National Aeronautics and Space Administration

BUDGET ESTIMATES

FISCAL YEAR 1976

Volume I

AGENCY SUMMARY

RESEARCH AND DEVELOPMENT

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1976 ESTIMATES

AGENCY SUMMARY AND RESEARCH AND DEVELOPMENT

TABLE OF CONTENTS

VOLUME I

AGENCY SUMMARY

	Page No.
General statement	AS 1
Budget summary	AS 2
Program highlights	AS 3
Summary of appropriations	AS 10
Summary reconciliation of appropriations to budget plan	AS 11
Distribution of budget plan by installation	AS 13
Summary of perminent positions by installation	AS 14
Organization chart	AS 15

RESEARCH AND DEVELOPMENT

General statement	SUM 1
Appropriation language (proposed)	SUM 8
Program and financing schedule	SUM 9
Research and development programs	SUM 11
Fiscal Year 1975 budget authority deferred	SUM 12
Distribution of research and development budget plan by installation and fiscal year	SUM 14

Page No.

Justification by program:

MANNED SPACE FLIGHT PROGRAMS

Budget plan..... MSF 1

SPACE SHUTTLE..... RD 1-1

SPACE FLIGHT OPERATIONS..... RD 2-1

ADVANCED MISSIONS..... RD 3-1

SPACE SCIENCE PROGRAMS

Budget plan..... SS 1

PHYSICS AND ASTRONOMY..... RD 4-1

LUNAR AND PLANETARY EXPLORATION..... RD 5-1

LAUNCH VEHICLE PROCUREMENT..... RD 6-1

APPLICATIONS PROGRAM

SPACE APPLICATIONS..... RD 7-1

AERONAUTICS AND SPACE TECHNOLOGY PROGRAMS

Budget plan..... AST 1

AERONAUTICAL RESEARCH AND TECHNOLOGY..... RD 8-1

SPACE AND NUCLEAR RESEARCH AND TECHNOLOGY..... RD 9-1

ENERGY TECHNOLOGY APPLICATIONS PROGRAM..... RD 10-1

TRACKING AND DATA ACQUISITION PROGRAM..... RD 11-1

TECHNOLOGY UTILIZATION PROGRAM..... RD 12-1

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1976 ESTIMATES

GENERAL STATEMENT

The National Aeronautics and Space Administration, established October 1, 1958, conducts space and aeronautical activities for peaceful purposes for the benefit of all mankind. In maintaining United States leadership in research, technology, and utilization in these fields, NASA's program:

--extend our knowledge of the Earth, its environment, the solar system, and the universe;

--expand practical applications of space technology;

--develop, operate, and improve manned and unmanned space vehicles;

--improve the civil and military usefulness of aeronautical vehicles, while minimizing their environmental effects and energy consumption.

--disseminate pertinent findings to potential users; and

--promote international cooperation in peaceful activities in space.

The industrial community, under contracts with NASA, will continue to carry forward the prime design, development, and fabrication effort of the major hardware elements involved in the NASA programs. Other elements of the programs will be pursued within NASA installations, other government agencies, universities, and research contractors.

Appropriations totaling $3,539,000,000 are requested for FY 1976 and $958,900,000 for the transition period to support the program described in these justifications.

BUDGET PLAN SUMMARY

	(Thousands of Dollars)			
	FY 1974	FY 1975	FY 1976	Transition Period
Obligational Authority				
Research and development...	$2,310,882	$2,323,315	$2,678,390	$730,600
Construction of facilities.	101,100	142,655	84,620	14,500
Research and program management.....	743,968	765,175	776,000	213,800
TOTAL, BUDGET PLAN.....	$3,155,950	$3,231,145	$3,539,000	$958,900
TOTAL, OUTLAYS.....	$3,256,216	$3,207,200	$3,498,000	$905,200

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

BUDGET SUMMARY
(Thousands of Dollars)

Research and Development	Budget Plan FY 1974	FY 1975	FY 1976	Transition Period
MANNED SPACE FLIGHT.....	999,900	1,110,300	1,414,600	376,600
Space shuttle.....	475,000	797,500	1,206,000	321,000
Space flight operations.....	523,400	311,300	207,100	55,100
Advanced missions.....	1,500	1,500	1,500	500
SPACE SCIENCE.....	664,482	542,815	582,600	160,300
Physics and astronomy.....	94,000	136,315	155,800	46,600
Lunar and planetary exploration.....	392,482	266,000	259,900	73,300
Launch vehicle procurement.....	178,000	140,500	166,900	40,400
APPLICATIONS.....	159,000	174,500	175,030	54,700
Space applications.....	159,000	174,500	175,030	54,700
AERONAUTICS AND SPACE TECHNOLOGY.....	234,307	237,765	250,250	69,100
Aeronautical research and technology.....	168,000	166,400	175,350	46,800
Space and nuclear research and technology.....	66,307	71,365	74,900	22,300
ENERGY PROGRAMS.....	4,693	4,435	5,900	1,500
Energy technology applications	4,693	4,435	5,900	1,500
TRACKING AND DATA ACQUISITION.....	244,000	248,000	243,000	66,400
TECHNOLOGY UTILIZATION.....	4,500	5,500	7,000	2,000
TOTAL RESEARCH AND DEVELOPMENT.....	2,310,882	2,323,315	2,678,380	730,600
Construction of Facilities....	101,100	142,655	84,620	14,500
Research and Program Management.....	743,968	765,175	776,000	213,800
TOTAL.....	3,155,950	3,231,145	3,539,000	958,900
TOTAL OUTLAYS.....	3,256,216	3,207,200	3,498,000	905,200

National Aeronautics and Space Administration

MANNED SPACE FLIGHT

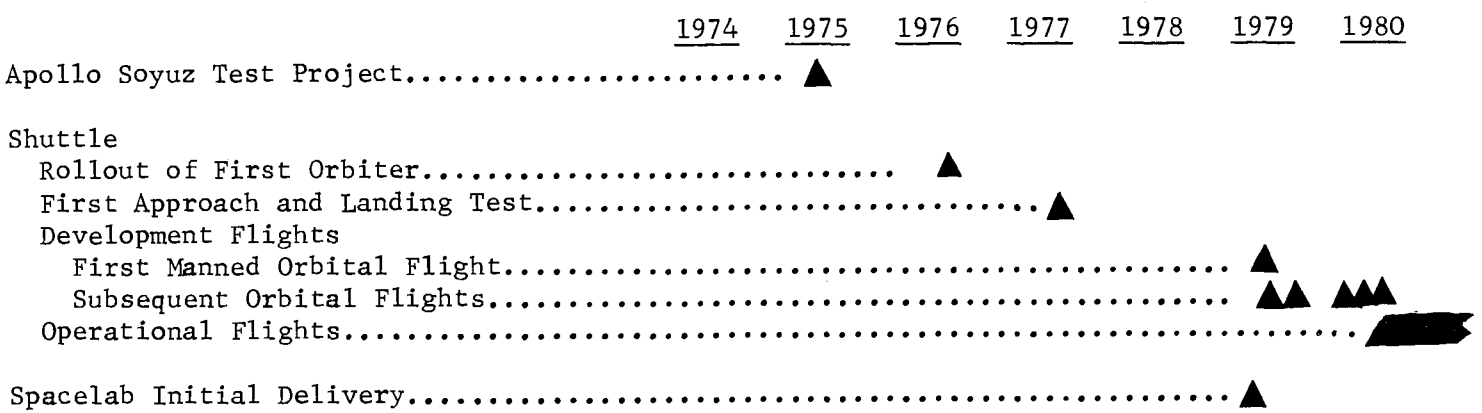
- Promote international cooperation in space

  --Apollo/Soyuz Docking Mission with USSR
  --Spacelab Development by European Space Research Organization

- Develop Space Shuttle Transportation System

  --Routine Access to and from Space
  --Economical Transportation Costs
  --Economical Payload Costs

MAJOR FLIGHT ACTIVITY

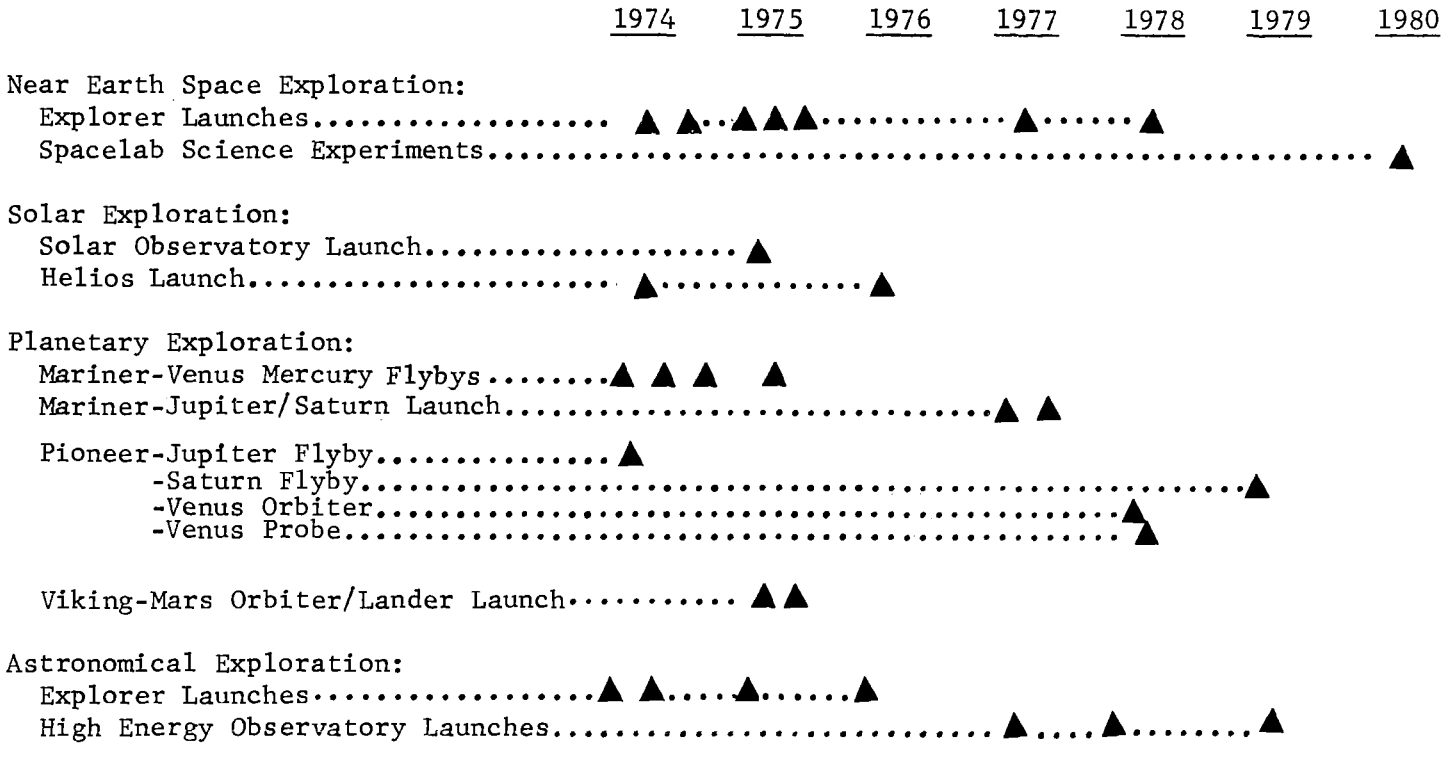


National Aeronautics and Space Administration

SPACE SCIENCE

- Extend the current state of knowledge in space sciences through a balanced program of new exploratory missions and ground-based investigations
- Exploit the knowledge gained from current and completed program efforts by thorough analysis and interpretation of the scientific data obtained

MAJOR FLIGHT ACTIVITY



National Aeronautics and Space Administration

SPACE APPLICATIONS

- Develop and demonstrate practical uses of space and space technology.

MAJOR FLIGHT ACTIVITY

	1974	1975	1976	1977	1978	1979	1980
Weather and Climate:							
NIMBUS-F		▲					
Synchronous Meteorological	▲	▲					
TIROS					▲		
Pollution Monitoring:							
NIMBUS-G					▲		
Applications Explorers (Stratospheric Aerosols and Gas Experiment)						▲	
Earth Resources Survey:							
LANDSAT		▲		▲			
Applications Explorer (Heat Capacity Mapping Mission)				▲			
Earth and Ocean Physics:							
GEOS		▲					
LAGEOS			▲				
SEASAT					▲		
Communications:							
ATS	▲						
CAS		▲					

National Aeronautics and Space Administration

Aeronautical Research and Technology

- For civil and military aircraft:
  - --Improved Performance
  - --Reduced Energy Requirements
  - --Reduced Environmental Effects

MAJOR PROGRAMS

- --Highly Maneuverable Aircraft Technology
- --Quiet, Clean, STOL Experimental Engine
- --Tilt Rotor Research Aircraft
- --Rotor Systems Research Aircraft
- --Quiet Propulsive Lift Technology

National Aeronautics and Space Administration

SPACE AND NUCLEAR RESEARCH AND TECHNOLOGY

- Provide a technology base for future space activities

  --Advanced Spacecraft and Spacecraft Systems Materials and Structures

  --Improved Chemical and Electric Propulsion

  --High-Reliability Electronics

  --Improved Thermal Design for Spacecraft

  --Efficient Nuclear and Non-Nuclear Power Systems

566-537 O - 75 - 2

National Aeronautics and Space Administration

ENERGY TECHNOLOGY APPLICATIONS

- To assist in insuring the attainment (and maintenance) of National energy self-sufficiency

  --Provides support to federal, state and local governmental agencies in implementing energy programs which requires or can benefit from NASA's aerospace systems technology and management techniques.

  --Evaluates the potential of various elements of aerospace technology for energy

National Aeronautics and Space Administration

TRACKING AND DATA ACQUISITION

- Worldwide networks of ground stations, an instrumentation ship, and instrumented aircraft interconnected with highly reliable communications to provide support to:

  --Manned Missions - Apollo/Soyuz Test Project

  --Automated Earth Orbiting Missions - Covers approximately 40 Active Satellites including upcoming Synchronous Meteorological Satellite (SMS)B, NIMBUS F, Geodynamic Experimental Ocean Satellite (GEOS)C, Earth Resources Technology Satellite (LANDSAT)2 and Orbiting Solar Observatory (OSO)I missions

  --Planetary Missions - In addition to continuing Pioneer, Helios I, and Mariner support, Viking 75 A&B and Helios B missions will be covered

  --Sounding Rockets

  --Research Aircraft

TECHNOLOGY UTILIZATION

- Accelerate the dissemination of scientific and technical information generated by the conduct of the space and aeronautics programs.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1976 ESTIMATES

SUMMARY OF APPROPRIATIONS
(Thousands of Dollars)

Appropriations	1974 PL 93-137*	1975 PL 93-414*	1976 Request	Transition Period Request
Research and Development	$2,194,000	$2,331,015	$2,678,380	$730,600
Basic Appropriation	2,194,000	2,326,580	2,678,380	730,600
Special Energy Research and Development Appropriation Act, 1975 (PL 93-322)	---	4,435	---	---
Construction of Facilities	101,100	140,155	84,620	14,500
Research and Program Management	744,600	759,975	776,000	213,800
Basic Appropriation	(707,000)	(740,000)	(776,000)	(213,800)
Supplemental Appropriation for civilian pay raises (PL 93-305)	(37,600)	---	---	---
Proposed supplemental for civilian pay raises	---	(19,975)	---	---
Total	$3,039,700	$3,231,145	$3,539,000	$958,900

* Except as noted

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1976 ESTIMATES

SUMMARY RECONCILIATION OF APPROPRIATIONS TO BUDGET PLANS
(Thousands of Dollars)

Fiscal Year 1974	Total	Research and Development	Construction of Facilities	Research and Program Management
Basic Appropriation, PL 93-137.....	$3,002,100	$2,194,000	$101,100	$707,000
Supplemental Appropriation PL 93-305.....	37,600	---	---	37,600
Total Appropriation (Budget Authority).	3,039,700	2,194,000	101,100	744,600
1973 & prior funds applied to 1974 program plan.....	+116,882	+116,882	---	---
Unobligated balance lapsing.....	-632	---	---	-632
Total Budget Plan.....	$3,155,950	$2,310,882	$101,100	$743,968
Fiscal Year 1975				
Appropriation: PL 93-414.....	$3,206,735	$2,326,580	$140,155	$740,000
*PL 93-322.....	4,435	4,435	---	---
Subtotal.....	3,211,170	2,331,015	140,155	740,000
Proposed supplemental for civilian pay raises.....	19,975	---	---	19,975
Transfers between appropriations.....	---	-7,700	+2,500	+5,200
Total Adjusted Appropriation (Budget Authority)/Budget Plan.....	$3,231,145	$2,323,315	$142,655	$765,175

* Special Energy Research and Development Appropriation Act, 1975.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1976 ESTIMATES

SUMMARY RECONCILIATION OF APPROPRIATIONS TO BUDGET PLANS (CONTINUED)
(Thousands of Dollars)

Fiscal Year 1976	Total	Research and Development	Construction of Facilities	Research and Program Management
Appropriation request/Budget Plan.....	$3,539,000	$2,678,380	$84,620	$776,000
Transition Period				
Appropriation request/Budget Plan.....	$958,900	$730,600	$14,500	$213,800

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1976 AND TRANSITION PERIOD ESTIMATES

SUMMARY OF APPROPRIATION BUDGET PLANS BY INSTALLATION

(In millions of dollars)

Installation	Research and Development				Construction of Facilities				Research and Program Management				Total			
	1974	1975	1976	Transition Period	1974	1975	1976	Transition Period	1974	1975	1976	Transition Period	1974	1975	1976	Transition Period
Johnson Space Center.....	614.1	797.9	1014.5	267.5	11.1	3.1	7.2	.5	118.0	121.6	125.2	29.8	743.2	922.6	1146.9	297.8
John F. Kennedy Space Center, NASA.....	110.9	113.8	106.6	34.5	18.9	66.2	37.0	.7	93.6	95.9	95.0	35.0	223.4	275.9	238.6	70.2
Marshall Space Flight Center....	297.6	285.8	409.3	105.7	18.6	11.6	1.4	1.1	136.6	131.3	130.5	34.4	452.8	428.7	541.2	141.2
National Space Technology Laboratories.....	1.5	8.2	9.1	2.4	11.8	.1	.1	.2	1.6	1.7	1.7	.4	14.9	10.0	10.9	3.0
Goddard Space Flight Center.....	403.0	385.2	354.0	104.1	2.5	3.7	1.3	1.4	97.5	104.8	105.8	27.7	503.0	493.7	461.1	133.2
Wallops Flight Center.....	14.2	16.3	17.6	4.2	3.1	3.5	1.0	.2	11.5	12.1	12.7	3.5	28.8	31.9	31.3	7.9
Jet Propulsion Laboratory.....	127.1	169.8	186.2	55.1	2.0	11.1	1.9	1.6	--	--	--	--	129.1	180.9	188.1	56.7
Ames Research Center.....	85.3	114.5	138.9	37.8	2.1	5.3	4.8	1.3	46.4	48.4	49.3	12.8	133.8	168.2	193.0	51.9
Flight Research Center.....	15.6	16.3	20.8	5.2	.3	5.1	5.8	--	12.2	13.2	13.7	4.9	28.1	34.6	40.3	10.1
Langley Research Center.....	355.9	192.0	154.5	45.9	7.2	5.4	4.2	1.3	83.8	88.1	90.7	23.4	446.9	285.5	249.4	70.6
Lewis Research Center.....	185.6	132.6	170.0	43.5	2.2	5.6	1.4	.8	79.8	79.9	81.9	21.9	267.6	218.1	253.3	66.2
NASA Headquarters.....	100.1	90.9	96.9	24.7	--	--	--	--	63.0	68.2	69.5	20.0	163.1	159.1	166.4	44.7
Construction of Facilities Programs																
Various Locations.....					4.0	7.5	--	--					4.0	7.5	--	--
Facility Planning and Design..					13.6	10.9	9.3	2.8					13.6	10.9	9.3	2.8
Balance of the following programs undistributed by installation																
Space Shuttle Facilities....					--	--	3.0	--					--	--	3.0	--
Rehabilitation and Modification.....					1.9	1.6	3.8	1.8					1.9	1.6	3.8	1.8
Minor Construction.....					1.8	2.0	2.4	.8					1.8	2.0	2.4	.8
Total Budget Plan.....	2310.9	2323.3	2678.4	730.6	101.1	142.7	84.6	14.5	744.0	765.2	776.0	213.8	3156.0	3231.2	3539.0	958.9

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

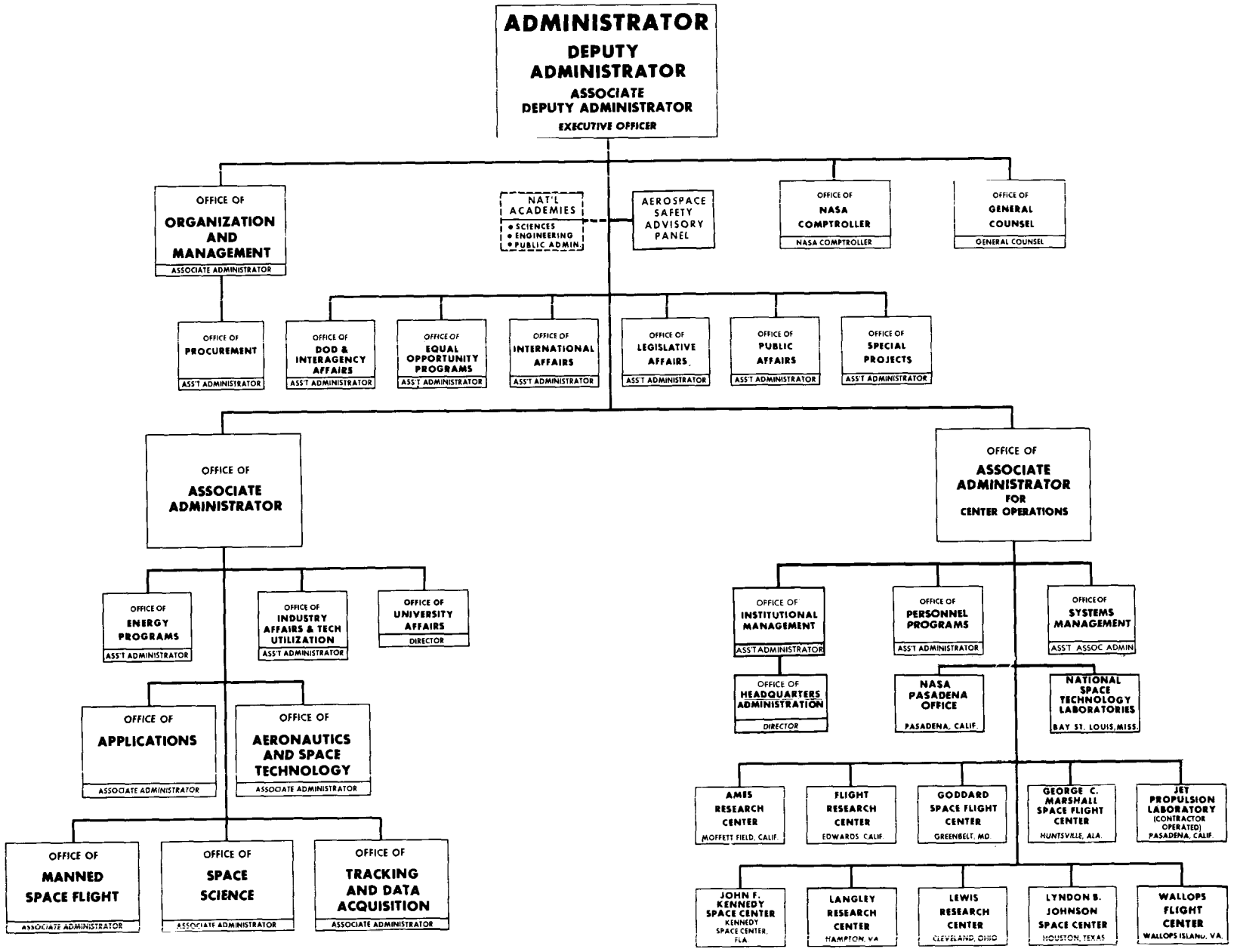
RESEARCH AND PROGRAM MANAGEMENT

TOTAL NUMBER OF PERMANENT POSITIONS

END OF YEAR

INSTALLATION	FY 1974	FY 1975	FY 1976
John F. Kennedy Space Center, NASA.....	2,309	2,259	2,259
Johnson Space Center.....	3,652	3,613	3,613
Marshall Space Flight Center.....	4,500	4,113	4,113
National Space Technology Laboratories.....	65	70	70
Goddard Space Flight Center.....	3,808	3,751	3,751
Wallops Flight Center.....	420	415	415
Ames Research Center.....	1,701	1,679	1,679
Flight Research Center.....	484	489	489
Langley Research Center.....	3,375	3,332	3,332
Lewis Research Center.....	3,115	3,025	3,025
NASA Headquarters.....	1,591	1,570	1,570
TOTAL.....	25,020	24,316	24,316

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION



566-537 O - '75 - 3

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1976 ESTIMATES

GENERAL STATEMENT

The National Aeronautics and Space Administration program of research and development is directed toward advancing our knowledge of earth and its space environment, and toward developing and utilizing aeronautics and space technology to accomplish National goals. The program is conducted through the following elements:

MANNED SPACE FLIGHT: A program to develop and utilize the capabilities of manned space flight, including an international cooperative space docking mission, building on the success of Apollo and Skylab, and development of the Space Shuttle as an economical, versatile space transportation system to provide a wide variety of users with routine, round trip access to space.

SPACE SCIENCE: A space flight program, supported by extensive ground-based and airborne investigations, to further our knowledge of the earth, the atmosphere, the moon, the sun, the planets, interplanetary space, and the stars.

APPLICATIONS: A research and development program using space, aircraft, and ground systems to identify and demonstrate the useful applications of space techniques in such areas as weather and climate, pollution monitoring, earth resources survey, earth and ocean physics, communications, and space processing.

AERONAUTICS AND SPACE TECHNOLOGY: A program to acquire fundamental knowledge and develop the technology needed to maintain United States leadership in aeronautics and space programs.

TRACKING AND DATA ACQUISITION: A worldwide program to support the manned and unmanned programs of the agency.

ENERGY TECHNOLOGY APPLICATIONS: A program to assist in insuring the attainment and maintenance of national energy self-sufficiency, designed to identify aeronautics and space technologies of importance to the energy community.

TECHNOLOGY UTILZATION: A program to accelerate the dissemination to government, industry and other users of the technological and engineering information gained during NASA missions.

MANNED SPACE FLIGHT

The final preparations are now in progress for the launch of the Apollo Soyuz Test Project (ASTP), the first international cooperative manned flight. During FY 1976, the ASTP flight will occur and activities on the development of the Space Shuttle and the NASA support to the European development of the Spacelab will continue to intensify as we move forward to a new era in expanding the beneficial returns from space operations.

The Apollo Soyuz Test Project, a joint US/USSR effort to develop and test systems for rendezvous and docking of manned spacecraft, is planned for launch in July 1975. During this mission, United States astronauts using a modified Apollo Command and Service Module and a newly developed Docking Module will rendezvous and dock in earth orbit with a Soyuz spacecraft manned by Soviet cosmonauts. During the mission, joint activities will be conducted by the two crews, including crew transfers between the two spacecraft.

The Space Shuttle is the key element of an economical versatile space transportation system for routine access to and from low earth orbit. The Shuttle will consist of a reusable delta-wing orbiter vehicle with three main engines, a large expendable propellant tank, and reusable twin solid rocket boosters. The Shuttle will provide for placement and retrieval of satellites, in-orbit servicing of satellites, short-duration manned orbital missions, and delivery to earth orbit of payloads and propulsive stages for high energy and escape missions. The advent of routine, rapid transportation to and from low earth orbit for both unmanned payloads and for scientists and other personnel without special flight training, will revolutionize our concepts of using space. In addition to the savings resulting from reduced transportation costs, major savings are anticipated in payload costs, resulting from repair and reuse of payloads and from relaxation of the stringent payload weight, size, and reliability requirements currently imposed.

All the main elements of the Space Shuttle are now under contract and the design and component fabrication and testing activities are progressing well toward the first approach and landing test in 1977 and the first manned orbital flight of the Space Shuttle in 1979.

The Spacelab will be a multipurpose payload carrier to be used in conjunction with the Space Shuttle. The Spacelab will allow researchers and scientists to conduct their experiments personally in a space environment. It is being designed and built for NASA by the European Space Research Organization (ESRO), with ten European nations participating in the Spacelab development.

SPACE SCIENCE

The Space Science program is a broad-based program of scientific exploration using data from manned and automated spacecraft, sounding rockets, balloons,

aircraft, and ground-based research. Investigations are directed toward observing and understanding the characteristics and interactions of the earth and its atmosphere, the moon, the sun, the planets, the stars, and interplanetary and interstellar space.

The Skylab program provided a wealth of new information about the sun, complementing and adding to data received from the series of automated Orbiting Solar Observatories. These solar observations will be continued through the quiescent period of the solar cycle using another Orbiting Solar Observatory, OSO-I, to be launched in 1975. Project definition and advanced technology development is continuing for the Solar Maximum mission, which would gather data during the next period of peak solar activity. The Orbiting Astronomical Observatory-3, Copernicus, continues to transmit data on the stars and the interstellar matter. The High Energy Astronomy Observatory program is moving forward with the development of flight hardware for launch in 1977, 1978, and 1979, to explore the high energy universe in the x-ray, gamma ray and cosmic ray spectrum. Planning and technological activity is underway on concepts for a Large Space Telescope, a facility which could provide a revolutionary capability in the 1980's for studies of our universe by the international scientific community.

Analysis continues on the data returned by the Apollo missions and on that being received from the Apollo Lunar Surface Experiment Packages left on the lunar surface by the astronauts, as well as the data returned from current and previous planetary missions. Pioneers 10 and 11 completed their flybys of Jupiter, returning close-up imagery and demonstrating the ability of spacecraft to survive the hazards of both the asteroid belt and Jupiter's intense radiation. Pioneer 11 is proceeding on toward the first encounter of Saturn in 1979. Meanwhile, Mariner 10 is proceeding toward a third encounter of Mercury, following two successful visits to that innermost planet last year, and an earlier swing-by of Venus which provided a demonstration of the first gravity-assisted maneuver to go from one planet to another. International cooperative missions to explore the interplanetary region near the sun are underway by the United States and West Germany. These missions are Helios 1, launched in December, 1974, and Helios B, to be launched in 1976. Two Viking missions, each of which will contain both an Orbiter and a Lander, will be launched in 1975 with a planned Mars landing in July 1976. The primary purpose of these missions is to search for the existence of life or the possibility of past or future life on Mars. In 1977, two Mariner spacecraft will be launched to fly by Jupiter and, utilizing a gravity assist from that planet, will travel on to investigate Saturn. In 1978, two Pioneer spacecraft will be launched, one to orbit Venus and another to probe its dense atmosphere. These spacecraft will return a wealth of data on Venus and help to answer questions about earth's atmosphere and dynamics.

The Space Science program also provides launch vehicles for the science and applications missions of the agency, as well as providing launches on a reimbursable basis to other government users and a growing number of international and domestic commercial customers.

APPLICATIONS

Demonstrations of the use of space and space-related technology for practical benefits are the primary objective of the Applications program. Specific areas of such demonstrations include weather and climate, pollution monitoring, earth resources survey, earth and ocean physics, space processing, and communication.

Work continues on development of an ocean dynamics satellite, SEASAT A, to demonstrate a wide range of physical ocean phenomena, including sea state, the location and motion of currents, global circulation patterns, ocean tides, wind stress and geoid udulations. This satellite, scheduled for launch in 1978, should provide global information on the dynamics of the interactions of the air and the sea, which is important to understanding global weather and climate patterns.

The second Earth Resources Technology Satellite, Landsat B, was launched in January 1975 to continue the space-based earth resources survey begun so successfully by Landsat 1. The third satellite in the series, Landsat C, will fly in 1977 with improved instrumentation, to provide the continuity of data analysis effort necessary to long-range user community requirements. Additionally, the practical capability of Landsat information systems to make substantial contributions in the most promising areas of research is being documented through the concerted effort of user agencies and resources managers.

Understanding of earthquake mechanisms will be enhanced by both ground-based experiments and development work on LAGEOS, a high density, laser reflector satellite. The LAGEOS, when launched in 1976, will provide a stable, long term reference point for earth crustal motion studies.

Communications satellites include an experimental Applications Technology Satellite (ATS-6), launched in 1974: to begin a national and international experimental communications program in satellite broadcasting; and a joint US/Canadian project--Cooperative Applications Satellite (CAS-C), scheduled for launch in 1975.

Among other missions under development in the Applications program are TIROS-N, to be flown in 1978 as the prototype for a third generation operational weather satellite system, and Nimbus-G, a 1978 experimental satellite to demonstrate the use of a space platform to monitor air pollution and to measure ocean dynamics. Two applications Explorer projects are also included: a heat capacity mapping mission in 1977 to locate and map geothermal sources in the earth's crust and to identify materials contained in surface rocks; and a single-instrument satellite mission to be launched in 1979 to detect and map stratospheric aerosols and gas concentrations.

Effort will continue in data management to improve the definition and integration of ground and spacecraft data. Systems analyses and cost/benefit studies will be pursued to test the effectiveness of space applications.

AERONAUTICS AND SPACE TECHNOLOGY

The Aeronautics program will continue to advance aeronautical technology to make possible safer, more economical and environmentally acceptable air transportation systems which are responsive to current and future national needs. This technology will help to maintain the strong competitive position of the United States in the international aviation market place and support the military in maintaining the superiority of the Nation's military aircraft.

The program contains a strong fundamental research effort 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 will focus on reducing aircraft energy consumption and the undesirable environmental effects of noise and pollution by providing the technology for quiet, clean and efficient propulsion systems; the reduction of aerodynamic drag; the reduction of aircraft structural weight through the application of active control concepts, advanced materials, and structural concepts; and by the characterization of candidate nonpetroleum-based fuels for aircraft. Improvement of terminal area operations and safety will be pursued through the development of technology in areas such as avionics systems, operating procedures, crashworthy aircraft structures and fire-resistant aircraft interior materials.

The technology for advanced long haul and short haul air transportation systems will be advanced by a focused technology effort in the areas of Short Takeoff and Landing (STOL) systems, Vertical Takeoff and Landing (VTOL) systems, rotorcraft systems, Conventional Takeoff and Landing (CTOL) subsonic systems, and a modest effort aimed at developing supersonic and hypersonic technology to provide options for aircraft of the future.

The Space and Nuclear program will continue to advance technology to provide a technology base that will adequately support current and future space activities involved in the exploration and exploitation of space, and provide standardized, low cost components and systems for the future. 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.

The program will advance technology in the areas of materials and structures for use in spacecraft; chemical and electric propulsion systems to expand mission capabilities; highly reliable and efficient electronic components; guidance, control and information-handling systems; aerothermodynamics of spacecraft entry into planetary atmospheres; and power systems to meet the more stringent requirements of future space missions.

TRACKING AND DATA ACQUISITION

This program provides for continuation of tracking and data acquisition support for manned and unmanned earth orbiting spacecraft, planetary missions, sounding rockets, and research aircraft. This support is provided by a worldwide network of NASA ground stations, an instrumentation ship, and instrumented aircraft, interconnected by a highly reliable communications system which provides the capability for instantaneous transmission of data and critical commands between spacecraft and the flight control centers. Facilities also are provided to process into meaningful form the large amounts of scientific, applications, and engineering data which are collected from flight projects.

The support workload will remain high with the Spaceflight Tracking and Data Network (STDN) supporting an average of approximately 40 unmanned scientific and applications spacecraft and the Deep Space Network (DSN) supporting a full complement of planetary missions. Upcoming missions to be supported by STDN include the Synchronous Meteorological Satellite B, Nimbus F, Geodynamic Experimental Ocean Satellite C, the second Earth Resources Technology Satellite, Orbiting Solar Observatory I and the Apollo Soyuz Test Project. Additions to support now provided by DSN will include the two Viking missions and Helios B.

ENERGY PROGRAMS

To assist in insuring the attainment and maintenance of national energy self sufficiency, the Energy Technology Applications Program has been established to provide support to other agencies in advanced research, technology and development; define and, if appropriate, implement programs which require broad application of aerospace technology and management techniques; and provide support of the application of aerospace technology to immediate energy problems.

TECHNOLOGY UTILIZATION

This program provides for wide and rapid dissemination of scientific and technical information acquired as a result of the agency programs. Recipients include other government agencies, the university and nonprofit research community, and industry. Also included is a program to identify public sector problems capable of solution by the application of aerospace technology. These efforts are accomplished through a series of publications and through Industrial Applications Centers.

FUNDING

The FY 1976 Research and Development budget plan totals $2,678,380,000 an increase of $355,065,000 from FY 1975.

Research and Development outlays in FY 1976 are estimated at $2,613,900,000 up $271,000,000 from the $2,342,900,000 estimate for FY 1975.

The Budget Plan and Outlay estimates for the transition period for Research and Development are $730,600,000 and $659,900,000 respectively.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROPOSED APPROPRIATION LANGUAGE

RESEARCH AND DEVELOPMENT

For necessary expenses, not otherwise provided for, including research, development, operations, services, minor construction, maintenance, repair, rehabilitation and modification of real and personal property; tracking and data relay satellite services as authorized by [section 7 of the National Aeronautics and Space Administration Authorization Act, 1975] *law* and purchase, hire, maintenance, and operation of other than administrative aircraft, necessary for the conduct and support of aeronautical and space research and development activities of the National Aeronautics and Space Administration, [$2,326,580,000] *$2,678,380,000*, to remain available until expended.

[For necessary expenses of the National Aeronautics and Space Administration relating to programs and other activities in research and development, including services as authorized by 5 U.S.C. 3109. $4,435,000, to remain available until expended.]

For "Research and development," to be available July 1, 1976, $730,600,000, to remain available until expended. (42 U.S.C. 2451, et seq.; Department of Housing and Urban Development; Space, Science, Veterans, and Certain Other Independent Agencies Appropriation Act, 1975; Special Energy Research and Development Appropriation Act, 1975; additional authorizing legislation to be proposed for fiscal year 1976, and for the period beginning July 1, 1976.)

566-537 O - 75 - 4

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND DEVELOPMENT

Program and Financing (in thousands of dollars)

Identification code 27-00-0108-0-1-999	Budget plan (amounts for research and development actions programed)			Costs and obligations		
	1974 actual	1975 estimate	1976 estimate	1974 actual	1975 estimate	1976 estimate
Program by activities:						
Direct program:						
1. Manned space flight:						
(a) Space shuttle	475,000	797,500	1,206,000	502,116	850,000	1,143,000
(b) Space flight operations	523,400	311,300	207,100	583,751	354,200	238,200
(c) Advanced manned mission studies	1,500	1,500	1,500	1,966	2,300	1,800
(d) Apollo	----------	----------	----------	4,097	3,500	----------
2. Scientific investigations in space:						
(a) Physics and astronomy	104,300	157,215	182,100	115,683	154,400	181,300
(b) Lunar and planetary exploration	456,282	285,000	300,600	366,374	369,600	302,200
(c) Launch vehicle development and support	89,700	93,000	88,000	89,883	102,172	89,600
3. Space applications	173,200	182,100	186,930	157,792	168,428	194,900
4. Space research and technology	66,307	71,365	74,900	68,717	81,000	73,600
5. Aeronautical research and technology	168,000	166,400	175,350	155,291	172,700	174,500
6. Energy programs	4,693	4,435	5,900	1,756	5,000	5,400
7. Supporting activities:						
(a) Tracking and data acquisition	244,000	248,000	243,000	246,173	257,000	259,500
(b) Sustaining university program	----------	----------	----------	729	700	----------
(c) Technology utilization	4,500	5,500	7,000	4,230	5,700	6,000
Total direct program costs, funded	2,310,882	2,323,315	2,678,380	2,298,558	2,526,700	2,670,000
Reimbursable program:						
1. Manned space flight:						
(a) Space shuttle	----------	----------	----------	60	8	----------
(b) Space flight operations	9,751	12,375	14,878	8,897	14,830	14,878
(d) Apollo	----------	----------	----------	45	425	----------
2. Scientific investigations in space:						
(a) Physics and astronomy	12,187	10,192	5,550	9,086	13,086	5,550
(b) Lunar and planetary exploration	----------	66	----------	----------	66	----------
3. Space applications	181,600	165,814	144,357	130,490	235,557	144,357
4. Space research and technology	433	693	647	437	1,030	647
5. Aeronautical research and technology	23,163	20,888	17,502	19,170	34,527	17,502
6. Energy programs	3,946	10,120	35,100	868	12,496	35,100
7. Supporting activities:						
(a) Tracking and data acquisition	394	525	426	24	622	426
(c) Technology utilization	435	2,027	1,740	277	2,243	1,740
Total reimbursable program costs	231,909	222,700	220,200	169,354	314,890	220,200
Total program costs, funded	2,542,791	2,546,015	2,898,580	2,467,912	2,841,590	2,890,200
Change in selected resources (undelivered orders and stores)				−2,100	34,995	80,380
10 Total	2,542,791	2,546,015	2,898,580	2,465,812	2,876,585	2,970,580

Program and Financing (in thousands of dollars)—**Continued**

Identification code 27-00-0108-0-1-999	Budget plan (amounts for research and development actions programed)			Costs and obligations		
	1974 actual	1975 estimate	1976 estimate	1974 actual	1975 estimate	1976 estimate
Financing:						
Receipts and reimbursements from:						
11 Federal funds	−104,645	−83,830	−110,845	−104,645	−83,830	−110,845
14 Non-Federal sources	−127,264	−138,870	−109,355	−127,264	−138,870	−109,355
21 Unobligated balance available, start of year:						
For completion of prior year budget plans:						
Direct	.....	.....	.....	−279,634	−310,380	−72,000
Reimbursable	.....	.....	.....	−45,978	−92,190	.....
Available to finance new budget plans: Direct	−116,882	.....	.....	−116,882	.....	.....
24 Unobligated balance available, end of year:						
For completion of prior year budget plans:						
Direct	.....	.....	.....	310,380	72,000	.....
Reimbursable	.....	.....	.....	92,190	.....	.....
25 Unobligated balance lapsing	.....	.....	.....	21	.....	.....
Budget authority	**2,194,000**	**2,323,315**	**2,678,380**	**2,194,000**	**2,323,315**	**2,678,380**
Budget authority:						
40 Appropriation	2,194,000	2,331,015	2,678,380	2,194,000	2,331,015	2,678,380
41 Transferred to other accounts	.....	−7,700	.....	.....	−7,700	.....
43 **Appropriation (adjusted)**	**2,194,000**	**2,323,315**	**2,678,380**	**2,194,000**	**2,323,315**	**2,678,380**
Relation of obligations to outlays:						
71 Obligations incurred, net				2,233,903	2,653,885	2,750,380
72 Obligated balance, start of year				959,243	771,594	1,082,579
74 Obligated balance, end of year				−771,594	−1,082,579	−1,219,059
90 **Outlays**				2,421,552	2,342,900	2,613,900

Note.—Reconciliation of budget plan to obligations:	*1974 actual*	*1975 estimate*	*1976 estimate*
Total budget plan	2,542,791	2,546,015	2,898,580
Deduct portion of budget plan to be obligated in subsequent years	301,614	72,000	.....
Add obligations of prior year budget plans	224,635	402,570	72,000
Total obligations	2,465,812	2,876,585	2,970,580

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

BUDGET SUMMARY
(Thousands of Dollars)

Research and Development	Budget Plan FY 1974	FY 1975	FY 1976	Transition Period
MANNED SPACE FLIGHT.....	999,900	1,110,300	1,414,600	376,600
Space shuttle.....	475,000	797,500	1,206,000	321,000
Space flight operations.....	523,400	311,300	207,100	55,100
Advanced missions.....	1,500	1,500	1,500	500
SPACE SCIENCE.....	664,482	542,815	582,600	160,300
Physics and astronomy.....	94,000	136,315	155,800	46,600
Lunar and planetary exploration.....	392,482	266,000	259,900	73,300
Launch vehicle procurement.....	178,000	140,500	166,900	40,400
APPLICATIONS.....	159,000	174,500	175,030	54,700
Space applications.....	159,000	174,500	175,030	54,700
AERONAUTICS AND SPACE TECHNOLOGY.....	234,307	237,765	250,250	69,100
Aeronautical research and technology.....	168,000	166,400	175,350	46,800
Space and nuclear research and technology.....	66,307	71,365	74,900	22,300
ENERGY PROGRAMS.....	4,693	4,435	5,900	1,500
TRACKING AND DATA ACQUISITION.....	244,000	248,000	243,000	66,400
TECHNOLOGY UTILIZATION.....	4,500	5,500	7,000	2,000
TOTAL.....	2,310,882	2,323,315	2,678,380	730,600

National Aeronautics and Space Administration

FY 1975 BUDGET AUTHORITY DEFERRED

The FY 1975 estimates contained in the National Aeronautics and Space Administration FY 1976 Budget Estimates include $72 million of the 1975 Research and Development appropriation identified for deferral into FY 1976 as part of the President's budget restraint message of November 26, 1974. These funds, which are planned for obligation early in FY 1976, are distributed as follows:

Space Flight Operations	20,000,000
Apollo Soyuz Test Project	20,000,000
Physics and Astronomy	3,000,000
Orbiting Astronomical Observatories	300,000
Solar Maximum Mission-Advanced Technological Development	550,000
Airborne Research	200,000
Sounding Rockets	1,050,000
Supporting Research and Technology/Advanced Studies	900,000
Lunar and Planetary Exploration	8,000,000
Pioneer-Venus	5,000,000
Lunar Sample Analysis	1,200,000
Lunar Data Analysis	1,300,000
Lunar Science Supporting Research and Development	500,000
Space Applications	16,000,000
TIROS-N	2,800,000
Global Atmospheric Research Program	500,000
Weather and Climate: Advanced techniques in observing and forecasting	100,000
Nimbus-G	7,200,000
Pollution Monitoring: Sensor definition and feasibility evaluations	200,000
SEASAT-A	500,000
Tectonic Plate Motion	500,000
Earth Resources Survey: Data interpretation techniques, special investigation and data analysis	1,000,000
Earth and Ocean Physics Data Analysis	200,000
Earth and Ocean Physics Measurement Systems, Forecasting Techniques, and Modeling	200,000
Data Management	500,000
Shuttle Payloads Development	900,000
Advanced Applications Flight Experiments	900,000
Heat Capacity Mapping Mission	500,000

FY 1975 Deferral Budget Authority - Continued

Aeronautical Research and Technology	13,500,000
Systems Technology Programs	4,000,000
Quiet, Clean, Short-Haul Experimental Engine	2,000,000
Tilt Rotor Research Aircraft	2,000,000
Quiet Propulsive Lift	5,500,000
Space and Nuclear Research and Technology	1,500,000
Research and Technology Base	1,200,000
Systems Technology Programs	300,000
Tracking and Data Acquisition	10,000,000
Systems Implementation	6,200,000
Supporting Research and Technology	200,000
Tracking and Data Relay Satellite Studies	3,600,000
Total Deferrals	72,000,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1976 ESTIMATES

DISTRIBUTION OF RESEARCH AND DEVELOPMENT BUDGET PLAN BY INSTALLATION AND FISCAL YEAR
(Thousands of Dollars)

