferral of such action until the enactment of the next Authorization Act would be inconsistent with the interest of the Nation in aeronautical and space activities. The funds so made available may be expended to acquire, construct, convert, rehabilitate, or install permanent or temporary public works, including land acquisition, site preparation, appurtenances, utilities, and equipment. No portion of such sums may be obligated for expenditure or expended to construct, expand, or modify laboratories and other installations unless (A) a period of thirty days has passed after the Administrator or his designee has transmitted to the Speaker of the House of Representatives and to the President of the Senate and to the Committee on Science and Technology of the House of Representatives and to the Committee on Aeronautical and Space Sciences of the Senate a written report containing a full and complete statement concerning (1) the nature of such construction, expansion or modification, (2) the cost thereof including the cost of any real estate action pertaining thereto, and (3) the reason why such construction, expansion, or modification is necessary in the national interest, or (B) each such committee before the expiration of such period has transmitted to the Administrator written notice to the effect that such committee has no objection to the proposed action.

SEC. 4. Notwithstanding any other provision of this Act—

(1) no amount appropriated pursuant to this Act may be used for any program deleted by the Congress from requests as originally made to either the House Committee on Science and Technology or the Senate Committee on Aeronautical and Space Sciences,

(2) no amounts appropriated pursuant to this Act may be used for any program in excess of the amount actually authorized for that particular program by sections 1(a) and 1(c), and

(3) no amount appropriated pursuant to this Act may be used for any program which has not been presented to or requested of either such committee,

unless (A) a period of thirty days has passed after the receipt by the Speaker of the House of Representatives and the President of the Senate and each such committee of notice given by the Administrator or his designee containing a full and complete statement of the action proposed to be taken and the facts and circumstances relied upon in support of such proposed action, or (B) each such committee before the expiration of such period has transmitted to the Administrator written notice to the effect that such committee has no objection to the proposed action.

SEC. 5. It is the sense of the Congress that it is in the national interest that consideration be given to geographical distribution of Federal research funds whenever feasible, and that the National Aeronautics and Space Administration should explore ways and means of distributing its research and development funds whenever feasible.

SEC. 6. The National Aeronautics and Space Administration is authorized, when so provided in an appropriation Act, to enter into a contract for tracking and data relay satellite services. Such services shall be furnished to the National Aeronautics and Space Administration in accordance with applicable authorization and appropriation Acts. The Government shall incur no costs under such contract prior to the furnishing of such services except that the contract may provide for the payment for contingent liability of the Government which may accrue in the event the Government should decide for its convenience to terminate the contract before the end of the period of the contract. Facilities which may be required in the performance of the contract may be constructed on Government-owned lands if there is included in the contract a provision under which the Government may acquire title to the facilities, under terms and conditions agreed upon in the contract, upon termination of the contract. The Administrator shall in January of each year report to the Committee on Science and Technology and the Committee on Appropriations of the House of Representatives and the Committee on Aeronautical and Space Sciences and the Committee on Appropriations of the Senate the projected aggregate contingent liability of the Government under termination provisions of any contract authorized in this section through the next fiscal year. The authority of the National Aeronautics and Space Administration to enter into and to maintain the contract authorized hereunder shall remain in effect as long as provision therefor is included in Acts authorizing appropriations to the National Aeronautics and Space Administration for subsequent fiscal years.

SEC. 7. In addition to the amounts authorized to be appropriated under Section 1 of this Act, there is hereby authorized to be appropriated to the National Aeronautics and Space Administration, to be available no earlier than July 1, 1976:

(a) For "Research and development," $730,600,000;

(b) For "Construction of facilities," $14,500,000;

(c) For "Research and program management," $213,800,000, and such additional or supplemental amounts as may be necessary for increases in salary, pay, retirement, or other employee benefits authorized by law.

All of the limitations and other provisions of this Act which are applicable to amounts appropriated pursuant to subsections (a), (b) and (c) of Section 1 of this Act shall apply also to amounts appropriated pursuant to subsections (a), (b) and (c), respectively, of this section.

SEC. 8. In addition to the amounts authorized to be appropriated under Sections 1 and 7 of this Act, there is hereby authorized to be appropriated to the National Aeronautics and Space Administration, to be available no earlier than October 1, 1976:

(a) For "Research and development," $2,702,900,000;

(b) For "Construction of facilities," $146,100,000;

(c) For "Research and program management," $776,000,000, and such additional or supplemental amounts as may be necessary for increases in salary, pay, retirement, or other employee benefits authorized by law.

All of the limitations and other provisions of this Act which are applicable to amounts appropriated pursuant to subsections (a), (b) and (c) of Section 1 of this Act shall apply also to amounts appropriated pursuant to subsections (a), (b) and (c), respectively, of this section.

SEC. 9. This Act may be cited as the "National Aeronautics and Space Administration Authorization Act, 1976".