PROGRAM		TOTAL	Johnson Space Center	Kennedy Space Center	Marshall Space Flight Center	National Space Technology Laboratories	Goddard Space Flight Center	Jet Propulsion Laboratory	Wallops Flight Center	Ames Research Center	Flight Research Center	Langley Research Center	Lewis Research Center	NASA Headquarters
OFFICE OF MANNED SPACE FLIGHT, TOTAL	1974	999,900	586,252	106,731	277,892	1,450	848	645	48	9,907	100	1,172	250	14,605
	1975	1,110,300	753,163	100,875	225,487	8,000	444	500	---	8,065	106	97	200	13,363
	1976	1,414,600	967,298	90,000	327,550	8,900	440	600	---	8,450	75	237	250	10,800
	TP	376,600	254,465	31,250	82,150	2,300	125	200	---	2,525	---	85	200	3,300
Space shuttle	1974	475,000	357,102	2,931	110,311	700	---	---	---	175	---	174	---	3,637
	1975	797,500	622,113	14,000	149,687	1,000	68	---	---	---	---	28	---	10,604
	1976	1,206,000	864,940	50,900	278,400	1,900	100	---	---	---	---	52	---	9,700
	TP	321,000	227,265	21,000	69,200	500	25	---	---	---	---	10	---	3,000
Space Flight operations	1974	523,400	228,574	103,700	167,006	750	848	645	48	9,720	100	998	250	10,761
	1975	311,300	130,600	86,725	75,300	7,000	376	500	---	8,065	106	69	200	2,359
	1976	207,100	101,750	38,950	48,550	7,000	340	600	---	8,450	75	185	250	950
	TP	55,100	27,000	10,200	12,750	1,800	100	200	---	2,525	---	75	200	250
Advanced missions	1974	1,500	576	130	575	---	---	---	---	12	---	---	---	207
	1975	1,500	450	150	500	---	---	---	---	---	---	---	---	400
	1976	1,500	600	150	600	---	---	---	---	---	---	---	---	150
	TP	500	200	50	200	---	---	---	---	---	---	---	---	50
OFFICE OF SPACE SCIENCE, TOTAL	1974	664,482	8,282	3,878	11,207	---	122,137	58,631	2,205	15,701	---	284,663	102,574	55,204
	1975	542,815	11,758	11,670	49,725	---	110,465	91,761	2,469	44,758	---	107,293	68,044	44,872
	1976	582,600	11,884	15,160	71,800	---	92,373	100,147	2,865	72,225	---	61,791	102,168	52,187
	TP	160,300	3,039	3,000	20,650	---	27,315	29,103	825	19,007	---	20,176	24,700	12,485
Physics and astronomy	1974	94,000	180	---	8,927	---	56,755	650	2,150	6,435	---	2,708	---	16,195
	1975	136,315	850	---	49,505	---	55,419	628	2,404	6,927	---	1,358	---	19,224
	1976	155,800	1,000	---	71,400	---	53,038	700	2,800	7,400	---	862	---	18,600
	TP	46,600	200	---	20,550	---	17,075	400	800	1,950	---	925	---	4,700
Lunar and planetary exploration	1974	392,482	8,102	---	25	---	6,380	57,371	55	9,266	---	274,273	---	37,010
	1975	266,000	10,908	22	20	---	8,558	90,937	55	37,831	---	94,476	---	23,193
	1976	259,900	10,884	---	---	---	7,553	99,397	55	64,825	---	48,914	---	28,272
	TP	73,300	2,839	---	---	---	1,640	28,603	25	17,057	---	16,151	---	6,985
Launch vehicle procurement	1974	178,000	---	3,878	2,255	---	59,002	610	---	---	---	7,682	102,574	1,999
	1975	140,500	---	11,648	200	---	46,488	196	10	---	---	11,459	68,044	2,455
	1976	166,900	---	15,160	400	---	31,782	50	10	---	---	12,015	102,168	5,315
	TP	40,400	---	3,000	100	---	8,600	100	---	---	---	3,100	24,700	800
OFFICE OF APPLICATIONS (Space applications)	1974	159,000	18,133	285	4,155	---	100,285	4,757	6,267	6,598	---	8,749	3,935	5,836
	1975	174,500	32,400	1,200	7,100	200	92,200	9,600	7,300	5,700	---	8,900	2,600	7,300
	1976	175,030	33,030	1,300	6,500	200	86,400	14,600	9,300	5,400	---	9,300	2,500	6,700
	TP	54,700	9,500	200	2,050	50	30,100	4,500	1,900	1,600	---	2,700	400	1,700
OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY, TOTAL	1974	234,307	959	---	3,467	---	4,650	14,257	137	53,139	13,464	60,842	77,784	5,608
	1975	237,765	175	50	2,960	---	5,656	17,093	346	55,746	13,587	75,652	61,246	5,254
	1976	250,250	430	50	3,230	---	5,470	17,020	300	52,670	18,350	83,060	64,370	5,300
	TP	69,100	70	---	850	---	1,200	5,290	110	14,600	4,600	22,900	18,000	1,480
Aeronautical research and technology	1974	168,000	259	---	647	---	---	702	137	46,155	12,164	47,688	57,925	2,323
	1975	166,400	100	---	650	---	---	878	285	46,673	12,587	60,985	41,754	2,488
	1976	175,350	280	---	600	---	---	1,200	250	44,150	17,400	64,740	43,990	2,740
	TP	46,800	70	---	150	---	---	390	110	12,000	4,300	17,000	12,000	780
Space and nuclear research and technology	1974	66,307	700	---	2,820	---	4,650	13,555	---	6,984	1,300	13,154	19,859	3,285
	1975	71,365	75	50	2,310	---	5,656	16,215	61	9,073	1,000	14,667	19,492	2,766
	1976	74,900	150	50	2,630	---	5,470	15,820	50	8,520	950	18,320	20,380	2,560
	TP	22,300	---	---	700	---	1,200	4,900	---	2,600	300	5,900	6,000	700
OFFICE OF ENERGY PROGRAMS (Energy technology applications)	1974	4,693	430	---	875	---	---	2,008	---	---	28	316	1,036	---
	1975	4,435	380	---	550	---	230	2,500	---	225	---	90	460	---
	1976	5,900	1,875	50	250	---	225	2,500	---	175	---	75	750	---
	TP	1,500	375	25	50	---	75	675	---	75	---	25	200	---
OFFICE OF TRACKING AND DATA ACQUISITION	1974	244,000	---	---	---	---	175,113	46,833	5,544	---	1,978	200	---	14,332
	1975	248,000	---	---	---	---	176,200	48,400	6,200	---	2,600	---	---	14,600
	1976	243,000	---	---	---	---	169,100	51,500	5,100	---	2,400	---	---	14,900
	TP	66,400	---	---	---	---	45,300	15,300	1,400	---	600	---	---	3,800
OFFICE OF TECHNOLOGY UTILIZATION	1974	4,500	---	---	---	---	---	---	---	---	---	---	---	4,500
	1975	5,500	---	---	---	---	---	---	---	---	---	---	---	5,500
	1976	7,000	---	---	---	---	---	---	---	---	---	---	---	7,000
	TP	2,000	---	---	---	---	---	---	---	---	---	---	---	2,000
TOTAL BUDGET PLAN	1974	2,310,882	614,056	110,894	297,596	1,450	403,033	127,131	14,201	85,345	15,570	355,942	185,579	100,085
	1975	2,323,315	797,876	113,795	285,822	8,200	385,195	169,854	16,315	114,494	16,293	192,032	132,550	90,889
	1976	2,678,380	1,014,517	106,560	409,330	9,100	354,008	186,167	17,565	138,920	20,825	154,463	170,038	96,887
	TP	730,600	267,449	34,475	105,750	2,350	104,115	55,068	4,235	37,807	5,200	45,886	43,500	24,765

Note: Amounts shown for NSTL exclude funding for Earth Resources Laboratory, which is suballocated from JSC.
TP: Transition Period

O - 566-537

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1976 ESTIMATES

RESEARCH AND DEVELOPMENT BUDGET PLAN FOR

MANNED SPACE FLIGHT PROGRAMS

Programs	Budget Plan				
		1975			
	1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Space shuttle.....	$475,000	$800,000	$797,500	$1,206,000	$321,000
Space flight operations.	523,400	323,300	311,300	207,100	55,100
Advanced missions.....	1,500	1,500	1,500	1,500	500
Total.....	$999,900	$1,124,800	$1,110,300	$1,414,600	$376,600

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1976 ESTIMATES

BUDGET SUMMARY

OFFICE OF MANNED SPACE FLIGHT — SPACE SHUTTLE PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Orbiter.....	$363,125	$647,500	$634,600	$877,300	$230,900
Main engine.....	82,307	92,300	92,300	135,500	36,000
Solid rocket boosters.....	8,567	22,600	22,600	76,200	18,000
External tank.....	18,100	26,000	34,000	66,100	15,100
Launch and landing...	2,901	11,600	14,000	50,900	21,000
Total.....	$475,000	$800,000	$797,500	$1,206,000	$321,000

Distribution of Program Amount by Installation:

Johnson Space Center...	$357,102	$630,200	$622,113	$864,948	$227,265
Kennedy Space Center...	2,901	11,600	14,000	50,900	21,000
Marshall Space Flight Center.....	110,311	147,700	149,687	278,400	69,200
National Space Technology Laboratories..	700	1,000	1,000	1,900	500
Goddard Space Flight Center.....	---	---	68	100	25
Ames Research Center...	175	---	---	---	---
Langley Research Center	174	---	28	52	10
Headquarters.....	3,637	9,500	10,604	9,700	3,000
Total.....	$475,000	$800,000	$797,500	$1,206,000	$321,000

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1976 ESTIMATES

OFFICE OF MANNED SPACE FLIGHT

SPACE SHUTTLE PROGRAM

SCHEDULE

PROJECT	MISSION	CALENDAR YEAR
Space Shuttle	Rollout of Orbiter No. 1	3rd Qtr 1976
	Approach and Landing Tests	4th Qtr 1977
	First Manned Orbital Flight	2nd Qtr 1979
	Developmental Flights	3rd Qtr 1979-Mid 1980
	Operational Shuttle	Mid-1980

566-537 O - 75 - 5

OFFICE OF MANNED SPACE FLIGHT SPACE SHUTTLE PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION:

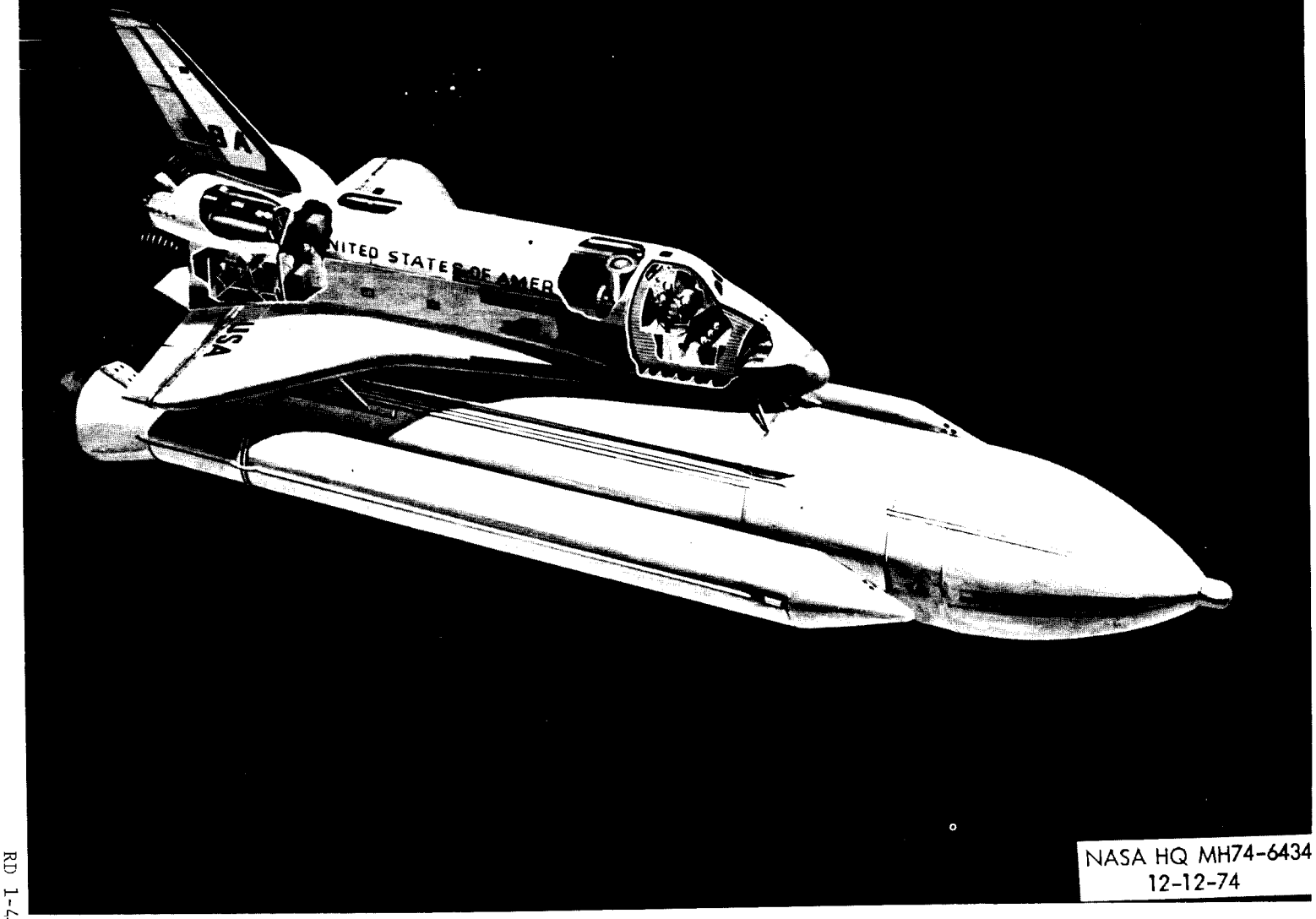
The Space Shuttle is the key element of an economical space transportation system that will provide a wide variety of national and international users with routine access to space beginning in the 1980's. The Shuttle will be the first reusable space vehicle and will be configured to carry many different 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 down-to-earth 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 industries, universities, research organizations, and national and international organizations.

The Space Shuttle's design features and operational flexibility are the key to driving down 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 Shuttle orbiter, with its large payload volume of 285 cubic meters (370 cubic yards) and cargo carrying capacity of up to 29,500 kilograms (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.

SPACE SHUTTLE SYSTEM



NASA HQ MH74-6434
12-12-74

Mission Profile

The Space Shuttle will be boosted into orbit by the thrust of its three liquid oxygen/liquid hydrogen main engines burning in parallel with the twin solid rocket boosters. Two minutes into the flight, at an altitude of about 40 kilometers (km) (22 nautical miles), the solid rocket boosters burn out, are separated and descend by parachute to a soft splashdown in the ocean about 240 km (130 nautical miles) down range. They will then be recovered for refurbishment and reuse. The orbiter, powered by its three main engines, will continue on into space for another six minutes. At the end of that time, the engines will be shut down. At this point, just prior to orbital insertion, the external tank will be jettisoned. Following a ballistic trajectory, the empty tank will fall in a remote ocean area about 18,500 km (10,000 nautical miles) down range. The orbiter, firing its orbital maneuvering engines, will then enter earth orbit to perform its mission. After completing its mission, the orbiter will again fire its orbital maneuvering engines to deorbit and reenter the atmosphere at a high angle (about 34°) in a shallow flight path to minimize frictional heating. At 21 km (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 (3-g forces) during launch and landing and can perform their work in shirt-sleeve comfort.

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 in FY 1975 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 and several major milestones have been accomplished.

The Space Shuttle development is proceeding on schedule to meet the major milestones of first approach and landing test in 1977 and first manned orbital flight in 1979.

BASIS OF FUND REQUIREMENTS:

Orbiter

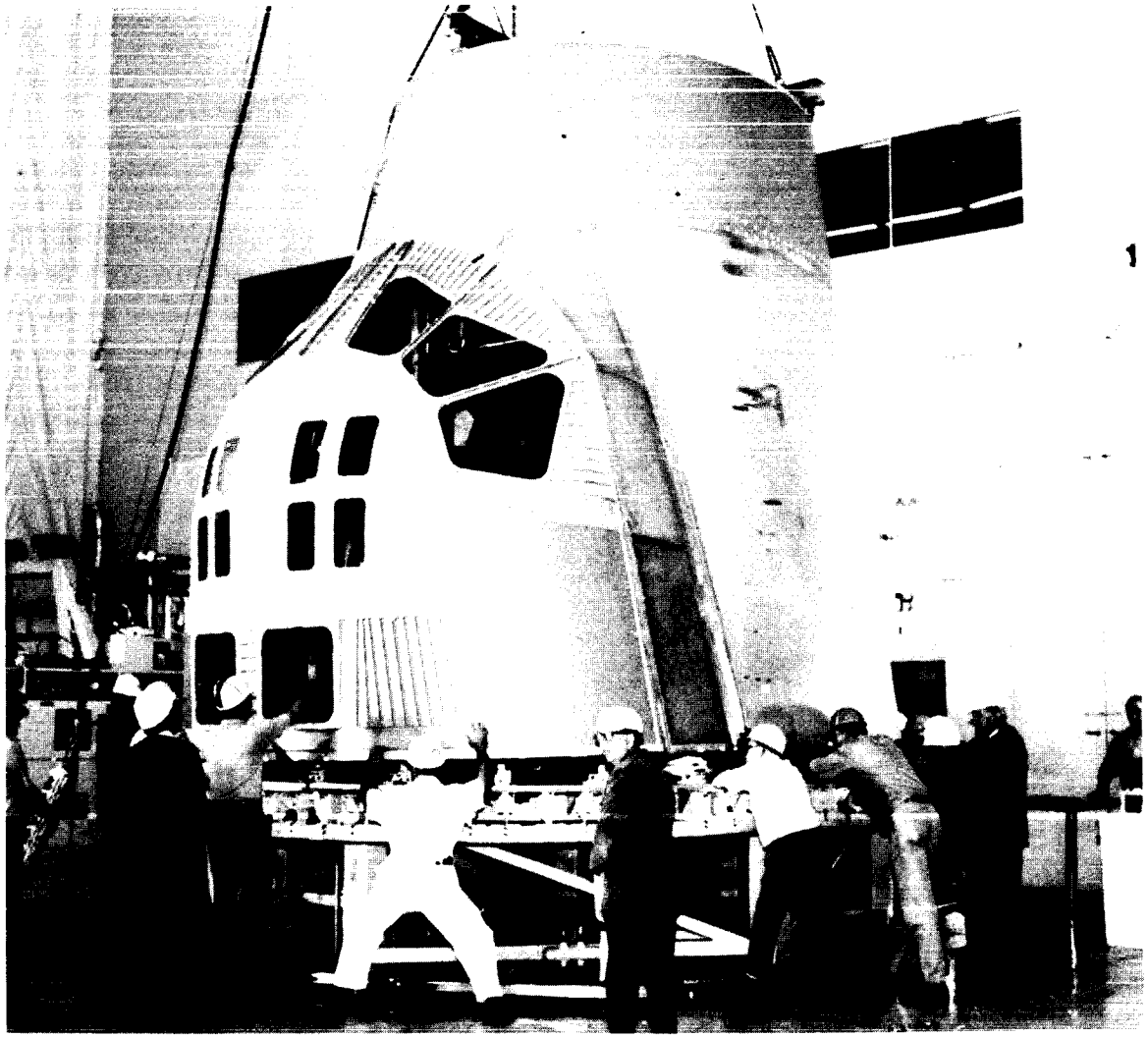
1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$363,125	$647,500	$634,600	$877,300	$230,900

OBJECTIVES AND STATUS

The orbiter will be a reusable airplane-like vehicle with a versatile capability for multipurpose low earth orbital operations. It will have a payload bay measuring about 18 meters (60 feet) in length with a diameter of 4.5 meters (15 feet). With the two solid rocket boosters, the orbiter will be able to place up to 29,500 kilograms (65,000 lbs.) into a 185 kilometer (100 nautical mile) circular orbit, due east launch azimuth.

Orbiter No. 1 crew module fabrication was completed by the prime contractor, Rockwell International/Space Division, in FY 1975 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 carrier aircraft modification was completed in FY 1975. The thermal protection system development, during the fiscal year, 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. Methods of production and manufacturing procedures were also developed for the thermal protection system. 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, i.e., freon coolant loops, heat exchanges, cold plates, radiator panels, ammonia boliers, and pressure controls.

ORBITER NO.1 CREW MODULE



CHANGES FROM FY 1975 BUDGET ESTIMATE:

The difference between the 1975 budget estimate and the current estimate resulted from actions taken in 1974 to accelerate procurement of pacing equipment, supplies and materials. These actions were taken to maximize assurance of meeting key schedule milestones and to lessen the impact of inflation on the funding plans for FY 1975. In addition, $2.5 million was transferred to Construction of Facilities to provide for the increase in the amount required for the orbiter approach and landing test facilities, and initiation of the Shuttle/carrier aircraft mating facilities.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

During FY 1976 the prime contractor will continue design, fabrication and assembly of Orbiter No. 1 and begin to manufacture Orbiter No. 2. 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. The major subcontractors for the mid-section, wings, vertical stabilizer, cargo doors, landing gear, nose section, leading edges for wing and vertical stabilizer, and tail fairing will complete fabrication and ship these components for Orbiter No. 1 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 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 FY 1976. 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 and is basic to its success. 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 (bread board/prototype) and software will be performed in FY 1976 at Rockwell International/Space Division. 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 requirements 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, which is currently targeted for the third quarter of 1976. 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

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$82,307	$92,300	$92,300	$135,500	$36,000

OBJECTIVES AND STATUS:

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 operates is a major technological advancement. This high chamber pressure allows the use of a higher expansion ratio nozzle and results in a more efficient operating engine without increasing size. Another new dimension has been added to the Space Shuttle main engine, that of long life. 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 Santa Susana, California. 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 contractor effort in FY 1975.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

During FY 1976 the prime contractor, Rocketdyne, will continue testing and fabrication of the major subsystems of the Space Shuttle main engine. 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 (RPL) 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, logistics support will be provided 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.

566-537 O - 75 - 6

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

Solid Rocket Boosters

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$8,567	$22,600	$22,600	$76,200	$18,000

OBJECTIVES AND STATUS

The booster element of the Space Shuttle system consists of two reusable solid rocket boosters approximately 3.6 meters (12.2 feet) in diameter and 45.5 meters (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 240 km (130 nautical miles) from the launch site. They will be recovered and returned to land for refurbishment and reuse.

Thiokol, Wasatch Division, is the contractor for the solid rocket motors. The 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 of structural drawings for the nose cap, frustrum, forward skirt and aft skirt was completed as was the solid rocket booster Preliminary Design Review. 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.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

The prime contractor will begin fabrication of development motors in FY 1976 to support first firings in FY 1977. Subcontractor effort will proceed with manufacture, heat treatment and machining of the solid rocket motor cases. A prototype flexible bearing for the thrust vector control (TVC) system will be fabricated and tested in FY 1976. 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

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$18,100	$26,000	$34,000	$66,100	$15,100

OBJECTIVES AND STATUS:

The external tank is a single assembly approximately 8.5 meters (27.5 feet) in diameter, and 47 meters (154 feet) long. It contains liquid oxygen and liquid hydrogen tanks and is mounted below the orbiter and between the solid rocket boosters. 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 design and development contractor for the external tank is the Martin Marietta Corporation/Denver Division. The design and development activities are proceeding in the Government-owned Michoud Assembly Facility, New Orleans, Louisiana.

Since the external tank represents the only expendable element in the Shuttle operational system, every effort is being made to reduce the unit cost to a minimum. The prime contractor will use the latest production techniques and the lowest cost materials consistent with safety and reliability.

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.

CHANGES FROM FY 1975 BUDGET ESTIMATES:

The original FY 1975 budget estimate differs from the current estimate in that NASA and the external tank contractor have now negotiated a definitized contract, with earlier funding required to integrate the tank into the overall schedule. The design, development, test and evaluation cost is consistent with NASA's overall estimate.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

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. The main propulsion test article will be integrated and tested with the orbiter aft fuselage and the three propulsion test engines at the National Space Technology Laboratories. Welding facilities and equipment will be completed 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. Project support activities during FY 1976 will 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, the contractor will complete the assembly of the intertank and the liquid oxygen tank for structural article tests. Fabrication and assembly of the main propulsion test article will also be continued.

Launch and Landing

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$2,901	$11,600	$14,000	$50,900	$21,000

OBJECTIVES AND STATUS:

New launch processing equipment and operational techniques are required to assure that the Shuttle ground operations are compatible with vehicle operation 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.

At Kennedy Space Center, Phase I of the orbiter landing facility is nearly complete. This phase, using Construction of Facilities funds, includes land clearing, digging the runway out to establish a solid base and installing drainage systems and runway lighting system conduit. Detailed design for facility modifications to Launch Complex 39 and for the construction of a new orbiter processing facility is also nearly complete. Software analysis has been proceeding for most of the past year to verify the procedures for an automated launch checkout system utilized in the LPS.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The additional FY 1975 funding requirements resulted from a decision to utilize launch processing system checkout equipment in the Solid Rocket Booster electrical and instrumentation verification test and bench maintenance equipment tests.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

Design effort on the launch processing system 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 launch processing system will be a major effort at the Kennedy Space Center 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. Also planned is the initial procurement of major components of the CDS large scale computers.

Major engineering support services tasks to be performed or completed in FY 1976 include 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.

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1976 ESTIMATES

BUDGET SUMMARY

OFFICE OF MANNED SPACE FLIGHT — SPACE FLIGHT OPERATIONS PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Development, test and mission operations...	$220,200	$175,200	$170,200	$166,100	$43,200
Space life sciences....	21,000	18,000	18,000	19,000	5,500
Mission systems and integration.....	15,500	15,500	13,500	22,000	6,400
Apollo Soyuz Test Project.....	90,000	114,600	109,600	---	---
Skylab.....	176,700	---	---	---	---
Total.....	$523,400	$323,300	$311,300	$207,100	$55,100
Distribution of Program Amount by Installation:					
Johnson Space Center...	$228,574	$135,709	$130,600	$101,750	$27,000
Kennedy Space Center...	103,700	89,800	86,725	38,950	10,200
Marshall Space Flight Center.....	167,006	79,430	75,300	48,550	12,750
National Space Technology Laboratories..	750	6,000	7,000	7,000	1,800
Goddard Space Flight Center.....	848	250	376	340	100
Jet Propulsion Laboratory.....	645	775	500	600	200
Wallops Flight Center..	48	---	---	---	---
Ames Research Center...	9,720	7,536	8,065	8,450	2,525
Flight Research Center.	100	100	106	75	---
Langley Research Center	998	550	69	185	75
Lewis Research Center..	250	250	200	250	200
Headquarters.....	10,761	2,900	2,359	950	250
Total.....	$523,400	$323,300	$311,300	$207,100	$55,100

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1976 ESTIMATES

OFFICE OF MANNED SPACE FLIGHT

SPACE FLIGHT OPERATIONS PROGRAM

FLIGHT SCHEDULE

PROJECT	MISSION	CALENDAR YEAR
Apollo Soyuz Test Project	International Docking Test	July 1975

OFFICE OF MANNED SPACE FLIGHT — SPACE FLIGHT OPERATIONS PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION:

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. The highly successful Skylab program, which was completed in 1974, was funded under the Space Flight Operations program.

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 U.S. 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 U.S. 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

566-537 O - 75 - 7

All the planned objectives for the Skylab program were successfully accomplished. Fiscal Year 1974 was the last year of funding requirements for the Skylab flight program.

BASIS OF FUND REQUIREMENTS:

Development, Test and Mission Operations

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Research and test operations.....	$61,024	$57,100	$54,500	$55,400	$14,500
Data systems and flight operations....	65,356	40,900	40,900	40,000	10,400
Operations support.....	42,906	43,100	43,100	44,300	11,500
Launch systems operations.....	50,914	34,100	31,700	26,400	6,800
Total.....	$220,200	$175,200	$170,200	$166,100	$43,200

OBJECTIVES AND STATUS:

Development, test and mission operations (DTMO) provides the equipment, supplies and contractor support to maintain the basic capabilities 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 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. These in-house capabilities must exist to 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 are also performed to support specific programs. Examples

are specific program tasks resulting in required end items that have not been placed under prime contract but are essential to the successful completion of the program.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The decrease is the result of Congressional action on the FY 1975 Authorization. The amount authorized was $5 million below the FY 1975 funding requirements for development, test, and mission operations.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

The Fiscal Year 1976 and transition period funding will continue to support manned programs, including Shuttle, as well as activities conducted under space life sciences, mission systems and integration, and advanced missions. The FY 1976 development, test and mission operations funding requirements will also be sued for approximately 6,000 support contractor personnel. These people are an essential part of NASA' in-house capability required to pursue ongoing and planned manned space flight efforts.

Research and Test Operations

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Engineering and test	$56,099	$52,900	$50,300	$50,900	$13,300
Reliability, quality and safety.....	4,925	4,200	4,200	4,500	1,200
Total.....	$61,024	$57,100	$54,500	$55,400	$14,500

OBJECTIVES AND STATUS:

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 across the nation.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The current FY 1975 estimate for the research and test operations activities reflects an adjustment required to absorb part of the $5 million Congressional Authorization reduction in DTMO, As a result of this Congressional action, the FY 1975 funding for engineering and test efforts is $2.6 million below the amount requested. The reduction required a cutback of originally planned level of engineering and test support.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

The FY 1976 funding requirements for research and test operations will provide for support of the rapidly increasing Space Shuttle development activities and the efforts complementing the European Spacelab development. In addition, the requirements will support continued Space Shuttle and Spacelab utilization planning. Research and test operations 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 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 research and test operations funds which are to be provided to 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.

During the transition period, research and test operations 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

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Ground-based flight data systems.....	$20,905	$18,300	$18,300	$15,500	$4,000
Flight simulation and development data systems.....	38,458	16,300	16,300	18,100	4,700
Spacecraft and aircraft operations	5,993	6,300	6,300	6,400	1,700
Total.....	$65,356	$40,900	$40,900	$40,000	$10,400

OBJECTIVES AND STATUS:

This project, formerly titled Crew and Flight Operations, has been reconfigured to support the requirements of the Space Shuttle at the Johnson Space Center.

Data systems and flight operations includes the requirements definition, design, implementation, and checkout of hardware and software modifications to the Johnson Space Center's Mission Control Center (MCC) and the Real Time Computer Complex (RTCC), and for the operation and maintenance of these facilities during preparations for mission support and during the flight missions.

Flight simulation efforts will require operation and maintenance of full-mission and part-task simulations for flight procedures development, as well as operation of the Johnson Space Center's 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.

Data systems and flight operations also provides for 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.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

In FY 1976 major efforts will involve the 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. During FY 1976, this effort will also include the 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.

In FY 1976 efforts will emphasize flight data processing support and mission and systems design, and performance studies for the Shuttle.

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

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$42,906	$43,100	$43,100	$44,300	$11,500

OBJECTIVES AND STATUS:

Operations support provides 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, and the National Space Technology Laboratories. These supporting technical services are also provided for the Johnson Space Center's off-site operations at the White Sands Test Facility in New Mexico and for the Marshall Space Flight Center's off-site operations at the Michoud Assembly Facility and the Slidell Computer Complex in Louisiana.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

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 required 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 required at the White Sands Test Facility to support program requirements, including 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 a continuation of effort needed to operate and maintain technical support services required for all manned space flight programs and activities.

Launch Systems Operations

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Mechanical ground systems.....	$25,893	$19,900	$19,000	$15,700	$4,000
Electrical/instrumentation systems.....	25,021	14,200	12,700	10,700	2,800
Total.....	$50,914	$34,100	$31,700	$26,400	$6,800

OBJECTIVES AND STATUS:

Launch systems operations at the Kennedy Space Center 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.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The current estimate for FY 1975 launch systems operations reflects a decrease of $2.4 million. This adjustment was necessary to absorb part of the $5 million Congressional authorization reduction in development, test, and mission operations funding. The FY 1975 mechnaical ground systems effort is $900,000 below the level originally planned and the electrical/instrumentation systems efforts are programmed at $1.5 million below the original plan.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

The beginning of FY 1976 will witness the final checkout activities and launch of the Apollo Soyuz Test Project mission which will have utilized KSC's launch processing capabilities for assembly and integration of the flight hardware for the Apollo Soyuz Test Project.

Fiscal Year 1976 funding provides 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 continue to be maintained in an appropriate mode of readiness to support reconfiguration activities to meet the Space Shuttle requirements.

Fiscal Year 1976 funding also provides 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.

During the transition period, the funds requested will be devoted to maintaining, reconfiguring, and preparing KSC's 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

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Space life research...	$10,500	$8,900	$8,900	$8,900	$2,400
Life support and protective equipment...	7,000	6,000	6,000	6,000	1,500
Bioinstrumentation and man-machine technology.....	3,500	3,100	3,100	3,100	1,150
Life sciences dedicated Spacelab mission common operating research equipment (CORE)....	---	---	----	1,000	450
Total.....	$21,000	$18,000	$18,000	$19,000	$5,500

OBJECTIVES AND STATUS:

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 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.

566-537 O - 75 - 8

The primary areas of activity in the Space Life Sciences program are: space life research, life support and protective equipment, bioinstrumentation and man-machine technology, and the Common Operating Research Equipment (CORE) concept to be used in the life sciences dedicated Spacelab missions. 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.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

In Fiscal Year 1976, emphasis will be placed on the definition and evaluation of experiments for the Spacelab; spacesuit development for the Space Shuttle; and bioinstrumentation research. Studies will also be undertaken on design and development of common operating research equipment, which will be utilized in Spacelab missions dedicated to life sciences.

The transition period funding provides for continuation of research, test, and evaluation efforts and completion of engineering and study efforts necessary to develop the common operating research equipment design.

Space Life Research

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$10,500	$8,900	$8,900	$8,900	$2,400

OBJECTIVES AND STATUS:

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 multidisciplinary 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.

Carefully controlled biomedical experiments were performed during the Skylab missions, which were essentially completed in 1974. This documentation was analyzed and resulted in a FY 1975 program which emphasizes specific areas requiring further study, such as motion sickness, cardiovascular deconditioning, mineral loss, muscle mass loss, and red blood cell loss. In addition, physiological and psychological criteria are being developed for use in selecting crew members and scientist passengers for Space Shuttle missions.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

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

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$7,000	$6,000	$6,000	$6,000	$1,500

OBJECTIVES AND STATUS:

The objectives of the life support and protective equipment efforts is 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.

In FY 1975, advanced techniques are being developed to improve the extravehicular spacesuit design concepts. Advanced manufacturing techniques and modular "universal fit" spacesuit configurations are being developed to reduce suit costs and to simplify suit design for the Space Shuttle. Significant advances are being made in the cooling garment used under the spacesuit to keep the body temperature within acceptable physiological limits. Improved waste management systems are also being developed for use in space. These systems are compatible with either male or female use. In addition, a silver ion sterilization system, designed to purify the drinking water generated by the fuel cells on the Shuttle, has been completed. A new "Flash Evaporator" concept for simple and reliable heat rejection in space is also being developed.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

The FY 1976 life support and protective equipment efforts will focus on 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 maintenance of research, test and evaluation efforts for those necessary life support subsystems and components approaching the design phase.

Bioinstrumentation and Man-Machine Technology

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
$3,500	$3,100	$3,100	$3,100	$1,150

OBJECTIVES AND STATUS:

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.

Bioinstrumentation technology advancements in FY 1975 will result in a prototype blood analysis system to provide inflight, real time measurements of blood constituents, a one-dimensional ultrasonic-bone densitometer utilizing a dual photon source for measurement of bone width and mineral content. The assembly, installation, checkout and acceptance testing of a remote health care delivery system, analogue of a space health care system, were completed, and routine operations have been initiated.

In the man-machine technology area, an extravehicular activity (EVA) cost model was completed. This model will be used to study equipment interface requirements and system trade-offs in the performance of operational or emergency tasks. EVA work station conceptual designs, which are needed in studies of servicing Shuttle payloads and inspection of the Shuttle vehicle, were also generated. Teleoperator achievements produced new force sensing devices for the tongs of the manipulator and effectors and have opened a new area of study concerning force feedback. This advancement will provide firmer control over remote-servicing operations and handling of payloads. A visual system, producing a 3-D display effect, was developed using low-cost, non-stereo cameras and a specially constructed lens. The system is undergoing human factor evaluation under laboratory conditions. A control system designed to precisely maneuver remote manipulators has also been developed and installed in a laboratory engineering model.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

In FY 1976, the bioinstrumentation program 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.

In FY 1976, the man-machine technology activities will 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, funds are identified to 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)

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
---	---	---	$1,000	$450

OBJECTIVES AND STATUS:

The Common Operating Research Equipment 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. These experiments are required to gain information on life sciences questions associated with manned space missions. In addition, basic research will be conducted using zero gravity as a tool for identifying life systems functions which are altered as a result of the normal influence of the earth's gravity. The scientists onboard the Shuttle will be able to perform and adapt their experiments while in orbit and to consult with their collegues on the ground.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

In FY 1976, two parallel contractor definition (Phase B) 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 (Phase C/D).

During the transition period, funds will be used to maintain an orderly completion of sequential engineering and study efforts. These activities are necessary to develop a common operating research equipment design that is both cost-effective and responsive to the requirements of biomedical flight experimentation.

Mission Systems and Integration

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Payload integration and mission analysis.....	$5,500	$5,500	$5,000	$6,000	$1,800
Spacelab/concept verification testing.....	2,500	2,500	2,000	6,100	1,900
Advanced development	7,500	6,000	5,500	6,500	2,000
Interim upper stage/ Space Tug.....	---	1,500	1,000	3,400	700
Total.....	$15,500	$15,500	$13,500	$22,000	$6,400

OBJECTIVES AND STATUS:

Mission Systems and Integration program activity is classified into four major areas of effort: Payload Integration and Mission Analysis, Spacelab/ Concept Verification Testing, Advanced Development, and Interim Upper Stage/Space Tug.

The study and analytical effort under Payload Integration and Mission Analysis assures hardware and operational compatibility between the payloads and the payload carriers, such as the Space Shuttle, the Spacelab, and the Interim Upper Stage/Space Tug. It also provides low cost, standardized, reusable equipment to accommodate a wide range of payloads.

Spacelab activities support the European Space Research Organization (ESRO) Spacelab development effort with engineering and operations studies in such areas as payload safety, accommodations, operations and logistics. In addition, development of a crew transfer tunnel and procurement of various mockups and other ground support equipment are being initiated. The concept verification testing effort deals with interface testing and verification of operational concepts resulting from the Spacelab studies.

Advanced development is directed toward development of critical and long-lead items, experimental systems and operational techniques, as well as the establishment of design and technology requirements for potential future development programs.

The Interim Upper Stage (IUS)/Space Tug effort is twofold. The IUS will be used to transport payloads during the early Shuttle missions to high energy and escape orbits. The IUS is being developed by the U.S. Air Force. NASA supports this development through studies which will define NASA and other non-DoD requirements. The Space Tug is designed with an increased performance to be used with later Shuttle missions. Activities in this area concentrate on testing of components and conducting systems analyses of subsystems and operational procedures.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The $2 million diffenerce between the FY 1975 budget estimate from mission systems and integration and the current estimate stems from Congressional appropriation action reducing NASA's 1975 budget requested R&D appropriation.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

In FY 1976 the Payload Integration and Mission Analysis program will emphasize studies and analyses involving definition of payload and operational requirements for use as design data for the Shuttle, IUS/Space Tug, and Spacelab; hardware and support systems interface compatibility; low cost concepts for payload design and operations; new payload development approaches; new payload applications; the development of low cost, reusable multiuse mission support equipment to accommodate different payloads; and the formulation of procedures and systems for orbital and ground handling operations.

Funding in FY 1976 for Spacelab/Concept Verification Testing will provide for continued support of development and operations-oriented studies; design, fabrication and use of engineering mockups and will initiate development of peripheral flight hardware. Fiscal Year 1976 funds will also provide for acquisition of subsystems and associated computer software for concept verification testing of the Spacelab experiments.

Advanced Development funding in FY 1976 will provide for the development and test of new technology concepts, components and systems, and advanced operational software techniques for future program applications to reduce future program costs and technical risks; initiation of long-lead component and subsystem development. FY 1976 funds will also provide a basis for technical decisions through program planning and integration with the advanced missions studies, contractors, independent research and development efforts and other technology related activity.

The Interim Upper Stage/Space Tug FY 1976 funding will provide for defining NASA unique IUS requirements; performing systems analyses and preliminary subsystem development for the Space Tug; support USAF's evaluation and selection of an Interim Upper Stage (IUS); preparing a Tug Phase B Statement of Work; and supporting the Shuttle Critical Design Review (CDR).

The transition period funding will provide for continuation of the Payload Integration and Mission Analysis tasks; continuation of studies and the development of Spacelab support hardware and software; completion of the acquisition of the equipment and software for CVT, allowing the full system to be brought into operational capability in FY 1977; and continuation of the Advanced Development activities. Definition of NASA-unique IUS software and ground facilities requirements will be continued as well as initiation of a study to define crew training requirements.

Payload Integration and Mission Analysis

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$5,500	$5,500	$5,000	$6,000	$1,800

OBJECTIVES AND STATUS:

Objectives are (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.

To achieve these objectives, the following principal task areas have been identified; 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.

566-537 O - 75 - 9

In FY 1975, STS planning activities have been focused on early Shuttle missions planning, and a preliminary plan has been developed. Payload operations and handling studies have helped to identify operations procedures, interfaces and hardware systems. Study effort is currently underway to identify STS/payload ground and flight interface/ancillary support hardware which would be more easily furnished from a standard inventory of equipment rather than by individual payloads.

This class of hardware has been identified as "multiuse mission support equipment." Initial identification of this equipment will be completed during FY 1975, leading to the preparation of an overall development plan defining equipment need dates, development lead times and funding requirements. During FY 1975, payload descriptions are being updated and refined. In addition, preliminary design reviews of the Space Shuttle have been conducted and are planned for the Spacelab and the launch and recovery facilities to analyze the compatibility of payload and STS interfaces. Planning activities for the first Spacelab mission were supported, and preliminary definitions of the first two years of Shuttle operations were developed. Contact is being maintained with the user community to determine new requirements for STS capabilities. The feasibility and cost effectiveness of various alternatives for orbital servicing of automated spacecraft are being studied. Analyses to development reimbursable policies and procudures for the Space Transportation System are being continued.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The current estimate reflects an adjustment made to accommodate Congressional appropriation action reducing NASA's FY 1975 budget request. As a result, the scope of effort has been reduced through across-the-board deferral of project content.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

In FY 1976, study efforts will be concentrated on defining payload 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

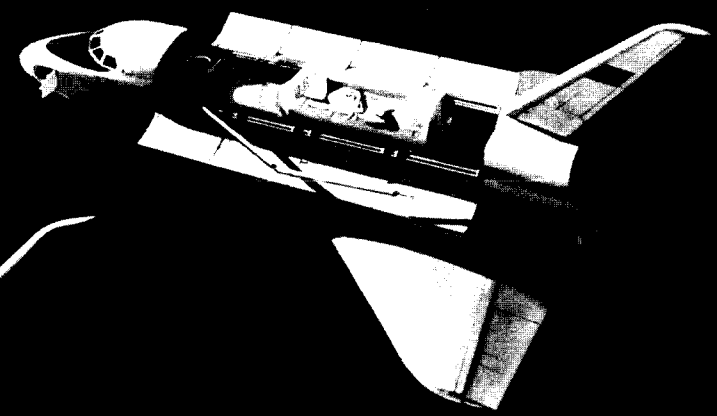
	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$2,500	$2,500	$2,000	$6,100	$1,900

OBJECTIVES AND STATUS:

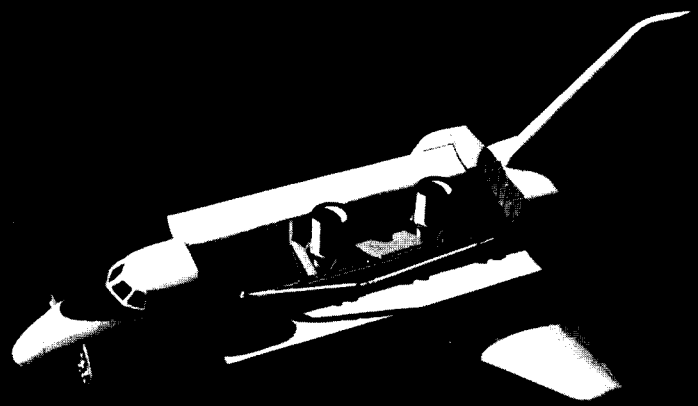
The Spacelab will be a versatile payload carrier to be flown to and from space in the cargo bay of the Space Shuttle. Spacelab will allow researchers and scientists to conduct their experiments personally in a space environment, and, in some cases, to use their ground-based laboratory equipment in space to save additional cost. As part of the President's program of promoting greater international participation in the U.S. space effort, 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 1975 funds are being used to conduct studies at NASA's Marshall Space Flight Center in support of the European Spacelab development effort and NASA utilization plans. Studies include engineering cost trades, payload safety, payload accommodations, software development and payload operations. In addition, Spacelab funding is supporting simulated Spacelab missions using the Convair 990 aircraft to assess low cost payload integration and mission operations concepts. Fiscal Year 1975 funds are also being used to define the crew transfer tunnel to be used in conjunction with the ESRO-developed Spacelab, and to develop certain mock-ups and interface simulators.

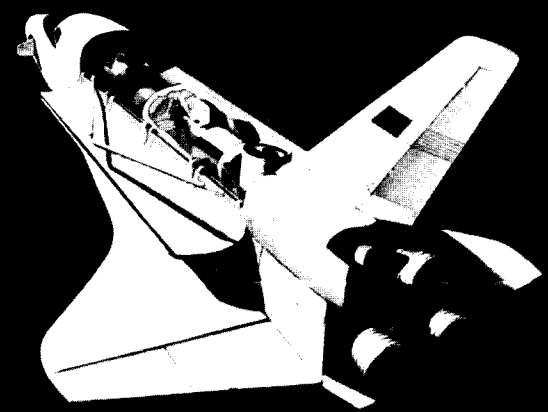
SPACELAB



PRESSURIZED MODULE



PALLET ONLY



PRESSURIZED MODULE AND PALLET

NASA HQ MF74 5113
10-2-74

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 1975 funding is being used for completion of acquisition of the CVT Data Management Subsystem Simulator and development of associated support software. In addition, demonstration experiment activities and testing of commercial equipment for use in Spacelab are being carried out in FY 1975.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The current estimate reflects an adjustment to accommodate Congressional Appropriations action reducing NASA's FY 1975 budget request. The operational date of the CVT systems for Spacelab simulation will be delayed from June 1976 to March 1977.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

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. Efficient and low-cost techniques for computerized approaches to experiment integration, mission planning, payload specialist training, and payload operations will be included. 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.

In the FY 1976 transition period, funds will be used to continue engineering and logistics studies, and to continue the development of Spacelab support hardware and 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.

Fiscal Year 1976 funds will be used for simulation activities in the CVT Data Management Subsystem Simulator, 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

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$7,500	$6,000	$5,500	$6,500	$2,000

OBJECTIVES AND STATUS:

The objectives of the Advanced Development program are 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.

Advanced Development tasks normally take from three to four years to complete since they involve the use of small numbers of high technology specialists who are pushing the state-of-the-art. In FY 1975, approximately 100 advanced development tasks are under contract to industrial firms, universities, research institutions, and other Government agencies. These tasks are for initiation or continuation of development activities on communication and information management systems; operations, maintenance, and safety requirements; advanced propulsion components; rendezvous and docking systems; new software systems; lightweight structures and materials; thermal control systems; space power systems; guidance and control hardware; and computer aided design capability.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The current estimate reflects an adjustment to accommodate Congressional Appropriation action reducing NASA's FY 1975 budget request. Since most of the available funding is committed to the continuation of efforts in progress, most of the new activities planned for FY 1975 have been deleted or deferred.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

Fiscal Year 1976 efforts will continue the ongoing activities described and will be directed toward 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.

Specific task activities will include:

Orbital Operations - Development and evaluation of the use of a laser radar for automatic rendezvous and docking; development of advanced laser gyro concepts; and development of a light weight highly reliable modular computer for long duration multi-use, Tug type upper stage guidance and control applications.

Thermal Control - Design of inflatable, deployable radiator systems to improve the Space Transportation System future mission capabilities; simplification of thermal control components for use by the Tug and other future, long-life, reusable spacecraft.

Propulsion and Power - Design and test of components to increase life and thereby reduce costs; initiation of testing of Shuttle fuel cell elements to determine their applicability to low power use associated with potential Tug application.

Communications and Information Systems - Development of S-band and Ku-band communication systems with emphasis on flush mounted electronically steerable antennas to eliminate large mechanically steered antennas; development of wide-band high data rate information processing systems to handle the large volume of data expected from Spacelab and IUS/Tug deployed payloads.

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

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
---	$1,500	$1,000	$3,400	$700

OBJECTIVES AND STATUS:

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 U.S. 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 U.S. 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.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The current estimate reflects an adjustment to accommodate Congressional Appropriations action reducing NASA's FY 1975 budget request. The initiation of Tug simulation and demonstration effort will be defered to FY 1976.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

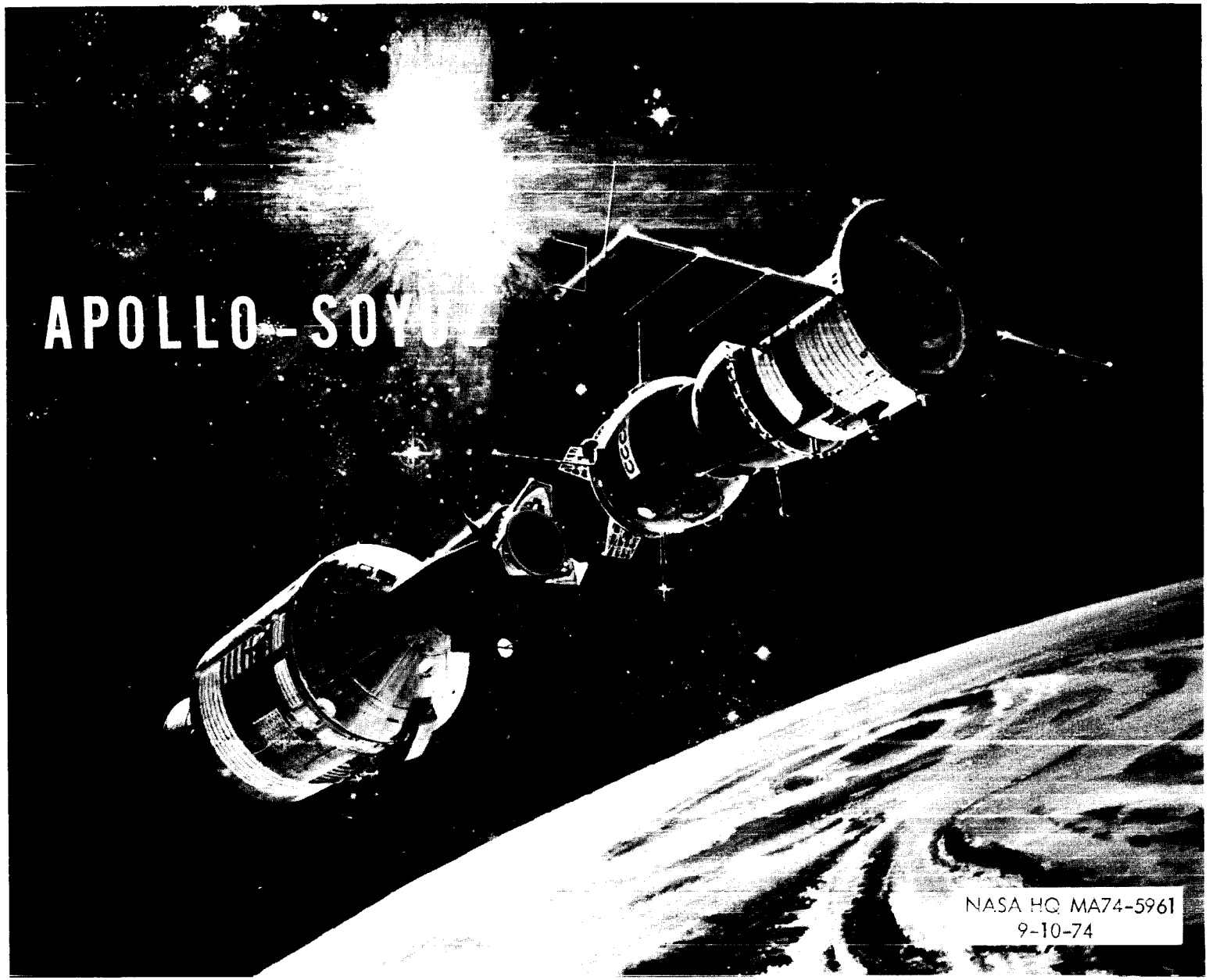
NASA activity in FY 1976 will support the U.S. Air Force's evaluation of the current IUS system studies for the selection of a concept for the validation and development phases. Studies to define NASA-unique IUS/Tug software requirements will be based on the operations studies currently in progress. 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 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.

Apollo Soyuz Test Project

		1975			
	1974	Budget Estimate	Current Estimate	1974	Transition Period
		(Thousands of Dollars)			
Command and service module	$18,300	$8,000	$6,000	---	---
Docking module and docking system	16,000	3,400	4,400	---	---
Experiments	12,000	5,000	4,000	---	---
Launch vehicle	13,000	32,500	32,500	---	---
Launch operations	14,200	45,000	45,000	---	---
Flight support and operations	16,500	20,700	17,700	---	---
Total	$90,000	$114,600	$109,600	---	---

566-537 O - 75 - 10


APOLLO-SOY
NASA HQ MA74-5961
9-10-74

OBJECTIVES AND STATUS:

The Apollo Soyuz Test Project (ASTP) is a joint endeavor of the United States and the Soviet Union as part of the agreement on cooperation in space which the President signed in Moscow in May of 1972. Both countries have agreed to develop compatible rendezvous and docking systems and to test these systems in orbit with a joint experimental mission in mid-1975 to rendezvous and dock a manned Apollo spacecraft with a manned Soyuz-type spacecraft. These compatible rendezvous and docking systems will provide a basis for possible future joint manned space activity as well as space rescue. Each nation has separately developed docking systems based on a mutually agreeable single set of interface design specifications.

The major new U.S. program elements are a docking module and docking system necessary to achieve compatibility of rendezvous and docking systems with the USSR developed hardware on a Soyuz spacecraft. The docking module and system together with an Apollo command and service module (CSM) will be launched on a Saturn IB launch vehicle. The docking module and the docking system will be stowed in the spacecraft launch vehicle adapter and extracted by the CSM while in earth orbit in a manner similar to that used with the lunar module on an Apollo lunar mission.

The primary objective of the mission is to conduct space experiments to test the technical requirements and solutions for compatibility of systems for rendezvous and docking in orbit. More specifically, this includes the testing of a compatible rendezvous system in orbit, verifying techniques of crew transfers and inter-control center activities as well as testing of the universal docking assemblies. During both the docked and undocked phases of the mission, individual experiments covering the fields of earth resources, science, space processing and manufacturing, and life sciences will be conducted.

Joint US/USSR working groups have been meeting on a scheduled basis to review and agree on the technical and operational aspects of the joint project.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The FY 1975 Congressional Authorization for the Apollo Soyuz Test Project was $5 million below the budget request. It was necessary to rebalance the funding plans for the various ASTP project elements to absorb the Congressional reduction and to cover increased requirements for the docking module and docking system activities.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

Fiscal Year 1976 new obligational authority is not required.

Command and Service Module

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$18,300	$8,000	$6,000	---	---

OBJECTIVES AND STATUS:

The Apollo spacecraft is a modified version of the command and service module (CSM) flown during the first several lunar landing missions. Major CSM modifications include additional propellant tanks for the reaction control system and the addition of controls and displays required for the proper operation of the docking module and docking system.

Fiscal Year 1975 funding provides for completion of modifications and checkout and for delivery of the flight spacecraft and launch vehicle adapters to the Kennedy Space Center; modification of the backup spacecraft; and development of compatible rendezvous and docked configuration guidance and navigation programs for the mission, including preflight checkout and verification.

Fiscal Year 1975 funding also provides for inplant engineering support for the flight spacecraft during the space vehicle assembly and checkout, the preparations for launch and the flight mission. Contract administration services provided by the Department of Defense on a reimbursable basis are also included.

Funding will also provide for support of the launch, flight, and mission operations in July of 1976. Post-flight activities in FY 1976 will include deactivation of the returned spacecraft and closeout of the spacecraft contracts, including disposition of property.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The current estimate for the command and service module effort reflects a $2 million downward adjustment as part of the actions necessary to absorb the $5 million Congressional authorization reduction in ASTP.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

Fiscal Year 1976 new obligational authority is not required.

Docking Module and Docking System

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$16,000	$3,400	$4,400	---	---

OBJECTIVES AND STATUS:

The docking module is cylindrical in shape and is approximately 1.5 meters (about 5 feet) in diameter and 3 meters (about 10 feet) in length. It will serve as an airlock for the internal transfer of crewmen between the different atmospheres of the Apollo and Soyuz spacecraft. The docking module will be equipped with radio and TV communications, antennas, stored gases, heaters, and the displays and controls necessary for transfer operations.

The docking module is designed to handle two crewmen simultaneously. Hatches with controls on both sides will be installed at each end of the module. A universal docking system will be located at the Soyuz end of the module and will be capable of functioning with similar components on the Soyuz-type spacecraft.

Fiscal Year 1975 funding provides for final manufacturing checkout of the docking module test and flight articles; required ground testing; and engineering support involved in such activities as the docking module thermal vacuum qualification tests, the joint docking system qualification tests, and the US/USSR final joint docking system equipment acceptance review.

Fiscal Year 1975 funding also provides for development center engineering support for the flight docking module at the Kennedy Space Center during space vehicle assembly, final joint US/USSR docking system preflight compatibility tests of the flight hardware, and support of the docking hardware in preparation for launch, including the final flight readiness review and the flight mission.

Funding will also provide for support of the mission in July of 1975 and subsequent closeout of the docking module and docking system contract including disposition of property.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The current estimate reflects an increase of $1 million, which was transferred from experiments to cover additional requirements in the critical area of docking module and docking system development hardware.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

Fiscal Year 1976 new obligational authority is not required.

Experiments

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$12,000	$5,000	$4,000	---	---

OBJECTIVES AND STATUS:

During the ASTP mission, important new experiments covering the fields of earth resources, science, space processing and manufacturing and life sciences will be conducted.

In the area of earth resources, experiments covering earth observations, doppler tracking, geodynamics and stratospheric aerosol measurements will be conducted.

In the field of scientific experiments, six experiments will be carried, covering extreme ultra-violet astronomy, helium glow measurements, ultra-violet absorption, sky-earth x-ray observations, artificial solar eclipse and crystal activation measurements.

Eleven space processing and manufacturing and six life sciences experiments are planned to be conducted. Eight of the space processing and manufacturing experiments involve the operation of a multipurpose furnace and include seven separate experimental samples which are to be processed in the furnace. Also included is the experimentation in electrophoresis processing, a process where an electric field will be used to separate living cells and other biological materials from a flowing medium without decreasing their activity, to determine whether the near zero gravity conditions enhance a similar process now involved in work by the Max Planck Institute in Germany on treatment of cancer by cell transfusions and transplants.

The life sciences experiments include extension of work done in the Apollo and Skylab programs, such as additional study of the phenomena of the cosmic light flashes observed by Apollo flight crews and studies of the effects of zero gravity and radiation on organisms. Studies will also be conducted on pre- and post-flight astronaut blood samples to determine, among other things, immunity retention. There are also joint US/USSR life science experiments planned, such as an experiment designed to determine

the degree of transfer of micro-organism and microflora between crew members and the two spacecraft involved in this mission. This experiment is designed to take advantage of a mission involving two spacecraft launched from widely separated ground environments.

Fiscal Year 1975 funding provides for the continued development, testing, qualification and integration of these experiments into the command and service module and the docking module. The funding also supports participation of the experiment principal and co-investigators in premission planning, crew training and flight readiness reviews. Requirements for data retrieval, reduction and analysis for one year after the mission are also included.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

Early development problems in experiment hardware required the application of more FY 1974 funds than anticipated. These problems were successfully solved in FY 1974, allowing the completion of the experiment program with $1 million less in FY 1975 funds than planned. This amount was reallocated to meet the Docking Module and Docking System requirements.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

Fiscal Year 1976 new obligational authority is not required.

Launch Vehicle

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$13,000	$32,500	$32,500	---	---

OBJECTIVES AND STATUS:

ASTP utilizes residual Apollo-Skylab Saturn IB launch vehicle hardware. The Saturn IB, consisting of an S-IB stage, an S-IVB stage, and an instrument unit, will launch the spacecraft from the Kennedy Space Center into earth orbit for rendezvous and docking with the Soyuz spacecraft.

Fiscal Year 1975 funding provides for launch vehicle stage sustaining engineering, and systems engineering and integration activities. The stage engineering capability will provide those engineering skills necessary to carry out contractor stage design responsibilities. These include continuing development of checkout criteria and requirements; checkout data

analysis and evaluation; required "make-it-work" changes, failure analysis, logistics management and other engineering activities required to support the final ASTF flight readiness review.

Systems engineering and integration activities include launch vehicle flight mechanics and trajectory studies for design and development of the launch vehicle flight program, flight and propulsion performance predictions and structural assessment of the stacked launch vehicle.

Funding will also provide for support of the launch in July 1975 and close-out of launch vehicle contracts, including disposition of property.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

Fiscal Year 1976 new obligational authority is not required.

Launch Operations

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$14,200	$45,000	$45,000	---	---

OBJECTIVES AND STATUS:

Test and checkout operations of the U.S. space vehicle will be conducted at the Kennedy Space Center, with launch to be accomplished from Launch Complex 39B.

Fiscal Year 1975 funding will provide for the continuation of this contractor support, including final assembly of the space vehicle, movement of the vehicle to the launch pad, final checkout at the launch pad, and launch. Funds are also provided for fuels and pressurants to support the space vehicle checkout at the Kennedy Space Center, and the flight mission, and for the systems engineering effort to provide stage and command service module support necessary to meet all test, checkout and flight readiness activities required for the final readiness review and the launch. Funding will also provide for support of the launch in July 1975 and closeout of the launch support contracts, including disposition of property.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

Fiscal Year 1976 new obligational authority is not required.

Flight Support and Operations

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$16,500	$20,700	$17,700	---	---

OBJECTIVES AND STATUS:

Flight support and operations provides for a broad range of essential activities which directly support the ASTP mission.

Fiscal Year 1975 funding covers continued maintenance of camera systems; food and waste systems; bioinstrumentation; and transportation. In addition, this funding provides for the continued procurement of Government-furnished equipment, including space suits, crew provisioning and television; communication and docking system tests and evaluations; and the use of automatic checkout equipment utilized previously on Apollo and Skylab.

Fiscal Year 1975 funding also provides for training of crew and flight controllers on ASTP equipment; maintenance of the docking module trainer; CSM fuels and pressurants to support test and checkout of the CSM and docking module; module and hardware transportation; cartography, and programmatic engineering support for the CSM, docking module, and docking system. In addition, FY 1975 funding also provides mission analysis and recovery planning; language translation capability, including interpreters; and a portion of the operations modifications to the mission control center in support of the mission.

Fiscal Year 1975 funds also provide for the cost of recovery of the crew and spacecraft; and the subsequent closeout of contracts, property disposition, transportation of the hardware returned from the mission and the preparation of final reports.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The decrease reflects a $3 million adjustment as part of the actions taken to accommodate the $5 million reduction in FY 1975 Congressional authorization.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

Fiscal Year 1976 funds are not required.

566-537 O - 75 - 11

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1976 ESTIMATES

BUDGET SUMMARY

OFFICE OF MANNED SPACE FLIGHT — ADVANCED MISSIONS PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Advanced mission studies....	$1,500	$1,500	$1,500	$1,500	$500
Total.....	$1,500	$1,500	$1,500	$1,500	$500
Distribution of Program Amount by Installation:					
Johnson Space Center.....	$576	$500	$450	$600	$200
Kennedy Space Center.....	130	200	150	150	50
Marshall Space Flight Center	575	600	500	600	200
Ames Research Center.....	12	---	---	---	---
Headquarters.....	207	200	400	150	50
Total.....	$1,500	$1,500	$1,500	$1,500	$500

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1976 ESTIMATES

OFFICE OF MANNED SPACE FLIGHT — ADVANCED MISSIONS PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION

The objective of the Advanced Missions program is to conduct study efforts that 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 these studies. Emphasis is given to the utilization of existing systems that can be used to advance the nation's space capabilities at a minimum cost. The Advanced Missions program also includes independent studies of potential new systems and operational concepts.

BASIS OF FUND REQUIREMENTS

		1975			
	1974	Budget Estimate	Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Advanced mission studies...	$1,500	$1,500	$1,500	$1,500	$500

OBJECTIVES AND STATUS

The advanced mission studies are the building blocks for new manned space flight programs. The Skylab, Apollo Soyuz Test Project and the Shuttle were originated and carried through Phase A level studies as a part of the advanced mission studies program. During FY 1971 through FY 1973, the advanced missions studies were devoted almost exclusively to the Space Shuttle and the Space Tug concepts. These programs are now an integral part of the Space Transportation System. With the FY 1974 program, a transition from Space Transportation System studies to exploration of new mission options was initiated.

The FY 1975 study program is examining the requirements for extensions and improvements of the Space Transportation System, and pursuing prior year studies of manned orbital systems concepts and related ground support and flight requirements. The effort to improve cost estimating techniques is continuing by the use of contracted studies to develop new procedures and to expand the data base. Independent studies are being conducted to assess the safety aspects of new systems and operational concepts. Integrated launch site operations for all elements of the Space Transportation System are also being studied.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

The FY 1976 study program will include the exploration of new techniques for geosynchronous and low earth orbit applications with emphasis continuing on studies of manned orbital systems concepts, and on-orbit maintenance and assembly of large free-flying structures, such as solar power arrays, large radio telescopes and mirrors, and antennas. The feasibility of adding a crew module to the Tug for geosynchronous operations will be studied as well as initiation of a study of shuttle hardware utilization and growth options for advanced mission concepts.

During FY 1976, study efforts will also include evaluation of concepts evolving from NASA's long-range planning studies. An integrated approach to launch site operations will also be reviewed to identify problems and solutions associated with processing diverse kinds of modules and payloads.

During the transition period, payloads and launch site analyses will be continued so that an optimum set of capability and operational requirements can be constructed. Studies of orbital maintenance, module integration, and geosynchronous operation will also be continued.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1976 ESTIMATES

RESEARCH AND DEVELOPMENT BUDGET PLAN FOR

SPACE SCIENCE PROGRAMS

Programs	Budget Plan				
		1975			
	1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Physics and Astronomy.....	$94,000	$140,515	$136,315	$155,800	$46,600
Lunar and Planetary Exploration.....	392,482	266,000	266,000	259,900	73,300
Launch Vehicle Procurement.	178,000	140,500	140,500	166,900	40,400
Total.....	$664,482	$547,015	$542,815	$582,600	$160,300

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1976 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE SCIENCE — PHYSICS AND ASTRONOMY PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)				
Large observatories	$19,939	$50,410	$50,770	$62,000	$13,500
Orbiting explorers.	32,787	33,000	33,000	33,000	11,000
Suborbital programs	23,113	25,000	24,500	24,800	7,500
Supporting activities	17,661	28,605	24,715	31,400	11,100
Spacelab science program.....	500	3,500	3,330	4,600	3,500
Total.....	$94,000	$140,515	$136,315	$155,800	$46,600
Distribution of Program Amount by Installation					
Johnson Space Center.....	$180	$975	$850	$1,000	$200
Marshall Space Flight Center....	8,927	50,280	49,505	71,400	20,550
Goddard Space Flight Center....	56,755	55,875	55,419	53,038	17,075
Jet Propulsion Laboratory.....	650	650	628	700	400
Wallops Flight Center.....	2,150	2,850	2,404	2,800	800
Ames Research Center	6,435	6,905	6,927	7,400	1,950
Langley Research Center.....	2,708	1,705	1,358	862	925
Headquarters.....	16,195	21,275	19,224	18,600	4,700
Total.....	$94,000	$140,515	$136,315	$155,800	$46,600

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1976 ESTIMATES

OFFICE OF SPACE SCIENCE — PHYSICS AND ASTRONOMY PROGRAM

FLIGHT SCHEDULE

PROJECT	MISSION	CALENDAR YEAR
Large Observatories:		
Solar Observatories	OSO-I	1975
High Energy Astronomy Observatories	HEAO-A	1977
	-B	1978
	-C	1979
Explorers:		
Space Physics Explorers	Dual Air Density	1975
	Atmosphere Explorer-D	1975
	-E	1975
	International Sun-Earth Explorer-A	1977
	-B	1977
	-C	1978
Astronomy and Astrophysics Explorers	Small Astronomy Satellite-C	1975
	International Ultraviolet Explorer	1976
Suborbital Programs:		
Sounding Rockets	About 65 launches per year	
Balloon Flights	About 40-50 launches per year	

OFFICE OF SPACE SCIENCE PHYSICS AND ASTRONOMY PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION

The major objective of the Physics and Astronomy program is to increase our knowledge and understanding of the Earth's space environment, the sun, stars, and other celestial bodies. Under this program, research is being conducted to investigate the Earth's upper atmosphere and ionosphere, the magnetosphere, and the interplanetary medium. Space-based investigations of cosmic ray, X-ray, gamma ray, ultraviolet, infrared, and radio emissions, not possible from ground-based observatories because of the obscuring effect of the Earth's atmosphere, give us a unique opportunity to study the sun and other celestial bodies. These investigations are the basis for increasing our knowledge 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 techniques ranging from theoretical and laboratory research through aircraft, balloon, and sounding rocket flights to small Explorer spacecraft, large automated observatories, and manned spacecraft. Research teams involved in this 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 and include 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. The Observatories include the Orbiting Solar Observatory (OSO) series, and the High Energy Astronomy Observatories (HEAO) to be launched in 1977-79. The Apollo Telescope Mount (ATM), launched on Skylab in 1973, was 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.

The year 1975 will be a particularly active one with five launches scheduled. The OSO-I represents a considerable advance over its predecessors, by a factor of 900 in resolvable field of view and a factor of 100 in spectral resolution, which should greatly expand our knowledge of the Sun. The third Small Astronomy Satellite (SAS-C) will expand on the discoveries and observations of SAS-A (UHURU). Two Atmosphere Explorer missions (AE-D and E) will investigate the detailed processes which occur as a result of solar energy absorption in the lower regions of the Earth's atmosphere. The Dual Air Density (DAD) Explorer will investigate the uppermost layers of the Earth's atmosphere.

Work is continuing on the HEAO series designed to explore the previously inaccessible regions of celestial X-ray, gamma ray, and cosmic ray sources. These investigations will be carried out with three launches of HEAO in 1977, 1978, and 1979. Advanced technological development and mission planning have commenced on a Solar Maximum Mission (SMM) to take advantage of the next peak of the solar cycle. Work is also underway on Physics and Astronomy projects designed to capitalize on the capabilities of the Space Shuttle. Initial definition studies are underway to define a variety of Astronomy and Space physics payloads for the Shuttle. One of these Atmospheres, Magnetospheres, and Plasmas-in-Space (AMPS), 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.

The funding requested for FY 1976 and the transition period provides for continuation of the on-going program.

BASIS OF FUND REQUIREMENTS

Large Observatories - Summary

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(In Thousands of Dollars)			
Orbiting solar observatories....	$12,763	$7,630	$5,400	$2,600	$500
Orbiting astronomical observatories....	2,326	2,380	2,470	2,800	1,000

536-537 O - 75 - 12

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(In Thousands of Dollars)			
High energy astronomy observatories....	4,850	40,400	42,900	56,600	12,000
Total, Large observatories....	$19,939	$50,410	$50,770	$62,000	$13,500
(Launch vehicle procurement)					
Delta (OSO).....	($3,500)	(---)	(300)	(---)	(---)
Atlas/Centaur (HEAO).....	(---)	($8,900)	($7,000)	($19,500)	($5,100)
Orbiting Solar Observatories (OSO)					
OSO spacecraft.....	$8,689	$4,687	$2,308	$1,154	---
OSO experiments....	4,074	2,943	3,092	1,446	$500
Total, OSO.....	$12,763	$7,630	$5,400	$2,600	$500

OBJECTIVES AND STATUS

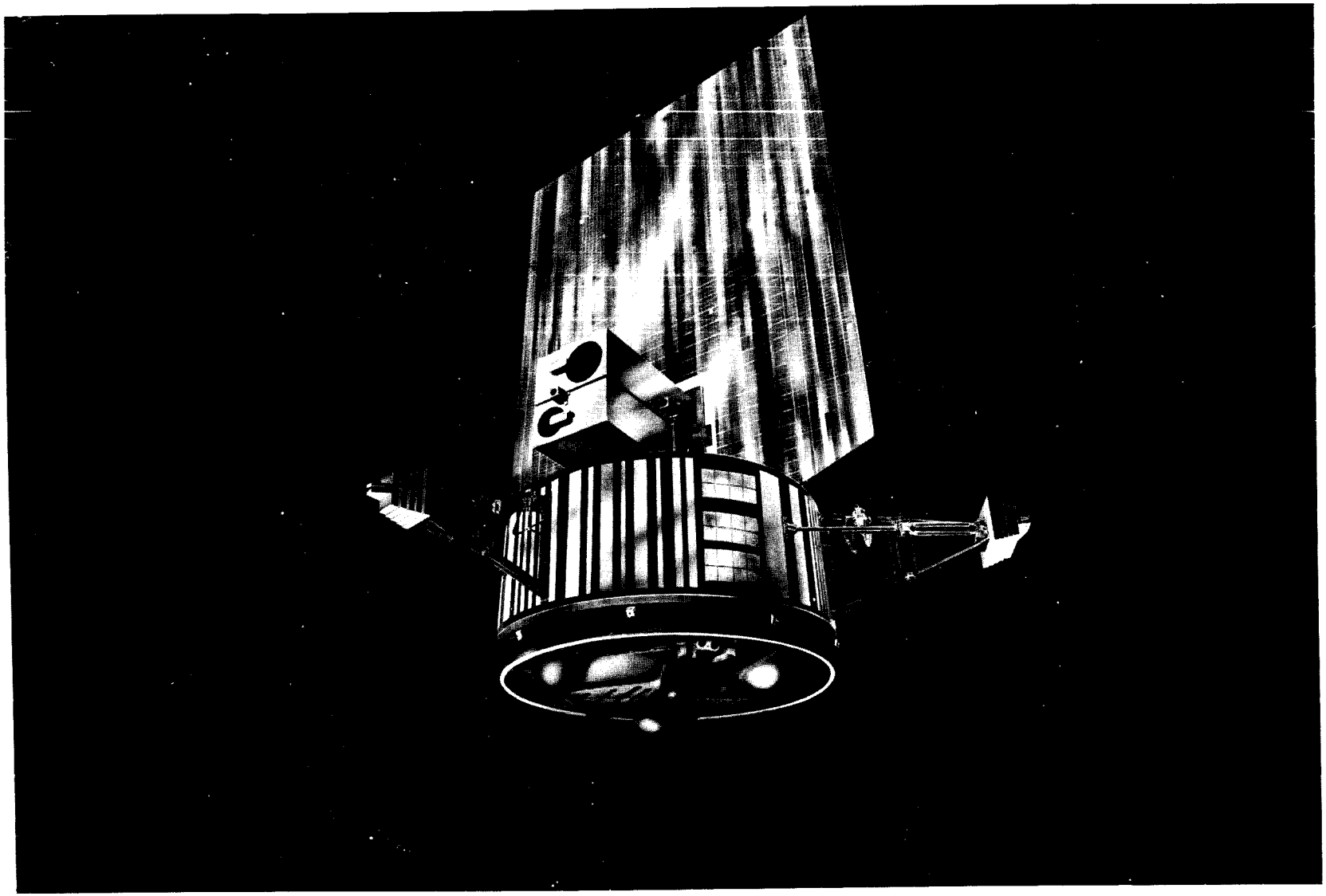
The Sun plays a dominant role in the creation and maintenance of an environment necessary to sustain life on Earth. The objective of the OSO program is to increase our understanding of the basic physical processes of the Sun and of their interaction with the Earth's environment.

The OSO series of missions has provided for a systematic study of the Sun both in terms of its cyclic variations and of a more directed study of spacific phenomena in response to the knowledge gained on previous missions.

The OSO's have provided significant discoveries about the Sun and the Earth, and have provided a foundation for design of the ATM flown on Skylab and for the Solar Maximum Mission proposed for the late 1970's. OSO-7, launched in 1971, took data on the solar corona and the spectrum of solar and cosmic X-rays until operations were terminated in June 1974.

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 provide a substantial increase in spacecraft capabilities over previous solar missions, i.e., by a factor of 900 in resolvable field of view and a factor of 100 in spectral resolution. A comprehensive Guest Investigator Program has been initiated for OSO-I with about 50 investigators from six countries including the USSR.

ORBITING SOLAR OBSERVATORY I (OSO-I)



Fiscal Year 1975 funds are being used for analysis of data from the OSO-7 mission and for the completion, launch, and mission operation of OSO-I.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The reduction in the FY 1975 estimate for OSO reflects a rephasing of requirements; an increase was required in FY 1974, with a corresponding decrease in FY 1975, to maintain assembly and test schedules leading to the planned launch of OSO-I in 1975.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

Fiscal Year 1976 and transition period funds are required for support of the orbital operations of OSO-I, and for the reduction and analysis of the scientific data returned from the experiments.

Orbiting Astronomical Observatories (OAO)

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Program
		(Thousands of Dollars)			
OAO orbital operations, Data analysis....	$2,326	$2,380	$2,470	$2,800	$1,000

OBJECTIVES AND STATUS

Since 1968, the OAO program 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 1975 funds are being used for completion of the OAO-2 data analysis and for the operation and analysis of data obtained from the OAO-3. We are also supporting a Guest Observer Program which enables a broad segment of the astronomical community to use OAO to study celestial objects.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The FY 1975 funding has been increased to provide additional support for the Guest Investigator Program.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATE

Fiscal Year 1976 and transition period funds will be required 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)

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)				
HEAO spacecraft....	---	$22,024	$23,497	$34,009	$7,000
HEAO experiments...	---	18,376	19,403	22,591	5,000
Redefinition of HEAO program.....	$4,850	---	---	---	---
Total, HEAO.....	$4,850	$40,400	$42,900	$56,600	$12,000

OBJECTIVES AND STATUS

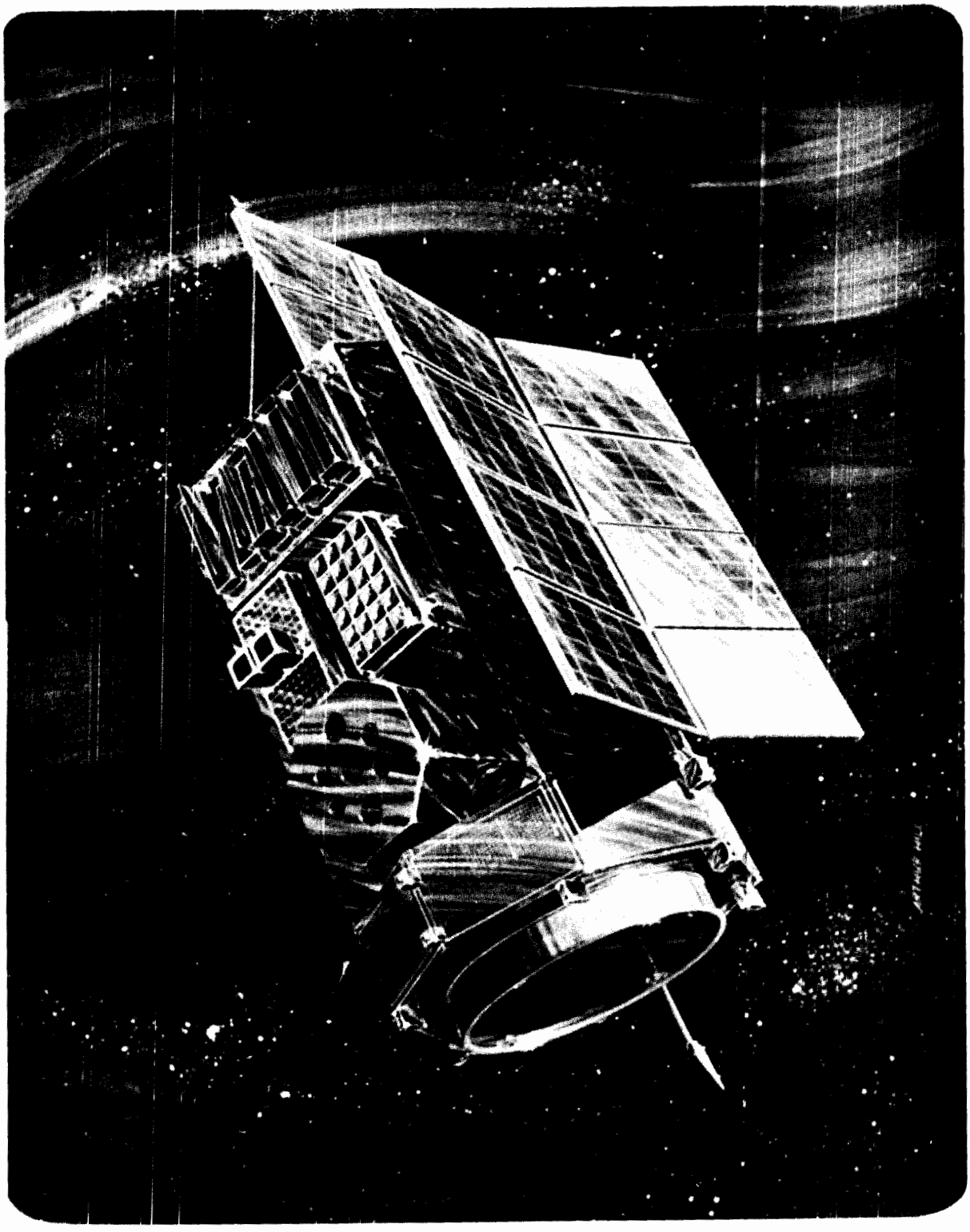
According to the best current theories, nearly one-third of the observable energy existing in the universe is in that portion of the spectrum which contains X-rays, gamma rays, and cosmic rays. The basic scientific objective of the HEAO program is to explore these regions of the universe which cannot be observed from the ground. This program has the potential to enhance our understanding of newly discovered energy processes and of the creation of matter, and thus lead to practical applications of these processes.

Also, it will greatly improve our understanding of observed phenomena such as quasars, pulsars, novae, and supernovae. Various advisory boards, including the President's Scientific Advisory Council and the National Academy of Sciences (Woods Hole Summer Study), have given this program a very high 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 (ETR). Block II will be considered as a future new start to be launched by the Space Shuttle and will carry those heavier and larger types of instruments which Block I cannot accommodate.

About 80 percent of the HEAO subsystem components use existing flight hardware designs from ongoing programs such as OSO, ATM, SAS, and Fleet Satellite Communications (FLTSATCOM). 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 indentified by HEAO-A. The third, HEAO-C, will carry a combination of gamma ray and cosmic ray instruments.

HIGH ENERGY ASTRONOMICAL OBSERVATORY (HEAO)



The FY 1975 funds provide for the detailed design and start of development of the spacecraft and the HEAO-A scientific instruments. Design of the HEAO-B instruments and mirror has also begun and definition of the HEAO-C payload is continuing. Long lead time items, such as telescope mirror blanks, large sodium iodide crystals, star sensors, and tape recorders are being procured. Subcontracts for vendor items have been negotiated and procurements are under way.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The FY 1975 requirements have increased by $2.5 million because of longer lead times for procurement of critical parts and higher labor rates than previously estimated.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATE

The FY 1976 and transition period funds are required 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 - Summary

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)				
Space physics explorers.....	$19,283	$18,420	$18,289	$22,547	$6,600
Astronomy and astrophysics explorers.....	13,504	14,580	14,711	10,453	4,400
Total Explorers..	$32,787	$33,000	$33,000	$33,000	$11,000
(Launch vehicle procurement)					
Delta.....	($6,800)	($6,200)	($9,500)	($5,800)	($1,000)
Scout.....	(---)	(4,450)	(2,800)	(1,000)	(500)

The Explorer program provides 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 contrubutions 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 program 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

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)				
Atmosphere explorers (AE)...	$12,711	$7,480	$7,480	$5,500	$1,200
International Sun-Earth explorers (ISEE).....	---	6,800	6,957	15,000	4,000
Other space physics explorers.....	6,572	4,140	3,852	2,047	1,400
Total.....	$19,283	$18,420	$18,289	$22,547	$6,600

OBJECTIVES AND STATUS

These Explorers provide the means for conducting studies of the Earth's near-space environment. The program requires a wide variety of satellites extending from the very lowest reaches of the upper atmosphere, being investigated by the Atmosphere Explorers, to the interplanetary medium beyond the Earth's magnetosphere, being investigated by the Interplanetary Monitoring Platform (IMP) series.

The program is in a 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 year 1974 was very successful and included the launch in February of a satellite with Italy (San Marco C-2), as well as a Neutral Point Explorer mission (Hawkeye) which was successfully launched in June 1974. In 1975, it is planned to launch the Dual Air Density (DAD) Explorer.

The Atmosphere Explorers (AE) series consists of three missions. The first (AE-C) was successfully launched in December 1973. The second and

third, AE-D and E, will be launched during 1975. Each spacecraft is equipped with an onboard propulsion system which will permit the AE's to dip lower into the Earth's atmosphere than any previous satellite. This region has previously been investigated only by sounding rockets and is an area of increasing concern relative to the stability of the Earth's environment. Data from AE-C have demonstrated that large scale dynamic motions have an important direct bearing on the distribution of pollutants.

During 1974 we initiated a cooperative program with the European Space Research Organization (ESRO), which has been designated the International Sun-Earth Explorer (ISEE). This program consists of two launches in 1977 and 1978, involving three spacecraft which will usher in a new phase of investigation, that of real time cause and effect relationships between the incoming solar wind and its influence on the Earth's environment.

In response to two Announcements of Opportunities issued in the fall of 1974, a large number of proposals have been received from the scientific community for both experiments and complete Scout-class spacecraft. We have selected a number of candidate experiments for inclusion in conceptual studies of spacecraft to be conducted during 1975 under the Supporting Research and Technology program. These include the Electrodynamic Explorer designed to systematically investigate the Earth's electric field for the first time. A Mesospheric Explorer is also being considered to investigate this very critical region of the Earth's environment as it affects the transport of pollutants and the creation and stability of the ozone layer.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The reduction in the FY 1975 estimate reflects savings achieved through the launch of Hawkeye earlier than originally planned.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

Fiscal Year 1976 and transition period funds are required for in-orbit operation of AE-C and D, analysis of data from AE-C and D experiments, and completion and launch of AE-E. In the ISEE project, funds will provide for procurement of hardware, subsystem fabrication, assembly, and test of the ISEE spacecraft. In addition, funds will be required for integration and launch of DAD, in-orbit operation of Hawkeye and analysis of data from Hawkeye experiments, the continued operation and reduction of data from the IMP-J and H launched in 1972 and 1973 respectively, the analysis of data from other missions previously launched, and definition studies of proposed missions.

566-537 O - 75 - 13

Astronomy and Astrophysics Explorers

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)				
Small astronomy satellites (SAS).	$6,500	$4,130	$4,230	$1,638	$500
International ultraviolet explorers (IUE)..	5,608	10,000	10,000	6,500	1,600
Other astronomy and astrophysics explorers.....	1,396	450	481	2,315	2,300
Total.....	$13,504	$14,580	$14,711	$10,453	$4,400

OBJECTIVES AND STATUS

These Explorers provide the means for carrying out astronomical studies relating to the sun, stars, galaxies, and planets which do not require large, complex astronomical observatories. Included here are the Small Astronomy Satellites (SAS); the Radio Astronomy Explorers (RAE); the International Ultraviolet Explorer (IUE), which is an international cooperative effort with the United Kingdom (UK) and ESRO; and cooperative astronomy missions with the UK and the Netherlands (UK-5 and ANS, respectively). The most recent mission, UK-5 and ANS, were successfully launched in October and August 1974, respectively, The SAS-C is scheduled for launch in the spring of 1975.

The Astronomy and Astrophysics Explorers permit the study of various spectral regions of the electromagnetic spectrum. SAS-A, launched in December 1970, was the first satellite devoted to X-ray astronomy and has raised X-ray astronomy to an importance equivalent to traditional optical astronomy. SAS-B, launched in 1972, was the first effective gamma ray satellite and has yielded the most comprehensive data on gamma ray distribution in our galaxy.

The IUE is designed to study, with high resolution, various processes occurring within and near the vicinity of many different ultraviolet emitting objects ranging from the planets to the puzzling quasars. This project has many unique features, including international agreements under which UK and ESRO will provide, respectively, the imaging system and the solar panels for a NASA spacecraft. This equipment, plus a planned ESRO ground station, represents a European commitment of more than $18 million to the IUE project.

As in the case of Space Physics Explorers, a number of proposed experiments have been identified as candidate payloads for inclusion in conceptual studies

of several proposed Explorers during 1975 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). This mission is 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.

CHANGES FROM FY 1975 BUDGET ESTIMATES

The increase in the FY 1975 estimate reflects additional work required to remedy deficiencies disclosed during the final testing of the U.S. experiment on the ANS mission.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

Fiscal Year 1976 and transition period funds will support the analysis of data from SAS-C experiments; the continuation of acquisition, processing, and analysis of data from operational satellites previously launched (SAS-A and B, RAE-B, ANS, and 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 - Summary

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)				
Sounding rockets...	$18,113	$20,000	$19,600	$20,000	$6,200
Airborne research..	4,000	4,000	3,900	3,800	1,000
Balloon program....	1,000	1,000	1,000	1,000	300
Total, Suborbital Program.....	$23,113	$25,000	$24,500	$24,800	$7,500
(Launch vehicle procurement)					
Scout.....	(---)	($1,350)	($1,300)	(---)	(---)

Sounding Rockets

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
(In Thousands of Dollars)				
$18,113	$20,000	$19,600	$20,000	$6,200

OBJECTIVES AND STATUS

The sounding rocket program provides a low cost and versatile tool for scientific research in the suborbital space environment. This program provides broad-based support of all of the scientific disciplines, including the study of cosmic dust and interplanetary matter, magetospheric 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 the Sounding Rocket program 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 programs 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 has been 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 is being placed on the coordination of near-simultaneous lauching of several rocket payloads. Fifty-four sounding rockets were launched during the summer of 1974 at Wallops Flight Center in a cooperative venture with the Air Force Cambridge Research Laboratory (AFCRL) called ALADDIN (Atmospheric Layering and Density Distribution of Ions and Neutrals). Luminescent clouds released by five rockets were observed from the NASA Lear Jets. A major activity during FY 1975 is an expedition to Peru for equatorial aeronomical observations.

In the stellar astronomy area, continuing emphasis is being 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 to be flown in order to make measurements which cannot be made with existing satellites.

The Solar Physics Sounding Rocket program will continue to form an important part of the research in this area of Physics and Astronomy. After the intensive activity related to ATM calibration and collaborative investigations, the emphasis during FY 1975 will now shift to similar activities in support of the OSO-I mission. In addition, new instrumentation for studies of both quiet and active solar features is being developed and tested. Seven Solar Physics Sounding Rockets are planned for this period.

The Gravity Probe-A project, which was initated 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.

CHANGE FROM FY 1975 BUDGET ESTIMATE

The decrease in FY 1975 funding results from a postponement in the procurement of replacement vehicles.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

During FY 1976 and the transition period, there will be a continuation of most of the activities discribed above, with emphasis on the coordination of rocket launches and on correlation with satellite observations. Environmental test for the Gravity Probe-A will be completed, the flight performed, and data analysis initiated.

Airborne Research

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$4,000	$4,000	$3,900	$3,800	$1,000

OBJECTIVES AND STATUS

Research with instrumented jet aircraft has been an integral part of the overall NASA program in physics and astronomy since 1965. The aircraft platform provides a large payload capacity and facilities for extended observations over the entire Earth. It also may be transported readily to high operational altitudes, near 15 Kilometer (Km) (50,000 feet) in order to provide a cloud-free site for geophysics experiments and astronomical observations. The possibility of 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, shirtsleeve 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 have actively participated in the Airborne Research program for over three years utilizing a 30-cm telescope carried on a Lear Jet. This Lear Jet program involves, at present, about ten astronomical groups.

The FY 1975 Airborne Research program funds have been used to complete the operational testing and initiate operations of the Airborne IR Observatory on the C-141A. The Lear Jet astronomical program continues to support infrared astronomy objectives.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The reduction in the level of funding was made possible by the purchase, in 1974, of a Lear Jet, which eliminated the need for budgeting lease costs formerly associated with the Lear Jet activity.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

The FY 1976 and transition period airborne research budget will be used mainly to continue operations of the Airborne Observatory. Requirements cover support for the astronomical groups, acquisition of subsystems, and operation of the C-141A. The Lear Jet program will also be continued.

Balloon Program

1974	Budget Estimate	Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$1,000	$1,000	$1,000	$1,000	$300

OBJECTIVES AND STATUS

In the development of scientific experiments for space flight and other independent scientific missions, it is necessary to test the instrumentation in the space environment and to make observations at altitudes which are not accessible to rockets and spacecraft. In many instances, it is less expensive and more efficient to fly these payloads on balloons. The new "superpressure" balloons, in particular, offer unique opportunities for long duration missions. Approximately one million dollars has been expended annually to support about 40-50 balloon flights a year. These funds provide for balloons, helium and special services. Funding for the experiments is provided from Supporting Research and Technology (SR&T).

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

The FY 1976 and transition period request will support a level of effort approximately equal to FY 1975, although a decrease in total number of flights is possible due to the increased emphasis on more complex payloads, higher altitude requirements, and correspondingly larger balloons and, perhaps most important, the combined effects of inflation and higher costs of petroleum-based products such as balloons.