SECTION-BY-SECTION ANALYSIS

Section 1. Subsections (*a*), (*b*), *and* (*c*) authorizes to be appropriated to the National Aeronautics and Space Administration funds, in the total amount of $3,544,710,000, as follows: (a) for "Research and development," a total of 11 program line items aggregating the sum of $2,686,580,000; (b) for "Construction of facilities," a total of 6 line items aggregating the sum of $82,130,000; and, (c) for "Research and program management," $776,000,000. Subsection (c) also authorizes to be appropriated such additional or supplemental amounts as may be necessary for increases in salary, pay, retirement, or other employee benefits authorized by law.

Subsection 1(d) authorizes the use of appropriations for "Research and development" without regard to the provisions of subsection 1(g) for: (1) items of a capital nature (other than the acquisition of land) required at locations other than NASA installations for the performance of research and development contracts; and (2) grants to nonprofit institutions of higher education, or to nonprofit organizations whose primary purpose is the conduct of scientific research, for purchase or construction of additional research facilities. Title to such facilities shall be vested in the United States unless the Administrator determines that the national program of aeronautical and space activities will best be served by vesting title in any such grantee institution or organization. Moreover, each such grant shall be made under such conditions as the Administrator shall find necessary to insure that the United States will receive benefit therefrom adequate to justify the making of that grant.

In either case no funds may be used for the construction of a facility in accordance with the subsection the estimated cost of which, including collateral equipment, exceeds $250,000, unless the Administrator notifies the Speaker of the House, the President of the Senate and the specified committees of the Congress of the nature, location, and estimated cost of such facility.

Subsection 1(e) provides that, when so specified in an appropriation Act, (1) any amount appropriated for "Research and development" or for "Construction of facilities" may remain available without fiscal year limitation, and (2) contracts for maintenance and operation of facilities and support services may be entered into under the "Research and program management" appropriation for periods not in excess of twelve months beginning at any time during the fiscal year.

Subsection 1(f) authorizes the use of not to exceed $35,000 of the "Research and program management" appropriation for scientific consultations or extraordinary expenses, including representation and official entertainment expenses, upon the authority of the Administrator, whose determination shall be final and conclusive.

Subsection 1(g) provides that of the funds appropriated for "Research and development" and "Research and program management," not in excess of $25,000 per project (including collateral equipment) may be used for construction of new, or additions to existing, facilities, and not in excess of $50,000 per project (including collateral equipment) may be used for rehabilitation or modification of existing facilities; however, of the funds appropriated for "Research and development," not in excess of $250,000 per project (including collateral equipment) may be used for construction of new facilities or additions to, or rehabilitation or modification of, existing facilities required for unforeseen programmatic needs.

Section 2. Section 2 authorizies upward variations of the sums authorized for the "Construction of facilities" line items (other than facility planning and design) of 10 per centum in the discretion of the Administrator or his designee, or 25 per centum following a report by the Administrator or his designee to the Committee on Science and Technology of the House of Representatives and the Committee on Aeronautical and Space Sciences of the Senate on the circumstances of such action, for the purpose of meeting unusual cost variations. However, the total cost of all work authorized under these line items may not exceed the total sum authorized for "Construction of facilities" under subsection 1(b), paragraphs (1) through (5).

Section 3 provides that not more than one-half of 1 per centum of the funds appropriated for "Research and development" may be transferred to the "Construction of facilities" appropriation and, when so transferred, together with $10,000,000 of the funds appropriated for "Construction of facilities," shall be available for the construction of facilities and land acquisition at any location if (1) the Administrator determines that such action is necessary because of changes in the space program or new scientific or engineering developments, and (2) that deferral of such action until the next authorization Act is enacted would be inconsistent with the interest of the Nation in aeronautical and space activities. However, no such funds may be obligated until 30 days have passed after the Administrator or his designee has transmitted to the Speaker of the House, the President of the Senate and the specified committees of Congress a written report containing a description of the project, its cost, and the reason why such project is necessary in the national interest, or each such committee before the expiration of such 30-day period has notified the Administrator that no objection to the proposed action will be made.

Section 4. Section 4 provides that, notwithstanding any other provision of this Act—

(1) no amount appropriated pursuant to this Act may be used for any program deleted by the Congress from requests as originally made to either the House Committee on Science and Technology or the Senate Committee on Aeronautical and Space Sciences;

(2) no amount appropriated pursuant to this Act may be used for any program in excess of the amount actually authorized for that particular program by subsections 1(a) and 1(c); and,

(3) no amount appropriated pursuant to this Act may be used for any program which has not been presented to or requested of either such committee,

unless (A) a period of 30 days has passed after the receipt by the Speaker of the House, the President of the Senate and each such committee of notice given by the Administrator or his designee containing a full and complete statement of the action proposed to be taken and the facts and circumstances relied upon in support of such proposed action, or (B) each such committee before the expiration of such period has transmitted to the Administrator written notice to the effect that such committee has no objection to the proposed action.