Supporting Activities

		1975			
	1974	Budget Estimate	Current Estimate	1976	Transition Period
		(In Thousands of Dollars)			
Supporting research and technology (SR&T).....	$12,780	$14,390	$13,800	$14,400	$4,000
Data analysis.....	4,881	5,000	5,000	5,000	1,300
Skylab data analysis	---	1,500	1,400	6,000	1,500
Large space telescope (LST) - advanced technological development.....	---	6,200	3,000	5,000	3,000
Solar maximum mission (SMM) - advanced technological development.....	---	1,515	1,515	1,000	1,300
Total, Supporting Activities.....	$17,661	$28,605	$24,715	$31,400	$11,100

Supporting Research and Technology (SR&T)

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$12,780	$14,390	$13,800	$14,400	$4,000

OBJECTIVES AND STATUS

This effort enhances the overall scientific and technological return from NASA flight projects and helps assure the continued viability of the future research program in space science. The objectives can be stated 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 work 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 include studies of the solar atmosphere and the influence of the Sun on interplanetray and planetary environments, work instrument development, and laboratory and theoretical studies of basic physical processes peculiar to the Sun. Also included are solar radio astronomy projects and research tasks related to objects outside of the solar system, including 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 are also supported in this area.

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. These tasks include continuing studies of advanced missions and Advanced Technological Development (ATD) of solid state detector devices, superfluid helium research, development of improved photometers and support of theoretical investigations.

CHANGES FROM FY 1975 BUDGET ESTIMATES

SR&T funding in FY 1975 has been reduced slightly from the planned level by postponing certain ATD tasks, and mission planning activity, such as that for a follow-on Gravity Probe Mission.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

During FY 1976 and the transition period, continued support will be given to 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 concerning pointing and stabilization, onboard processing, onboard data storage, and detector background will be studied. In addition, studies will be made of advanced techniques for releasing tracers into the upper atmosphere and of such instruments for introducing controlled perturbations into the space environment as spaceborne radio transmitters, electron and ion accelerators and lasers. Basic studies will be continued to define future scientific objectives in astronomy and physics that will utilize the capabilities of early shuttle missions.

Data Analysis

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$4,881	$5,000	$5,000	$5,000	$1,300

OBJECTIVES AND STATUS

The purpose of this effort is to obtain the maximum return on the investment represented by the data gathered in the Space Science program, including that from a number of spacecraft which are operating well beyond their planned lifetimes.

Limited operation of spacecraft, beyond the times originally planned, has made additional data available for specific investigations with preference being given to correlative operations designed to illuminate physical problems, and to the exploitation of unusual opportunities such as unexpected encounters with comets. Further work using existing data is also supported, with emphasis on correlative studies. Under this project, investigators are expected to prepare data, complete with calibrations, in a form suitable for deposit in the National Space Science Data Center.

The operation of the National Space Scinece Data Center is also supported under this project.

566-537 O - 75 - 14

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

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

Skylab Data Analysis

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
---	$1,500	$1,400	$6,000	$1,500

OBJECTIVES AND STATUS

The Skylab Data Analysis project will support the integration of data from ATM and other Skylab experiments, the ATM Guest Investigation Program, and symposia and workshops on ATM results.

The data acquired by the six major ATM instruments, together with that obtained by the worldwide program of complementary ground-based and rocket-borne observations from the most comprehensive set of simultaneous high resolution solar data ever collected. An analysis of these data promises 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 activity and solar wind structure can be studied. These results will prove invaluable in the design of future space efforts oriented specifically toward the understanding of flares.

The Skylab FY 1975 activities are primarily directed toward the reduction and cataloging of the vast quantity of photographic and photoelectric data obtained (over 171,000 photographic images from ATM alone). In addition, 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.

CHANGES FROM FY 1975 BUDGET ESTIMATES

The $100 thousand reduction in the FY 1975 estimate reflects a change in the scope of activities for ATM principal investigators and guest investigators.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

Fiscal Year 1976 and the transition period will see the emphasis in the Skylab Data Analysis Program shift from the basic reduction and preparatory task to data analysis, and the primary support for these activities 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 necessarily result in an extension of this phase over several years. However, the combined efforts of the Skylab scientists and their collaborators in the definition of many scientific objectives will help make this period one of the most productive and exciting ever known in solar physics.

Large Space Telescope (LST)-
Advanced Technological Development (ATD)

	1975			
1974	Budget Estimate	Currect Estimate	1976	Transition Period
	(In Thousands of Dollars)			
---	$6,200	$3,000	$5,000	$3,000

OBJECTIVES AND STATUS

The LST, is under study as a possible future project for a shuttle launched multiple purpose telescope, between two and three meters in diameter, to provide the capability for making unique major advances in astrophysics.

The LST will 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 will 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 the scientific investigations may well contribute to our continued pre-eminence as a high technology society.

In the 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. Since the definition studies are not yet completed, NASA will not be in a position to start the hardware phase until FY 1977.

During the FY 1975 Congressional hearings, NASA was asked to look at lower cost options for the LST and to investigate the possibility of international participation. In response to this request, the contractors which have been studying the Optical Telescope Assembly/Scientific Implementation have been directed to investigate and to recommend methods of reducing the total cost of the LST project.

In November 1974, three aerospace companies-- Boeing Aerospace Company, Lockheed Missiles and Space Company, Inc., and Martin-Marietta Corporation-- were selected to provide the definition studies necessary for a more detailed definition of the Support Systems Module, the spacecraft portion of the telescope, previously studied in-house by the Marshall Space Flight Center. 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 our 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 smaller mirror would mean some reduction in performance, an intermediate system on the order of 2.4 meters (7.9 feet) would clearly represent a significant advance over any existing or planned space telescope.

For the past two years, a team of approximately thirty astronomers has worked with NASA to determine the requirements for the scientific instrumentation to be used in conjunction with the LST. One of the ways to approach a lower cost LST is to reduce the number of instruments. To help us examine this option the instrument definition teams have established a priority list of candidate instruments which could accomplish the scientific objectives outlined for the LST project. This list includes such instruments as the High Resolution Camera (f/24) and the Faint Object Spectograph.

As a part of the NASA response to the desires of the Congress for lower cost options, ESRO and individual European countries were contacted to explore the possibility of their contributing parts of the LST . Pratical areas identified for their participation were the scientific instruments and solar panels. Definition studies are underway at both ESRO and the United Kingdom for scientific instruments they could contribute.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The FY 1975 Budget Estimate has been reduced by $3.2 million in accordance with Congressional direction. This reduction resulted in the deferral of an instrumentation technology task, primary and secondary mirror studies, and several ATD tasks such as fine pointing controls, thermal controls, and analytical studies of the telescope assembly.

BASIS FOR FY 1976 AND TRANSITION PERIOD EXTIMATES

During FY 1976 and the transition period, NASA will concentrate on a specific size and preliminary design for the LST. Careful planning and cost estimating will be performed to insure that the LST can be developed, built and put into operation within the resources and the time schedule projected. Long-term

development such as the sensors and selected ATD will be continued to avoid costly problems later. All of the imformation 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)

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
---	$1,515	$1,515	$1,000	$1,300

OBJECTIVES AND STATUS

The Solar Maximum Mission (SMM) is planned to conduct specific problem-oriented solar scientific research during the next period of maximum solar activity, projected to occur at 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 we 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 emission; 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 line 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.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

During Fiscal Year 1976 and the transition period, it is planned to complete 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

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)				
Space science payload definition..	$500	$3,500	$3,330	$3,500	$900
Spacelab science payload development	---	---	---	1,100	2,600
Total, Spacelab Science Program	$500	$3,500	$3,330	$4,600	$3,500

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

Spacelab Science Payload Definition

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$500	$3,500	$3,330	$3,500	$900

OBJECTIVES AND STATUS

To prepare for the opportunities for scientific investigations in the Shuttle era, Spacelab Science Payload studies are underway which will generate data on which to base priority decisions for initiatives and to

examine the extent to which costs may be reduced for payloads developed for Space Shuttle flight. Initial studies concern 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.

In Atmospheric and Space Physics, a preliminary payload design for the Atmospheres, Magnetospheres, and Plasmas-in-Space Spacelab (AMPS) is in progress. This facility will capitalize on the commonality of instrumentation required for investigations of the dynamics of the near-earth environment in the several disciplines represented. An AMPS Work Group is to provide scientific defintion of this facility.

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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

A reduction in the FY 1975 estimate reflects a change in the level of AMPS study activity planned for FY 1975.

BASIS OF FY 1976 AND TRANSITION PERIOD EXTIMATES

Fiscal Year 1976 and transition period funding will be used to complete the definition of the total 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

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(In Thousnads of Dollars)			
---	---	---	$1,100	$2,600

OBJECTIVES AND STATUS

The first Spacelab flight, which will be a joint effort with the European Space Research Organization, will carry a multi-disciplinary payload. The specific instruments to be flown will be selected from those identified in the Spacelab Science Payload Definition activity which has been funded under the Physics and Astronomy Program since FY 1973.

While Astronomy, High Energy Astrophysics and Solar Physics are included as major program disicpline elements of the overall Spacelab Science Payload Development Program, the emphasis in the intial flight is on Atmospheric and Space Physics. Several prime candidate instruments are incremental building blocks of instruments currently planned for the Atmospheres, Magnetospheres and Plasmas-in-Space (AMPS) mission which is being studied for flight on a later Spacelab mission. The incremental development of these instruments, such as the 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. Selection of these instruments is consistant with the philosophy of providing for an early scientific return while building to the more comprehensive AMPS flight. This allows significant science to be accomplished with hardware which can then be further upgraded and used as part of more specialized payloads at considerable cost savings.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

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.

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1976 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE SCIENCE — LUNAR AND PLANETARY EXPLORATION PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Mariner Venus/Mercury..	$11,135	$4,119	$5,377	---	---
Viking.....	290,437	89,016	89,016	$39,500	$14,000
Outer planets missions.	27,390	69,761	69,761	82,400	22,600
Pioneer/Helios.....	7,005	33,500	33,642	62,600	16,300
Supporting research and technology/advanced studies.....	11,195	14,300	14,300	14,300	3,600
Planetary astronomy....	3,800	4,200	4,200	4,200	1,100
Data analysis.....	1,400	1,400	1,400	1,400	400
Planetary quarantine...	1,500	1,500	1,500	1,500	400
Planetary flight support.....	21,170	25,500	24,900	29,300	8,800
Lunar research program.	17,450	22,704	21,904	24,700	6,100
Total.....	$392,482	$266,000	$266,000	$259,900	$73,300

Distribution of Program Amount by Installation:

Kennedy Space Center...	---	---	$22	---	---
Johnson Space Center...	$8,102	$12,726	10,908	$10,884	$2,839
Marshall Space Flight Center.....	25	---	20	---	---
Goddard Space Flight Center.....	6,380	8,090	8,558	7,553	1,640
Jet Propulsion Laboratory.....	57,371	91,700	90,937	99,397	28,603
Wallops Flight Center..	55	50	55	55	25
Ames Research Center...	9,266	35,722	37,831	64,825	17,057
Langley Research Center	274,273	94,110	94,476	48,914	16,151
Headquarters.....	37,010	23,602	23,193	28,272	6,985
Total.....	$392,482	$266,000	$266,000	$259,900	$73,300

566-537 O - 75 - 15

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1976 ESTIMATES

OFFICE OF SPACE SCIENCE

LUNAR AND PLANETARY EXPLORATION PROGRAM

FLIGHT SCHEDULE

PROJECT	MISSION	CALENDAR YEAR
Pioneer/Helios	Helios A	1974
	Helios B	1976
	Pioneer Venus-Probe Mission	1978
	Pioneer Venus-Orbiter	1978
Viking	Mars 1975 (2)	1975
Outer Planets Missions	Jupiter-Saturn (2)	1977

OFFICE OF SPACE SCIENCE LUNAR AND PLANETARY EXPLORATION PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION:

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 planning 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 flight missions undertaken to date have been highly successful, beginning with the first visit to another planet--the Mariner 2 flyby of Venus in 1962--and continuing with the first successful orbiting of Mars in November 1971 by the Mariner 9. Pioneer 10, launched in March 1972, has now successfully traversed the Asteroid Belt and survived the radiation belts of Jupiter. Pioneer 11, launched in April 1973, has now completed its mission to Jupiter and is at present on its way to Saturn. Both of these missions have provided valuable data on these first trips to Jupiter. Mariner 10, launched in November 1973, successfully gained scientific measurements of Venus and Mercury and was the first spacecraft to use an intermediate planet for the gravity assist required to reach its ultimate objective. 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 extending man's frontier of knowledge about the solar system farther into the outer planets. 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.

BASIS OF FUND REQUIREMENTS:

Mariner Venus/Mercury 1973

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Spacecraft.....	$5,265	$1,332	$1,332	---	---
Science.....	2,303	2,134	2,134	---	---
Mission operations.....	3,567	653	653	---	---
Third encounter support..	---	---	1,258	---	---
Total.....	$11,135	$4,119	$5,377	---	---

OBJECTIVES AND STATUS:

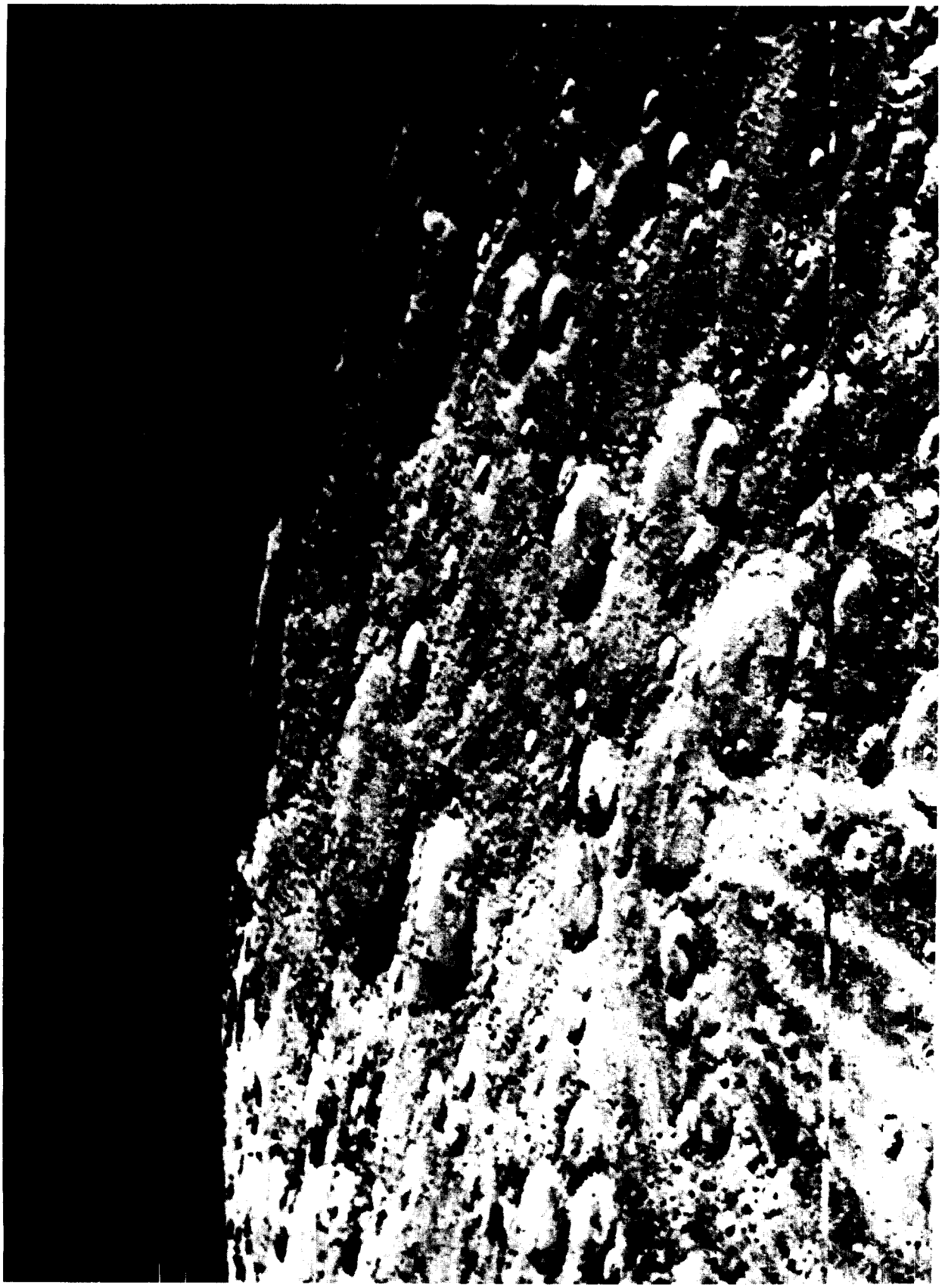
This single Mariner spacecraft was successfully launched in November 1973. It has now successfully completed its swingby of Venus and two encounters with Mercury. The science data gathered to date by this mission has provided valuable insight into the circulation patterns of the upper Venusian atmosphere, yielded important experience in gravity assisted, multiplanet trajectories, and revealed the moon-like topography of Mercury.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

Following the successful completion of the basic Mariner Venus/Mercury (MVM) 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 funds were applied to continue science and mission operations support through the third encounter in March 1975.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

No additional funds are required to complete this mission.



RD 5-5

Viking

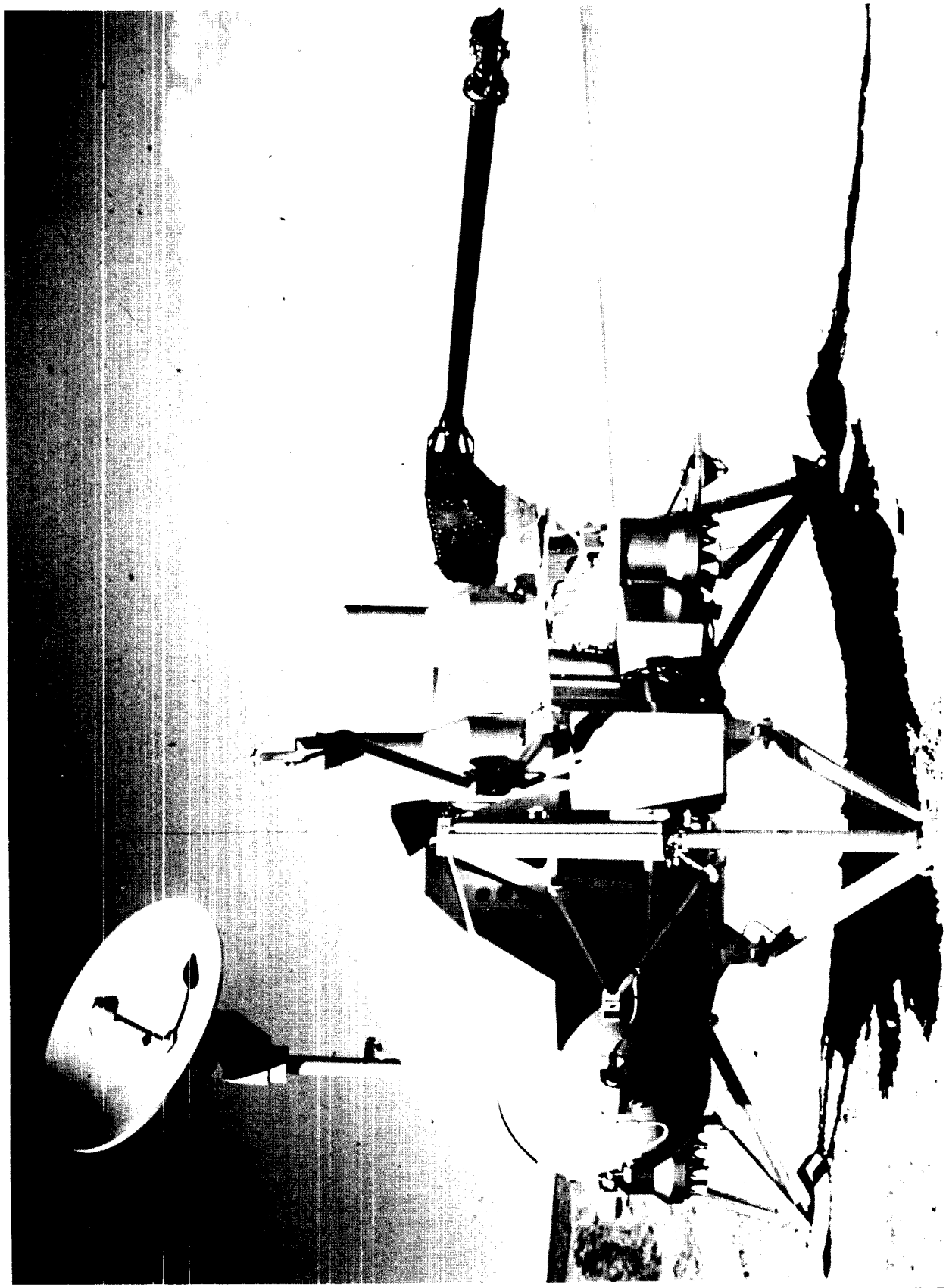
	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Orbiter spacecraft..	$55,450	$26,000	$26,000	$9,200	$7,000
Orbiter science.....	8,320	4,000	4,000	2,100	1,200
Lander spacecraft...	142,892	27,008	27,008	17,700	400
Lander science.....	69,500	14,808	14,808	4,600	1,900
Project management and project integration.....	14,275	17,200	17,200	5,900	3,500
Total.....	$290,437	$89,016	$89,016	$39,500	$14,000
Titan/Centaur (Launch Vehicle Procurement Program).....	($23,000)	($2,400)	($2,400)	($300)	(---)

OBJECTIVES AND STATUS:

The objective of the Viking program is to significantly advance our knowledge of the planet Mars by means of observations from Martian orbit and direct measurements in the atmosphere and on the surface. The Viking 1975 mission will greatly expand the exploration of Mars initiated by the earlier Mariners. Emphasis will be placed 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 shortly after arrival at Mars and descend through the 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, funds are being used to complete the qualification testing of the Lander; to complete the assembly and testing of two flight Orbiters and two flight Landers; and to proceed with software development, training, and the spacecraft final preparations necessary for two launches in the first quarter of FY 1976.



RD 5-7

CHANGES FROM FY 1975 BUDGET ESTIMATE:

Although there was no change in the use of funds appropriated for the Viking project in FY 1975, funding to support FY 1975 activities was made available through reprogramming funds appropriated pursuant to the 1974 Authorization Act. The Congress was apprised of this action in October 1974. The reprogrammed funds were required to solve the technical problems encountered in the guidance computer, biology instrument, and the proof test Lander capsule qualification program.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

In 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, at the start of FY 1976, the two Landers will be sterilized by heat in large ovens. Afterwards, the Landers and Orbiters will be mated and then each combined spacecraft will be encapsulated, transported to Launch Complex 41, and installed on its Titan IIIE/Centaur launch vehicle.

The launch period begins on August 11, 1975, and extends for roughly 40 days. During this period, both the Viking A and B spacecraft will be launched from the single pad to begin the flight operations portion of 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 any 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 first Viking science data to the waiting science analysis teams at the SFOF. The preselected landing sites will be reviewed and the health of the attached Lander determined. If all appears well, after the spacecraft orbit is properly adjusted, the command will be send from earth for the first Lander to make its automatic landing on Mars around July 4, 1976. The second landing will occur about September 4. The nominal mission will end November 8, but an extended lifetime is likely.

Viking will require a large flight team of more than 700 persons 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 maximum scientific information.

Funds requested for FY 1976 and the transition period will be used for the following activities:

Orbiter Spacecraft - These funds will support the final assembly and test of spacecraft hardware, and launch and flight operations.

Orbiter Science - These funds will be utilized for final science tests and integration, science launch and flight operations, science team support, and science image processing and ground data handling.

Lander Spacecraft - The activities funded will be final test and integration, launch preparation and operations, flight operations, and prime contractor periodic award and mission success fees.

Lander Science - Funds requested are to support science launch and flight operations, lander investigation science teams and final assembly, integration, and testing of instruments.

Project Management - Requested funds will be utilized to make final Radioisotope Thermo-Electric Generator payments to the Atomic Energy Commission, to provide trajectory and software verification analysis, to provide for support service contracts, and to provide project reserve funds for problem resolution.

Outer Planets Missions
(Mariner Jupiter/Saturn 1977)

		1975			
	1974	Budget Estimate	Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Project management.....	$2,497	$4,144	$3,806	$4,200	$1,600
Spacecraft design and development.....	13,116	47,503	47,782	58,800	14,800
Science.....	11,372	17,141	16,916	15,200	3,300
Mission operations.....	405	973	1,257	4,200	2,900
Total.....	$27,390	$69,761	$69,761	$82,400	$22,600
Titan/Centaur (Launch Vehicle Procurement Program).....	($19,200)	($9,100)	($9,100)	($33,600)	($4,500)

566-537 O - 75 - 16

OBJECTIVES AND STATUS:

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 only by a special alignment of Jupiter and Saturn. This alignment permits a spacecraft launched to Jupiter to reach Saturn in less than four years 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 mission affords the chance to conduct comparative studies of the Jupiter and Saturn systems, including their satellites and the rings of Saturn, as well as to perform investigations in the interplanetary and interstellar media. One prime target will be the Saturn satellite Titan, which is comparable in size to the planet Mercury and is known to possess an atmosphere.

The use of a Mariner-class spacecraft with its ample power and precise pointing capability will permit the use of science instrumentation which is more sophisticated than that of Pioneer 10 and 11. The spacecraft will weight about 750 kg (1,652 lbs.), will use the Atomic Energy Commission's Multi-Hundred-Watt Radioisotope 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 required increment of injection velocity.

In FY 1975, Mariner Jupiter/Saturn (MJS '77) activities consist of the completion of the mission and systems level design, completion of the spacecraft detailed system and subsystem designs, and completion of the mission operations planning. Hardware fabrication will be completed for those items being obtained from add-on contracts to the Viking Orbiter procurements. By the end of FY 1975, parts will have been acquired and preparation for fabrication of the flight hardware will be underway. The testing of subsystems prototypes will be in process to provide the basis for the critical design reviews.

The Pioneer 10 encounter of Jupiter in December 1973 revealed intense fluxes of high-energy electrons within Jupiter's magnetosphere several orders of magnitude greater than had been predicted. This discovery has led to significant changes to the MJS '77 spacecraft design, with increased shielding and parts substitution undertaken to decrease sensitivity to radiation. Because of the increased scientific interest in the electromagnetic processes occuring within Jupiter's magnetosphere, a plasma-wave investigation was added to the MJS '77 science complement in place of an ultraviolet photometer.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

Changes within the elements of this project in FY 1975 were due largely to the substitution of the plasma-wave investigation for the ultra-violet photometer, a change in the propulsion module thruster configuration, and changes required to accomplish radiation hardening of the spacecraft to enable it to withstand Jupiter's environment.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

Funds requested for FY 1976 and the transition period will be used as follows:

Project Management and Mission Design - Activities will 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.

Spacecraft Design and Development - Critical design reviews of all subsystems, which will begin in the last quarter of FY 1975, will be completed in the first quarter of FY 1976. Prototype fabrication and testing at the subsystem level will be completed coincident with the critical design reviews. Subsystem flight hardware will be fabricated and functionally tested. Type approval testing at the subsystem level will be accomplished during the last half of FY 1976, with some flight acceptance testing being started during the closing months. All engineering subsystems for assembly of the Proof Test Model (PTM) will be delivered to the JPL Spacecraft Assembly Facility and assembly will begin during the last two months of FY 1976. Assembly and testing will continue through the transition period. Computer software for the Command Control Computer, Attitude and Articulation Control Subsystem and the Flight Data Subsystem will be reviewed and accepted in mid-FY 1976. A Development Test Model and a Temperature Control Model will be assembled and tested during the year with results fed into final designs prior to PTM deliveries.

Science - Critical design reviews of all science instruments will be completed. The science activities for FY 1976 and the transition period consist primarily of the fabrication and testing of the science instruments.

Mission Operations - FY 1976 will be devoted to final work on the functional design of the mission operations complex and to initiation of the implementation of that design. Mission Computing System (MCS) computers will be in place 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 -- Summary

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Pioneer Venus.....	---	$27,100	$26,916	$57,600	$15,300
Pioneer 6-11.....	$5,680	5,000	5,326	3,900	900
Helios A&B.....	1,325	1,400	1,400	1,100	100
Total.....	$7,005	$33,500	$33,642	$62,600	$16,300
Centaur (Launch Vehicle Procurement Program)					
Helios.....	($21,600)	($7,100)	($7,100)	($400)	(---)
Pioneer Venus.....	(---)	(---)	(400)	(6,400)	(1,000)
		Pioneer Venus			
Spacecraft.....	---	---	$16,816	$31,400	$8,000
Science.....	---	---	8,900	17,000	4,100
Operations.....	---	---	140	2,400	1,200
Project management.....	---	---	1,060	6,800	2,000
Total.....	---	$27,100	$26,916	$57,600	$15,300

OBJECTIVES AND STATUS:

The objective of the Pioneer Venus program is to conduct scientific investigations of the planet Venus, its atmosphere and its environment. There are two missions in the program: a multiprobe atmospheric mission and an orbiter mission. 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 program. A second objective 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.

The program is structured to achieve its science objectives at the lowest possible cost. Ample weight margins are being allowed to minimize the need for new development. The basic spacecraft will employ many existing subsystems, and will be "standardized" for easy adaptation to either a probe carrier or an orbiter configuration. This commonality concept will serve to minimize the total development cost for the two missions.

The orbiter mission will be launched 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 will be launched with an Atlas/Centaur in August 1978. A 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 synergistic study of the planet.

During FY 1975 funds are being used for spacecraft design, development and start of fabrication of test models.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

Refinements in the estimates for FY 1975 have resulted in a slight overall reduction.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

Spacecraft - FY 1976 and transition period funds will support testing and start of fabrication of flight subsystems.

Science - Funds requested are for fabrication of design verification units, science support, and initiation of flight instruments fabrication.

Operations - Funds requested are for navigation and trajectory analysis and initiation of flight operations software tasks.

Project Management - Funds requested are to support mission design and definition and special mission parameter studies.

Pioneers 6-11

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Spacecraft.....	$1,015	$180	$210	---	---
Science.....	1,735	2,275	2,503	$2,585	$600
Operations.....	2,930	2,545	2,613	1,315	300
Total.....	$5,680	$5,000	$5,326	$3,900	$900

OBJECTIVES AND STATUS:

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 represent the information 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.

Objectives of the Pioneer 10 and 11 missions are to conduct exploratory investigations of the interplanetary medium beyond the orbit of Mars, to determine the nature (distribution, size, and velocity of asteroids) of the Asteroid Belt, and measure the environment and atmospheric characteristics of the planet Jupiter. As the Pioneer spacecraft passed near Jupiter, instruments measured the magnetic fields, electromagnetic emissions, charged particles, and thermal balance associated with this largest planet of the solar system.

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, both during the trip 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.

Tracking of Pioneer 10 will continue as it moves into interplanetary space beyond Jupiter. It is 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 11 will extend its investigation of the outer planets by continuing its flight to the first encounter of Saturn in 1979.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The FY 1975 increase in science and mission operations was the result of the additional analysis and operational support required to retarget the Pioneer 11 spacecraft in its approach to Jupiter so that it could continue its flight to Saturn.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATE:

Science - FY 1976 and transition period funds are required to support the analysis of the scientific data from Pioneers 10 and 11.

Operations - FY 1976 and transition period funds support flight operations, data processing, and mission analysis.

Helios A & B

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Science	$430	$755	$755	$750	$75
Operations.....	895	645	645	350	25
Total.....	$1,325	$1,400	$1,400	$1,100	$100

OBJECTIVES AND STATUS:

The Helios project is an international cooperative project between the Governments of the United States and West Germany. Its scientific 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, weights 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.

Fiscal Year 1975 funds have been used to prepare the instruments for Helios A and to support their integration, testing, launch, and flight operations. Data analysis for Helios A, and preparation of procedures, software and instruments for Helios B are also being supported.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATE:

Science - During FY 1976 and the transition period, support of flight operations and data analysis for Helios A will continue. Helios B testing, launch and flight data analysis will also be supported.

Operations - FY 1976 and transition period funds are required for mission operations planning and for launch and flight operations.

Supporting Research and Technology/Advanced Studies

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Planetary science.....	$4,500	$4,600	$4,600	$4,600	$1,200
Exobiology.....	3,300	3,300	3,300	3,300	800
Planetary advanced studies.....	1,200	1,200	1,200	1,200	300
Planetary advanced technical development	2,195	5,200	5,200	5,200	1,300
Total.....	$11,195	$14,300	$14,300	$14,300	$3,600

The Supporting Research and Technology and Advanced Studies programs furnish essential support to the planning and conducting of flight programs. They serve as the foundation for defining science objectives and mission concepts. The scientific competence necessary for flight programs is established through these programs, and they also assure technological readiness and adequate planning for new projects at their inception.

Planetary Science

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$4,500	$4,600	$4,600	$4,600	$1,200

OBJECTIVES AND STATUS:

This program is subdivided into two major areas of research, planetary atmospheres and planetology. Research conducted under the planetary atmospheres program 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. The supporting theoretical studies and laboratory research necessary to lay the science foundation for future missions is being continued, as are similar tasks exploiting the results of previous flight experiments to arrive at a better understanding of the planets and their atmospheres.

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 in the mid-1970's 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.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATE:

During FY 1976, and the transition period, particular emphasis is being directed toward experiments to determine the planetary surface composition by in-situ and remote sensing techniques; such experiments are candidates for future missions. Emphasis will also be placed on the development of imagery experiments suited to particular requirements of investigations of Mars, Venus, and the outer planets, and on Mars-Earth comparative geology studies. Efforts will be directed toward Mercury-Mars-Earth-Moon analog studies to determine similarities between them.

566-537 O - 75 - 17

Exobiology

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$3,300	$3,300	$3,300	$3,300	$800

OBJECTIVES AND STATUS:

This program is directed toward 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. Work is now being directed toward follow-on exploration of Mars as well as toward investigation and analyses ot the complex and potentially "organic" atmospheres of Jupiter and Titan. The gas chromatograph to fly on Pioneer Venus is also a product of this program. In addition, work has been initiated on problems associated with the analysis and study of returned samples from another planet (e.g., Mars), from the point of view of life and organic molecules, as well as the problems induced by the possibility of back contamination.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

During FY 1976 and transition period, Exobiology will continue to support specific tasks 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 pursue the overall objective of studying other planets for evidence related to the presence of life and/or life related molecules. In addition, feasibility demonstration instruments will be developed for future missions to the planets, and ground-based research will be aimed at aiding in the ultimate interpretation of data returned from such investigations.

Planetary Advanced Studies

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$1,200	$1,200	$1,200	$1,200	$300

OBJECTIVES AND STATUS:

The purpose of the advanced studies project are to define mission concepts that are feasible for performing a systematic exploration of the solar system and to develop a rationale with schedule and resources requirements for conducting such missions in a logical, timely, and cost effective manner. Only with such advance effort can new mission opportunities be identified (e.g., multiple outer planet flyby opportunities) and new flight projects defined to the point where realistic cost estimates can be made. 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.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

The FY 1976 and transition period program includes 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

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$2,195	$5,200	$5,200	$5,200	$1,300

OBJECTIVES AND STATUS:

The Advanced Technical Development (ATD) program supports the planned and the advanced development of new and improved spacecraft technologies critically required for future planetary missions. It is under this program that the detailed planning for potential projects is performed and the technology readiness achieved that will place them on a firm basis for the development of realistic schedules and cost estimates. Methods for achieving cost effective missions through optimum utilization of existing spacecraft and subsystem design are a prime consideration.

During FY 1975 the preproject activities for the Pioneer Venus program were completed. The science payload was defined and instrument feasibility was established. This activity and support of Pioneer-class probe missions to the outer planets were the primary emphasis in FY 1975.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

During FY 1976 and the transition period, efforts to be emphasized will include preproject activity for a Jupiter Uranus mission opportunity in 1979. During that unique year, Jupiter can be used as a springboard to Uranus and even Neptune. Other major aspects of the program during FY 1976 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 major activities will involve the identification of and conceptual solutions for the technological problems peculiar to Jupiter orbital missions. At a lower level of effort, 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

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$3,800	$4,200	$4,200	$4,200	$1,100

OBJECTIVES AND STATUS:

This continuing program makes important contributions to 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-based observatories. Using the techniques of optical, infrared, radio and radar astronomy, observations can be made at almost all wavelengths. The large infrared telescope being built under the Construction of Facilities appropriation will add substantially to our capability. Results from the Planetary Astronomy program both supplement and complement the planetary flight programs.

The objectives of the program are accomplished through research projects which are carried out by the astronomers and other scientists located at NASA centers, universities, observatories, and other organizations.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

In FY 1976 and the transition period, approximately 40 research projects will be conducted, ranging in size from the work of a single investigator to large multifaceted research projects at major observatories. The majority of the research projects require sustained effort over several years.

Major emphasis will be on studies of the outer planets from Jupiter through Pluto. This emphasis reflects our increased knowledge of Venus and Mars and a need for additional information on the other planets to support upcoming flight programs.

A recently completed NASA-supported addition of a high power radar system at the National Astronomy and Ionosphere Center at Arecibo, Puerto Rico, a National Science Foundation (NSF) facility, will be used in a program of planetary radar astronomy. Initial programs will include a study of Saturn's Rings and a high resolution mapping of the surface of Venus.

Planetary Data Analysis

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$1,400	$1,400	$1,400	$1,400	$400

OBJECTIVES AND STATUS:

The Data Analysis program 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, asteroids and comets.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

During FY 1976 and the transition period, major emphasis in Planetary Data Analysis will be placed on conclusion of Mars geological mapping and analysis of the wealth of data obtained during the 11-month period in which Mariner 9 studied Mars, and on the analysis of data obtained by the very successful Pioneer 10 and 11 spacecraft on their Jupiter flybys. The studies of Venus and Mercury 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

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$1,500	$1,500	$1,500	$1,500	$400

OBJECTIVES AND STATUS:

The objectives of the Planetary Quarantine program 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 Committee on Space Research. The results of this program are also required for compliance with Article IX of the Space Treaty of 1966.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

Planetary Quarantine research in FY 1976 and the transition period will emphasize studies of the possibility that terrestrial micro-organisms can survive, but not reproduce, on the Mars surface. Studies of the new environment encountered in outer space that may sterilize spacecraft during transit will be continued. Studies will be supported at a low level, to better define 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. Operations in support of the Viking 1975 mission will be continued in FY 1976 to provide the required support, biological monitoring, and certification for that mission.

Planetary Flight Support

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$21,170	$25,500	$24,900	$29,300	$8,800

OBJECTIVES AND STATUS:

Tracking, telemetry, and command functions which support all planetary flight projects are funded under Planetary Flight Support. Support of these functions requires a highly sophisticated computer complex along with associated terminals, displays, and many other devices. The general purpose scientific and engineering computing at the Jet Propulsion Laboratory (JPL) is also supported with these funds.

Fiscal Year 1975 funds are being used to support Pioneers 6 through 11, including the highly successful Pioneer 11 flyby of Jupiter in December 1974; extended Mariner 10 mission with a second encounter of Mercury in September 1974 and a planned third encounter in March of 1975; the Helios A launch in December 1974 and subsequent Helios flight operations; final preparations for the Viking A and B launches in mid-1975; and beginning of the build-up to support the two Mariner Jupiter Saturn launches in 1977. This level of planetary activity is significantly higher than in 1974.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The reduction to the FY 1975 budget estimate was accomplished by deferring a minor portion of the planned equipment procurement for the support complex in order to partially fund Pioneer 11 retargeting and Mariner 10's third Mercury encounter.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

During FY 1976 and the transition period, funds will be used to continue support of Pioneers 6 through 11, the Helios A mission, and the Viking A and B missions. The 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. Again, this level of activity will be significantly higher than in FY 1975.

Additional activities which will be supported from these funds during FY 1976 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.

5. Selected project-peculiar activities for all projects.

As these activities are not level-of-effort type, they may vary substantially from year to year. Some have been increasing steadily due to the increasing number of spacecraft which are being supported. The increase in funding from FY 1975 to FY 1976 reflects these increasing requirements and the continuing planning and implementation of updating, upgrading, and replacing various parts of the total support complex.

Lunar Research Program - Summary

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Lunar science SR&T...	$2,492	$3,500	$3,901	$4,700	$1,300
Lunar data analysis and synthesis.....	7,277	9,073	7,407	9,600	2,300
Lunar sample analysis	6,067	5,798	5,798	5,600	1,400
Lunar science operations.....	1,614	4,333	4,798	4,800	1,100
Total.....	$17,450	$22,704	$21,904	$24,700	$6,100

In the Lunar program a concentrated scientific effort is underway to analyze and interpret fully the large amount of data available from the lunar flight programs, ground-based 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
Supporting Research and Technology

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$2,492	$3,500	$3,901	$4,700	$1,300

OBJECTIVES AND STATUS:

This program emphasizes scientific studies that provide a broad, sound base for the scientists engaged in analysis and synthesis of lunar data. With the exception of the still-operating Apollo Lunar Surface Experiment Packages (ALSEP) and the Laser Ranging Project, the Supporting Research and Technology (SR&T) program is presently the only source of significant new lunar data. Our 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.

This project also supports the activities of the Lunar Science Institute (LSI) adjacent to Johnson Space Center (JSC) and operated by the Universities Space Research Association (USRA). The LSI acts as a portal to the outside scientific community since it serves as an important data repository facility open to all qualified scientists, and enables these scientists to utilize the extensive scientific equipment at JSC.

Our advanced mission studies are concerned with evaluating, in view of our rapidly expanding knowledge engendered by Apollo and previous lunar flight data, the highest priority unanswered scientific questions and determining the optimum flight systems needed to collect the required data. Apollo surface experiments, returned samples, and data from the orbital experiments showed the existence of major geologic units which can be accurately mapped from orbit. Apollo also found significant gravity and magnetic anomalies.

566-537 O - 75 - 18

We are now in a position to attack these and similar problems and complete the Apollo data set. This can be done by mapping from 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.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The change in the FY 1975 budget estimate reflects an adjustment in the renewal (anniversary) dates of a number of research grants at universities, primarily to permit more orderly and efficient workload and financial planning at the institutions. This effort to bring the anniversary dates for such grants in the SR&T program into a common cycle with those for Lunar sample research and data analysis grants required funding some grants for periods of 14 to 18 months rather than one calendar year.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

Fiscal Year 1976 and transition period funding is required for continued support to Lunar Science ground-based efforts, including telescopic observations and Lunar Science Institute activities. Definition studies will continue to examine the 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

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$7,277	$9,073	$7,407	$9,600	$2,300

OBJECTIVES AND STATUS:

The immediate objective of this work 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 our knowledge of the origin, present characteristcs, and history of the moon. The longer term objective is to integrate such knowledge with that from terrestrial, planetary and solar studies, in order to gain a better understanding of the earth and the solar system.

During the Apollo flight phase of the program, the primary scientific effort was limited largely 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 program of interdisciplinary analysis and synthesis which will provide the major scientific pay-off from the lunar flight programs. This new data analysis and synthesis program is receiving enthusiastic support from researchers with broad scientific backgrounds who desire to utilize these data in attacking the major problems of lunar orgin and history.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The FY 1975 estimate change reflects two factors: first, several ALSEP experiments ceased to function and data reduction funds for Principal Investigators were reduced; second, the funding for some data analysis and synthesis grants was rephased, resulting in a net reduction in FY 1975 funding.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

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

Also supported will be the Apollo Lunar Surface Experiment Package (ALSEP) Principal Investigators who are still reducing and analyzing the data received from the five ALSEP's operating on the lunar surface. Support is included for the lunar 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 end point of this work is the cartographic products needed to support the present and future lunar scientific efforts.

Lunar Sample Analysis

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$6,067	$5,798	$5,798	$5,600	$1,400

OBJECTIVES AND STATUS:

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 have 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.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

During FY 1976 and the transition period, it is planned that this project will continue to support the current level of 109 domestic Principal Investigators and 37 foreign investigators, as well as over 700 co-investigators. The funds are used to provide for salary support, computer efforts, supplies, and instruments for only the U.S. investigators. In order that major lunar questions can be answered, detailed investigations are being carried out by highly qualified Principal Investigator teams at institutions where unique research capabilities and skills have been developed. The success of the lunar sample program depends on our ability to fund and maintain these centers. In addition, keeping these centers viable will insure that their skills and capabilities are adopted by the scientific community and applied to significant earth applications such as: improved analysis of terrestrial measurements in the fields of biology, medicine or agriculture.

Lunar Science Operations

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$1,614	$4,333	$4,798	$4,800	$1,100

OBJECTIVES AND STATUS:

The full scientific potential of the Apollo Lunar Landing Missions is being realized with the continued operation of the five long-lived Apollo Lunar Surface Experiment Packages (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 minimum 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.

Many of the experiments are still furnishing valid scientific information; no degradation of the retroreflectors has been detected. We will continue to operate these lunar systems as long as they furnish valuable scientific data. Annual reviews of all instruments are being conducted to verify the scientific validity and merit of each experiment. Continued observations under this task require support at Johnson Space Center (JSC): (1) to operate these instruments and to record and format raw data for Principal Investigators, (2) for Principle 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 Sample Curatorial Facility is a major component of the post-Apollo scientific effort. Its operation involves support at Johnson Space Center (JSC) for handling, scoring, 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.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The change in the 1975 budget estimate reflects increases in several elements of cost associated with ALSEP data reduction, including computing rates.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

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 its 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-month system. The primary objectives include the study of physics of the moon, gravitation and relativity, and the physics of the earth. Significant secondary benefits that will increase our understanding of the earth are more accurate measurements of the wobbles of the earth's axis of rotation, which could enhance our capacity for earthquake prediction; and 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 to the Sample Curatorial Facility, will also be provided during this period. It is currently planned to improve the present JSC facility in order to provide increased security and assurance that these irreplaceable materials will not be compromised. As an added precaution a selected portion of this material will be placed in an especially prepared, secondary storage site, remote from the primary curatorial facility.

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1976 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE SCIENCE — LAUNCH VEHICLE PROCUREMENT PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Scout.....	$7,800	$13,800	$12,300	$12,100	$3,400
Centaur.....	106,000	75,000	75,400	113,800	26,400
Delta.....	60,200	47,700	51,800	36,600	10,300
Atlas-F.....	---	---	---	3,400	---
Supporting research and technology/ advanced studies....	4,000	4,000	1,000	1,000	300
Total.....	$178,000	$140,500	$140,500	$166,900	$40,400
Distribution of Program Amount by Installation:					
Kennedy Space Center..	$3,878	$10,415	$11,648	$15,160	$3,000
Marshall Space Flight Center.....	2,255	1,790	200	400	100
Goddard Space Flight Center.....	59,002	42,890	46,488	31,782	8,600
Wallops Flight Center.	---	---	10	10	---
Jet Propulsion Laboratory.....	610	1,015	196	50	100
Langley Research Center.....	7,682	13,465	11,459	12,015	3,100
Lewis Research Center.	102,574	68,675	68,044	102,168	24,700
Headquarters.....	1,999	2,250	2,455	5,315	800
Total.....	$178,000	$140,500	$140,500	$166,900	$40,400

OFFICE OF SPACE SCIENCE

LAUNCH VEHICLE PROCUREMENT PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION

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 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. For a typical mission, vehicle hardware, i.e., the booster, upper stages, shrouds, adapters and other related equipment, is procured under a vehicle hardware category, all of which is readily identifiable with specific mission needs. Under the supporting activities category, launch preparations and operations are conducted, including launch services and engineering analysis for pre- and post-flight activities. 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.

BASIS OF FUND REQUIREMENTS

	Scout				
		1975			
	1974	Budget Estimate	Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Hardware.....	---	$5,800	$4,100	$3,000	$500
Supporting activities.	$7,800	8,000	8,200	9,100	2,900
Total Scout.....	$7,800	$13,800	$12,300	$12,100	$3,400

OBJECTIVES AND STATUS

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.

The prime contractor for the production, checkout, and launch of Scout is the Ling-Temco-Vought Aerospace Corporation located in Dallas, Texas.

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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The change in FY 1975 funding plan is due to rephasing of hardware procurement. This allowed for an overall reduction of $1,500 thousand in FY 1975 Scout requirements.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

Hardware - Funds will be utilized to continue hardware procurement to support Dual Air Density, Heat Capacity Mapping Mission, and the Stratospheric Aerosol and Gas Mission.

Supporting Activities - Engineering and technical support, vehicle test and checkout, launch operations, and maintenance of launch facilities and ground equipment will be funded to support the launch schedule.

Centaur

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Hardware	$63,800	$27,500	$26,000	$60,200	$10,600
Supporting activities	38,400	47,200	49,400	53,600	15,800
Major improvements	3,800	300	---	---	---
Total	$106,000	$75,000	$75,400	$113,800	$26,400

OBJECTIVES AND STATUS

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 orbits. 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 proof launch was conducted in February 1974 to insure confidence in the mating of the Titan and the Centaur stage. The flight demonstrated the compatibility of the mating of the two stages and the adequacy of the Centaur standard shroud. However, a problem did occur in the propulsion system in the Centaur stage, which precluded gaining data applicable to the Viking and Mariner Jupiter/Saturn missions. Subsequently, a second Titan Centaur was successfully launched for 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).

CHANGES FROM FY 1975 BUDGET ESTIMATE

The change in FY 1975 funding plan for hardware is due to rephasing of hardware procurement in support of the High Energy Astronomy Observatory (HEAO) missions.

The change in FY 1975 funding plan for supporting activities is due to additional engineering support 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.

The change in FY 1975 funding plan for major improvements reflects the shift of these funds into supporting activities to carry out the corrective actions referred to above.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

Hardware - Funds are required to continue incremental procurement of hardware to support Helios-B, Viking-A, Mariner Jupiter/Saturn-A and -B, High Energy Astronomy Observatory (HEAO) -A, -B, and -C, and Pioneer Venus-A and -B missions.

Supporting Activities - Funding will be utilized for management and engineering support effort, launch support operations, field services, and to maintain facilities and ground equipment.

566-537 O - 75 - 19

Delta

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Hardware.....	$24,500	$12,800	$17,400	$12,300	$1,000
Supporting activities....	34,700	32,900	34,400	24,300	9,300
Major improvements.....	1,000	2,000	---	---	---
Total.....	$60,200	$47,700	$51,800	$36,600	$10,300

OBJECTIVES AND STATUS

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 experienced a success record of 90 percent. It is presently operational with 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 provides 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.

During 1974, this vehicle system experienced a launch failure in launching the Skynet IIA mission in January 1974, as was covered in our testimony in review of the FY 1975 budget last year. Subsequently, vehicle anomalies occurred during the launches of Westar A in April and SMS-A in May, 1974. 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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The change in FY 1975 funding plan for hardware is due to rephasing of procurement for Nimbus-G, International Ultraviolet Explorer (IUE) and International Sun-Earth Explorer (ISEE) missions, which require earlier obligation of funds than previously anticipated.

The change in the FY 1975 plan for supporting activities is due primarily to the added engineering effort attributable to the launch failure in the Skynet IIA mission and anomalies in the SMS-A and Westar-A missions. Corrective actions such as contamination control, improved vibration testing techniques and procedures and changes in materials and design required additional funds.

The deletion of major improvement activity in FY 1975 is due to the use of these funds for activities associated with the recommendations of the failure review committees.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

Hardware - Funds will be used to continue the hardware procurement contracts initiated in FY 1973 and 1974 and to be initiated in FY 1975 in support of International Ultraviolet Explorer-A (IUE), Nimbus-G, International Sun-Earth Explorer A/B and C (ISEE), and the LANDSAT-C missions.

Supporting Activities - Necessary technical and engineering support, to sustain vehicle test and checkout and launch operations and to support maintenance of launch facilities and ground equipment, will be provided with FY 1976 and transition period funds.

Atlas-F

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Hardware.....	---	---	---	$3,400	---

OBJECTIVES AND STATUS

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) being managed by the USAF for space missions.

BASIS FOR FY 1976 AND TRANSITION PERIOD ESTIMATE

Funds requested for FY 1976 will be used to initiate work to refurbish and modify the Atlas-F for the launch of the Tiros-N meterological satellite. The Tiros-N mission is planned to be launched in early CY 1978.

Supporting Research and Technology/ Advanced Studies

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Advanced studies.....	$1,257	$1,535	$700	$700	$100
Propulsion and energy conversion.....	1,639	1,330	214	50	100
Guidance, control and navigation.....	669	735	---	200	100
Vehicle engineering.....	210	175	52	50	---
Instrumentation and electronics.....	125	125	34	---	---
Structures and materials.....	100	100	---	---	---
Total.....	$4,000	$4,000	$1,000	$1,000	$300

OBJECTIVES AND STATUS

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

In FY 1975, the Advanced Studies program is directed toward investigations of a solar electric propulsion stage for use with the Shuttle/Tug or conventional launch vehicles for both earth orbital and planetary mission application. The SR&T program is directed at improving reliability, cost, and safety of launch vehicles and determining their environmental effects. Activities include testing and evaluation of inertial components and evaluation of the most cost-effective use of new electronic technology in guidance control computer applications.

CHANGES FROM FY 1975 BUDGET ESTIMATE

Decreases in the FY 1975 funding plan are the result of funds having been reprogrammed to meet the more urgent requirements to carry out corrective actions in Centaur and Delta.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

Advanced Studies - Solar electric propulsion advanced studies will be continued. Launch vehicle phase out studies will be initiated in order to insure an orderly transition of our current vehicle usage to the Space Shuttle.

Propulsion and Energy Conversion - Solar array technology for solar electric propulsion and research in solar electric propulsion system capabilities will be continued.

Guidance, Control, and Navigation - Development, test, and evaluation of strap down guidance system components consisting of inertial sensors and computer technology will be continued.

Vehicle Engineering - Investigation of atmospheric effects resulting from effluents produced during vehicle launching activities will be continued.

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1976 ESTIMATES

BUDGET SUMMARY

OFFICE OF APPLICATIONS — SPACE APPLICATIONS PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Weather and climate...	$50,926	$35,000	$36,500	$33,600	$11,700
Pollution monitoring..	11,596	29,800	22,400	19,200	8,700
Earth resources survey	47,488	58,600	60,600	62,030	15,000
Earth and ocean physics.....	10,400	18,500	18,900	26,400	7,800
Space processing.....	2,825	3,500	3,300	3,700	1,200
Communications.....	22,300	8,300	11,000	7,500	2,000
Data management.....	---	4,000	4,000	4,000	1,500
Shuttle payloads.....	4,500	4,500	4,500	3,000	1,500
Advanced applications flight experiments..	4,700	4,700	4,700	4,700	1,300
Applications systems analyses.....	1,265	5,000	5,000	5,000	1,400
Applications explorer missions.....	---	2,600	2,600	5,900	2,600
Earth observation satellite definition	3,000	1,000	1,000	---	---
Total.....	$159,000	$175,500	$174,500	$175,030	$54,700

Distribution of Program Amount by Installation:

Johnson Space Center..	$18,133	$31,700	$32,400	$33,030	$9,500
Kennedy Space Center..	285	1,400	1,200	1,300	200
Marshall Space Flight Center.....	4,155	4,800	7,100	6,500	2,050
National Space Technology Laboratories.	---	200	200	200	50
Goddard Space Flight Center.....	100,285	89,100	92,200	86,400	30,100
Jet Propulsion Laboratory.....	4,757	3,200	9,600	14,400	4,500

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Wallops Flight Center.	$6,267	$7,700	$7,300	$9,300	$1,900
Ames Research Center..	6,598	7,100	5,700	5,400	1,600
Langley Research Center.....	8,749	8,400	8,900	9,300	2,700
Lewis Research Center.	3,935	2,100	2,600	2,500	400
Headquarters.....	5,836	19,800	7,300	6,700	1,700
Total.....	$159,000	$175,500	$174,500	$175,030	$54,700

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1976 ESTIMATES

OFFICE OF APPLICATIONS — SPACE APPLICATIONS PROGRAM

FLIGHT SCHEDULE

PROJECT	MISSION	CALENDAR YEAR
Weather and Climate:		
All Weather Atmospheric Sounding Experiments Satellite	Launch of NIMBUS F	1975
Operational Temperature Sounding Satellite	Launch of TIROS-N	1978
Cloud Imaging from Synchronous Satellites	Launch of SMS-B	1975
Global Atmospheric Research Program	GARP Atlantic Tropical Experiment	1974
	Data Systems Test	1975-76
	First GARP Global Experiment	1977-79
Meteorological Sounding Rockets	Launch about 300 annually	
Pollution Monitoring:		
Oceanographic and Air Pollution Observing Satellite	Launch of NIMBUS G	1978
Earth Resources Survey:		
Earth Resources Technology Satellites	Launch of LANDSAT-B	1975
	Launch of LANDSAT-C	1977
Earth and Ocean Physics:		
Geodynamic Experimental Ocean Satellite	Launch of GEOS-C	1975
Ocean Dynamics Satellite	Launch of SEASAT-A	1978
Laser Geodynamics Satellite	Launch of LAGEOS	1976

FLIGHT SCHEDULE

PROJECT	MISSION	CALENDAR YEAR
Space Processing:		
Sounding Rocket Missions	Launch about 6 annually	
Communications:		
Cooperative Applications Satellite	Launch of CAS-C	1975
Applications Explorers:		
Heat Capacity Mapping Mission	Launch of HCMM	1977
Stratospheric Aerosols and Gas Experiment	Launch of SAGE	1979
Reimbursable Missions:		
ITOS*	Launch of ITOS E2-I	1975-1978 (Subject to call-up by NOAA)
GOES*	Launch of GOES A-C	1975-1977 (Subject to call-up by NOAA)
	Launch of GOES D, E, F	1980-1985 (Subject to call-up by NOAA)
NOAA*	Launch of NOAA A-G	1978-1989 (Subject to call-up by NOAA)

* National Oceanic and Atmospheric Administration (NOAA) funded.

566-537 O - 75 - 10

OFFICE OF APPLICATIONS SPACE APPLICATIONS PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION:

The objective of the Space Applications program is to conduct research and development activities that demonstrate the applications of space-related technology, systems and other capabilities which can be effectively applied and used in the civil sector for practical benefits to mankind. Generally, these R&D 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 Application Experiments and Studies.

In each of these areas, programs are being planned to make substantive contributions to solving pressing national problems and meeting national needs.

Weather and Climate - Reliable short- and long-term weather forecasts can mean savings of life, property, and money. The Weather and Climate program is directed toward the application of satellite data to problems in detection, prediction, and early warning of severe storms and the improvement of our capability for mid-range (1-14 days) and long-range (climatic) weather prediction. The atmospheric processes associated with these phenomena, i.e., severe storms, daily weather and climate, require different approaches and differing satellite systems to provide the data to achieve better forecasts. The major activities in FY 1976 and the transition period will be: (1) continued emphasis on applied research and technology; (2) severe storm research; (3) the prototype development of the third generation NOAA operational weather satellite (TIROS-N); and (4) planning for the first international Global Atmospheric Research program experiment to be conducted in CY 1978. A significant activity proposed for FY 1976 is the continued augmentation of the Severe Storm Research program including the definition of STORMSAT. This satellite would observe those short-lived and violent meteorological features which describe and are associated with severe storms, e.g., thunderstorms and tornados, and provide a capability for improved warnings to the population as to their formation and path.

Pollution Monitoring - Man must learn to achieve progress while living in harmony with his environment. The monitoring of the environment is an important aspect of this task. The Pollution Monitoring program has as its objective the development and demonstration of systems capable of identifying and measuring pollutants in the air and water on global and regional scales. This will be done by: (1) determining the present

composition of the atmosphere for use as a baseline against which the long-term trends of atmospheric pollutants can be measured; (2) monitoring changes in the composition from established norms with respect to time and place; and (3) incorporating the data describing atmospheric constituents and their behavior into circulation related environmental quality models

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 stratospheric aerosols and gas concentrations. The information derived will complement that obtained by the Nimbus-G program currently under development.

Earth Resources Survey - The effective utilization of the world's natural resources requires that their extent be surveyed, their changes be monitored and that systems for wisely managing their exploration be constructed. In the Earth Resources Survey area, two objectives have been established: (1) to develop the capabilities for remotely sensing the earth's resources from aircraft and spacecraft in order to perform comprehensive global surveys; and (2) to apply these to oceanography, geology, hydrology, geography, and cartography. Achieving these objectives will provide an information base that can be used in the world's resources management.

Significant activities being continued are involved with the Applications Systems Verification Tests program (ASVT) and Landsat-C. The ASVT program is designed to demonstrate to the user community that remotely obtained information (from satellites and aircraft) provides entirely new capabilities that may efficiently supplement and/or complement existing data gathering systems. The most significant demonstration taking place in FY 1975 and FY 1976 is the Large Area Crop Inventory Experiment (LACIE), an experiment using Landsat data to determine wheat production over the North American continent with possible extension to the entire world. Landsat-C, an Earth Resources Technology Satellite just getting underway, will provide greater resolution and additional information as well as continuity. It will differ from the earlier Landsat 1 and B in that (1) the resolution of the Return Beam Vidicon system will be increased twofold, a change fully supported by the Department of Interior and many other Government agencies, and (2) the Multispectral Scanner will incorporate a thermal sensing capability (Fifth Band), providing better discrimination of both land and water features.

Earth and Ocean Physics Applications - This program provides a focus for the use of space platforms and related research efforts to acquire data on the dynamic qualities of the earth and oceans. The study of ocean dynamics from space provides data for ocean research which can lead to major advances in our ability to predict sea conditions. The benefits of such a predictive capability include improved ship routing, advanced ocean structures design, storm damage avoidance, and coastal protection and development. The SEASAT-A satellite, now under development, is a significant forward step in achieving this predictive capability. Earth dynamics research is centered on the study

of the motions of the large solid plates (tectonic plates) which make up the surface of the earth. The motion of these tectonic plates is one of the causes of large earthquakes. Measurement of these motions using both the LAGEOS satellite which will be launched in 1976 and accurate ground measurements will permit a better understanding of this dynamic process and may lead to an earthquake prediction capability.

Space Processing - The objective of this program is to exploit the unique characteristics of zero gravity 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. These will be directly applicable to industrial and biomedical processes on the ground as well as the unique new products produced in space.

Communications - From the inception of the space age, NASA has engaged in a vigorous research and development effort that has clearly demonstrated the viability of satellite-based communications systems. The current NASA effort is directed toward the development of advanced technology and the performance of the Agency's responsibilities to provide 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 be continued 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 - Data Management activities are directed toward the systematic study, design, development, and demonstration of the technology needed to improve the flow of data from the initial collection by satellite to the user. Satellite systems being developed in the Applications program will require the extension of current technology to accommodate the increased volume, complexity, and exceedingly high rates of data, and reductions in origin-to-user transmission times. The user must also be provided with improved capabilities for rapidly storing, maintaining, and retrieving the required data products.

Applications Experiments and Systems Analysis - 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. This approach avoids the high costs associated with a premature commitment of new technology. Applications studies and systems analyses are undertaken to add assurance that the research and development activities of the Applications program are practical and cost-effective, and based on established user needs and requirements. To accomplish this objective, special emphasis is placed on user-oriented economic analyses and assessments of ongoing and proposed new programs. A major consideration in such investigations is to establish need and economic justification. These are performed as early in the life of a program activity as possible and updated through follow-on studies as more detailed information is developed.

BASIS OF FUND REQUIREMENTS:

WEATHER AND CLIMATE

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
All weather atmospheric sounding experiment satellites (Nimbus 5 and F).....	$16,400	$7,000	$9,300	$3,500	$900
Operational temperature sounding satellite (Tiros-N).....	10,000	9,000	7,500	9,000	2,100
Operational satellite improvements.....	2,500	3,500	3,500	5,000	2,400
Global atmospheric research program (GARP)	5,698	7,400	7,200	7,000	3,000
Meteorological sounding rocket program.....	1,500	1,700	1,500	1,900	600
Severe storm observations satellite (Stormsat) definition studies...	---	---	---	1,500	300
Advanced techniques in observing and forecasting.....	4,828	5,000	5,400	5,700	2,400
Cloud imaging from synchronous satellites (SMS 1 and B).....	10,000	1,400	2,100	---	---
Total.....	$50,926	$35,000	$36,500	$33,600	$11,700

The main objective of the Weather and Climate program is directed toward the application of satellite data to problems in detection, prediction, and early warning of severe storms and the improvement of our capability for mid-range and long-range (climatic) weather prediction. The atmospheric processes associated with these phenomena, i.e., severe storms, daily weather, and climate, require different approaches and differing satellite systems to provide the data to achieve better forecasts. Severe storm forecasting requires the measurement of local atmospheric changes over a period of minutes to hours on an around-the-clock basis, a unique capability of the geosynchronous satellite, while daily and climatic forecasting require an ability to measure detailed changes over extended periods of time on an integrated global basis, a capability of the polar-orbiting satellite.

Severe storm research will apply the continuous observations from geostationary orbit to the problem of detection and prediction of short-lived, violent storms. The short life time of tornadoes, for example, requires high-resolution observations with a frequency on the order of minutes. The capability to selectively measure the atmospheric structure on a nearly continuous basis and improved data manipulation and analyses procedures provide the research tools which will lead to significant improvement in severe storm forecasting.

Satellites making important contributions toward improvements in our weather forecasting capability include the polar-orbiting satellites of the Improved TIROS Operational Satellite (ITOS) series developed by NASA for the National Oceanic and Atmospheric Administration (NOAA); the Synchronous Meteorological Satellite/Geostationary Operational Environmental Satellite (SMS/GOES) series; and the Nimbus research and development polar-orbiting weather satellite series. The polar-orbiting satellites provide quantitative soundings of the global atmosphere for use in numerical weather forecasting, data for advanced research on atmospheric processes, and global viewing of clouds and storm systems. A prototype of the third generation operational satellite of this kind (TIROS-N) is currently under development. The geostationary satellites (the first operational prototype was launched in early 1974) provide continuous viewing of the earth-atmosphere for nearly real-time surveillance of changing weather features.

The Ocean Dynamics Satellite, SEASAT-A, and the Oceanographic and Air Pollution Observing Satellite, Nimbus-G, will also make important contributions to weather forecasting by providing additional data (e.g., sea surface temperatures, wave heights and lengths, surface wind speed and direction, and measurements of the earth's radiation budget and minor atmospheric constituents) essential to the study of the ocean-atmosphere energy exchange processes.

All Weather Atmospheric Sounding
Experiment Satellites (NIMBUS 5 and F)

		1975			
	1974	Budget Estimate	Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Spacecraft.....	$8,161	$3,430	$4,295	$2,500	---
Sensors and data analysis	7,222	2,270	3,432	400	$200
Ground operations.....	1,017	1,300	1,573	600	700
Total.....	$16,400	$7,000	$9,300	$3,500	$900
Delta (Launch vehicle procurement program)...	($1,100)	(---)	(---)	(---)	(---)

OBJECTIVES AND STATUS:

The major objectives of the All Weather Atmospheric Sounding Experiment Satellites (Nimbus 5 and F) are to provide data on a global basis for more accurate long term weather forecasts. Toward this end, sensors aboard Nimbus 5 and F are designed to provide measurements of the atmosphere's structure and composition between the surface and the upper reaches of the stratosphere. Advanced infrared and microwave sensors are being flown to provide all-weather global data with improved vertical resolution and to a higher range of altitudes than previously obtained.

Nimbus F will also provide basic data to assess the role of incoming solar radiation and the earth's outgoing radiation on large-scale weather systems. Another experiment aboard Nimbus F will provide information on tropical and southern hemisphere wind and temperature structures. In addition to the study and analysis of the data from these experiments by the principal investigators, the data is also provided to the scientific community such as participants in the Global Atmospheric Research program, the Goddard Institute for Space Science, the National Oceanic and Atmospheric Administration, and others for further analysis and model development and incorporation into a better understanding of the atmosphere and improved forecasting.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The increase in the FY 1975 Budget Estimate is required due to physical problems experienced in the development of the Nimbus-F payload. Delays in the delivery of several of these instruments also led to delays in the scheduled launch date, thereby increasing spacecraft, sensors and ground system contractor support costs.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

Final Nimbus-F spacecraft pre-launch systems tests were conducted in FY 1975 in preparation for a launch in late FY 1975. Orbital operations and data acquisition and analysis for Nimbus-4 and -5 were also continued during FY 1975.

During FY 1976 and the transition period, some data will continue to be collected and analyzed from Nimbus-5, although primary emphasis will be placed on the collection and analysis of the data obtained from Nimbus-F. Supplementary measurements will be made for the First GARP Global Experiment (FGGE) by tracking and relaying data from approximately 300 balloons through a special Nimbus-F system during the Tropical Wind, Energy Conversion and Reference Level Experiment. Nimbus-F will also serve as a tracking and data relay platform for a large number of globally-distributed remote data sites measuring ice movement and status, ocean current flows and other related data. The ability to accurately track a low earth orbital satellite from a synchronous altitude satellite will be demonstrated in an experiment conducted in conjunction with the Applications Technology Satellite-6. New

and, in some instances, improved techniques for determining on a global basis the status and distribution of ocean conditions, and atmospheric distributions of certain gases will also be demonstrated. It is expected that these techniques and the measurements obtained will significantly improve our knowledge of the factors which influence weather and atmospheric modifications.

Operational Temperature Sounding Satellite (TIROS-N)

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Spacecraft and support...	$6,323	$7,000	$4,482	$5,500	$1,700
Sensor development.....	3,677	2,000	3,018	3,300	300
Operational station equipment.....	---	---	---	200	100
Total.....	$10,000	$9,000	$7,500	$9,000	$2,100
Atlas-F (Launch vehicle procurement program)...	(---)	(---)	(---)	($3,400)	(---)

OBJECTIVES AND STATUS:

The objectives of the Operational Temperature Sounding Satellite (TIROS-N) program are to develop both an advanced operational prototype satellite and the sensors capable of meeting the National Operational Environmental Satellite System and the Global Atmospheric Research program requirements for improved environmental data and better data handling capability. These requirements include a higher resolution day/night capability to make cloud cover observations on a local and global scale; improved observations of vertical temperature/moisture profiles; and a high capacity data collection and relay and platform-location system.

TIROS-N is the R&D protoflight spacecraft for the third generation of operational weather satellites. In accordance with the basic agreement between the Department of Commerce and NASA, the Department of Commerce will fund follow-on operational satellites of the TIROS-N configuration, although NASA will continue to build and launch the spacecraft and then check out spacecraft operations in orbit prior to turning over the operational responsibility to the National Oceanic and Atmospheric Administration (NOAA). The spacecraft which will carry the sensors is a modification of the 5-D spacecraft being built by RCA for the Defense Meteorological Satellite program; NOAA, NASA, and the Department of Defense are all planning to use this spacecraft in order that the costs of a separate development program can be avoided.

The TIROS-N sensors are being developed to take advantage of advancements in technology, particularly in microwave sounding and infrared imagery, to meet the increased requirements indicated above. The microwave sounding capability will provide a means of penetrating the clouds which continually cover much of the earth. Microwave sounding, coupled with infrared imaging, will provide an all-weather, day-and-night measurement capability; such data is fundamental to accurate global numeric weather forecasting. In addition to its complement of sensors, TIROS-N will include an operational data collection system capable of receiving, processing, and retransmitting sensor data from buoys, balloons, aircraft, and remote ground stations. This system will obtain meteorological measurements not otherwise available in tropical and Southern Hemisphere ocean regions for the Global Atmospheric Research program (GARP).

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The reduction in the FY 1975 Budget Estimate is due to a delay in the initiation of the spacecraft development phase incurred to permit more detailed studies of the 5-D spacecraft and the necessary modifications for the TIROS-N configuration to be performed.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

During FY 1975, the TIROS-N sensors continued under development, the spacecraft definition study was completed by RCA, specifications were prepared, and the spacecraft development contract awarded.

Efforts during FY 1976 and the transition period will include the detailed design of the spacecraft structure, spacecraft data handling system, and ground support equipment. Spacecraft subsystem manufacturing, fabrication, and test will be initiated. The development of the sensors will continue, including breadboard buildup and the fabrication and testing of the engineering models. The protoflight sensors will subsequently be tested and delivered to the spacecraft. Contract award for instrument integration, storage, call-up, launch, and post-launch support is also scheduled for this period. Launch is currently scheduled for 1978.

Operational Satellite Improvements

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$2,500	$3,500	$3,500	$5,000	$2,400

566-537 O - 75 - 2

OBJECTIVES AND STATUS:

The objective of the operational satellite improvements program is the conduct of research and development for specific improvements to advanced sensors, spacecraft subsystems, and ground equipment in support of present and future operational satellite systems.

Current developments include modifications to the Vertical Temperature Profile Radiometer (VTPR) now being flown on the NOAA ITOS weather satellite to improve the accuracy and utility of this sensor; modifications of the Advanced Very High Resolution Radiometer (AVHRR) to add a fifth spectral channel to provide improved sea-surface temperatures for operational use, and modifications to the Visible Infrared Spin-Scan Radiometer (VISSR) being flown on the Geostationary Operational Environmental Satellites (GOES) to provide an atmospheric sounding capability. All these efforts are coordinated with the National Oceanic and Atmospheric Administration (NOAA).

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

In FY 1976 these efforts will be continued and development of an all-weather microwave sounding capability for follow-on satellites of the TIROS-N series will be initiated. All-weather soundings of greater accuracy are essential to better numerical weather prediction and must be provided if improved weather forecasts are to result. 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. This effort, based on preliminary work funded under the Advanced Applications Flight Experiment (AAFE) program, is in response to a NOAA requirement for an atmospheric sounder on a geostationary satellite providing data which are improved in both resolution and accuracy for use in severe storm detection and forecasting.

Global Atmospheric Research Program (GARP)

		1975			
	1974	Budget Estimate	Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Data systems test support..	$1,359	$1,340	$1,295	$500	$80
Simulation studies.....	3,098	3,601	4,230	4,800	2,400
First GARP global experiment.....	400	956	156	1,200	450
GARP atlantic tropical experiment support.....	624	1,165	1,074	---	---
Technology support.....	217	338	445	500	70
Total.....	$5,698	$7,400	$7,200	$7,000	$3,000

OBJECTIVES AND STATUS:

The Global Atmospheric Research Program (GARP) is a long-term, world-wide international effort sponsored by the World Meteorological Organization of the United Nations and the International Council of Scientific Unions. The major objectives of GARP are improving the accuracy and length of time over which weather forecasts can be made and understanding the physical processes that affect climate and create climatic change. In pursuing these objectives, the current program centers on the design and testing of a series of atmospheric numerical models to permit an increasingly precise description of atmospheric behavior, and observational and experimental studies of the atmosphere for the design of such models and for the testing of their validity.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

A one year delay in the start of the First GARP Global Experiment resulted in a reduction in overall funding requirements in FY 1975, and allowed additional FY 1975 funds to be provided for simulation studies at the Goddard Institute of Space Studies in support of the GARP Atlantic Tropical Experiment.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

In early FY 1975 NASA participated in the first large-scale international GARP experiment--the GARP Atlantic Tropical Experiment--with the ship Vanguard, the CV-990 aircraft, and the SMS-1, ATS-3, and Nimbus-5 satellites. 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. The Data Systems Test consisted of the simulation of a DST data management system, and the implementation of a data utilization program for application of the data sets; the focus of this work was on uncovering the potential difficulties that may arise in meeting the First GARP Global Experiment objectives.

In October 1974, a preliminary Data Systems Test was completed using wind vector data from the SMS-1 cloud images in real time. Also 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 Rocket Program

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Procurement and launch of research sounding rockets.....	$500	$700	$700	$800	$200
Development of sounding rocket systems.....	200	100	100	---	---
Field experiment support...	800	900	700	1,100	400
Total.....	$1,500	$1,700	$1,500	$1,900	$600

OBJECTIVES AND STATUS:

The major objective of the Meteorological Sounding Rocket program is to explore the atmosphere from 30 to about 100 km to gain a better understanding of its structure and composition, and how it reacts with and affects weather phenomena in the lower atmosphere. Data obtained by rockets at these altitudes are used to study the composition and chemical processes related to upper air pollution, chemical dynamics, and their effects on climate and man's health. Part of the program is a cooperative international effort to obtain and analyze mutually useful data which will permit analyses of upper atmospheric phenomena in both the eastern and western hemispheres such as stratospheric warmings and stimulate the use of the data for practical applications.

Data from meteorological rockets are also used to calibrate temperatures obtained from satellite remote sensors. These comparative data permit corrections to be made to the radiance weighting functions, and thereby produce more accurate temperatures from satellite observations. Improvements of the design and operation of aeronautical and space vehicles flying through the atmosphere and into space also require data on the variations of atmospheric density and circulation, as well as data on sudden stratospheric warmings with major density changes. The detailed vertical resolution obtained from rockets is vital for atmospheric studies and complements global coverage from satellites.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The reduction in the FY 1975 Budget Estimate for Field Experiment Support was made in order that additional FY 1975 effort in severe storm research

might be undertaken. Previously planned activities in Field Experiment Support affected by the reduction have been deferred until FY 1976.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

Development of an improved meteorological rocket system will be completed in FY 1975. This system will reach 80 km instead of the existing 60 km height.

During FY 1976 and the transition period, approximately 65 Nike Cajun, Arcas, and boosted dart-type rockets will be launched at widely separated sites to obtain information about the distribution and concentrations of minor stratospheric constituents. About 38 optical ozone soundings will be made to obtain the vertical profile of ozone during daylight and about 8 chemi-luminescent soundings will be made to obtain the vertical profiles of ozone during night time. Stratospheric ozone is critical because it shields the earth from the dangerous ultraviolet rays emanating from the sun.

Two nitric oxide soundings will be made to obtain the vertical profile of nitric oxide and one payload will be flown to 40 km on a balloon to measure solar spectral irradiance profiles. Nitric oxide is of interest because it is a stratospheric contaminant produced by high-flying aircraft.

Three payloads will be launched to determine the Bremstrahlung ozone source. Additionally, in accordance with the US/USSR Agreement establishing an Eastern and Western Hemispheric meridional network of meteorological rocket stations, a total of approximately 300 improved rockets that will reach about 80 km will be launched from Wallops Flight Center and foreign sites. Wallops Flight Center's field experiment support will provide for an aircraft to fly range safety surveillance. Cooperative assistance will also be provided for a new rocket sounding site in Brazil.

Severe Storm Observations Satellite (STORMSAT)
Definition Studies

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
---	---	---	$1,500	$300

OBJECTIVES AND STATUS:

In a typical year, the U.S. mainland experiences eight tropical storms, 600 tornadoes, 600 damaging hailstorms, and 800 severe local windstorms, with the attendant property damage and loss of life. The capability to selectively measure the atmospheric structure on a nearly continuous

basis along with improvements data handling and analysis will provide the research tools which will lead to significant improvements in severe storm forecasting. The objective of the STORMSAT definition studies 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 meteorological features which describe and are associated with severe storms.

The STORMSAT is planned to be positioned at geosynchronous altitude at a longitude which passes through the middle of the North American continent. It will complement the existing spin-stabilized satellites of the Synchronous Meteorological Satellite (SMS)/Geostationary Operational Environmental Satellite (GOES) system by providing data of higher spatial and temporal resolution required to detect severe storms over the continental U.S. The STORMSAT will have three-axis stabilization which will enable the satellite sensors to be pointed continuously at the earth. The AASIR will be a second generation very high resolution radiometer, and will utilize the telescope and selected other systems of the SMS/GOES Visible and Infrared Spin-Scan Radiometer (VISSR) and the VISSR Atmospheric Sounder (VAS) currently under development in the Advanced Applications Flight Experiments program.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

Definition studies conducted in FY 1976 and the transition period will evaluate the trade-offs associated with sensor integration, the spacecraft characteristics, desired orbital characteristics, appropriate launch vehicle, and the data handling requirements. The results of these studies will provide the necessary information prior to proceeding with the implementation phase. If undertaken as an FY 1977 new initiative, the launch of STORMSAT could occur in 1980.

Advanced Techniques in Observing and Forecasting

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$4,828	$5,000	$5,400	$5,700	$2,400

OBJECTIVES AND STATUS:

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. This effort provides the interconnecting bridge between scientific investigations and the design and development of engineering hardware for both research and operational uses in meteorology.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The increase in the FY 1975 Budget Estimate resulted from an augmentation of severe storm research, especially for increased aircraft surveillance of areas of extreme atmospheric turbulence.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

In FY 1975, research activities are being focused on the development of advanced techniques for observing and forecasting severe local storms, particularly thunderstorms, tornados, and hurricanes, and on the problems of climate variability. Efforts are also directed toward the application of advanced techniques in infrared and microwave sounding of atmospheric moisture profiles to improve understanding of the behavior of the earth's atmosphere. Research will continue on the physical processes of radiative transfer as they affect the earth's heat budget and the quality of the environment.

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, tornados 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.

New investigations will also be initiated to improve numerical weather prediction, using the Nimbus-series satellites' measurements of atmospheric composition, solar radiation, sea-surface temperature, and thermal structure of the earth's atmosphere. To make optimum use of these important descriptive data, improved techniques are being developed for their processing, display, and application to numerical models. 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.

Cloud Imaging from Synchronous Satellites (SMS- 1 and B)

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Spacecraft.....	$8,546	$1,400	$1,225	---	---
Sensors.....	505	---	475	---	---
Ground station support....	949	---	400	---	---
Total.....	$10,000	$1,400	$2,100	---	---
Delta (Launch vehicle procurement program)....	($5,600)	(---)	(---)	(---)	(---)

OBJECTIVES AND STATUS:

The objectives of the Synchronous Meteorological Satellite (SMS) program are to demonstrate a prototype operational system which will meet the requirements of the National Oceanic and Atmospheric Administration (NOAA) to: (1) permit continuous observation of major weather systems routinely, thus enhancing the ability to predict and locate severe short-lived storms; (2) derive important wind field data over large areas and in much less time than heretofore possible; and (3) provide a capability for rapid dissemination of processed meteorological data to local meteorologists.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The increase in the FY 1975 Budget Estimate was required to correct technical problems in the SMS-B spacecraft communications and sensor systems, and in the development of the trilateration ground system. Also, increased funding was necessary to cover increases in launch and post-launch support as a result of the delay in the launch date of SMS-B from mid-1974 to January 1975.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

No funds are requested for FY 1976 and the transition period. The NOAA will fund the operations of SMS-1 and SMS-B, as well as subsequent satellites of this series.

POLLUTION MONITORING

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Oceanographic and air pollution observing satellite (Nimbus-G)....	$8,800	$27,000	$19,000	$15,000	$7,500
Sensor definition and feasibility evaluations, modeling, operational methodology.....	2,796	2,800	3,400	4,200	1,200
Total.....	$11,596	$29,800	$22,400	$19,200	$8,700

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.

For the atmosphere, this effort will focus on providing the technology needed to establish a baseline on the levels and distribution of natural and man-made pollutants. It is presently thought that a disturbance of the atmosphere by aerospace vehicles, aerosol sprays, refrigerants, or other sources of thermal or chemical pollutants could eventually cause a reduction in stratospheric ozone--a trace gas that shields the biosphere from harmful ultraviolet radiation. Thus, global data on atmospheric pollutants and natural constituents are needed to determine both their change and the rate of that change. Data of this type is now being obtained from instruments flown on aircraft; and development of the needed global space observation capability has been initiated. In the area of water quality, a capability is being developed in the area of remote sensing of chlorophyll, pollution, sediment and salinity. Development of instrumentation to provide data on these parameters is now underway.

The Oceanographic and Air Pollution Observing Satellite (Nimbus-G) currently under development and scheduled for launch in CY 1978, will be a major step forward in providing important global data on the pollutants and constituents of the atmosphere and on surface parameters of the ocean. In addition, the Stratospheric Aerosol and Gas Experiment (funded under the Applications Explorer program) will provide complementary data on atmospheric particles. This small satellite will be placed in an orbit designed to permit mapping stratospheric particulates over regions of the globe not covered by Nimbus-G. When the data from both satellites is combined, stratospheric particulates can be mapped over nearly all of the earth.

566-537 O - 75 - 22

Air Pollution and Oceanographic Observing Satellite (NIMBUS-G)

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Spacecraft.....	$74	$11,800	$10,700	$5,500	$2,500
Sensors and data analysis	8,726	14,700	8,000	7,900	4,100
Ground support.....	---	500	300	1,600	900
Total.....	$8,800	$27,000	$19,000	$15,000	$7,500
Delta (Launch vehicle procurement program)...	(---)	($400)	($1,400)	($3,500)	(---)

OBJECTIVES AND STATUS:

The major objectives of the Oceanographic and Air Pollution Observing Satellite (Nimbus-G) are the acquisition of environmental data on a global basis which is integrated, repetitive, and synoptic. This data is required for atmospheric pollution and oceanography investigations and will be applied to studies in the concentration, distribution, and time variation of the atmospheric and oceanic contaminants.

Five sensors on Nimbus-G will provide measurements of important atmospheric gaseous and particulate pollutants. The gases to be measured are directly related to such large-scale pollution problems as the use of fossil fuels and the effect of high altitude aircraft operations on the stratosphere. The gases to be measured include ozone, methane, nitric acid, nitric oxide, nitrogen dioxide, carbon monoxide, carbon dioxide, water vapor, sulfur dioxide and ammonia. In addition, concentrations of particulates will be studied to measure their long-term effects on climate; another experiment will obtain heat budget measurements of the earth for the establishment of thermal baselines and to detect changes, particularly those attributable to the activities of man. The other three instruments will obtain data for use in oceanography investigations to support studies in ocean food sources and surveys of ocean pollution, and to improve our knowledge of the interactions between the ocean and the atmosphere. The measurements to be obtained are: high-accuracy sea-surface temperature measurements; high spatial resolution ocean color measurements near the coastlines (relating to nutrients, pollutants, and salinity); and microwave measurements of the interchange of of moisture and energy between the ocean and atmosphere.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The reduction in the FY 1975 Budget Estimate is due to delays in initiation of the sensors development activities, which permitted the reallocation of $5.0 million to the LANDSAT-C development.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

During FY 1975 contracts for the development of all engineering and flight model sensors are to be let. The spacecraft prime contract was awarded in FY 1975; procurement of long-lead time spacecraft hardware and payload interface studies have been initiated.

During FY 1976 and the transition period, the primary effort will be in the spacecraft and sensor development and fabrication areas. The spacecraft detailed design will commence together with initiation of spacecraft fabrication. All instrument engineering models will be built and tested, and fabrication of the protoflight models will be nearing completion. Fabrication of the flight models will be well underway by late FY 1976. The Nimbus Observatory Processing System for Nimbus-G will be designed and hardware delivery will begin. In addition, software necessary for computer programs and mission operations planning will be initiated.

Sensor Definition and Feasibility Evaluations, Modeling, Operational Methodology

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$2,796	$2,800	$3,400	$4,200	$1,200

OBJECTIVES AND STATUS:

The objective of this effort is to apply aerospace technology to the assessment of environmental quality and to the evaluation of candidate strategies for enhancing air and water quality. This requires study of the unique physical and chemical properties of pollutants and the use of mathematical models to determine how accurately and how frequently such pollutants must be measured. From this information, instruments are developed, demonstrated, and data obtained to validate and update the models. This leads to selection of sensors for monitoring systems and development of prototype systems, frequently in cooperative programs with other Government agencies.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The increase in the FY 1975 Budget Estimate results from an augmentation of the effort in stratospheric research; the additional effort is required to initiate modeling activities on the effects of pollution on upper atmospheric constituents, particulary ozone, and to increase the data analysis activities related to airborne research flights.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

Fiscal Year 1975 activities include, for air pollution, laboratory investigations on the properties of some key gases; in addition, other atmospheric constituents have been identified for detailed study. The data are used with theoretical models to define appropriate sensing techniques. Techniques are also being developed to allow separation of the effects of atmospheric particles from those gases. Existing engineering models of remote sensors for atmospheric constituents are being tested in aircraft.

Fiscal Year 1975 efforts in the remote sensing of water quality involved laboratory measurements of the optical characteristics of water containing known pollutants. The measurements were made to permit judgments concerning ways to discriminate between pollutants and the necessary sensor technology to obtain the required measurements. In addition, plans were developed for a coordinated NASA Stratospheric Research program, for a cooperative program in the Great Lakes Region with the Environmental Protection Agency (EPA) and in the New York Bight with the National Oceanic and Atmospheric Administration (NOAA). Implementation of the first two is expected in late FY 1975.

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. 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

		1975			
	1974	Budget Estimate	Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Earth resources technology satellite (LANDSAT 1 and B).....	$16,400	$11,100	$8,700	$5,300	---
Multispectral scanner 5th band development..	1,000	4,000	4,000	2,000	---
Earth resources technology satellite (LANDSAT-C).....	---	---	5,000	11,000	$3,500
Applications airborne research program.....	16,600	17,300	15,500	13,330	3,600

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Earth resource experiment package (EREP) investigations.....	($3,200)	$3,800	$2,500	$1,500	---
Applications systems verification tests (ASVT).....	---	---	(7,900)	9,300	$2,900
Data interpretation techniques, special investigations and data analyses.....	13,488	22,400	24,900	19,600	5,000
Total.....	$47,488	$58,600	$60,600	$62,030	$15,000

The very serious global energy and food crises are reminders that better information about the planet we inhabit is needed. Better geological data are required for energy exploration. More rapid and accurate agricultural information is needed for crop assessment. What is clearly developing is a need to manage resources and the environment in order to cope with global problems. Satellites containing remote sensors are one of the few means available to provide objective information on a worldwide basis. They have the unique capability of passing over every point on the earth repetitively and acquiring data of value to resource managers.

The Earth Resources Survey program has as its objective the development of the technology for acquiring and interpreting remotely sensed information necessary for large-scale management purposes. A sizeable commitment has already been made to obtain and use satellite acquired earth resources data. Enthusiastic cooperation of government agencies at Federal, State, and local levels as well as in the private sector and in the international arena has developed, and practical applications of remotely sensed data have been demonstrated.

Accomplishments to date include the successful operation of the first Earth Resources Technology Satellite, 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-B. Data from these missions has 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. To demonstrate

the practical values of LANDSAT data for user activities in land use, geological exploration, coastal zone monitoring, world crop surveys, flood mapping and others, an Applications Systems Verification Test program was initiated.

The Application Systems Verification Test program will take the most promising areas of research identified in the LANDSAT-1 program and, in concert with user agencies and resource managers, define, demonstrate and document the application of remote sensing systems on a simulated operational basis. One example is the Large Area Crop Inventory Experiment, being undertaken with the U.S. Department of Agriculture and the National Oceanic and Atmospheric Administration. Because of the increased demand for digital data for these applications, an increased capacity to produce radiometrically and geometrically corrected computer tapes is being established.

Additional data of value for investigations in earth resources will be obtained by the Heat Capacity Mapping Mission. The Heat Capacity Mapping Mission is the first Applications Explorer Mission, and is separately funded under the Applications Explorer Missions program. This satellite will fly the Surface Composition Mapping Radiometer, which will obtain data of sufficient quality to produce thermal maps for discrimination of rock types and mineral resource location.

Earth Resources Technology Satellite (LANDSAT 1 and B)

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Spacecraft.....	$4,917	$3,200	$3,394	$1,100	---
Sensors.....	2,647	---	359	---	---
Ground operations.....	1,381	2,300	2,637	1,900	---
Investigations.....	7,455	5,600	2,310	2,300	---
Total.....	$16,400	$11,100	$8,700	$5,300	---
Delta (Launch vehicle procurement program)...	($3,500)	($1,100)	($1,100)	(---)	(---)

OBJECTIVES AND STATUS:

The objective of the Earth Resources Technology Satellites, LANDSAT-1 and -B, is to frequently and repetitively obtain large-scale images of the earth for the purpose of developing improved means to manage many dynamic resources on a local, regional, and national basis, and as necessary on a worldwide basis. The current program activity is directed

to the demonstration of useful applications of LANDSAT data to significant problems in agriculture, geology, hydrology, ecology, cartography, and oceanography.

The launch of LANDSAT-1 in July 1972 initiated the program of repetitive observations of earth resources from space. The Departments of Agriculture, Interior, Commerce, and Defense actively participated with NASA in planning the overall program as well as by conducting investigations relating to their areas of special interest. As these investigations are nearing their completion, 93 follow-on investigations, consisting more of research teams than individuals, have been selected to conduct more in-depth applications of LANDSAT data.

The multispectral scanner data has continued to be of exceptional technical quality since launch. It has proven to be extremely versatile and valuable for producing map-like images which exceed National Map Accuracy standards at the 1:1,000,000 scale and for its capability to be automatically analyzed by high-speed digital computers. A wide range of crops, land use categories, and important surface features have been automatically classified by using this computer processing technique.

Previously unrecognized major geologic faults related to earthquake epicenters have been detected by LANDSAT-1. Mapping of floods, snow covered areas, and regional water resources has been accomplished. Pollution plumes, strip mining, and reclamation efforts have also been monitored. Observations of coastal water turbidity has been correlated with the location of menhaden fish schools; and sea ice affecting ocean shipping has been mapped and its movement plotted.

The continuity of data provided by LANDSAT-B will broaden the range of user activities in the Federal Government and the overall civilian sector. The additional data will increase the accuracy of the assessments of such phenomena as crops, water, and environmental conditions subject to seasonal effects.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The overall reduction in the FY 1975 Budget Estimate is due to longer than anticipated nogotiations of contracts for the follow-on investigations. Minor increases in the spacecraft, sensors, and ground operations activities have resulted from minor technical problems encountered and an increase in the amount of contractor support required.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

The FY 1975 effort includes continued operations of the LANDSAT-1, support of ongoing and follow-on investigations, and the launch and initial period of LANDSAT-B operations. Selective operation of both LANDSAT-1 and LANDSAT-B is being conducted in order to test the value of more frequent observations

of rapidly changing phenomena, such as crop growth, rangeland grass buildup, and snow melt. The NASA data processing facility is being augmented to provide an increased capacity for producing tape products to meet user requirements. In FY 1975 this augmentation is providing a capability to produce about ten times as many computer compatible tapes as were previously attainable; late in 1976 a capability will be developed to deliver all data received as geometrically accurate computer compatible tapes.

The primary effort in FY 1976 and the transition period will be directed toward the flight operations of the LANDSAT's 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 - Fifth Band Development

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$1,000	$4,000	$4,000	$2,000	---

OBJECTIVES AND STATUS:

The objective of adding a thermal channel to the LANDSAT's primary sensor, the Multispectral Scanner, is to provide a measurement of radiation in the thermal spectrum in addition to the four channels in the visible and near-infrared portions of the spectrum.

The thermal infrared channel will provide the capability required to observe resources and conditions characterized by temperature differences, especially those which require intercomparison with simultaneous observations at visible or near-infrared wavelengths. At the Laboratory for Applications of Remote Sensing at Purdue University, it has been shown that the addition of a thermal channel to the existing four channels of the Multispectral Scanner significantly increases the ability to classify agricultural products. Such intercomparisons also indicate high utility for identification of forest types; mapping and measuring thermal pollution of large lakes, bays, and estuaries; and providing information about moisture content of soils. Observations of ocean temperature differences will also provide data needed for investigations of shoreline changes, fisheries, and coastal circulation patterns.