Section 5. Section 5 expresses the sense of the Congress that it is in the national interest that consideration be given to geographical distribution of Federal research funds whenever feasible and that the National Aeronautics and Space Administration should explore ways and means of distributing its research and development funds whenever feasible.

Section 6. Section 6 authorizes the National Aeronautics and Space Administration, when so provided in an appropriation Act, to enter into a contract (or contracts) for tracking and data relay satellite services. The Government would incur no costs under such contract prior to the furnishing of such services except that the contract could provide for the payment for contingent liability of the Government which may accrue in the event the Government should decide for its convenience to terminate the contract before the expiration of the contract period. Such tracking and data relay satellite services would be furnished to the Administration in accordance with applicable authorization and appropriation Acts. It is envisaged that facilities may be required to be provided under such a contract in order to provide such services. The bill would authorize the construction of such facilities on Government-owned land if there is included in the contract a provision under which the United States may, in accordance with terms and conditions agreed upon in the contract, acquire title to the facilities upon contract termination. In January of each year the Administrator would be required to report to the Committee on Science and Technology and the Committee on Appropriations of the House of Representatives and the Committee on Aeronautical and Space Sciences and the Committee on Appropriations of the Senate the projected aggregate contingent liability, through the next fiscal year, of the Government under termination provisions of any contract authorized under this section. It is specified that the authority of the National Aeronautics and Space Administration to enter into and maintain the contract (or contracts) authorized in this section shall remain in effect as long as provision therefor is included in acts authorizing appropriations to the National Aeronautics and Space Administration for subsequent fiscal years.

Section 7. Section 7 authorizes to be appropriated to the National Aeronautics and Space Administration funds, in addition to those amounts authorized under Section 1, necessary to cover the three-month transition period between the close of fiscal year 1976 on June 30, 1976, and the beginning of fiscal year 1977 on October 1, 1976. The appropriations so authorized are in the total amount of $929,900,000 as follows: (a) for "Research and development," $704,600,000 (b) for "Construction of facilities," $11,500,000 and, (c) for "Research and program management," $213,800,000. Such amounts become available no earlier than July 1, 1976. Subsection (c) also authorizes to be appropriated such additional or supplemental amounts as may be necessary for increases in salary, pay, retirement, or other employee benefits authorized by law. All of the limitations and other provisions of the Act applicable to amounts appropriated pursuant to subsections (a), (b) and (c) of Section 1 also apply to amounts appropriated pursuant to subsections (a), (b) and (c), respectively, of this section.

Section 8. Section 8 amends the National Aeronautics and Space Act of 1958, as amended, by the addition of a title IV, Upper Atmospheric Research. This title authorizes and directs the National Aeronautics and Space Administration to develop and carry out a comprehensive program of research, technology and monitoring of the phenomena of the upper atmosphere so as to provide for an understanding of and to maintain the chemical and physical integrity of the earth's upper atmosphere. In carrying out the program authorized by this title the National Aeronautics and Space Administration shall (a) arrange for participation by the scientific and engineering community of both industrial organizations and institutions of higher education, (b) provide, by way of grant, contract, scholarship or other arrangements for the widest practicable and appropriate participation by the scientific and engineering community, and (c) make all results of the program available to appropriate regulatory agencies and provide for the widest possible dissemination of results. Title IV requires the National Aeronautics and Space Administration, subject to the direction of the President and after consultation with the Secretary of State, to make every effort to enlist the support and cooperation of appropriate scientists and engineers of other countries and international organizations. Finally, the title requires the National Aeronautics and Space Administration to submit to the President, for transmittal to the Congress, an annual report on the activities being carried out together with a description of accomplishments achieved in the implementation of the title.

Section 9. Section 9 provides that the Act may be cited as the "National Aeronautics and Space Administration Authorization Act, 1976".

○

94TH CONGRESS } HOUSE OF REPRESENTATIVES { REPORT
1st Session } { No. 94-63

AUTHORIZING APPROPRIATIONS TO THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MARCH 14, 1974.—Committed to the Committee of the Whole House on the State of the Union and ordered to be printed

Mr. TEAGUE, from the Committee on Science and Technology, submitted the following

REPORT

[To accompany H.R. 4700]

The Committee on Science and Astronautics, to whom was referred the bill (H.R. 4700) to authorize appropriations to the National Aeronautics and Space Administration for research and development, construction of facilities, and research and program management, and for other purposes, having considered the same, report favorably thereon without amendment and recommend that the bill do pass.

PURPOSE OF THE BILL

The purpose of the bill is to authorize appropriations to the National Aeronautics and Space Administration for fiscal year 1976, and transition period, as follows:

Programs	Authorization		Page Nos.
	Fiscal year 1976	Transition period	
Research and development	$2,684,180,000	$700,600,000	19, 171
Construction of facilities	125,693,000	8,050,000	137, 171
Research and program management	776,000,000	213,800,000	167, 171
Total	3,585,873,000	922,450,000	

This lengthy publication was not digitized. Please contact the Gerald R. Ford Presidential Library or the government documents department of a local library to obtain a copy of this item.