The need for thermal infrared observations to correlate with those at visible and near-infrared wavelengths was recognized early in the planning of the Earth Resources Technology Satellite. Work was started to develop the hardware but technical difficulties in designing an apparatus to cool the

thermal infrared detector prevented inclusion on LANDSAT-1 or LANDSAT-B. It was decided nonetheless to pursue the development of this important sensor in order to be assured that the thermal channel capability on a future earth resources satellite was technically feasible. It will now be incorporated on LANDSAT-C.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATE:

In FY 1975, work on the instrument continued and a satisfactory passive radiative cooler was built and tested. 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)

		1975			
	1974	Budget Estimate	Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Spacecraft.....	---	---	$4,000	$9,000	$3,200
Sensors.....	---	---	1,000	1,500	200
Ground operations.....	---	---	---	500	100
Total.....	---	---	$5,000	$11,000	$3,500
Delta (Launch vehicle procurement program).	(---)	(---)	(---)	($3,000)	(---)

OBJECTIVES AND STATUS:

The principal objective of LANDSAT-C is to continue the research and development of medium-resolution, multispectral 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 -3. These performance improvements will permit more accurate assessments in a wide range of applications in agriculture, the environment, hydrology, and mineral and energy resources.

LANDSAT-C will include both an improved Multispectral Scanner and an improved Return Beam Vidicon camera system. The Multispectral Scanner (MSS) will have a thermal channel added to the existing four channel instrument. This thermal infrared channel will enable the observation of phenomena characterized by temperature. The new data obtained and the related

566-537 O - 75 - 23

investigations could be invaluable in the areas of crop forecasting, measurements of thermal pollution of water resources, and improved reliability of classifications of hydrological and geological phenomena. This five-channel MSS has been separately developed and funded. The modifications to the Return Beam Vidicon (RBV) camera system will allow the spatial resolution to be improved by a factor of two, thus providing greater accuracy in locating, identifying, and mapping surface features.

The data which will be returned by LANDSAT-C will provide a basis for comparisons showing general trends and changes as well as the degradation or improvement of environmental and ecological quality. LANDSAT-C will also provide the continuity of data analysis effort necessary to long-range user community requirements. Current planning is for a launch in the third quarter of 1977.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

A third Earth Resources Technology Satellite received Congressional authorization in FY 1975; although funds were not specifically appropriated for the program, both House and Senate Appropriation Committees urged NASA to reprogram the necessary funds within the total resources made available to the Agency. The Administration has decided to proceed with the program and consequently $5.0 million was reallocated as indicated.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

In FY 1975, the effort on the spacecraft will primarily be for procurement of long-lead items essential to meet a CY 1977 launch date. These include the Data Collection System, the Versatile Information Processor (Data formatter), solar arrays, command clock and piece parts for the spacecraft structure, electrical harnesses and telemetry modules. Where practical, these procurements will be made in concert with the Nimbus-G program to reduce overall costs.

Procurement of long-lead components for the Return Beam Vidicon Camera (RBV) system are also required. These include electronic parts, base plate castings, on-off transformer, etc. A design study will be conducted to determine the remaining long lead items for the RBV, such as lenses and the selection and test of vidicons essential for the required resolution of the RBV system for LANDSAT-C. The Multispectral Scanner effort is being funded separately.

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

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Applications airborne research.....	$14,800	$16,400	$14,600	$12,630	$3,600
CV 990 replacement.....	1,800	900	900	700	---
Total.....	$16,600	$17,300	$15,500	$13,330	$3,600

OBJECTIVES AND STATUS:

The objectives of the Applications Airborne Research program are to acquire remote sensing data necessary to support the development, demonstration and evaluation of remote sensing instruments and interpretive techniques to provide for satellite underflights for verifying space acquired data, and to conduct in situ data acquisition flights in support of meteorological and environmental quality programs.

This program continues to serve as a national airborne remote sensing facility and is being used to support the investigative programs of NASA and several other agencies. The release of a substantial portion of the total aircraft remote sensing capability from the extensive Earth Resources Technology Satellite and Skylab underflight effort has permitted NASA to focus on a much wider range of applications related research tasks. These include meteorology, environmental quality communications and earth and ocean physics.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The reduction in the FY 1975 Budget Estimate is due to a decision to reallocate funds from this program element to initiate the Large Area Crop Inventory program. Reduced data analysis requirements and reductions made in the planned number of flight hours permitted the reallocation to be made.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

For the Earth Resources Survey program in 1975, the aircraft program will provide support for several ongoing and planned Applications System Verification Tests including the Large Area Crop Inventory Experiment being

conducted in cooperation with the USDA and the Great Lakes ice monitoring project to be demonstrated by Lewis Research Center in cooperation with the U.S. Coast Guard.

Continuing spacecraft underflight activity is also anticipated in conjunction with evolving projects such as the LANDSAT follow-on investigations program and Nimbus-G, but at a much reduced level from that committed to LANDSAT-1 and Skylab during the past two years.

During FY 1976 and the transition period, severe storm research and environmental quality 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. These include the integration of new avionics systems and the addition of experiment support systems and sensor ports. These modifications were scheduled for FY 1976 in order to have the aircraft available for the recently completed GARP Atlantic Tropical Experiment expedition (GATE).

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 Experiment Package (EREP) Investigations

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
($3,200)	$3,800	$2,500	$1,500	---

OBJECTIVES AND STATUS:

The objectives of the Earth Resources Experiment Package (EREP) investigations program are to use the data obtained from the EREP on Skylab to conduct studies in earth resources disciplines and to provide the information needed to complete the definition of the second generation of remote sensing instruments (being developed in other earth observation projects).

The EREP was developed under the Skylab program and was launched as an integral part of the Skylab Workshop in May 1973. The EREP included photographic cameras, a visible and infrared spectrometer, a thirteen-band multispectral scanner, active and passive microwave instruments, a control panel and magnetic tape recorders. During the three subsequent Skylab missions over 40,000 photographs and 240,000 feet of recorded observations of the earth were acquired by the Skylab crews.

Initial study results have provided new information on the detection and mapping of snow, on the usefulness of microwave techniques for soil moisture measurements, on geoidal variations associated with subsurface ocean topography, on the determination of local wind speeds over ocean areas, and on mesoscale eddies associated with ocean current systems. Other results are providing quantitative evaluation of the significance of specific spectral bands and spatial resolution not available in the LANDSAT system to crop inventories, land use determinations, and many other applications.

The acquisition and processing of EREP data and the initial support through FY 1974 of the data analysis was funded by the Office of Manned Space Flight. The Office of Applications is responsible for the selection and management of the investigators and investigations and for funding completion of the studies.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The reduction in funding requirements for FY 1975 results from the deletion of plans to initiate new data use investigations as part of the EREP program. EREP data are available through the Federal Data Centers and will be used, as necessary, to support studies funded as part of the Supporting Research and Technology program.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

In FY 1975 the processing and dissemination of EREP data to Principal Investigators and other users will be completed. Approximately one fourth of the 140 EREP investigations are scheduled to be completed. These investigations include studies of land use, water resources, cartography, agriculture, geology, geodesy, and coastal zones.

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)

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
---	---	($7,900)	$9,300	$2,900

OBJECTIVES AND STATUS:

The objective of the Application Systems Verification Test (ASVT) program is to take the most promising areas of research obtained from the LANDSAT investigation program and--through a concerted effort with user agencies and resources managers--to define, demonstrate and document the practical capability of remote-sensing-based information systems to make substantial contributions in these areas. The results should allow cognizant resource managers to make decisions on whether or not to implement remote-sensing-based systems operationally. If so, these activities will facilitate the transfer of demonstrated capabilities to the appropriate user organizations by providing the necessary information on organization, costs and procedures.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

Some ASVT projects were initiated as a separate effort in FY 1975 with funding from the Earth Resources Survey Data Interpretation Techniques, Special Investigations and Data Analyses area. The program is identified in FY 1976 as a separate budget item.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

One of the projects under the Applications Systems Verification Test program is the Large Area Crop Inventory Experiment (LACIE). LACIE has been initiated as a cooperative effort with the Department of Agriculture and the National Oceanic and Atmospheric Administration (NOAA). The principal objective during FY 1975 and FY 1976 is to determine whether remote sensing data acquired by LANDSAT-1 and -B and analyzed with the aid of computers can improve the timeliness and accuracy of major crop forecasts first for North America and then for other regions. Wheat will be the test crop for the experiment. If successful, the techniques and approaches developed will be made available for expanded international coverage and for incorporation into routine USDA agriculture forecasting. Another project is a joint Lake Ice program involving NASA, the United States Coast Guard (USCG) and NOAA. The objective of this project is to develop an aircraft-data-based, rapid all-weather system to provide accurate ice distribution maps to ships in order to expand the shipping season on the Great Lakes. In FY 1975 the system will be developed and an initial field

demonstration with the USCG and NOAA will be conducted. The FY 1976 objective will be to conduct a complete demonstration over the full 1975 ice season and transfer the technology to the users for operational use.

Several other ASVT projects have been undertaken in cooperative efforts with a number of State and regional agencies. These projects include: an automated natural resources system for the State of Mississippi; an automated environmental system for updating the Corps of Engineers basic environmental atlas of a predominantly wetlands region of southern Louisiana; a project to accurately monitor snow accumulation and spring run-off for water management purposes in Arizona, California, Colorado, and the Pacific Northwest; and a project using advanced data processing techniques to generate information on land use changes, soil moisture, snow cover and other environmental parameters required for large area water district management.

For all of the ASVT projects, the objective will be to define the management structure and the operation of the system as well as ways in which remotely sensed data would be processed and utilized by the cooperating user agencies.

During FY 1976 and the transition period, the ASVT program will continue selected demonstrations of the application of remotely sensed data to routine operational use; as the application is proven and reaches mature status, the technology will be transferred to the using agencies. In the Large Area Crop Inventory Experiment (LACIE), aggregate production estimates based on sample areas and yield data will be developed; modifications will be made as needed to the system to improve operations. The Lake Ice program will conduct a complete demonstration over the full ice season and then will transfer the technology to the users for operational use. Other ASVT's mentioned above will also be developed to the point of being ready for transfer to user organizations.

Data Interpretation Techniques, Special Investigations and Data Analyses

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Data interpretation techniques, special investigations and data analyses	$13,488	$13,000	$15,500	$11,600	$3,000
Earth resources survey data processing, evaluation and analysis, photographic services, related supplies, and equipment.....	(9,500)	9,400	9,400	8,000	2,000
Total.....	$13,488	$22,400	$24,900	$19,600	$5,000

OBJECTIVES AND STATUS:

The objectives of this effort are to conduct initial research on promising advanced remote sensing systems, to develop the technology to extract the maximum amount of information possible from available remote sensing data. Another objective is to identify promising areas of application on which special effort should be placed in Application Systems Verification Tests (ASVT's). These research tasks provide the foundation and direction for for future development of the Earth Resources Survey program. It is here that the new technology is developed to maintain the U.S. as the recognized world leader in the use of remote sensing data for earth resources investigations.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The increase in the FY 1975 Budget Estimate was required to provide greater support to the Applications Systems Verification Tests (ASVT) activity; notably the Large Area Crop Investigation Experiment (LACIE).

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

In FY 1975 research and development was concentrated in four major areas: the initial development of new imaging systems including microwave sensors that have all-weather sensing capabilities; the development of advanced data handling and processing techniques and equipment; the improvement of data interpretation and classification; and the demonstration, documentation, and effectiveness analysis of remote sensing techniques to meet the earth resources information requirements of users. In addition, work continued on those design studies for the development of a Thematic Mapper with a resolution about a factor of two better than the LANDSAT or EREP Multispectral Scanners.

In FY 1975 emphasis was also shifted away from conducting a relatively large number of small exploratory experiments toward conducting a lesser number of larger scale tests of potential remote sensing information systems under realistic conditions. Several Application Systems Verification Tests (ASVT) were initiated in 1975.

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 through temporal analyses, crop calendars, and effects of varying sun angle as well as techniques to help indicate crop vigor and forecast yield. 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)

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Laser geodynamics satellite (LAGEOS)....	$1,300	$2,300	$2,300	$1,000	$300
Ocean dynamics satellite (SEASAT-A).....	---	8,000	8,000	17,000	5,000
Tectonic plate motion...	---	2,000	1,900	2,600	800
Measurement systems, forecasting techniques and modeling/advanced studies.....	3,000	2,600	3,100	3,100	900
Experiment data analysis.....	2,700	2,700	2,700	2,700	800
Geodynamic experimental ocean satellite (GEOS-C).....	3,400	900	900	---	---
Total.....	$10,400	$18,500	$18,900	$26,400	$7,800

The primary objective of the Earth and Ocean Physics Applications program (EOPAP) is to provide the focus for those applications which make use of space or space-derived techniques for monitoring numerous ocean phenomena, such as sea state, currents, surface winds, and general ocean circulation patterns on a global basis, as well as for very precise monitoring of the earth's crustal motion, polar movement, and changes in rotation rate.

566-537 O - 75 - 21

Program activities are directed toward development and validation of: (1) means for predicting the general ocean circulation and surface currents, and their transportation of mass, heat, and nutrients; (2) methods for synoptic monitoring and predicting of transient ocean surface phenomena, including the magnitudes and geographical distributions of sea state, storm surges, swell, surface winds, etc., with emphasis on identifying existing and potential hazards; (3) methods leading to earthquake hazard assessment and alleviation models which can predict probable time, location, and intensity of earthquakes; and (4) expansion of our knowledge about the global geoid, of the geomagnetic field, and the geodesy of inaccessible areas such as the ocean floors. To accomplish these objectives, both satellite and surface-based measurements are required. Each of these projects is discussed below.

Laser Geodynamic Satellite (LAGEOS)

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Spacecraft.....	$830	$1,455	$1,455	---	---
Ground operations.....	470	845	845	$1,000	$300
Total.....	$1,300	$2,300	$2,300	$1,000	$300
Delta (Launch vehicle procurement program)	($3,000)	($1,600)	($1,300)	(---)	(---)

OBJECTIVES AND STATUS:

The objective of the LAGEOS program is to 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 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; tectonic plate motion; earth rotation; polar motion; and solid earth tides, as well as contributing to other efforts such as the EOPAP ocean dynamics program.

The LAGECS program includes the building and launching of a very accurate reference satellite incorporating precision retroreflectors, the development and use of accurate laser ground tracking stations, and the application of the laser data in connection with the generating of models of the earth's crustal and dynamic motions.

The satellite will be a dense sphere covered with 426 laser retroreflectors. It will have a diameter of about 0.6 meters (2 feet), and will weigh 411 kg (906 pounds). Its array of corner reflectors will be especially designed to

minimize errors associated with the reflection of the short laser pulses. It will be launched into a 5,900 km circular orbit at 110° inclination. Its altitude will be high enough to lessen the effect on the orbit due to perturbations in the earth's gravitational field. It will have a mass-to-area ratio great enough to markedly diminish the effects on the orbit caused by variations in the pressure of radiation from the sun and the earth. The high orbit is well suited to the problem of measuring large scale motions of the earth's crustal plates and the dynamic motions of the earth as a whole as it rotates about its polar axis.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

The satellite qualification model was built by NASA inhouse at the Marshall Space Flight Center. This was accomplished during the latter part of FY 1974 and early FY 1975. Since the satellite is a very rigid structure of simple design, the qualification model was built to the flight specifications. The qualification tests have now been completed, and the qualification model has been determined to be acceptable for flight, thus deleting the requirement for a separate flight satellite. This results in a programmatic savings and the estimated total runout cost has been reduced by $500,000.

During FY 1976 and the transition period, the last increment of retro-reflectors will be delivered. The final assembly of the satellite and optical performance verification 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.

Three mobile laser ranging stations and four stationary ones will be available to work with the LAGEOS at the time of launch and additional stations will be available during the next year.

Ocean Dynamics Satellite (SEASAT-A)

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Spacecraft design, development and test...	---	$4,800	$4,800	$7,000	$1,700
Sensor development.....	---	3,200	3,200	10,000	3,300
Total.....	---	$8,000	$8,000	$17,000	$5,000

OBJECTIVES AND STATUS:

The objectives of the Ocean Dynamics Satellite (SEASAT-A) mission include: the demonstration of techniques for global monitoring and mapping of the principal oceanographic phenomena and features; the provision of oceanographic data for both application and scientific users; the creation of a new data base which can be used to extend the scientific understanding of ocean dynamics; and the demonstration of the key features of an operational ocean dynamics monitoring system.

The mission objectives and preliminary design concepts have been developed through the combined efforts of NASA and the user community. Among those participating are some 20 organizations representing other parts of the Government, universities, and maritime interests in the private sector. Included, in particular, are the Departments of Commerce, Defense, and Transportation; Scripps Institute of Oceanography, Woods Hole, and City University of New York; American Institute of Merchant Shipping, American Petroleum Institute, and the Sea Use Council.

The monitoring of the oceans from space by SEASAT-A will provide oceanographers for the first time with the kind of global, synoptic coverage for scientific analysis which have been supplied to meteorologists investigating the atmosphere by TIROS and NIMBUS satellites. The SEASAT-A data will constitute an indispensable base upon which to build new ocean dynamics and improved meteorological forecasting capabilities having major scientific and economic potential.

An existing flight-qualified spacecraft bus will be used to insure program cost efficiencies. This existing bus will be coupled to a sensor module that will contain three new active radar sensors, one existing flight-qualified passive sensor, and associated data handling and power conditioning subsystems. The combined sensor module and existing spacecraft bus will be launched into a 108° inclination circular orbit in 1978.

The three new active radars on SEASAT-A stem from recent NASA research and development activities aimed at evolving sensors suitable for oceanographic data gathering from space. These radar sensors will be complemented by a scanning visible and infrared radiometer originally flown on ITOS, and will be used on SEASAT to provide images of visible and infrared emissions from oceans, coastal and atmospheric features. These SEASAT-A instruments will enable the monitoring of ocean surface conditions to be accomplished with the precision and repetition necessary to make major advances for scientific and user applications including predictions of sea conditions for ship routing, ship design, storm damage avoidance, coastal protection and development, and deep-water port development. Economic benefit studies show that large benefits are associated with the potential capabilities which SEASAT-A will demonstrate.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

During FY 1975, procurement of the spacecraft module, launch vehicle selection, and sensors was finalized, and the detailed design of the sensor module was initiated. 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 sensor preliminary design reviews will be held and the breadboard tests will be completed. Detailed sensor module design will begin following the selection of the spacecraft bus contractor, and the preliminary design review of the module will be completed. 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

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
---	$2,000	$1,900	$2,600	$800

OBJECTIVES AND STATUS:

The objective of the Tectonic Plate Motion program is to make key measurements which are expected to contribute significantly to the development of an earthquake prediction capability. These include the measurement of the earth's crustal motion near the earthquake fault zones and the behavior of the earth as a whole as it rotates about its polar axis.

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. If two adjoining plates are moving at certain places, but are locked elsewhere, then strain is building up. When this strain is released, an earthquake occurs. During the past two years, experimental data have been collected and major progress has been made in measurement systems as well as modeling capabilities, opening up new possibilities for gaining an understanding of the physical processes involved.

The Tectonic Plate Motion program consists of three projects as follows: the San Andreas Fault Experiment (SAFE); the Pacific Plate Motion Experiment (PPME); and Astronomic Radio Interferometer Earth Surveying (ARIES).

The SAFE will demonstrate the feasibility of using laser satellite tracking data to determine surface motions along an active fault over a period of several years.

The PPME will demonstrate the feasibility of using Very Long Baseline Interferometry (VLBI) measurements to determine the relative motions of the Pacific and North American plates.

ARIES will demonstrate the use of VLBI techniques for the measurement of regional scale crustal motion.

During FY 1975 initial observations were made by each of these systems. These observational data have been used to establish positions of the stations involved to accuracies ranging from 15 cm to 5 cm.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

Reduced FY 1975 funding requirements were occasioned by a delay in equipment development for the VLBI activities, particularly PPME.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

During this period of time new equipment will be added to each VLBI station thus improving the system; additional equipment will be evaluated; and a second series of observations and intercomparisions will be completed. These include VLBI triangle closures using stations in Massachusetts, Texas, and California, and the completion of a third station site in Utah for SAFE.

Measurement Systems, Forecasting Techniques, and Modeling

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$3,000	$2,600	$3,100	$3,100	$900

OBJECTIVES AND STATUS:

The objectives of the Measurement Systems and Forecasting Techniques program 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.

This effort consists of an integrated series of interconnected tasks including: systems studies for the Earth and Ocean Physics Applications program; design studies of advanced satellite and ground systems; analytical design of Earth and Ocean Physics Applications program missions; preliminary design of experiments (ground-based, aircraft, ships, buoys, and satellites); establishment of measurement requirements; preliminary design

of sensors and subsystems; feasibility experiments on new techniques; intercomparison experiments; analytical models for earthquake hazard assessment and alleviation, ocean currents, ocean dynamics effects, circulation and transport; and development testing of forecasting techniques. Universities, institutions, and other Government agencies will be utilized to perform scientific studies of fundamental phenomena in earth and ocean dynamics. These studies will serve as a basis for establishing detailed requirements for developing experimental and analytical techniques.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The increase in the FY 1975 Budget Estimate was required for studies to better define the specifications of analytical and measurement approaches so as to enhance the orderly development of models, instruments and techniques used in the Earth and Ocean Physics Applications program.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

Efforts planned for FY 1976 and the transition period include studies exploring the use of new space techniques, of improvements in present techniques and in more effective use of current systems. Advanced models leading to a better understanding of mechanisms that govern the dynamics of the solid earth and the world's oceans will be developed. Technique, instrument, and model development for supporting the program will be undertaken in order to insure proper program evolution.

Experiment Data Analysis

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition period
	(Thousands of Dollars)			
$2,700	$2,700	$2,700	$2,700	$800

OBJECTIVES AND STATUS:

This program has the following objectives: 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; to monitor and forecast sea state, other ocean dynamics effects, and the interactions between ocean and atmosphere; and to assess earthquake hazards.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

During FY 1975 this program provided for the analysis of experiments currently in process to demonstrate the application of precision laser ranging to satellites for the measurement of fault motions. Included in this effort are the analysis and evaluation of new methods of making precision measurements of crustal deformations and earth motions, as well as intercomparisons on basic measurement and analytical techniques, and the analysis and evaluation of related earth dynamics.

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 demonstrate the feasibility and limitations of the various space and ground systems to contribute to the solution of scientific 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

		1975			
	1974	Budget Estimate	Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Ground-based investigations, analyses and studies.....	$2,825	$3,100	$2,900	$3,100	$900
Sounding rocket missions.	---	400	400	600	300
Total.....	$2,825	$3,500	$3,300	$3,700	$1,200

OBJECTIVES AND STATUS:

The objectives of the Space Processing program are to develop applications offered by the unique environment of space for work in materials science and technology and in biological processes; ultimately, this is intended to lead to commercial manufacturing of suitable 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.

Areas in which such tests are needed include levitation techniques, containerless melting, dynamics of levitated liquids, directional solidification of metal and semiconductors, and performance characteristics of electrophoresis apparatus.

CHANGES FROM THE FY 1975 BUDGET ESTIMATE:

The reduction from the FY 1975 Budget Estimate in Ground-Based Investigations, Analyses and Studies resulted from the deferral of several planned projects into FY 1976.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

In FY 1975 the Space Processing program concentrated on products and processes that appeared to have the potential for early applications. Preparations were made for tests of essential processes on longer duration rocket flights. These flights offer test durations of five to ten minutes and permit potential users to explore useful applications at relatively low cost. The program emphasis initiated in FY 1975 will continue during FY 1976 and the transition period. Projects to be undertaken will include: electrophoretic separation of cells and establishment of cell cultures; growth of electronic crystals in ribbon and sheet form; production of ultrahomogeneous semiconductor materials; vapor and solution growth of electronic crystals; refractory metal purification and grain refinement by vacuum/levitation processing; production of new types of optical glass from oxides; and controlled eutectic solidification for optical, electronic and specialty structural parts. Work in these areas will be oriented toward accomplishing critical tests on rocket flights where feasible, in order to acquire preliminary evaluations with minimum resource requirements. In addition to experimental work, economic analysis of the economics of future space processing operations will continue during FY 1976 and the transition period.

COMMUNICATIONS

		1975			
	1974	Budget Estimate	Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Cooperative applications satellite (CAS-C).....	$2,760	$1,550	$1,550	$1,100	$100
Experiment coordination and operations support.....	800	3,700	6,200	2,900	800
Technical consultation and support studies..	2,540	1,650	1,650	2,100	600

566-537 O - 75 - 25

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Advanced communications research....	---	$1,400	$1,600	$1,400	$500
Multi-user communications experimental satellite (ATS-6)...	$16,200	---	----	---	---
Total.....	$22,300	$8,300	$11,000	$7,500	$2,000

The objective of this program is to keep the nation in the forefront of satellite communications technology through technological developments well in advance of commercially motivated initiatives. Current efforts include: the continued development of the Cooperative Applications Satellite-C (CAS-C); the operation of ATS-6, successfully launched in May 1974; the development of communications technology and concepts too advanced to warrant commercial development; the conduct of special radio interference and propagation studies; and provision of technical consultation services to other agencies as requested.

The successful launch of ATS-6 began a national and international experimental communications program in satellite broadcasting as compared to point-to-point capabilities of all other current systems. This new area of satellite communications was made possible by this most technologically advanced of the Applications Technology Satellite series. This spacecraft is now well into the most extensive and sociologically significant experiment program yet undertaken in the continuing investigation of the applications of space communications to benefit mankind. Continuing into FY 1976 and beyond, this spacecraft will play a major role in the definition of needs of communities for satellite supported health care delivery, delivery of educational services and other innovative applications of communications satellites.

After a one year period of operations, under an agreement between the U.S. and India, the spacecraft will be moved over a location to support the Indian Satellite Instructional Television Experiment (SITE). During the movement of the satellite to India, ATS-6 will provide television and data relay support to the Apollo Soyuz Test Project (ASTP). The activities of of ATS-6 are more fully discussed in the Experiment Coordination and Support narrative.

As the use of satellite communications proliferates both in the U.S. and abroad, the need for NASA to move into development and experimentation with the technology of future generations of communications satellite continues. This effort which is needed to maintain the United States'

position of leadership in this field, is sponsored by NASA in those areas of research which are not commercially motivated. This research also makes possible continued satisfaction of NASA's statutory responsibilities to provide technical consultation as Federal agencies and others request.

Cooperative Applications Satellite-C (CAS-C)

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Spacecraft testing.....	$280	$790	$470	$620	---
Experiments.....	2,405	560	980	330	---
Mission analysis and operation.....	75	200	100	150	$100
Total.....	$2,760	$1,550	$1,550	$1,100	$100
Delta (Launch vehicle procurement program).....	($1,000)	($3,600)	($3,800)	(---)	(---)

OBJECTIVES AND STATUS:

In April 1971, the Canadian Department of Communications (DoC) and NASA entered into an agreement to launch a Cooperative Applications Satellite (CAS-C, also referred to as the Communications Technology Satellite or CTS). The launch is currently scheduled for late 1975. The overall objective of this project is to develop technical capabilities for satellite communications with small ground stations in the newly allocated 12 GHz frequency band. Investigation of the use of frequencies above 10 GHz is a key part of the effort to find ways to relieve frequency crowding by proliferating communication satellite systems.

In this joint program, NASA is responsible for the 200-watt Transmitter Experiment Package (TEP), which is considered the prime technology experiment on CAS-C. NASA will also provide for the launch of the satellite on a Thor-Delta launch vehicle into geostationary orbit.

Canada is responsible for development and production of the spacecraft, and for its operation when it is at the desired geosynchronous station which will be about the longitude of San Diego. Use of the satellite time will be shared equally by the U.S. and Canada.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The changes in the FY 1975 Budget Estimate are the result of technical problems experienced in development of the Traveling Wave Tube (TWT). These problems caused delays in testing the TWT and the spacecraft.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

Final development and production of TEP protoflight models is scheduled to be completed in FY 1975. Qualification and life tests will be conducted, and a flight unit will be delivered to the Canadian Communications Research Center for interaction with the Canadian-built protoflight spacecraft.

In FY 1976 acceptance testing and launch of the protoflight spacecraft is planned. Thermal vacuum and vibration testing will be conducted at Lewis Research Center (LeRC) followed by solar simulation, magnetic, and balance tests at Goddard Space Flight Center. Final network compatibility tests will be conducted before the protoflight spacecraft is shipped to the Eastern Test Range for launch operations. Launch is scheduled for the last quarter of 1975. Following insertion of the spacecraft into its final orbit, the performance of the TEP will be monitored by the LeRC ground terminal. This function as well as coordination of the United States user program will be continued through the remainder of FY 1976 and the transition period.

Experiment Coordination and Operations Support

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$800	$3,700	$6,200	$2,900	$800

OBJECTIVES AND STATUS:

The objectives of this program are to operate the communications satellites in orbit and conduct the experiments, as well as to coordinate the user experiments program after the NASA experimentation is completed. In 1969, NASA offered potential users of communications satellites the opportunity to use Applications Technology Satellites (ATS)-1, 3, and 5, for experimental purposes after the NASA experiments were completed. This offer received substantial response. Under the procedures established for such use, the experimenter provides funding for support of his experiment. NASA funds the continued operation of the satellites, provides experimenter time on the spacecraft and technical consultation to the experimenters as required. ATS-6, launched in May 1974, has followed the same pattern as ATS-1 through -5. The Cooperative Applications Satellite-C, (CAS-C) which has many approved experimenters, will also be operated under the same guidelines after launch in late CY 1975. NASA is cooperating with international, federal, regional and state agencies and industrial organizations in conducting these experiments covering a broad range of telecommunications objectives. A wide variety of technical experiments will also be conducted on these satellites to support the needs of NASA and other agencies.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

Changes from FY 1975 Budget Estimate are due to additional post-launch contractor support for ATS-6 and close-out of ATS-F backup spacecraft communications module.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

In FY 1975 operations included ATS-1, 3, 5, and 6 and post-launch prime contractor effort and disposition of ATS related hardware was completed. Operations of ATS-6 will continue in FY 1976 and through the transition period. While the design life of ATS-6 is two years, the highly successful operations to date indicate this will probably be significantly longer. ATS-6 is currently performing 23 technological and applications-oriented experiments in the United States. In May 1975, the spacecraft will be moved from its position over the United States to a position over the Eastern Hemisphere where it will support an experiment program in cooperation with India and several European countries. It is planned to return the satellite to the U.S. late in FY 1976 and resume operations with U.S. experimenters.

Technical Consultation and Support Studies

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$2,540	$1,650	$1,650	$2,100	$600

OBJECTIVES AND STATUS:

The objective of this program is to provide technical consultation and support services on space telecommunications and spacecraft technology. NASA and other agencies benefit through orbit and frequency utilization studies which deal with the analysis, development and evaluation of frequency sharing and spacing criteria for satellites and propagation phenomena; and interference studies and experiments. Adverse effects of propagation phenomena and manmade noise on the design and performance of satellite systems will thus be determined. This program also includes systems reviews, evaluations and assessments for NASA and for domestic satellites and INTELSATS in support of the Federal Communications Commission.

Competition for orbit position and frequency spectrum is becoming extremely intense. By 1980 the increase in demand for orbit and spectrum assignments may grow too great to meet without a concentrated technical attack on the problems involved. The rapid growth in use of satellites

is expected to continue with new applications arising out of NASA's experimental programs and user experiments stimulating that growth. Similarly increasing worldwide interest in NASA's Earth Resources Technology Satellites (LANDSAT), Ocean Dynamics Satellites (SEASAT), and Synchronous Meteorological Satellites (SMS) will create demand for more advanced sensors and data collection services, all of which will require radio frequency spectrum and orbit space.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

To address the problems associated with meeting these needs this program proposes to continue to conduct in FY 1976 the studies, experiments and consultation services described in the first paragraph. NASA's unique resources, expertise and technology base are used to provide this support not only within NASA but also to fulfill NASA's statutory obligations to support the Federal Communications Commission and other organizations upon request. Support to non-NASA organizations is on a reimbursable basis where appropriate.

In FY 1976 it will be necessary to begin preparation for the 1977 World Administrative Radio Conference (WARC) on broadcast satellites and the 1979 WARC on space and terrestrial communications services. NASA has a particularly large interest in the 1979 WARC since the International Radio Regulations will be revised for the first time since 1959 and all space allocations, technical standards, and system parameters will be re-evaluated. As part of this preparation, frequency interference and orbit compatibility analyses required for NASA spacecraft, including Shuttle experiment packages, will be conducted. Analysis of NASA's future frequency allocation, bandwidth and orbit position needs will continue. Where possible, we will examine alternatives for sharing use of existing frequency allocations and identifying use of higher frequency bands to alleviate radio frequency and orbital space crowding problems. The NASA/Canadian Cooperative Applications Satellite (CAS-C), to be launched in late 1975, and NASA's ATS-6, will provide the major means available through the end of this decade for obtaining measurements required to develop design criteria for satellite systems using these higher frequency bands.

The results emanating from the Technical Consultation and Support Studies program will make a major contribution to the national effort in preparing for these WARCs, and will help provide the framework for orderly growth of existing satellite and terrestrial services and the inclusion of new services in the late 1970's and the decade of the 1980's.

Advanced Communications Research

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
---	$1,400	$1,600	$1,400	$500

OBJECTIVES AND STATUS:

The objective of this program is to develop the advanced technology and concepts for satellite communications needed to continue the United States as a leader in this field. The research planned is also necessary to maintain NASA's position as the Federal Government's center of expertise in nondefense spacecraft technology and space telecommunications. In addition, the research provides the advanced technology for NASA's own needs in space telecommunications as it brings into being the technological base from which future generations of communications satellites will emerge. Out of this, NASA is also able to continue meeting its statutory responsibility to provide technical consultation to users of communications satellite systems. In the future, the Space Shuttle is expected to be used to make demonstrations of new techniques in space telecommunications.

CHANGES FROM FY 1975 BUDGET ESTIMATE:

The increase in the FY 1975 Budget Estimate is to initiate an effort on a pilot project in the area of communications as a substitute for transportation.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

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 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.

To meet the anticipated needs for NASA, DoD, and commercial communications satellites to provide prescribed geographic coverage without intra- or inter-system interference, new techniques are being developed that will

permit the design of antennas to produce beam contours conforming to such limits as the boundaries of a time zone or a state.

To increase the channel capacity of satellite systems within given size and weight limits for the satellite, and to reduce the per-channel cost of communications, research is underway on advanced transmitting device techniques and very low noise, uncoded receivers. To better utilize the presently assigned frequency bands, several improved modulation and data compression techniques and associated devices need to be investigated. Significant bandwidth conservation improvement should be obtained with the successful development of these techniques thereby increasing the amount of data a given bandwidth can contain and transmit.

DATA MANAGEMENT PROGRAM

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
---	$4,000	$4,000	$4,000	$1,500

OBJECTIVES AND STATUS:

The objective of this program is to improve the management of the data acquired through NASA's programs. As data from new sensors threatens 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.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

The major FY 1975 activity in the Data Management program is concerned with getting a better definition of the information needs of users so that the design of data collection systems can be specified more precisely. This activity takes several forms. For example, regional surveys are being conducted to identify the end-use application of remotely-sensed data. One of these is being carried out by Washington University in St. Louis for the Missouri Basin. Another survey will be made by the City University of New York to clarify needs of state government management for similar data.

Experiments using data system simulators are being planned at NASA centers to devise better interactive techniques for defining users needs and developing data handling procedures to optimize the flow of data from the collection system to the user. This includes choosing data analysis and retrieval equipment, data interpretation techniques, and advanced processing methods.

Work is underway in defining systems characteristics for both generalized and discipline-oriented information management systems. The objective is to incorporate upgraded data management systems into NASA operations.

The second area of major emphasis in this program is Data and Information Technology. Work is going forward on integrating data formats for all sensing systems on a given space vehicle, while preserving the characteristics needed to process the collected data into useful information.

In addition to the systems and vehicle-oriented effort, hardware devices are designed, developed and tested. These include low cost data terminals, mini-computers and software for optimizing data handling. System hardware is being procured for the Atmospheric and Oceanographic Information Processing System, an advanced system for handling data from the SEASAT and meteorological data collection programs. The system can be used interactively to help data users define their needs for extracting specific data.

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

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
(Thousands of Dollars)				
$4,500	$4,500	$4,500	$3,000	$1,500

OBJECTIVES AND STATUS:

The objectives of the Shuttle Payloads program for Space Applications are to develop the required instruments and the associated spacecraft technology that will advance the utilization of space for practical applications employing the planned manned shuttle sortie called Spacelab.

The Shuttle Spacelab is being developed to carry a variety of experiment payloads for the science and technology community. The Office of Applications plans to utilize the Shuttle Spacelab to complement its planned

566-537 O - 75 - 26

automated spacecraft program in the 1980's by filling gaps in experiment data gathering areas, and by developing and demonstrating new space technology to the user community. It is anticipated that employing the Shuttle Spacelab as an R&D tool will reduce the cost of technology developments and thus provide the needed systems information at an earlier date than present day methods can.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

In FY 1975, applications experiment concepts that appeared feasible for development in the 1980's were studied to ascertain their suitability for inclusion in Shuttle Spacelab missions. These definition studies have resulted in a selected list of experiments whose value to the various applications disciplines is high. Early Spacelab development testing of these experiments is desired to provide the technology for future applications.

During FY 1976 and the transition period, initiation of design and development is required on high priority experiments in order to have them available for Spacelab integration in 1979 and for flight in 1980-81.

The experiments tentatively selected for design and development efforts in FY 1976 are, for Communications: a radio frequency interference (RFI) mapping survey to characterize the sources of ground-based radio transmissions that interfere with space operations, and the development of an advanced kilowatt-power, communications tube for application to broadcast communications satellites; for Earth Observations: zero-gravity cloud physics laboratory to conduct atmospheric research that will provide data to assist in the understanding of the processes responsible for the formation of clouds, resulting cloud dynamics and the release of precipitation, and a high speed interferometer instrument that has the capability to sense and measure trace constituent gases in the atmosphere for pollution monitoring applications; and for Space manufacturing: payloads that will develop the techniques for the preparation of biological and electronic materials including organic, glass, ceramic, metallurgical, and chemical processes.

ADVANCED APPLICATIONS FLIGHT EXPERIMENTS

		1975			
	1974	Budget Estimate	Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Design and development of advanced experimental instruments	$4,700	$4,700	$4,700	$4,700	$1,300

OBJECTIVES AND STATUS:

The objective of the Advanced Applications Flight Experiments (AAFE) program is to develop application experiments from which future missions and flight experiments for approved flights can be proposed. In pursuing this objective, the AAFE program places emphasis on the early solution of technical problems and on engineering development of instrumentation without commitment to a definite flight mission. In this way, the AAFE program activities reduce the technical, funding and schedule risks of the flight programs by off-line development of experiments prior to flight commitments.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

In FY 1975, the AAFE program conducted a number of aircraft and balloon flight tests and evaluations to verify performance and applications potentials of experiments developed earlier. For example, a Radiometer/Scatterometer was flown in a C-130 aircraft over the East Coast to evaluate its performance for measuring oceanographic parameters. Several helicopter flight tests of a Fraunhofer Line Discriminator were made to measure stressed trees, water currents, land pollution and oil spills in water. The Correlation Interferometer was flown in helicopter tests to evaluate its capabilities to measure atmospheric pollution.

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. We expect to initiate development of active instrumentation such as lasers and radars to take advantage of advances in this technology and its inherent applications potential. These instruments will become primary tools for future applications missions since they have the capability of providing their own illumination at the target which significantly enhances remote detection and measurements.

APPLICATIONS SYSTEMS ANALYSES

		1975			
	1974	Budget Estimate	Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Applications studies	$1,265	$5,000	$5,000	$5,000	$1,400

OBJECTIVES AND STATUS:

The major objectives of the Applications Systems Analyses program are to determine the probable benefits of proposed and ongoing applications as well as to understand the needs of users of applications systems, and to identify and investigate the potential uses of space-derived technology.

An important effort in the Applications Systems Analyses program is the assessment of when and how applications technology should be made available in operational status for transfer to operating agencies or the private sector. Establishing criteria for determining when this transition is technically, economically and institutionally appropriate is being developed.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

In FY 1975, cost benefit studies were conducted in agricultural forecasting and land use planning. In addition, the SEASAT cost benefit study provided insight into the potential value of this system to the user community. Preliminary economic assessments are being made on potential commercial space processing systems. Activities continued on the Activated Carbon Wastewater Treatment System (ACTS) which has led to a grant from the EPA to Orange County, California, to develop a 1,000,000 gallon-per-day municipal pilot plant.

In FY 1976, some of these activities will be continued and a number of new studies and activities will be initiated which will be continued in the transition period. Future cost benefit studies will be conducted to better understand the potential economic benefits of new Applications programs.

In addition, major new activities will be undertaken to more directly meet with and educate the new user communities in all of these areas.

APPLICATIONS EXPLORER MISSIONS (AEM)

		1975			
	1974	Budget Estimate	Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
AEM-A (Heat Capacity Mapping Mission).....	---	$2,600	$2,600	$3,500	$600
AEM-B (Stratospheric Aerosols and Gas Experiment).....	---	---	---	2,400	2,000
Total.....	---	$2,600	$2,600	$5,900	$2,600
Scout (Launch vehicle procurement program).	(---)	(---)	(---)	($2,000)	(---)

OBJECTIVES AND STATUS:

The objective of the Applications Explorer Mission 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 will be tailored to the specific area of research and to the orbital requirements.

The first mission, the Heat Capacity Mapping Mission, is based on the adaptation of a spare Nimbus-5 flight instrument to be flown in a unique orbit for the collection of predawn and early afternoon time data required for the determination of thermal inertia of surface materials. Studies of the thermal inertia, an identifiable characteristics of various materials, will be used to develop maps of rock types for applications to mineral potential assessments. Data acquired with this mission in a secondary sense will also be useful for studies of soil moisture, for the mapping of thermal effluents, for the measurement of plant canopy temperature, and for the mapping of snow coverage. This mission is to be launched in late 1977 into a sun-synchronous polar orbit which will allow complete day/night coverage of the United States every eight days.

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. The measurement technique is based on observations of atmospheric attenuation of solar radiation near the earth's limb (horizon) in four bands during satellite sunrise and sunset.

Stratospheric aerosols and ozone concentrations can be altered by natural and man-induced changes. The measurement of concentrations is required in order to assess the role which these constituents play in the radiation balance of our environment on a global scale. The earth's radiation balance is an important factor in the determination of climatic changes. In addition, knowledge of the variations in the ozone blanket is important because of the protection from extreme ultraviolet radiation which this blanket affords the earth. This mission will be launched in 1979 into a 50° inclined orbit and will provide bi-weekly coverage of aerosols and ozone for latitudes from 72° north to 72° south. A similar instrument to be flown on Nimbus-G in 1978 will provide complementary measurements of aerosols at polar latitudes. The data from these two missions will provide the first global scale measurements of particulates which are important to the studies of the stratosphere.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

In FY 1975, design and development of a spacecraft base module to be used for these missions and for modification of the instrument for the Heat Capacity Mapping Mission were initiated.

During FY 1976 and the transition period, design of the base module will be completed and fabrication of a base module for the AEM-A will be essentially complete. Modification of the Sensor will be initiated and the refurbishment and reassembly will be undertaken. Base module procurement for the AEM-B and fabricate of flight hardware will be initiated. Design of the instrument for the Stratospheric Aerosol and Gas Experiment will be nearly completed.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1976 ESTIMATES

RESEARCH AND DEVELOPMENT PLAN FOR

AERONAUTICS AND SPACE TECHNOLOGY PROGRAMS

Programs	Budget Plan				
		1975			
	1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Aeronautical research and technology.....	$168,000	$166,400	$166,400	$175,350	$46,800
Space and nuclear research and technology.....	66,307	72,365	71,365	74,900	22,300
Total.....	$234,307	$238,765	$237,765	$250,250	$69,100

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1976 ESTIMATES

BUDGET SUMMARY

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

AERONAUTICAL RESEARCH AND TECHNOLOGY PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Research and technology base.....	$79,993	$83,900	$83,900	$85,100	$23,800
Systems studies.....	3,100	3,000	3,000	3,000	700
Systems technology programs.....	26,351	31,700	31,700	46,550	15,800
Experimental programs....	58,556	47,800	47,800	40,700	6,500
Total.....	$168,000	$166,400	$166,400	$175,350	$46,800
Distribution of Program Amount by Installation					
Johnson Space Center.....	$259	$164	$100	$280	$70
Marshall Space Flight Center	647	647	650	600	150
Jet Propulsion Laboratory...	702	620	878	1,200	390
Wallops Flight Center.....	137	124	285	250	110
Ames Research Center.....	46,155	44,153	46,673	44,150	12,000
Flight Research Center.....	12,164	12,898	12,587	17,400	4,300
Langley Research Center.....	47,688	60,428	60,985	64,740	17,000
Lewis Research Center.....	57,925	45,736	41,754	43,990	12,000
Headquarters.....	2,323	1,630	2,488	2,740	780
Total.....	$168,000	$166,400	$166,400	$175,350	$46,800

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1976 AND TRANSITION PERIOD ESTIMATES

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

AERONAUTICAL RESEARCH AND TECHNOLOGY PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION

The objectives of the Aeronautics program for FY 1976 and the transition period are to advance aeronautical technology to make possible safer, more economical and environmentally acceptable air transportation systems which are responsive to current and future national needs; to maintain the strong competitive position of the United States in the international aviation market place; and to support the military in maintaining the superiority of the nation's military aircraft.

CHANGES FROM FY 1975 BUDGET ESTIMATE

There were no changes from the FY 1975 budget estimate for the Aeronautical Research and Technology program as a whole. However, funding shifts did occur between individual programs within the Aeronautics program. Some of these apparent funding changes are due to a restructuring of the Aeronautics program and simply reflect new program locations within the overall program structure rather than changes in program emphasis. These changes will be addressed under the individual programs involved. Funding changes that occurred that were significant in terms of a change in program emphasis will also be specifically addressed under the individual programs involved.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

A strong research effort will be 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 Aeronautics 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, crashworthy 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

560-537 O - 75 - 27

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.

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.

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 lead 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.

BASIS OF FUND REQUIREMENTS

Research and Technology Base

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Materials research and technology.....	$6,687	$6,900	$6,700	$6,200	$1,700
Structures research and technology.....	6,204	7,000	6,900	6,250	1,800
Propulsion environmental impact minimization research and technology	13,097	10,400	10,400	11,410	3,200
Propulsion components research and technology..	8,529	9,000	8,900	9,050	2,700
Air breathing engine systems research and technology.....	7,796	8,000	8,000	8,150	2,000
Fluid and flight dynamics research and technology.....	8,667	9,400	9,400	10,200	2,900
Avionics research and technology.....	3,302	3,800	3,700	3,580	1,000
Aircraft operations and safety research and technology.....	3,638	3,900	3,900	3,900	1,100
Low speed vehicle aerodynamics and flight dynamics research and technology..	10,466	11,600	12,300	12,500	3,500
High speed vehicle aerodynamics and flight dynamics research and technology..	7,932	9,100	8,900	8,830	2,500
Aeronautical man-vehicle research and technology..	3,675	4,800	4,800	5,030	1,400
Total.....	$79,993	$83,900	$83,900	$85,100	$23,800

CHANGES FROM FY 1975 BUDGET ESTIMATE

Changes from the FY 1975 budget estimate for the Research and Technology Base as a whole were negligible. However, funding shifts did occur between the disciplinary programs within the Research and Technology Base, in order to increase the program emphasis in the Low Speed Vehicle Aerodynamics and Flight Dynamics program on upper-surface-blowing propulsive-lift concepts. Funding changes that occurred that were significant in terms of a change in program emphasis will be specifically addressed under the individual programs involved.

Materials Research and Technology

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
6,687	6,900	6,700	6,200	1,700

OBJECTIVES AND STATUS

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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The funding change reflects that the costs of services in support of the in-house materials research efforts were less than anticipated.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

During FY 1976 and the transition period, basic materials research will continue to be focused on understanding strengthening and failure mechanisms in alloys, composites, and ceramics, and the phenomena of oxidation and corrosion.

The effort on high temperature materials in FY 1976 and the transition period will emphasize oxide-dispersion strengthened nickel base alloys, and directionally solidified eutectics for use at 2,000 degrees Farenheit and 1,900 degrees Farenheit, respectively. The best method to improve the toughness of ceramics will also be determined.

The approach to obtaining safer, lightweight materials in FY 1976 and the transition period will emphasize the synthesis of new and improved polymers and composites, and more efficient joining techniques. Fire resistant, non-toxic polymers will be evaluated for use in aircraft interiors, and for improved composite matrices. Advanced polymeric systems will also be synthesized for better adhesives to insure safer structures.

Underlying this program will be a study of the fatigue and fracture behavior of both metal and composite materials. This study should lead to the development in FY 1976 of improved life prediction procedures and fracture control techniques for greater reliability and lower cost of both aircraft structures and propulsion systems.

Structures Research and Technology

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$6,204	$7,000	$6,900	$6,250	$1,800

OBJECTIVES AND STATUS

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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The funding change reflects that the costs of services in support of the in-house structures research efforts were less than anticipated.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

In FY 1976 and the transition period, studies of advanced concepts will be continued to explore structural arrangements which will improve efficiency and safety of current types of aircraft and provide feasible concepts for advanced aircraft. One important facet is a joint NASA/Federal Aviation Agency (FAA) program to improve the crashworthiness of general aviation aircraft. Development of analytical methods for predicting structural behavior in crash impacts will continue together with crash tests of flood damaged small aircraft to provide data needed to confirm the accuracy of analytical predictions. Experimental evaluations of high temperature structural concepts for hypersonic aircraft are being conducted. These will include high temperature wind tunnel and radiant heating tests of actively cooled structures as well as hot structures.

Improved methods for predicting design loads, aeroelastic behavior, and dynamic response for aircraft structures will continue to be developed during FY 1976 and the transition period. Research will include experimental and analytical studies of the complex factors affecting panel flutter, unsteady pressures in cavities open to the airflow, and improved computer methods for predicting aeroelastic loads including those due to gusts and active controls. Emphasis will also be given to development of unsteady aerodynamic theory in the difficult transonic regime supported by wind tunnel tests and a drone flight program. Applications of active control technology will be pursued to permit minimization of aeroelastic response; these will also be verified by wind tunnel and drone flight tests.

Systematic experimental and analytical studies will be conducted in FY 1976 and the transition period to improve design procedures needed to assure structural integrity in highly efficient aircraft structures. A life prediction rule for structural components subjected to complex stress histories will be based on consideration of the continuously changing residual stresses caused by local plasticity. A design rule for predicting rates of fatigue crack propagation under complex stress histories will be based on the NASA-developed crack closure concept. Analyses of fatigue crack propagation in stringer-stiffened panels will be extended to predict residual strength of wing structures with multiple failure nuclei. The fatigue behavior of composite materials with and without outdoor environments will be studied to provide background for developing life prediction rules and damage-tolerant composite structures.

In FY 1976 and the transition period research will be continued to improve the understanding and prediction of the structural behavior of filamentary composites. Improved theories being developed will be investigated in laboratory tests of composite components. Demonstration of composite secondary structures in routine airline service will continue; components include L-1011 fairings, B-737 spoilers, and DC-10 rudders involving 48 aircraft. The components on these aircraft will each have accumulated an average of 2,940 flight hours by the end of FY 1976; the flight service evaluations will continue in subsequent years to provide confidence for industry and airlines in the long term performance of composite structures.

Technology will be developed for advanced structural analysis and design methods during FY 1976 and the transition period. Effort will focus on more efficient and reliable techniques for complex problems and the potential for incorporating new and unique methods in large computer programs such as NASA Structural Analyses Program (NASTRAN) and Integrated Program for Aerospace Vehicle Design (IPAD).

Propulsion Environmental Impact Minimization Research and Technology

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$13,097	$10,400	$10,400	$11,410	$3,200

OBJECTIVES AND STATUS

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.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

In the area of propulsion noise reduction, research will be continued in FY 1976 and the transition period on fundamental studies of generation, propagation, and suppression of aircraft noise. The studies include extensive analytical and experimental research related to inlet and fan duct acoustics, turbomachinery noise (fan, compressor, combustor, turbine, nozzle, etc.) jet/flap impingement noise, wing shielding and forward velocity effects on noise, atmospheric propagation and attenuation, and inflight field measurements of noise.

In the area of noise prediction, research efforts are underway through the NASA Aircraft Noise Prediction Program Office, to improve techniques for accurate prediction of ground noise levels of operating and future aircraft to establish total acoustic characteristics, identify key sensitivity parameters and guide future research efforts. Interim noise prediction programs became operational in mid-1974, and in December 1974 the publication of key technology documents began. These documents present the state-of-the-art in noise source predictions, noise reduction technology, atmospheric propagation phenomena and other effects necessary for reliable prediction of the ground noise environment produced by aircraft. Based on these documents, the design and development of a new and much more accurate aircraft noise prediction program will continue during FY 1976 and the transition period. The objective of this work is to improve the accuracy of predicted noise contours (footprints) to within $\pm$ 1.5 decibels.

During FY 1976 and the transition period, in the area of pollution reduction a major NASA activity will be to develop and demonstrate low exhaust emission technology for all thrust classes of aircraft gas turbine engines and aircraft piston engines. Advanced exhaust emission reduction research includes investigations related to injection of hydrogen into aircraft piston engines and aircraft gas turbine combustors to achieve very low nitric oxide emission levels.

Research activities during FY 1976 and the transition period will strive to determine the effects of exhaust emissions interacting with the atmosphere. A major element of this research is the Global Air Sampling Program (GASP) which will measure aircraft exhause emission concentrations, over a five year period, along the world airways. Up to five specially instrumented Boeing 747 aircraft in commercial service will be used in the program. The first instrumented flight was in a United Airlines B-747 in December 1974. The second instrumented aircraft will be a Pan American B-747, to be flown in February 1975. Negotiations are underway with three other international airlines to obtain the desired global coverage for the GASP program. NASA is also developing a small, low cost, simple, remotely piloted vehicle (Mini-Sniffer) for in situ measurement of turbulence, atmospheric trace gases and particulate constituents at altitudes up to 100,000 feet. Air sampling measurements will be made with the Mini-Sniffer during FY 1976 and the transition period.

Other research during FY 1976 and the transition period will include fundamental studies of chemical reactions, kinetic rates and fluid mechanics models necessary to understand the processes involved in the injection of emission products into a supersonic aircraft wake and their subsequent dispersion into the stratosphere. Reactions of interest are those associated with nitric oxide/nitrogen dioxide conversion, hydroperoxyl and hydroxyl radical, and nitrogen "sinks" in the stratosphere such as nitric acid, particularly as they influence natural ozone concentrations. Reaction studies are conducted with consideration of exhaust particulates and the effects of low concentrations of ozone, various hydrocarbons and water vapor chemistry in the presence of solar ultraviolet radiation.

Propulsion Components Research and Technology

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$8,529	$9,000	$8,900	$9,050	$2,700

OBJECTIVES AND STATUS

The aeronautical 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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The funding change reflects the deferral of the design, fabrication and testing of a final stage of a compressor. This research and technology effort supports the Advanced Multi-State Axial Flow Compressor program which was delayed in starting during FY 1975.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

Inlet and nozzle research during FY 1976 and the transition period will concentrate mainly on development of highly sophisticated analytical techniques for accurately predicting complex external and internal flow fields associated with supersonic inlets and nozzles. A considerable portion of the research is concerned with the effect of aircraft maneuvers on inlet behavior since inlet performance during maneuvers can be seriously degraded because of air flow distortion. Airframe interference effects on exhaust nozzle performance is also being examined. During FY 1976 and the transition period, a methodology for prediction of inlet/engine compatibility will be developed, including effects of inlet flow distortion on engine operational stability.

The fan, compressor and turbine technology effort during FY 1976 and the transition period will stress achievement of high performance with minimum degradation of component efficiency. This is implemented by high tip-speed fan research, highly loaded compressor and turbine stage research, and high temperature turbine cooling and aerodynamics interactions. The effects of casing treatment on stable operation of high performance compressors under adverse conditions will be evaluated. Also FY 1976 and the transition period will see significant progress in analytical methodology for calculating compressor flow fields. Turbine research will continue in concentrating on the problems of aerodynamic design of high power, low speed turbines, and cooling techniques applicable to ultrahigh temperature (3,000-3,500 degrees Farenheit) turbines. The high power, low speed turbine research is expected to result in demonstrating performance of an advanced fan drive turbine with significantly fewer stages than contemporary turbines, for the same power output.

A program of research on combustion and augmentation systems technology, quite independent of exhaust emission pollution reduction, will look into techniques for achieving the high exit temperatures and efficiencies required by advanced engines. In FY 1976, in one of the key programs in this area, near 100 percent efficient operation at 3,500 to 4,000 degrees Farenheit will

566-537 O - 75 - 28

be demonstrated using an advanced version of an aircraft type swirl can modular combustor originally designed for 2,400 degrees Farenheit temperatures.

Drive system mechanical components provide the backbone, literally supporting the major thrust producing devices, and includes bearings, shafts, seals and lubrication systems. On-going programs from prior years are continuing, spurred on by the importance of such components as improved engine seals to reduce fuel consumption. In particular, compliant lift-pad compressor end-seal operation will be demonstrated in the laboratory in FY 1976. A seal of this type can effect a reduction of up to two percent in a commercial jet engine's fuel consumption.

Liquid hydrocarbon fuels technology research is focused on characterization of alternative hydrocarbon fuels derived from our abundant supplies of indigenous raw materials--coal and shale oil, including the effects of promising candidate fuels on propulsion systems and components, as well as on exhaust emissions. In FY 1976 and the transition period, the more significant properties of jet fuel derived from shale and coal will be identified.

Air Breathing Engine Systems
Research and Technology

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$7,796	$8,000	$8,000	$8,150	$2,000

OBJECTIVES AND STATUS

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.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

In the area of propulsion system dynamic behavior and control, the effects of transient flow conditions on gas turbine engine systems and components, and new on-line digital computerized control system theories will be demonstrated on complete propulsion systems during FY 1976 and the transition period. Flight tests of an advanced digital control system developed under a joint Air Force/NASA program will be conducted to demonstrate the potential of a system capable of sensing, computing, and controlling a optimum operating conditions the inlet, engine, and exhaust nozzle system of an F-111 airplane.

In FY 1976 and the transition period the intergration of components into complete turbine engine systems will be investigated to define basic performance limits, and evaluate the overall responses to dynamic disturbances and distortions. A joint NASA/United States Air Force full scale engine research program will emphasize acquisition of basic data and phenomenological understanding leading to better analytical and design procedures having the highest potential for reducing engine development cost and time, and which reduce dependence on trial and error development empiricism. Research will be undertaken to determine precisely the causes and relationships between component mechanical or physical condition and performance loss in engines. Several airline engines with varying degrees of wear and deterioration will be tested to determine quantitatively the effect of work components on engine performance.

Low cost engine systems research will be continued in FY 1976 and the transition period with exploration of promising design characteristics and fabrication techniques of interest for general aviation applications. A lightweight multiroller speed reducer for turbofan engines will also be studied.

During FY 1976 and the transition period in the area of hypersonic propulsion, a preliminary structures and systems study of a scramjet module design will be completed, and aerothermal tests of a subscale model will be conducted at Mach numbers of 4 and 7. An evaluation of methods for achieving adequate thrust at low speeds will be completed.

Advanced systems studies conducted during FY 1976 and the transition period will place increased emphasis on technology needed for achieving reductions in fuel consumption. Near term applications will include studies of the substitution of improved parts in existing airline engines. A study of next generation engines based on current design practice may achieve a 15 percent reduction in fuel consumption below that of current engines, by stressing energy conservation in the design of the engine components. Other studies will concentrate on the fuel savings achievable through use of relatively unconventional but very energy conservative devices such as the regenerator. Incorporation of the energy conservative components and devices into an engine could reduce fuel consumption by about 30 percent below that of current engines.

Fluid and Flight Dynamics Research and Technology

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$8,667	$9,400	$9,400	$10,200	$2,900

OBJECTIVES AND STATUS

The thrust of the fluid and flight dynamics program is to advance 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.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

In the area of prediction of aerodynamic phenomena, theoretical prediction techniques are being developed to predict complete aerodynamic characteristics of complex three-dimensional aircraft configurations, so that preliminary design concepts can be evaluated with marked reduction in costly, energy-consuming wind tunnel tests.

During FY 1976 and the transition period, the present predictive capability will be extended to configurations of increased complexity, with particular emphasis on the development and use of advanced turbulence modeling techniques to account for viscous effects on flow phenomena.

Efforts on reducing adverse environmental and aerodynamic effects are concentrated on such problems as wake vortex turbulence, airframe generated noise and airframe buffet. Research will continue in 1976 and the transition period to refine a number of aerodynamic alleviation devices for eliminating the wake vortex hazard restriction on aircraft landing operations, and to evaluate the operational feasibility tests of the most promising methods. Airframe noise activities will concentrate on developing and evaluating means for reducing the noise of flaps, landing gear, cavities and protuberances so that planned reductions in overall aircraft noise can be accomplished on schedule.

A focused effort is underway to provide improved single and multi-element high-lift airfoils for advanced general aviation, transport and rotating-wing aircraft. In FY 1976 and the transition period research will continue to generate airfoil design methodology, advanced airfoils for both subcritical and supercritical aerodynamic regimes and provide high quality data on selected configurations, particularly at high Reynolds number and angles of attack. Specifically, improvements will be sought in subsonic drag prediction and the ability to incorporate boundary layer and flow separation-reattachment effects in mixed subsonic-transonic flows in the predictive and design process. Three-dimensional viscous-potential flow interaction over highly swept wings with leading and trailing edge high lift devices will continue to be studied.

Another aspect of the program is concerned with developing improved experimental techniques, analytical methods and test facilities to increase the reliability of wind tunnel evaluations of advanced aircraft concepts.

Emphasis in FY 1976 and the transition period will continue on providing advanced transonic tunnel walls and support systems to minimize interference effects (including the use of magnetic suspension), on defining and minimizing stream turbulence factors at transonic and supersonic speeds, and on determining transonic three-dimensional scale effects on highly swept wings.

Significant emphasis is being placed on continuing efforts to provide a basic understanding of the aerodynamic characteristics of aircraft at high angles of attack, particularly on investigating the fundamental nature of stall/spin, the use of control systems to prevent divergence at high angles of attack, and the aerodynamic characteristics responsible for spin behavior. Efforts toward the definition of handling qualities criteria for highly augmented vehicles will also continue through FY 1976 and the transition period.

Avionics Research and Technology

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$3,302	$3,800	$3,700	$3,580	$1,000

OBJECTIVES AND STATUS

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, sort haul, vertical takeoff and landing, and long haul transport aircraft.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The funding change reflects the deferral of work on an advanced receiver for civil aviation use which is insensitive to multipath effects. Deferral of the effort was considered to be acceptable due to the lack of the near term requirement for the receiver.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

Flight tests of a time optimized, four-dimensional (4-D) guidance system have been successfully completed. Flight testing of an advanced fuel optimized 4-D system for Short Takeoff and Landing (STOL) aircraft will be completed during FY 1976. Subsequent analysis and simulation efforts will derive a full-flight-envelope autopilot design for powered-lift STOL aircraft by FY 1977. A practical assessment, both analytical and experimental, of Regional Navigation (RNAV) schemes for general aviation aircraft will be completed by the end of FY 1976.

During FY 1976 and the transition period promising new concepts offering the potential of significant improvements in performance and/or cost of avionics systems will be investigated. A split-surface stability augmentation system, which can reduce pilot workload and provide better aircraft handling and ride characteristics, will be flight tested in a Beech 99 commuter airline type aircraft. A low profile microstrip antenna, with a production cost of less than 1/8 of present antennae has been developed. A computer program to determine its characteristics in aircraft configurations will be developed in FY 1976, and the antennae will be flight tested on model airplanes in FY 1977.

Highly reliable, fault tolerant computers are being studied for the flight control of civil aircraft. The design of different fault tolerant computer organization concepts will be completed during FY 1976 and the transition period.

Automated Vertical Takeoff and Landing (VTOL) avionics efforts are aimed at the synthesis of integrated avionics systems for reliable and cost-effective automated flight, with primary emphasis on future helicopters and VTOL aircraft. Navigation and guidance requirements for commercial VTOL operations have been defined. Flight testing of an acoustic altimeter breadboard and a laser gyro strapdown navigation system will be completed in FY 1975. Flight testing of automatic and manual displays will be initiated in early FY 1976 and completed in FY 1977. The complete integrated guidance system is scheduled for flight tests on a CH-47 research helicopter by FY 1980.

Aircraft Operations and Safety
Research and Technology

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$3,638	$3,900	$3,900	$3,900	$1,100

OBJECTIVES AND STATUS

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.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

In the area of expanding our knowledge of basic atmospheric processes, improvement of our understanding of natural atmospheric behavior as it affects

the safe and efficient operation of aircraft is a continuing, long term process. FY 1976 and the transition period research will continue the process of functionally defining and describing atmospheric phenomena in a way that will facilitate a utilitarian use of this information by designers, operators, and forecasters. Research will also continue in the areas of fog formation and dissipation, and high altitude thermal and pressure gradients.

In the area of aircraft safety technology, research is focused on developing a technology base which can be used to reduce accident opportunities and to minimize accident fatalities and damage. This effort includes in-flight and post-crash aircraft fire prevention and protection, and lightning strike hazards reduction. In FY 1976 and the transition period, effort will continue on the test and evaluation of aircraft interior materials. A laser-Doppler system will be employed in vortex flight research programs and in flight detection of clear air turbulence. Work will continue in refining the structural failure model for high speed rotors and applying results to the concept development of burst-resistent rotors.

In the area of improving the operational efficiency of aircraft systems, the focus is to selectively boost technology development which will permit increases in the service life and efficiencies of aircraft subsystems. During FY 1976 and the transition period, new tire tread stock recapped on B-727 tire carcasses will be subjected to in-service evaluation. Also, Short Takeoff and Landing (STOL) aircraft will be fitted with a research landing gear to permit evaluation of operation in extremely high crosswinds. Flight test instrumentation needs for advanced in-house flight testing will be evaluated for possible new concept development activity.

Low-Speed Vehicle Aerodynamics and Flight Dynamics Research and Technology

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$10,466	$11,600	$12,300	$12,500	$3,500

OBJECTIVES AND STATUS

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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The funding for this program was increased to enhance the technology effort on upper-surface-blowing (USB) propulsive-lift concepts in response to the usage of USB on ongoing projects such as the Air Force Advanced Medium Short Take Off and Landing Transport (AMST) and the NASA Quiet Short Haul Research Aircraft (QSRA).

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

During FY 1976 and the transition period, the effort in general aviation will continue to be concentrated on the generation of reliable design data for spin resistant aircraft. A flight test program will verify the results of spin tunnel and radio controlled model tests and the effectiveness of a rocket spin recovery system. Aerodynamic performance studies will concentrate on the flight test verification of improved low speed airfoil sections and development of techniques for reducing drag penalties associated with engine cooling. Flight and handling qualities efforts will emphasize techniques for more precise flight path control during approach and landing.

In the advanced rotorcraft program, in FY 1976 and the transition period, a new rotor test apparatus and laser Doppler velocimeter will be used in the 40-by 80-foot wind tunnel to investigate various rotor systems for reduced noise, reduced vibration, and improved aerodynamic efficiency. An oscillating pitch rig and a generalized rotor aeroelastic model will be utilized in the transonic dynamics tunnel for investigation of rotor unsteady aerodynamic effects. Research on advanced tilt-rotor vehicles will include study of feedback control systems, methods of gust suppression, and handling qualities requirements. Helicopter flight tests will be carried out using arbitrarily shaped flight-paths for investigation of terminal area operating procedures, piloting techniques and handling qualities and display requirements. The dynamic characteristics of large helicopter transports which adversely affect the passengers and the community will also be investigated in flight.

During FY 1976 and the transition period, the advanced Vertical Takeoff and Landing (VTOL) aircraft program will concentrate on lift/cruise fan aircraft technology, with primary emphasis on the technology related to small lift/cruise fan vehicles that have good potential for both military and civil utility missions. Small and large scale wind tunnel tests, control system analyses and tests, large scale thrust-vectoring tests, and simulation experiments will be performed. Other efforts will include study of jet interactions and exploratory research on promising VTOL fighter-type vehicles.

In the area of powered-lift aircraft technology, in FY 1976 and the transition period, research on advanced upper-surface blowing (USB) concepts employing attached flow over the wing to achieve high lift will be emphasized. Large scale wind tunnel tests will provide aerodynamic data, and static tests will provide aerodynamic turning, acoustics, and loads information. The cruise

performance of advanced USB configurations will also be investigated in the 16-foot transonic wind tunnel. Study of advanced augmentor-wing concepts, including large scale tests of an improved nozzle and an acoustically treated augmentor will be carried out. A combined analytical, simulation and flight research program to provide data for revision and extension of existing handling qualities criteria for powered-lift Short Takeoff and Landing (STOL) aircraft will continue.

High-Speed Vehicle Aerodynamics
and Flight Dynamics Research and Technology

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$7,932	$9,100	$8,900	$8,830	$2,500

OBJECTIVES AND STATUS

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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The funding change reflects (1) the deferral of study and experimental efforts on active cooling systems for hypersonic aircraft until the hypersonic vehicle program can be better defined with the Air Force, and (2) cost savings realized by the successful completion of the F-15 RPRV stall/spin program ahead of schedule.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

During FY 1976 and the transition period in the area of medium and long haul cruise aircraft aerodynamics, design information will be provided through evaluations of promising concepts on transport configurations. Numerous concepts such as compliant skin, oblique-wing, supercritical wing, and winglets will be parametrically evaluated for exploitation on future cruise aircraft such as a fuel conservative transport. Evaluation of the oblique wing concept through facility tests, simulation, and parametric studies through spring 1975 will lead to a large (850 pound) radiocontrolled remotely piloted flight test by summer 1975. If the studies and early flight results substantiate the promise of the oblique wing concept, transonic flight tests will be programmed for a modified Firebee II vehicle.

In the area of new aerodynamic technology for increased combat effectiveness of fighters and missiles, in FY 1976 and the transition period, numerous concepts will be applied to improve efficiency in terms of increased range, maneuverability, and controllability. The vectoring in forward flight (VIFF) maneuvering technique, proven on Kestrel aircraft, will be evaluated on the improved Harrier Drop tests utilizing the 3/8-scale F-15 Remotely Piloted Research Vehicle (RPRV) to successfully and safely substantiate the stall, spin and recovery predictions of the spin tunnel will be completed by mid-CY 1975. Opportunity to compare RPRV results with F-15 aircraft results will be explored for further substantiation of predictive techniques. The aerodynamic influences of installed propulsion systems on fighter and other high speed aircraft will be investigated and promising beneficial interactions will be pursued for advanced configurations.

During FY 1976 and the transition period, in the area of hypersonic aerodynamics, representative configurations will be studied and tested to establish a technology base to extend predictive techniques to future applications.

In the area of Department of Defense (DOD) assistance, in FY 1976 and the transition period, experimental, consultative and other technical assistance will continue on major development programs such as B-1, F-14, F-15, ACF, and others as identified by DOD in future requests.

Aeronautical Man-Vehicle Technology

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$3,675	$4,800	$4,800	$5,030	$1,400

OBJECTIVES AND STATUS

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.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

In the area of aircraft noise, a multidisciplined group of scientists are developing laboratory measures and subjective response scales to define individual response to aircraft noise. In addition, field research is being

conducted to coincide with developed laboratory hypotheses so that transfer functions and algorithms can be developed. In FY 1976 and the transition period, preliminary studies will be concerned with number of flights, aircraft mix, time of day, directionality, landing versus takeoff, activity disruption and background noise.

Human response to interior noise, aircraft vibration, motion and other factors shaping attitudes towards the National Air Transportation System, i.e., technological advancements (Vertical Takeoff and Landing, Short Takeoff and Landing and supersonic cruise aircraft), are being analyzed from the standpoint of passenger acceptance and ride quality. Resulting data are being used to form a scientific information system of subjective response to specific vehicle ride characteristics. In FY 1976 and the transition period, contours of equal comfort will be developed along with studies to interpret effects of combined noise and vibration, frequency masking, sensitivity to and discomfort from vibration, and multimodal transportation systems.

In the area of flight management, a research program is being pursued to address the growth implications of civil aviation in the 1980-1990 period of automated flight systems. Anticipation of continued complexity of the airspace operating requirements is manifest in the conception and continued introduction of new control and display systems into the aeronautical world. Such systems tend to complicate and/or increase crew workload. To reap the benefits of the new systems and technologies the total cockpit system must be completely understood. In FY 1976 and the transition period, the human factors engineering techniques and methodologies will be used to develop the required cockpit configuration for the 1980's and demonstrate the safety, economy, and effectiveness of computer-based, automated cockpit systems.

In the area of simulation technology, a multifaceted program is underway to determine simulation fidelity requirements, and to develop and validate methods of effectively simulating the full range of aeronautical tasks performed in the cockpit. In FY 1976 and the transition period, studies will continue in the area of visual display requirements, techniques for using color digital systems, motion cue requirements and the investigation of methods of measuring pilot performance in simulation/flight environments.

Systems Studies

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$3,100	$3,000	$3,000	$3,000	$700

OBJECTIVE AND STATUS

The overall 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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The System Studies program presented in this budget has been restructured from the program appearing in last year's budget under the same title. Many of the studies justified here last year are now part of the Systems Technology Programs justification material. For comparison purposes, this change has also been shown in the FY 1974 and FY 1975 Budget Estimate columns.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

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 during FY 1976 and the transition period 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, during FY 1976 and the transition period, 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

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(In thousands)			
Materials and structures systems technology.....	$1,000	$3,400	$3,400	$8,100	$4,400
Propulsion systems technology.....	---	500	500	2,500	1,200
Avionics systems technology.....	1,220	4,100	4,100	6,000	2,000
Aircraft operating systems technology.....	14,975	12,250	12,250	11,900	2,600
Aerodynamic vehicle systems technology.....	860	3,350	3,350	4,650	1,200
Advanced civil Aircraft systems technology.....	7,146	7,300	7,300	12,500	4,300
Man-vehicle systems technology.....	---	---	---	200	100
Military aircraft systems technology.....	1,150	800	800	700	---
Total.....	$26,351	$31,700	$31,700	$46,550	$15,800

Materials and Structures Systems Technology

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$1,000	$3,400	$3,400	$8,100	$4,400

OBJECTIVE AND STATUS

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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The Materials and Structures Systems Technology program is a new budget structure category. The resources shown in FY 1975 reflect the Composite Primary Structures program, the Integrated Programs for Aerospace Vehicle Design effort and the Materials for Advanced Turbine Engines program. In FY 1974 this category consisted of the Composite Structures Flight Experiments program. For comparative purposes this change has been shown in both the FY 1974 and the FY 1975 Budget Estimate column.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

The Composite Primary Structures program was initiated in FY 1975 to demonstrate a 25 - 30 percent weight saving through the application of composite materials in primary structural components of commercial transport aircraft, and to establish confidence in the economy, durability, and maintainability of composites through actual flight service. This effort will be conducted through contracts with manufacturers of commercial airliners. It will include design and manufacture of a tail and wing component. The contract for the tail component is being initiated during FY 1975. The wing development will be initiated early in FY 1976. Each contract will include engineering development, design, test, Federal Aviation Agency (FAA) certification, and installation on a scheduled airline aircraft to replace a standard metal component. This will be accomplished in about 5 years followed by a 5-year flight service evaluation during which each component is expected to accrue approximately 15,000 hours of flight service.

The Integrated Programs for Aerospace Vehicle Design (IPAD) was initiated in FY 1975 to provide a computer software system that will significantly aid the vehicle design process by automating and integrating many of the time-consuming functions now required of the design staff. Preliminary studies have established the feasibility of the system and have indicated that savings in design cycle time and cost of 50 percent could be achieved. The system development will provide: (1) an executive program to interface with the user and control the rest of the system; (2) utilities programs which provide computer language translation, report writing, control of interactive graphics, etc.; and (3) a data base manager program to control the huge catalog of technical data required for vehicle design. The FY 1976 and transition period effort will continue activities on these elements leading to completing an operational system by FY 1980.

The Materials for Advanced Turbine Engines (MATE) program is aimed at determining the potential of new high technology materials for use in advanced aircraft turbine engines. The potential will be demonstrated by, accumulating engineering property data, and performance testing in rigs and in ground test engines. This rapid accumulation of engine experience will allow accelerated realization of an additional 5 percentage points of return on investment when the materials are used in advanced commercial aircraft. This effort is being

initiated in FY 1975 with the first material probably being an advanced superalloy blade material having a 75 degree Farenheit increase in temperature capability In FY 1976 the second material will be selected and will probably be a powder metallurgy disk alloy with potential of having three times longer life than cast or forged disks, and a 40 percent reduction in manufacturing cost.

A new activity, the Aeroelasticity of Turbofan Engines Program is being initiated to improve capability for understanding and avoiding aeroelastic instability in turbine engine fan blades. This is a joint research effort with the Aero Propulsion Laboratory of the United States Air Force. In FY 1976 and the transition period, the NASA effort will involve initiation of fan flutter tests, analytical and experimental studies of aeroelastic factors, and research on aero-mechanical coupling. The joint activity is aimed at providing advanced design and test methods for coping with increasingly critical engine aeroelasticity problems by FY 1979.

The Fire-Resistant Materials Engineering Program will be aimed at the development of fire-resistant, low toxicity materials for use in aircraft interiors, windows, and insulation for fuselages, fuel lines, and engine nacelles. In FY 1976 and the transition period work will begin on the synthesis and development of polymeric interior materials, high impact windows, and insulations based on char forming mechanisms. Work will be done to improve the fire safety of fuel lines and engines. Basic polymer rheology understanding will be applied to developing anti-misting fuels. An effort will be made to modify existing materials to improve fire resistance and a 737 fuselage will provide the test bed for systems testing. This is a three-year program with the aim of providing a full scale aircraft systems test in FY 1978.

Propulsion Systems Technology

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
---	$500	$500	$2,500	$1,200

OBJECTIVE AND STATUS

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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The Propulsion Systems Technology program is a new budget structure category. The resources shown in FY 1975 reflect the Advanced Multistage Axial Flow Compressor program.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

Compressors are recognized to be the pacing item in turbofan engine development programs. It appears possible from the results of research undertaken by NASA that a single spool axial flow compressor can develop a pressure ratio of 20 to 1 in as few as 6 stages compared to 13 stages in current technology compressors. Reductions of up to 20 percent in aircraft gross weight with significant reductions in fuel consumption and operating costs may be achieved as a result of this work. Initial program activity in the Advanced Multistage Axial Flow Compressor program began in FY 1975 with conceptual design study contracts awarded to two contractors. Completion of the study contracts will occur early in FY 1976. On the basis of these studies a single contractor will be selected in FY 1976 to design, fabricate and test the experimental compressor.

The energy crisis is one of the most far-reaching problems besetting the airline industry. The NASA Advanced Energy Conservative Turbofan Systems Technology Program includes many work elements related to energy conservation. It is estimated that by incorporation of appropriate advanced components and subassemblies resulting from NASA research into an advanced turbofan engine, as much as a 30 percent reduction in cruise fuel consumption may be attained, compared to present generation turbofan engines. Studies initiated during FY 1975 are examining unconventional, low energy consumption engine concepts which may include regenerators, intercoolers, and variable area turbines. These studies will be extended in FY 1976 and the transition period to identify specific systems technology experimental investigations of unique component and propulsion subassemblies. One or more contractors will be competitively selected in FY 1976 to conduct the experimental investigations of unique components and propulsion subassemblies identified in the extended studies.

The enlarging fleet of jet powered general aviation airplanes requires that some attention be devoted to the environmental problems of noise and pollution due to this segment of aviation. Previous NASA efforts have demonstrated significant noise suppression and emission reduction technology on large engines. However, a significant portion of the NASA technology had been conducted with low noise fans and clean combustors of a size representative of general aviation turbofan engines. The Quiet, Clean General Aviation Turbofan program, a 4-year systems technology program beginning in FY 1976, will demonstrate the low noise and clean combustor technology in a turbofan engine of less than 5,000 pounds of thrust. Studies have been initiated during FY 1975 to define the systems technology program to be followed by a contract award in FY 1976 for engine design fabrication and test. Program costs will be kept

at a minimum by extensive use of existing engine component technology and by use of existing engine cores requiring no major modifications, except for those parts bearing directly on noise or emissions experiments. There is no intention to carry the engine into a preprototype, development or production program. Cost sharing will also be explored to keep program costs at a minimum.

Avionics Systems Technology

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$1,220	$4,100	$4,100	$6,000	$2,000

OBJECTIVES AND STATUS

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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The Avionics Systems Technology program is a new budget structure category. The resources shown in FY 1975 reflect the Fly-By-Wire Flight Experiment program, the General Aviation Low Cost Avionics program and the Active Control Aircraft Flight Experiment program. In FY 1974, the resources reflect the Fly-By-Wire Flight Experiment program.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

The Fly-By-Wire program will provide an all electronic, redundant aircraft flight control system to be used for a feasibility demonstration, and to evaluate shuttle software concepts and advanced transport control laws in a representative environment. The principal emphasis is on reduced weight and fuel consumption, and on improved performance and operational flexibility. The final design review of the triplex, fully redundant, all digital Fly-By-Wire system is scheduled for May 1975 with the first flight scheduled for FY 1976.

The General Aviation Advanced Avionics program, aimed at providing a totally integrated advanced, low cost avionics system to enhance the safety, reliability, and utility of future general aviation aircraft will be designed and demonstrated. Data from inital design studies, scheduled for completion in

566-537 C - 75 - 33

FY 1976, will be used to define candidate configurations and to delineate subsystem requirements. Preliminary system specifications and requirements will also be derived during FY 1976 and the transition period. Critical avionics components for these subsystems will then be developed and evaluated during representative flight tests to ensure their feasibility and performance.

Under the Active Control Aircraft program, studies on the concepts of reduced static stability and gust and maneuver load alleviation for active control will be completed during FY 1976 for incorporation into an Active Control Analysis Computer Program. A contract for the integrated design of a long haul subsonic transport using these concepts will also be completed in FY 1976. The resultant active control aircraft configuration will then be extended to include flutter suppression and will be flight tested on a special research vehicle during FY 1980 and 1981. Concurrently, an active control system stressing ride quality improvement will be developed and flight tested on a short haul Twin Otter aircraft during FY 1976, the transition period and FY 1977. An expanded version of this system, including additional active control concepts such as gust and maneuver load control, and flight path control, will be designed and evaluated by FY 1978.

Aircraft Operating Systems Technology

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$14,975	$12,250	$12,250	$11,900	$2,600

OBJECTIVES AND STATUS

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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The Aircraft Operating Systems Technology program is a new budget structure category. The resources shown in FY 1974 and FY 1975 reflect the Operating Systems Experiments program plus a portion of the Systems Studies and Design Studies programs. For comparison purpose this change has also been shown in the FY 1974 and FY 1975 Budget Estimate columns.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

In System Technology Studies, FY 1976 and the transition period efforts will include definition and quantification of acceptance factors for short haul air travelers; investigation of area navigation techniques for flying direct terminal-to-terminal routes at low altitudes; establishing small community user requirements for microwave instrument landing systems; and analysis of flight data to identify potential accident causing factors.

The Terminal Configured Vehicle Systems, research will continue in FY 1976 and the transition period with a small contemporary jet aircraft, to provide technology for assuring compatability and safety of advanced conventional jet transport aircraft in future high density terminal area environments. Experiments with a digital autoland system in combination with a microwave instrument landing system will be commenced in FY 1976. A flight evaluation of curved, decelerating, and other types of noise reduction flight procedures will be completed in FY 1976.

In the Short Takeoff and Landing (STOL) Operating Systems program, a related effort is being conducted for short takeoff and landing aircraft under a joint agreement with the Federal Aviation Agency (FAA) to develop a data base for use by industry and government in establishing systems criteria and operational procedures. Flight experiments will be conducted in FY 1976 using an augmentor wing jet STOL research aircraft and a modified Twin Otter equipped with an advanced integrated digital avionics systems with sufficient capability and flexibility to investigate system configurations and define methods by which STOL aircraft can be operated effectively and safely in air traffic environments of the 1980-1990 time period.

In the Vertical Takeoff and Landing (VTOL) Operating Systems program, a technology base is being established for VTOL aircraft which will provide the capability to land and takeoff with optimized fuel consumption and safety while at the same time enabling operations in foul weather conditions from a wide variety of landing sites. Flight experiments with helicopters will continue in FY 1976 and the transition period and flight research with nonrotary wing VTOL research aircraft is planned for FY 1977.

Aerodynamic Vehicle Systems Technology

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$860	$3,350	$3,350	$4,650	$1,200

OBJECTIVES AND STATUS

This program is focused primarily on flight evaluation and demonstration of selected 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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The Aerodynamic Vehicle Systems Technology program is a new budget structure category. The resources shown in FY 1975 reflect the Wake Vortex Flight Minimization Flight Research program, the Rotor Systems for Rotor Systems Research Aircraft program, and the C-8 Augmentor Wing Flight Experiment program. In FY 1974, the resources reflect the C-8 Augmentor Wing Flight Experiment program and a portion of the Design Studies program. The C-8 program will be completed in FY 1975.

BASIS FOR FY 1976 AND TRANSITION PERIOD ESTIMATES

To guide the selection and definition of aerodynamic concepts for focused laboratory and flight evaluation, Systems Technology Studies are conducted to provide integrated design assessments of promising concepts in aircraft applications. These studies in FY 1976 and the transition period will include preliminary design of an advanced lift/cruise fan propulsion system and an assessment of the relative utility of lift fan, tilt rotor and advanced helicopter aircraft for a range of civil missions.

The Wake Vortex Minimization program will continue in FY 1976 and the transition period to develop and demonstrate aerodynamic methods to reduce the landing and takeoff separation distance imposed by wake vortices generated by large jet transports on trailing aircraft. A reduction from the present 3-5 miles separation to 2 miles is being sought without significant detrimental effects on aircraft performance. The results of ground facility and preliminary flight research in FY 1975 indicate that this goal may be feasible by utilizing techniques for changing wing lift distribution through tailored deflection of spanwise flap segments, or addition of turbulence through air injection, vortex generators and trailing devices. The effort in FY 1976 and the transition period will be focused on validating ground-based results and optimizing alleviation techniques.

In the Rotor Systems for Rotor Systems Research Aircraft (RSRA) program, improved rotor airfoils and blade tip shapes will be evaluated, and competitive contractual predesign studies completed in FY 1976 to define an advanced aero/acoustic rotor as a candidate research rotor system for future evaluation on the Rotor Systems Research Aircraft (RSRA). Dynamic model tests to investigate the aeroelastic characteristics, and contractual system design studies begun

in FY 1975 to define advanced variable-geometry and bearingless composite structure rotors for evaluation will also be completed. Major contractual efforts during FY 1976 will initiate the detailed design, fabrication and ground test checkout of two full scale flight test rotor systems for thorough evaluation on the RSRA. This rotor systems research activity is geared to exploit the potential for significantly improved military and civil helicopters in the broad areas of performance, efficiency, noise and dynamics through integrated systems technology development and flight validation.

Advanced Civil Aircraft Systems Technology

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$7,146	$7,300	$7,300	$12,500	$4,300

OBJECTIVES AND STATUS

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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The Advanced Civil Aircraft Systems Technology program is a new budget structure category. The resources shown in FY 1975 reflect the YF-12 Flight Experiments program, the Advanced Acoustic Composite Nacelle Flight program and a porting of the Systems Studies and Design Studies programs. In FY 1974 the resources shown reflect the YF-12 Flight Experiments program and a portion of the Systems Studies and Design Studies program.

BASIS FOR FY 1976 AND TRANSITION PERIOD ESTIMATES

System Technology Studies in FY 1976 and the transition period will assess the benefits of lightweight and composite structures, modularized engine components, advanced controls, noise and emission suppression and advanced lift systems could have on future short haul transport systems. Studies will also consider the effect of improvements in short haul aircraft terminal area maneuverability on community noise and airport congestion relief. Other studies will be made to integrate drag reducing aerodynamic developments (e.g. boundary layer control, oblique wing, winglets, etc.) to define practical long haul aircraft configurations of conventional or unconventional design, with improved economics and environmental compatibility. The advantages of using improved independent power generation for onboard utilities will be explored, including their application to powered wheels and boundary layer control.

In FY 1976 the Fuel Conservative Aircraft Systems Technology program will be initiated to exploit technical opportunities to reduce fuel consumption of transport aircraft in various areas, such as: active controls, composite materials, induced and viscous drag reduction, advanced propulsion systems and advanced avionics. At present, ongoing NASA programs have progressed to a point where it is appropriate to evaluate the potential fuel savings these technical opportunities might have on a fuel conservative aircraft design. Therefore, aerodynamic and advanced control technologies, that can lead to major savings in aircraft fuel consumption, will be developed to establish a state of technical readiness for implementation on transports of the mid-1980's. Flight tests will be conducted to verify and demonstrate that the fuel conservative technologies are feasible, and that an aircraft designed with these technologies can provide for practical, economical, and safe operations.

Forecasts indicate ultimate depletion of hydrocarbon fuels and expose the need for developing alternate aircraft fuels to insure a strong, competitive U.S. Civil Aviation Industry beyond the 1990 time period. Hydrogen is an abundant energy source and offers significant advantages as an aircraft fuel. In the Hydrogen Fueled Aircraft Systems Technology program, initiated in FY 1976, ground tests will be carried out to generate and verify the technology data base from which design requirements can be established for a safe hydrogen fueled transport aircraft. The research effort on long lead-time technology will include development of lightweight cryogenic tanks and insulation. Wind tunnel studies will determine the performance and stability characteristics of aircraft configurations with the fuel stored in wings, pods, fuselage, and booms.

New long range subsonic transport aircraft must be responsive to the demand for quieter operations. To achieve a significant reduction in the noise footprint area, without increased operating costs and fuel consumption, the Advanced Acoustic-Composite Nacelle will develop a composite nacelle for potential application to high bypass ratio engines of future transport aircraft. (Alternatively, this nacelle technology would permit a reduction in aircraft weight and fuel consumption at the expense of some of its noise reduction potential). The project will capitalize on improved methods for integrating acoustic absorbent and composite materials to form a lightweight, load-carrying structure obtimized for noise suppression. Design studies will define cost and weight-effective means of integrating various acoustic-composite material concepts in nacelle construction and include the sensitivity to noise reduction of such factors as direct operating cost, takeoff gross weight, and fuel consumption. Research on materials, structures, and noise will be performed to accrue the necessary technical base for multi-section acoustic duct liner design.

Variable-cycle engines show great promise for efficient operation of supersonic transport aircraft. Propulsion systems studies have identified several potential engine cycles which could, with proper component development,

provide the technology base required for a low noise, minimum pollution, economically feasible engine for a supersonic transport. In the Variable Cycle Engine Component System Technology program, initiated in FY 1976, the common components already identified such as diverter valves, variable inlets and nozzles, secondary burners, etc., would be designed, developed and tested. Studies will integrate the engine component technology data into the most likely candidate cycle for a possible future experimental engine program.

The YF-12 aircraft is the only United States aircraft that can be used for flight research in the Mach number range above 2.7. Propulsion systems, stability and control, structures, and aerodynamic experiments are conducted and compared with analytical studies and the results of wind tunnel and ground tests. In FY 1976 in the YF-12 Flight Experiments program, steady state and dynamic inlet performance data will be analyzed and compared with wind tunnel inlet test data. In the stability and control area, a cooperative control system will be flight tested and the lateral control and inlet shock stabilization system activities will begin to be programmed into the YF-12. Titanium honeycomb, boron-aluminum panels will be tested and resin and metal matrix panels will be installed for their initial flight tests. A cold wall hollow cylinder will be carried to high speed to establish the correlation of flight boundary layer temperatures/skin temperatures with similar measurements made in wind tunnels. The aircraft will also be used in support of the stratospheric emission impact studies and further work will define the effect of combined heating and loading on the calibration procedures for measurement of aerodynamic loads in flight.

To bolster the technology base in hypersonics, the Hypersonic Research Systems Technology program will be initiated in FY 1976 to conduct the ongoing activities in propulsion, structures, and aerodynamics that are to be augumented by experiments which could be carried on an X-24C type airplane. Studies, to be conducted jointly with the Air Force, will define an X-24C configuration with the capability of sustained flight for at least 30 seconds at Mach numbers above 6.5 and a payload bay of sufficient volume to carry instrument packages, structural experiments and the liquid hydrogen tank for a scramjet engine. Propulsion technology aspects will be directed toward developing and testing hot engine components. Structures technology will be directed toward the experimental evaluation of hot, actively cooled structures and fuselage liquid hydrogen tanks, which could lead to the development of the experimental packages for a research vehicle. The aerodynamics aspects are directed toward support of the X-24C activity and to develop the required scramjet/airframe integration.

Man-Vehicle Systems Technology

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
---	---	---	$200	$100

OBJECTIVES AND STATUS

The aeronautical Man-Vehicle System 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.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

The aviation community, both national and international has expressed major concern over human errors in air transportation. This concern covers the following areas of human factors: (1) aircrew safety awareness; (2) aircrew discipline; (3) cockpit discipline, (4) flight crew management and flight operations. The focus of these areas centers primarily on Approach and Landing Safety. The focus of the Approach and Landing Safety program in FY 1976 and the transition period will be to identify and investigate potential solutions to offset the increase in "human error"--caused commercial aircraft accidents. The program will be fully coordinated with industry and other appropriate agencies. A classification model for accident analysis will be developed for investigation of human factors elements in aircraft accidents or incidents and to isolate factors contributing to pilot or flight crew error. Strategies to minimize pilot error will be evaluated through crew role modification and flight simulation. Validation of proven concepts will be made through observation and monitoring pilot behavior. The full mission simulation capability being developed at Ames Research Center will be used to analyze mission profiles developed to test pilot error flight profiles, as well as those developed to eliminate pilot error and adverse flight crew interactions.

Military Aircraft Systems Technology

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$1,150	$800	$800	$700	---

OBJECTIVES AND STATUS

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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The Military Aircraft Systems Technology program is a new budget structure category. The funding in FY 1974 and FY 1975 reflects the Transonic Aircraft Technology Experiments program.

BASIS FOR FY 1976 AND TRANSITION PERIOD ESTIMATES

An ongoing effort in Transonic Aircraft Technology program will provide proof-of-concept of supercritical airfoil technology in the transonic and low supersonic flight regimes and provide design criteria. This joint United States Air Force/NASA program will conduct flight testing on an F-111A equipped with a set of supercritical wings especially designed and manufactured for high maneuverability in the high subsonic regime. Tests will evaluate such parameters as buffet onset, profile drag, maximum speed, turn performance, etc. The behavior of the F-111A variable swept wing high lift devices, maneuverability, and pilots tracking ability will be established. Flight test data will be reduced and correlated with wind tunnel test data in order to generate design criteria and for establishing the general performance improvement of the basic F-111A aircraft equipped with the supercritical wings. The flight test program will be completed late in FY 1976.

Experimental Programs

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Highly maneuverable aircraft technology.....	---	$1,500	$1,500	$4,900	$1,800
Quiet, clean, short haul experimental engine.....	$6,000	10,000	10,000	10,000	2,000
Refan program.....	19,545	1,000	1,000	---	---
Supersonic cruise aircraft research.....	10,100	8,900	8,900	8,900	2,000
Tilt rotor research aircraft.....	5,345	11,300	11,300	1,900	300
Rotor systems research aircraft.....	5,266	7,100	7,100	3,100	---
Quiet propulsive lift technology.....	12,300	8,000	8,000	11,900	400
Total.....	$58,556	$47,800	$47,800	$40,700	$6,500

566-537 O - 75 - 31

Highly Maneuverable Aircraft Technology

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
---	$1,500	$1,500	$4,900	$1,800

OBJECTIVES AND STATUS

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 in a multidisciplinary manner to exploit the potential of new technology for the design of future military combat vehicles. Reductions in the cost of the experimental flight tests to explore the new technology of approximately 50 percent over comparable manned test vehicles will be realized through flight test of subscale vehicles utilizing the relatively new Remotely Piloted Research Vehicle (RPRV) test technique.

In a recent study conducted under the auspices of the Aeronautics Panel of the Department of Defense (DOD)/NASA Aeronautics and Astronautics Coordinating Board (AACB), it was concluded that "substantial improvements will be needed for advanced fighters in the 1980's." The NASA HiMAT program is designed to respond to the identified needs by maturing through testing in the real and dynamic environment of new technologies for potential incorporation in fighter aircraft in the 1980's.

Design feasibility studies were completed in August 1973. Based on the encouraging results of the feasibility studies, follow-on conceptual design studies were conducted and completed in November 1974.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

One of the three firms participating in the conceptual design studies will be selected in late FY 1975 to carry his configuration into final design and then to fabricate two subscale unmanned flying models which will be tested at NASA's Flight Research Center using the remotely piloted flight-test technique. Preliminary design and initiation of final design of the subscale research vehicles will be accomplished during FY 1976 with completion of final design scheduled for the second quarter of FY 1977.

Quiet, Clean, Short Haul Experimental Engine (QCSEE)

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$6,000	$10,000	$10,000	$10,000	$2,000

OBJECTIVES AND STATUS

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.

The QCSEE program includes the design, fabrication, and testing of two experimental turbofan propulsion systems, suitable for "under-the-wing" and "over-the-wing" externally blown flap powered lift aircraft installations. The environmental technology will concentrate on obtaining low propulsion system noise (95 Equivalent Perceived Noise Pressure Level (EPNdB) noise footprint area less than 0.5 square miles or 95 EPNdB at 500 feet sideline) and low exhaust pollutants. Advanced technology is in the areas of very high bypass ratio engines, variable pitch fans, reduction gearing, composite fan blades and engine/nacelle structures, thrust reversing, and digital electronic engine controls. A contract was awarded December 1973 to the General Electric Company for the QCSEE development program.

BASIS FOR FY 1976 AND TRANSITION PERIOD ESTIMATES

The technical plan includes a critical design review of the "under-the-wing" propulsion system in January 1975 and the "over-the-wing" in July 1975. Upon approval of each design, the fabrication and assembly of components/propulsion systems will be initiated. Following completion of fabrication and assembly, the two propulsion systems will undergo a series of tests by the contractor to demonstrate structural integrity and capability to meet performance testing with appropriate powered-lift wing sections. The "under-the-wing" propulsion system will be delivered during the Transition Period. Approximately 56 months total program duration is planned including engineering support for tests at NASA for a period of about 12 months after delivery of the propulsion system.

Supersonic Cruise Aircraft Research

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$10,100	$8,900	$8,900	$8,900	$2,000

OBJECTIVES AND STATUS

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.

BASIS FOR FY 1976 AND TRANSITION PERIOD ESTIMATES

Noise and pollution are major factors impacting the design of supersonic transports. A variable cycle duct-heating turbofan engine concept promises to reduce noise and pollution. Current static tests of duct-heating turbofan suppressor nozzles will be extended in FY 1976 to establish the effects of forward velocity on acoustic performance. Ultralow emission studies will be complemented by the application of the emission reduction techniques to a duct-heating augmentor in FY 1976. The inlet shock stabilization system, developed to provide inlet tolerance to flow disturbance at very high speeds, will be modified in FY 1976 for eventual test on the YF-12.

Major reductions in structural weight are required for economical, supersonic cruise aircraft. Fatigue, fracture, flutter and lifetime characteristics of structures under the severe environment of supersonic flight must be addressed. Structural design studies for efficient arrow-wing concepts will be used to identify a typical wing section for test in FY 1976. Composite resin and metal matrix panels will be fabricated and tested for fatigue characteristics and then flight tested on the YF-12. Studies on a low speed model will be extended in FY 1976 to determine the applicability of active control systems for flutter suppression.

Wind tunnel tests of aircraft configurations will be conducted to improve cruise efficiency and noise reduction. These and other advanced configuration tests will assess the tradeoffs (technical, environmental, and economic) of using various variable-cycle engines. Improved analytical methods for aerodynamic design will be further developed in FY 1976 and the transition period for validation in FY 1977. By FY 1979, these developments are expected to provide a 30-percent improvement in lift-to-drag ratio.

Problems at high Mach numbers will be studied by flight testing a new control system and developing an engine inlet shock stabilization system.

Stratospheric emissions impact research will be continued in FY 1976 and the transition period to measure, with new sensitive instrumentation, the natural atmospheric constituents and the near-wake chemistry of the YF-12. The instrumentation will detect constituents which affect ozone production and decay to provide the basis for monitoring the upper atmosphere.

Tilt Rotor Research Aircraft

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$5,345	$11,300	$11,300	$1,900	$300

OBJECTIVES AND STATUS

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.

The low downwash and low noise inherent in rotors provide valuable benefits for military rescue missions and ground attack missions where short detection time is important to survival in a hostile arena. For civil applications, the efficient Vertical Takeoff and Landing (VTOL) capability will permit operations at small airfields and close-in populated areas to provide an efficient transportation system. The tilt rotor VTOL capability eliminates the need for taxiing and maneuvering on the ground and the attendant use of valuable fuel. The inherent efficiency of the rotors acting as propellers in cruise can provide an effective, fuel saving, public transport system for short and intermediate ranges. The tilt rotor research aircraft will have twice the cruise speed of the helicopter while retaining its efficient hover capability. Based on in-house studies and analyses by NASA/Army engineers, it has been concluded that the tilt rotor concept shows the greatest promise for a capability to meet military and civil Vertical/Short Takeoff and Landing (V/STOL) needs anticipated in the future.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

A preliminary design competition was conducted in early FY 1973. Bell Helicopter Company was awarded a contract for the design and fabrication of two tilt rotor research aircraft in July 1973. The principle design effort was completed in December 1974. Material procurement and manufacturing will be carried on through FY 1975 and FY 1976. First flight is scheduled for early FY 1977.

Rotor Systems Research Aircraft

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$5,266	$7,100	$7,100	$3,100	---

OBJECTIVES AND STATUS

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.

Extensive onboard instrumentation will provide better research data, and repeated use of the test vehicle will enable timely and economical completion of rotor research projects.

Currently, flight tests of promising advanced rotor concepts are conducted by modifying existing aircraft or by building a new aircraft for each concept. This approach is time consuming, costly, and often gives less than good results.

BASIS FOR FY 1976 AND TRANSITION PERIOD ESTIMATES

NASA and Army in-house and contractor predesign studies were conducted in early FY 1973 to establish the feasibility of an advanced research vehicle capable of testing a wide variety of advanced rotor systems concepts, and to define the characteristics of and requirements for the flight vehicle, the flight test control system, and the research instrumentation systems. A contract was awarded to Sikorsky Aircraft Company in November 1973 for the design and fabrication of two aircraft. Detail design and component fabrication began in January 1975. Design of the aircraft will be completed in FY 1975. Fabrication will continue in FY 1976 with first flight scheduled for late FY 1976.

Quiet Propulsive Lift Technology

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$12,300	$8,000	$8,000	$11,900	$400

OBJECTIVES AND STATUS

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 (STOL) Transport (AMST) 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 (QSRA).

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

In the AMST program, NASA participation involves taking maximum advantage of both the Boeing and Douglas AMST aircraft to accomplish part of the Quiet Propulsive-Lift Technology program objectives. In FY 1975 NASA is continuing to provide extensive simulator support to the AMST control system development, initiating installation of NASA flight research instrumentation in the AMST aircraft, and participating in the Air Force flight test planning through membership of the NASA Deputy Test Director on the Joint Test Team. In FY 1976 and the transition period, NASA will participate in the Air Force flight evaluation of the AMST and provide support for the conduct of the NASA research experiments. In FY 1977 NASA will take the lead for potential extended flight research investigations including the possibility of modifying the AMST aircraft. Stability, control, aerodynamic performance and handling qualities will be measured to the limit of the AMST capability.

The Quiet Short Haul Research Aircraft (QSRA) effort involves low cost modification of an existing Buffalo aircraft into an aircraft which has greater flight research capability than the AMST aircraft. The aircraft will be modified to a four-engine swept-wing advanced hybrid upper surface blowing propulsive-lift configuration to obtain stability, control, aerodynamic performance, noise footprint and handling qualities flight research data. In FY 1975, paralleled, preliminary aircraft design studies were completed by the Boeing Company and Lockheed-Georgia Company. In November 1974, Request for Proposals were issued for competitive procurement of final design, fabrication and flight test support of the QSRA. Contract award is scheduled for the end of FY 1975. Flight research with the modified aircraft would begin in early FY 1978 and by the end of FY 1978 NASA would provide industry and the FAA with data to establish initial certification criteria for handling qualities, operations, and noise footprints of civil propulsive-lift short haul aircraft.

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1976 ESTIMATES

BUDGET SUMMARY

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

SPACE AND NUCLEAR RESEARCH AND TECHNOLOGY PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Research and technology base	$60,022	$61,500	$60,500	$61,300	$18,500
Systems studies	1,300	1,600	1,600	1,600	400
Systems technology programs	1,885	2,265	2,265	2,200	800
Experimental programs	---	2,000	2,000	3,700	1,100
Low cost systems program	3,100	5,000	5,000	6,100	1,500
Total	$66,307	$72,365	$71,365	$74,900	$22,300
Distribution of Program Amount by Installation					
Kennedy Space Center	---	---	$50	$50	---
Johnson Space Center	$700	$765	75	150	---
Marshall Space Center	2,820	3,401	2,310	2,630	$700
Goddard Space Flight Center	4,650	5,222	5,656	5,470	1,200
Jet Propulsion Laboratory	13,555	13,912	16,215	15,820	4,900
Wallops Flight Center	---	---	61	50	---
Ames Research Center	6,984	7,390	9,073	8,520	2,600
Flight Research Center	1,300	1,128	1,000	950	300
Langley Research Center	13,154	15,920	14,667	18,320	5,900
Lewis Research Center	19,859	22,716	19,492	20,380	6,000
Headquarters	3,285	1,911	2,766	2,560	700
Total	$66,307	$72,365	$71,365	$74,900	$22,300

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

SPACE AND NUCLEAR RESEARCH AND TECHNOLOGY PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION

The objective of the Space and Nuclear Research and Technology program for FY 1976 and the transition period is to provide a technology base which will adequately support current and future space activities involved in 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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

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 current budget, these programs are all reflected under the Energy Technology Applications program. The major portion of the Energy and Environmental Systems Technology program was transferred from the Space and Nuclear Research and Technology program to the Energy Technology Applications program as a result of this. For comparison purposes the transferred program is not shown as part of the Space and Nuclear Research and Technology program in either the FY 1974 column or the FY 1975 Budget Estimate column.

Funding for the Research and Technology Base was reduced by one million dollars during formulation of the FY 1975 operating program. This reduction was accomplished by slowing the planned activity in the Electric Propulsion program and by reducing Shuttle support activities where prudent. These and other funding changes are discussed under the relevant sections of the program narrative which follow.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

Materials and structures technology will be 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

566-537 O - 75 - 32

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.

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.

The Space and Nuclear Research and Technology program for FY 1976 and the transition period contains a planned program augmentation in the Systems Technology programs area. This new initiative will advance the technology of high temperature composite materials. Application of these materials to spacecraft structures could result in major weight savings. The Space Technology Shuttle Payloads program has been expanded to include the development of a Long Duration Exposure Facility for possible deployment of an early Shuttle flight.

BASIS OF FUND REQUIREMENTS

Research and Technology Base

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Materials research and technology.....	$5,703	$9,122	$8,930	$8,900	$2,700
Structures research and technology.....	4,733	5,400	5,350	5,420	1,600
Fundamental electronics research and technology.....	5,145	4,800	5,550	5,300	1,600
Guidance and control research and technology.....	3,059	1,900	3,170	3,400	1,000
Information systems research and technology.....	5,223	6,800	4,780	5,190	1,600
Chemical propulsion research and technology.....	8,108	7,300	7,300	8,290	2,600
Electric propulsion research and technology.....	5,172	4,900	4,400	4,200	1,200
Space energy systems research and technology.....	7,882	8,200	8,100	7,290	2,200
Nuclear energy research and technology.....	2,792	2,200	2,200	2,200	700
High power lasers and energetics research and technology.....	4,600	5,000	5,000	5,410	1,600
Entry research and technology.....	7,605	5,878	5,720	5,700	1,700
Total.....	$60,022	$61,500	$60,500	$61,300	$18,500

CHANGES FROM FY 1975 BUDGET ESTIMATE

The funding for the Research and Technology Base as a whole was reduced by one million dollars during the formulation of the FY 1975 Operating Plan. Half of this one million dollar reduction was taken in the Electric Propulsion program, while the other half was taken by reducing Shuttle support activities where prudent. These and other funding changes are discussed under the relevant sections of the program narrative which follow.

A restructuring of three of the disciplinary programs with the resulting shift in program elements and associated resources accounts for the funding changes in the three programs involved. This restructuring consisted of the transfer of the high resolution sensor effort from the Information Systems program to the Fundamental Electronics program, and the transfer of the robotics and machine intelligence effort from the Information Systems program to the Guidance and Control program.

Materials Research and Technology

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$5,703	$9,122	$8,930	$8,900	$2,700

OBJECTIVES AND STATUS

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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The funding change reflects a reduction in the effort on alternate Reusable Surface Insulation (RSI) for the Shuttle. This reduction was made possible by increased confidence in the behavior of the RSI which is currently planned for use on the Shuttle.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

Materials Science is concerned with greater understanding of the electronic, molecular and atomic structures of materials, relating these to useful properties, and using the relationships as a guide toward obtaining new or improved materials. Studies of the surface properties of semiconductors will continue to be conducted in FY 1976 and the transition period with the goal of improving the efficiency of gallium arsenide solar cells to over 15 percent. The interaction of electrons with a polarizable organic system will be investigated in order to determine the feasibility of high temperature superconductors. The interactions of electrons with defects in dielectrics will also be studied for the purpose of improving long life microelectronics.

Graphite fiber reinforced aluminum composites promise large weight savings for advanced space transportation systems. Recent advances in coatings and processes will be utilized to advance this area in FY 1976 and the transition period. The effects of the space environment on the properties of columbium and nickel-base alloys will also be determined in FY 1976. An actuator bearing will also be evaluated at 315 degrees Centigrade for applications to advanced reentry vehicles.

The development of advanced techniques to withstand the effects of the space environment will be continued during FY 1976 and the transition period. A cryogenic heat pipe will be tested, and a second surface mirror will be evaluated for its stability for 3 years in simulated synchronous orbit. Cleaning procedures will also be assessed for their effectiveness on decontaminating optical surfaces.

The program will continue to provide the technology in FY 1976 and the transition period to improve the reliable Thermal Protection Systems (TPS) for the Space Shuttle, advanced earth orbital spacecraft and planetary probes. The effect of salt spray and other contaminants on Reusable Surface Insulation (RSI) for the Space Shuttle will be completed. The evaluation of the thermal performance of Shuttle heat shield materials will also be completed. Improvements in RSI technology will continue to be pursued by modification of fiber composition, use of new coatings and optimization of processing parameters with a long range target of 1,600 degrees Centigrade (^{o}C) capability. The Venus probe heat shield design will be experimentally verified in a simulated Venus entry environment.

Structures Research and Technology

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$4,733	$5,400	$5,350	$5,420	$1,600

OBJECTIVES AND STATUS

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.

CHANGES FROM FY 1975 BUDGET ESTIMATES

The funding change reflects a reduction in the wind tunnel testing of a Thermal Protection System (TPS) configuration that is no longer a candidate for use on the Shuttle.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

New concepts and materials applications will continue to be explored during FY 1976 and the transition period for large erectable space structures needed for future microwave antennas, solar arrays, and platforms. Technology activities will be completed in FY 1976 to determine the feasibility of a large (50 - 100 foot diameter) furlable deep space antenna concept. New concepts for much larger space structures will be given increased emphasis. The potential weight saving of composite pressure vessels in place of all-metal designs will continue to be explored and demonstrated in laboratory tests.

In FY 1976 and the transition period, in the area of vehicle design methods, emphasis will be given to improvements in structural analysis programs, design and testing of entry thermal protection systems, and fracture control methods. Improvements for NASA Structural Analysis Program (NASTRAN) will be continued and evaluation of Shuttle Thermal Protection System (TPS) structures in high temperature wind tunnel tests will be continued. Efforts will continue to extend fracture control methods to make possible the design of lightweight components while increasing the reliability and service life.

During FY 1976 and the transition period, space vehicle dynamics technology activities will involve verifying data and methods needed for Shuttle development and improvement of techniques for prescribing the acoustic and vibration

environments and response of payloads. Shuttle support efforts will include testing of TPS panels in thermal-acoustic environments, wind tunnel studies of flutter characteristics, advanced methods for predicting flutter margins, and wind tunnel studies of aerodynamic noise and exhaust plume effects. The dynamic response of Shuttle payloads will be investigated using payload models installed in the 1/8-scale Shuttle model. A mulitcenter coordinated program will continue to develop approaches to reduce the cost of dynamic test and analysis requirements for certifying spacecraft hardware.

Fundamental Electronics Research and Technology

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$5,145	$4,800	$5,550	$5,300	$1,600

OBJECTIVES AND STATUS

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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The high resolution sensor effort and associated funding were transferred from the Information Systems program to the Fundamental Electronics program in FY 1975.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

New technologies and materials are being investigated to improve the resolution, sensitivity and reliability of active and passive sensing systems. In FY 1976, a pulsed laser bathymeter to remotely measure coastal water depths will be flight tested. Fabrication of a tunable diode laser for measuring atmospheric constituents will be completed and flight tests initiated. Development of solid state image sensors for planetary missions will continue with emphasis on arrays of 400 by 400 elements to obtain high resolution video signals. The same solid state sensors will also be evaluated as astronomical sensors for low light level star field measurements. Acoustic sensors for predicting mechanical and structural failures in spacecraft systems will be developed and evaluated.

Research on electron devices exploits the electronic properties of materials to provide more effective and economical devices for information handling. In FY 1976, development of a 3-inch square liquid crystal display module will be completed and flight tests in an aircraft cockpit environment initiated.

An organic material now being developed for optical data storage applications will be evaluated as a holographic archival mass memory. Development of charge coupled devices for analog data processing applications will continue, and an infrared charge coupled device linear array imager will be evaluated.

Long life circuit research seeks to minimize failure rates and costs of electronic systems by developing fabrication, test and qualification techniques for large scale integrated circuit arrays. In FY 1976 and the transition period, design studies and evaluation of fabrication processes for semiconductor devices on insulating substrates will continue to increase operating speeds and reduce device size. Development of equipment and techniques to demonstrate automated design, processing and testing of large scale integrated circuit arrays will continue. Studies of failure mechanisms in integrated circuits and development of quantitative models to predict reliable operating life will continue with emphasis on insulating substrate technology for semiconductors.

Guidance and Control Research and Technology

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$3,059	$1,900	$3,170	$3,400	$1,000

OBJECTIVES AND STATUS

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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The robotics and machine intelligence effort and associated funding were transferred from the Information Systems Program to the Guidance and Control program in FY 1975.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

In the area of low cost control and stabilization components, efforts center on the development of improved momentum control devices and their integration with appropriate sensors and software to obtain long life, low

cost and high accuracy. In FY 1976, and the transition period evaluation of a breadboard annular momentum control device capable of 3-axis stabilization to 0.1 arc seconds will be completed and a study of the necessary modifications and software to provide experiment pointing and control initiated. Breadboarding of a video inertial pointing system for precise off-axis pointing of infrared telescopes will begin. Development of reaction wheels using magnetic suspension technology to achieve 5-10 year operating life for planetary spacecraft control systems will continue. Flight test of a laser gyro inertial reference system costing less than 50 thousand dollars will be completed and a study of the laser gyro as a rate sensor will be initiated.

Advanced navigation activities are focused on the development of sensors, data filters and guidance system designs which optimize the available science payloads on outer planet missions by increasing aim point accuracy and reducing required trajectory corrections. In FY 1976 and the transition period, the design of algorithms using on-board optical sensors will be initiated. Studies to provide 3 to 6 times more accurate locations of the planets and their satellites will continue. Advanced filtering techniques capable of reducing residual tracking errors by factors of four or more will be sought. Definition of spacecraft maneuver strategies offering up to 30 percent reduction in trajectory correction velocity and associated propellant savings will continue.

Research on autonomous systems for unmanned surface vehicle operation in FY 1976 and the transition period will focus on the evaluation of a robot roving vehicle in a tethered operating environment to test sensors, scene analysis software and control systems now being developed and assembled. Methods for augmenting the vehicles intelligence to permit automatic navigation and path finding will be examined and system improvements added to provide a semiautonomous manuevering capability in a natural environment in subsequent years.

Information Systems Research and Technology

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$5,223	$6,800	$4,780	$5,190	$1,600

OBJECTIVES AND STATUS

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.

566-537 O - 75 - 33

CHANGES FROM FY 1975 BUDGET ESTIMATE

The high resolution sensor effort and robotics and machine intelligence effort and associated funding were transferred from the Information Systems program to the Fundamental Electronics program and the Guidance and Control program, respectively, in FY 1975.

BASIS FOR FY 1976 AND TRANSITION PERIOD ESTIMATES

High capacity, high speeds and extremely flexible data systems will be required to store and process data from future space missions. In FY 1976 and the transition period, unified digital data systems which provide modular organization to permit multimission application will be breadboarded and evaluated to reduce costs and achieve operating lives in excess of six years. A first generation parallel processor with potential image processing rates of 10^{12} bits per second will be completed and evaluation of its application to real time video processing initiated. Evaluation of a 10^5 bit optical holographic memory breadboard will be completed and tests of new storage materials with potential storage densities of 10^9 bits per square centimeter initiated.

Microwave technology centers on the design and development of spacecraft radio systems and components for multiple mission applications. In FY 1976 and the transition period, fabrication of a modular microminiaturized dual frequency radio transponder with potential cost savings of 30 percent will continue. Design studies of a millimeter wave radio system to relieve spectrum crowding will be completed and development of appropriate components initiated. A solid state Ku band power amplifier with doubled operating life and 30 percent efficiency will be fabricated and evaluation initiated.

High rate data transfer and tracking activity will focus on the development of laser technology to provide precise position determination for satellite tracking systems and wide bandwidth data links between satellites. During FY 1976, and the transition period, fabrication of a 300 megabit per second carbon dioxide laser transceiver will be completed and evaluation initiated. Development of laser energy sources, detectors, and control and stabilization systems to permit ranging to accuracies of 2 centimeters will continue.

Chemical Propulsion Research and Technology

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$8,108	$7,300	$7,300	$8,290	$2,600

OBJECTIVES AND STATUS

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.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

In the reusable oxygen-hydrogen systems area, the program will provide the propulsion technology for a reusable Shuttle upper stage, capable of performing at least 20 missions, with minimum refurbishment between flights. During FY 1976 and the transition period, critical engine component technology is scheduled for completion. High performance turbomachinery and thrust chambers capable of 10-hour operational life and 1,200 start/stop cycles will be demonstrated. Investigation of the dynamics and controls of engine systems which incorporate this component technology will commence in FY 1977. Component technology will continue in the areas of fully reusable super insulations, light weight composite feed lines, and high performance oxygen-hydrogen auxiliary propulsion systems.

Future planetary missions require both increased propulsion system capability and in the case of outer planet missions, up to 10 years life. The long life space storable propulsion program is designed to provide the technology of spacecraft propulsion systems that will meet these requirements. The work is directed toward component technology for a fluorine-hydrazine propulsion system. In FY 1976 and the transition period thrust chamber testing will continue for the purpose of developing design criteria for flight weight engine designs. Also in FY 1976, component design criteria for valves and tank materials suitable for 5-year missions will be established. Work will also continue on propellant thermal control systems designed to prevent venting during ground handling, launch operations, in the Shuttle cargo bay, and in deep space.

In low cost solid propulsion, the technology program is directed toward allowing wider use of these inherently low cost systems in NASA missions by developing new capabilities and improving performance of current systems. Specific targets in FY 1976 and the transition period include the following: demonstration that a full scale (weight 3,000 pounds) solid motor can be ignited, quenched, reignited and requenched under simulated vacuum conditions; a controllable dual burn capability that would be useful from Shuttle orbit for

placement of payloads in higher orbits; a thermally sterilized solid motor (exposed six times to 275 degrees Fahrenheit) will be fired to demonstrate that solid motors can be used on or near planets having quarantine restrictions; a high performance kick stage will be tested which will combine a number of advanced technology features allowing nonpropellant weight to decrease to only 5 percent of the total motor weight. This type of motor is necessary to perform some of the difficult planetary missions in the 1980's.

Solid fuel boosters release exhaust products into the atmosphere during launch. A number of NASA centers are working under a program funded by the Office of Manned Space Flight and the Office of Aeronautics and Space Technology to determine the types and roles of interactions between the exhaust products and the complex species natural to the atmosphere. In FY 1976 and the transition period, the effort funded by the Office of Aeronautics and Space Technology will concentrate on understanding effects in the stratosphere. Some experiments will be performed with new types of propellants which minimize pollutants in the exhaust.

Basic research will be continued to deepen the understanding of the chemical and physical processes that occur in rocket propulsion systems and to establish new techniques of energy storage and use. Work in these areas in FY 1976 and the transition period will include studies of combustion and expansion losses to improve efficiency; evaluations of the influence of baffles and cavities on combustion stability; determination of the properties of liquid propellants at very high pressures; solid propellant polymers and visco-elastic properties; combustion and fire extinguishment in zero gravity; stabilization of activated states of elements with specific impulse potential of over 1,000 seconds; and a continuing evaluation of propulsion systems based on laser beam energy transmission.

Electric Propulsion Research and Technology

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$5,172	$4,900	$4,400	$4,200	$1,200

OBJECTIVES AND STATUS

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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

A one-half million dollar reduction was taken in the Electric Propulsion program as one of the actions necessary to formulate the FY 1975 Operating Plan. A recent re-examination of the near-term mission requirements for electric propulsion justify this decision to slow the activity in the Electric Propulsion program at this time.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

In the area of auxiliary electric propulsion, evaluation of the small one millipound, 150 watt, cesium ion thruster flight experiment aboard the Application Technology Satellite (ATS-6) will be continued during FY 1976 and the transition period. In addition, ground test programs presently underway to demonstrate 5-year cycle life capability for ion thruster systems will be continued. Evaluation of resistojets using low freezing point monopropellants to simplify the onboard satellite thermal control system will also be continued in FY 1976 and the transition period.

In the area of primary solar electric propulsion, the program is aimed at demonstrating the technology for a 3,000 second specific impulse, modular, mercury ion thruster system, and the technology for large, lightweight solar arrays, applicable to a wide range of missions. During FY 1976 and the transition period, endurance testing of 30-centimeter engineering model ion thrusters (2.75 kilowatt) will be continued including testing of a thruster with a breadboard model power processor. In addition, work on large (12.5 kilowatts per wing) lightweight (15 kilogram/kilowatt) solar arrays, aimed at demonstrating structural and dynamic suitability for solar electric propulsion mission applications will be continued in FY 1976 and the transition period.

In the area of basic research, ion thruster research aimed at evaluating the use of other propellants and at understanding the ion discharge chamber process such as its relation to ion surface erosion will continue in FY 1976 and the transition period.

Space Energy Systems Research and Technology

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$7,882	$8,200	$8,100	$7,290	$2,200

OBJECTIVES AND STATUS

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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The funding change reflects a reduction in the endurance testing of an alternate Auxiliary Power Unit (APU) for the Shuttle to the minimum needed to gain reasonable confidence in the unit.

BASIS FOR FY 1976 AND TRANSITION PERIOD ESTIMATES

In the area of solar cells and arrays, emphasis is on high efficiency, radiation resistant cells; and on lightweight, high power density, modular arrays. Thin (4 to 5 mil) cells will be assembled into modules and evaluated in simulated space tests in FY 1976. Research will continue in FY 1976 and the transition period on loss mechanisms and their elimination, to improve both efficiency and radiation resistance of solar cells. Details of a versatile array module will be developed. Solar cell standards will be prepared for balloon flights (above the atmosphere) and distributed to the users.

For energy storage, the rechargeable Nickel-Cadmium (Ni-Cd) cell and battery is being improved in uniformity, reliability and life. The non-destructive, accelerated test program will be continued in FY 1976 and the transition period with the objectives of (1) devising a simple, quick test method for use by spacecraft engineers; and (2) predicting, with a high degree of confidence the performance of cells and batteries for space missions, particularly in low orbit. Work on Silver-Zinc (Ag-Zn) cells with inorganic separators will continue, to obtain 5-year devices for synchronous orbit, with up to 3 times the energy density of NiCd. In addition, the research for low temperature solid electrolytes will be continued, to attain a tenfold increase in energy density and an indefinite life.

In the thermomechanical systems area, testing of available components of a highly efficient (20-25 percent) 0.5-2.0 kilowatt electric gas turbine

system for use with isotope heat sources is continuing. In FY 1976 performance testing will be conducted on an experimental turbocompressor-alternator unit currently under construction. Upon completion of these tests, the turboalternator and other key components will be delivered to the Energy Research and Development Administration (ERDA) for a breadboard system test which will demonstrate the systems performance capability and technical readiness.

The power processing program will be continued in FY 1976 and the transition period with emphasis on high power, long life and lower cost components. Of particular interest will be the continuation of a program aimed at mathematically modeling a power processing system. Such a capability will permit the design and optimization of systems on paper and greatly facilitate the design of standarized, low cost systems.

Nuclear Energy Research and Technology

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$2,792	$2,200	$2,200	$2,200	$700

OBJECTIVES AND STATUS

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.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

Research is being conducted in the field of thermionic energy conversion with a long-range goal of achieving efficiencies up to 30 percent with operating temperatures as low as 1,100 degrees Centigrade. Converter performance of this character would make thermionic converters extremely useful for topping cycles in both nuclear and fossil-fueled power plants. They would also be the logical choice for nuclear electric propulsion systems for a ferry vehicle for orbital transfer of spacecraft from and to the Space Shuttle or for future outer planet missions. The present ongoing research program will continue in FY 1976 and the transition period. The program includes fundamental investigations of the physics of emitter and collector materials and the inter-electrode plasma which are the critical areas in achieving high efficiency converter performance. In addition to analyses

and testing of new converter designs, preliminary systems studies will continue to be conducted of their applications in topping cycles and nuclear or solar powered electrical generating systems.

During FY 1976 and the transition period, gas-core reactor research will continue to investigate the production of fission energy with the nuclear fuel in the gaseous or plasma state. Gas-core reactors may become important new sources of energy since they are efficient users of uranium fuels, may be effective breeder reactors, have inherent safety features, and may permit the efficient transformation of fission energy to other forms by thermo-or photo-chemical means. Low power, low temperature, self-critical experiments employing gaseous uranium hexafluoride began in FY 1975 under NASA funding at the Los Alamos Scientific Laboratory. In FY 1976 a criticality experiment at up to one kilowatt power will be conducted. In addition, spectroscopy of electrically heated uranium plasmas and of uranium plasmas produced by compression of uranium hexafluoride in a ballistic piston compressor and by fissions that are induced by external neutron sources, will be conducted in the FY 1976-1977 period.

High Power Lasers and Energetics Research and Technology

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$4,600	$5,000	$5,000	$5,410	$1,600

OBJECTIVES AND STATUS

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.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

Research is conducted in the area of plasmadynamic energy systems to establish the knowledge required to produce, confine and utilize plasmas for advanced power and propulsion systems of potential importance to space missions. A project to investigate combustion-driven Magnetohydrodynamic (MHD) generators for very high power densities is in progress. In this project, combustor experiments will be completed during the period FY 1975 and 1976. Along with this work, superconductive magnets will be developed and tested for application to the generator, including a cooperative effort with the Air Force to assist the Air Force Aeronautical Research Laboratory in applying the NASA superconductive magnet expertise to their needs. This

will be followed by generator tests in subsequent years. Operation of the large superconducting magnetic mirror apparatus and the bumpy torus device will continue in FY 1976 and the transition period to explore the physics of direct current plasma heating and other fundamental problems which are of major significance to fusion energy for terrestrial and space applications. During FY 1974-1975, plasma temperatures at 50 million degrees Kelvin were achieved in the superconducting mirror apparatus, using helium. In FY 1976 and the transition period, even higher temperatures may be obtained, as a result of a current upgrading of the device.

In magnetics and cryophysics, research is conducted to achieve stable, intense magnetic fields from magnets of minimum mass and power use, and to understand the physics of materials and devices exposes to low temperatures and intense fields. In FY 1975, tests demonstrated the capabilities of a twisted filament superconductor in a small magnet. In the future, long lengths of this conductor will be procured from a production line process and tested in large magnet coils. Cooling will be demonstrated with a small magnetic heat pump during FY 1976 and the transition period.

Basic research is conducted to provide fundamental data and to investigate novel concepts in the emission and absorption of radiation from all states of matter in support of a broad range of possible applications in power generation, propulsion, lasers, space environment, and atmospheric physics. During FY 1975, the nuclear pumping of a xenon-helium laser was achieved, that is, the direct conversion of fission fragment energy into coherent light. In FY 1976 and the transition period, this method will be employed for energizing by nuclear power a high pressure xenon laser, that could radiate at larger power and higher frequency.

An integrated program of laser systems research and technology is being conducted to determine whether high power lasers can make a major impact on aerospace mission capabilities. To make this evaluation, a continuously operating laser will come into operation in FY 1975-1976 to determine what technical barriers may exist to long duration operation at high powers and how to obtain high efficiency. The areas of laser optics, beam transmission both in space and from earth-to-space with adaptive mirror systems, and conversion of laser energy to electrical energy or directly to propulsive forces will be studied during FY 1976 and the transition period as they apply to potential space applications. In this context, use is being made of the major laser programs in other agencies.

566-537 O - 75 - 34

Entry Research and Technology

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$7,605	$5,878	$5,720	$5,700	$1,700

OBJECTIVES AND STATUS

The entry research and technology program provides the technology base required to improve entry spacecraft design, operation, safety, and reliability.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The funding change reflects a reduction in the number of wind tunnel hours required to support the current Shuttle configuration.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

This effort supports the Shuttle program by providing wind tunnel testing and expertise for aerothermodynamic analysis and special problem solving. During FY 1976 and the transition period, investigations will be carried out to increase the usable center of gravity range, determine heat transfer effects between orbiter and external tank, determine separation aerodynamics, and plume effects on launch configuration aerodynamics. Computer codes which include the correct air chemistry parameters will be developed to compute windward surface flow over the Shuttle.

The program also defines the aerothermodynamic environment for planetary atmospheric entry probes through the use of simulation facilities and theoretical predictive techniques. In FY 1976 and the transition period attention will be focused on the high velocities of outer planet entry with emphasis on determining the critical high temperature radiative property data and the effects of heat shield ablation products on the shock layer flow around planetary entry probes.

Research will also be pursued to acquire aerothermodynamic technology for the design of advanced earth orbital vehicles for the 1990 time period. Calculation techniques will be developed during FY 1976 and the transition period to predict with a high degree of accuracy the complete three-dimensional flow fields about vehicles, including heating and real gas effects.

System Studies Program

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$1,300	$1,600	$1,600	$1,600	$400

OBJECTIVES AND STATUS

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

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

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.

In FY 1976 and the transition period, 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 in FY 1976 and the transition period 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.

The evaluation of Research and Technology Base programs, including measures of benefit and risk in the achievement of targets and objectives, will continue during FY 1976 and the transition period. Methodology will be developed with initial emphasis on new initiatives.

Systems Technology Programs

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Materials and structures systems technology....	---	---	---	$500	$300
Guidance, control and information systems technology.....	---	$800	$800	700	300
Entry systems technology	$1,050	1,000	1,000	1,000	200
Energy and environmental systems technology....	835	465	465	---	---
Total.....	$1,885	$2,265	$2,265	$2,200	$800

CHANGES FROM FY 1975 BUDGET ESTIMATE

The Energy and Environmental Systems Technology program, shown under the Systems Technology Programs category in the current budget, reflects only a small remnant of the program described in previous budgets. Responsibility for the major portion of the Energy and Environmental Systems Technology program was transferred from the Office of Aeronautics and Space Technology to the new Office of Energy Programs, and is addressed in the Energy Technology Applications program of the current budget.

Materials and Structures Systems Technology

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
---	---	---	$500	$300

OBJECTIVES AND STATUS

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.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

Future space transportation systems will benefit strongly if the temperature limits for composite structures can be increased above the limits of 350 degrees Fahrenheit. In FY 1976, the Composites for Advanced Transportation Systems program will be initiated to develop a practical polyimide resin composite system with the capability for operating at 600 degrees Fahrenheit. The initial activity will focus on materials and manufacturing processes and on design methods development. This will be followed by design and fabrication of structural components for laboratory testing. It is projected that evaluation of laboratory tested components will be completed by the end of FY 1979.

Guidance, Control and Information Systems Technology

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
---	$800	$800	$700	$300

OBJECTIVES AND STATUS

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.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

The Solid State Data Storage System, a program to provide a no-moving-part data storage system for aerospace vehicles with 10^8 bits of storage capability and reliability of 2×10^4 hours, or twice that of the average spaceborne tape recorder, was initiated in FY 1975. This Solid State Data Storage System uses magnetic "bubble" domain technology as the storage media, offers exceptional flexibility in data formats and can be sized to a variety of data storage applications through its modular organization. Memory elements and system architectural designs are being developed in FY 1975. In FY 1976, design, fabrication and evaluation of an engineering model data storage system will be initiated. In subsequent years, a flight model will be constructed, tested and qualified to space flight standards to demonstrate feasibility of a solid data storage system by the end of FY 1978.

Entry Systems Technology

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$1,050	$1,000	$1,000	$1,000	$200

OBJECTIVES AND STATUS

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.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

The Atmospheric Flight Experiments program, a joint Air Force/NASA research project, will carry out piloted flight experiments to evaluate flight characteristics, aerodynamic performance, and handling qualities of the X-24B aircraft at speeds from low supersonic through landing. The project utilizes the X-24B aircraft, which has a hypersonic lift-to-drag ratio of approximately 2.5 and is characteristic of the double delta class of wingless aircraft with potential use for future spacecraft or hypersonic military aircraft. In FY 1976 and the transition period, studies will continue to define the stability and control, vehicle handling, and piloting problems of the X-24B. Studies of flow separation, boundary layer noise, and vibration will be continued. The program will be completed during the transition period. The experience gained in this program has and will have contributed to the Shuttle design and flight operations as well as technical and flight data information for future hypersonic vehicles.

Experimental Programs

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Space technology shuttle payloads.....	---	$2,000	$2,000	$3,700	$1,110
Total.....	---	$2,000	$2,000	$3,700	$1,110

OBJECTIVES AND STATUS

The Space Technology Shuttle Payloads program 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.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

The Advanced Technology Laboratory (ATL), which utilizes the Spacelab to support technology experiments that require man interaction in space, is being supported in FY 1975, 1976 and the transition period. This effort includes participation in Shuttle and Spacelab reviews to insure compatibility with the ATL requirements, refinement of potential experiment requirements, and a systems and requirements definition study. A space technology/shuttle experiment summer workshop will be conducted during CY 1975 to define the technology required for CY 1980 to 1990 missions. Feasibility and definition studies of Shuttle compatible experiments to satisfy these technology requirements identified by the summer workshop will be conducted during FY 1976 and the transition period. Additional FY 1976 and transition period feasibility and definition efforts are focused on basic physics and chemistry experiments, an entry technology payload, and a Shuttle contamination experiment.

The Long Duration Exposure Facility (LDEF) is a low cost, free-flying, completely passive, reusable payload which will expose large numbers of experiments to the space environment. LDEF is proposed for deployment on an early Shuttle flight, with later retrieval, to obtain early data which will be beneficial to other Shuttle payloads. It is also being proposed for use during the shuttle development program as a method of verifying the Shuttle cargo bay environments, for demonstrating the space operation of the remote manipulator system, and for developing payload handling fixtures and procedures at the launch site. The FY 1976 and transition period effort is focused on the completion of the design package, initiation of procurement and fabrication activities, and on the development and expansion of a user (experiment) community.

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

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(Thousands of Dollars)			
Low cost systems program.....	$3,100	$5,000	$5,000	$6,100	$1,500

OBJECTIVES AND STATUS

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.

Standard Space Equipment Development

Use of standardized capabilities will reduce the costs of designing and developing unique equipment for different missions. Cost per unit will decline with quantity production; reliability and assurance will improve; delivery schedules will be shortened.

For certain utility functions which are common to many space systems, this program identifies space equipment and component requirements, defines their interfaces, and developes suitable standard subsystems, components, and/or software for use by the projects.

Standard equipment and components will be produced for spacecraft in five areas. These are: Power; Auxiliary Propulsion; Stablization, Guidance and Control; Communications and Data Handling; and Ground Support Equipment.

The availability of the equipment and/or software is made known agency-wide through a catalog.

Power

The objective is to reduce the cost of electrical power subsystems for NASA spacecraft by developing and qualifying an array of standard equipment designs, covering a range of needed capabilities.

In the FY 1976 and the transition period development of solar arrays, batteries, and transformers will be continued.

Auxiliary Propulsion

The selection, development and qualification of low cost standardized auxiliary propulsion components are the objectives. Options will be developed for tank and thruster sizes.

In FY 1976 and the transition period development of standard hydrazine attitude control propulsion elements and attitude control thrusters will be continued.

Stabilization, Guidance and Control

The objectives here are to identify, develop and qualify stabilization, guidance and control equipment and software that has utility for various space flight programs.

In the FY 1976 and the transition period development of standard fine solar sensor stabilization units, panoramic attitude sensors, and single axis inertial reference units will be continued.

Communications and Data Handling

The objectives are to coordinate mission requirements, and develop and qualify standardized flight equipment for spacecraft communications and data management.

In FY 1976 and the transition period development of spacecraft transponders, magnetic tape recorders, flight computers, telemetry modulator components and digital data interface units will be continued.

Ground Support Equipment (GSE)

The objective here is to reduce the cost of GSE by standardizing on existing GSE where practical to effect cost savings and developing standardized GSE where it is proven to be cost effective.

In FY 1976 and the transition period the following candidates for standardization will be examined: test equipment, transportation and handling equipment, servicing equipment, and launch control and monitoring equipment.

Business and Program Practice Studies

The objective of the business and program practice efforts is to identify opportunities for effecting cost savings within current and future projects.

566-537 O - 75 - 35

Program Practices

In FY 1976 and the transition period the following areas will be explored: development and maintenance of a developed component inventory, new lower cost methods of testing, reliability and quality assurance, spares philosophy, spacecraft integration, documentation and experiment development practices.

Business Practices

In FY 1976 and the transition period the Business Practices activity will continue to review and evaluate NASA's present space business practices with emphasis on the acquisition process, contract execution, and business data processing.

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1976 ESTIMATES

BUDGET SUMMARY

OFFICE OF ENERGY PROGRAMS

ENERGY TECHNOLOGY APPLICATIONS

SUMMARY OF RESOURCES REQUIREMENTS

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Energy research and technology	$2,693	$2,085	$2,035	$2,200	$550
Energy applications	2,000	2,000	2,000	3,000	750
Systems analysis	---	350	400	700	200
Total	$4,693	$4,435	$4,435	$5,900	$1,500
Distribution of Program Amount by Installation					
Johnson Space Center	$430	$380	$380	$1,875	$375
Kennedy Space Center	---	---	---	50	25
Marshall Space Flight Center	875	550	550	250	50
Goddard Space Flight Center	---	230	230	225	75
Jet Propulsion Laboratory	2,008	2,500	2,500	2,500	675
Ames Research Center	---	225	225	175	75
Flight Research Center	28	---	---	---	---
Langley Research Center	316	90	90	75	25
Lewis Research Center	1,036	460	460	750	200
Total	$4,693	$4,435	$4,435	$5,900	$1,500

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1976 ESTIMATES

OFFICE OF ENERGY PROGRAMS — ENERGY TECHNOLOGY APPLICATIONS

PROGRAM OBJECTIVES AND JUSTIFICATION

The broad goal of the National Aeronautics and Space Administration energy programs is to assist in insuring the attainment and maintenance of national energy self-sufficiency. In order to accomplish this goal, the Office of Energy Programs has four major objectives as follows:

1. Provide support in advanced research, technology and development to other Federal agencies.

2. Define and, if appropriate, implement programs in program areas related to energy which require the broad application of aerospace systems technology and management techniques.

3. Provide support to Federal, state and local governmental agencies in the application of aerospace technology.

4. Evaluate 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.

The FY 1976 activities of the Office of Energy Programs consist of small research and technology projects designed to identify, as well as mature, technologies of importance to the national energy community. These activities will be concerned with applying aeronautics and space technology to the discovery, production, conversion, transmission, storage, conservation, utilization and management of energy in terrestrial applications. They will include exploration of new and favorable alternatives to ongoing NASA research and technology. These activities will be conducted in the areas of energy research and technology, energy applications and systems analysis.

BASIS OF FUND REQUIREMENTS

Energy Research and Technology

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
$2,693	$2,085	$2,035	$2,200	$550

OBJECTIVES AND STATUS

The 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 that is being developed to assure that the technological strength of NASA is brought 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.

CHANGES FROM FY 1975 BUDGET ESTIMATES

With the creation of the Office of Energy Programs energy-related activities previously in NASA's Aeronautics and Space Technology program were assigned to the Energy Research and Technology program. As a result the distribution of resources between tasks was altered to take into account two major factors: the needs of the new office to better define energy-related research and technology areas that would make appropriate use of aerospace technology, and the expanded level of support provided to other agencies on a reimbursable basis. More specifically, small efforts that NASA has funded earlier are now being continued on a reimbursable basis in support of programs of other agencies. These efforts include: Potassium ranking topping cycle, Energy conversion alternatives study, Energy storage systems, Automotive gas turbine, and Aerodynamic drag of large road vehicles.

NASA resources which would have supported small efforts in these areas now support high efficency, low pollution internal combustion engines (including hydrogen injection for autombiles) and energy systems research and technology support projects.

An additional modification was made in the FY 1975 projects by transferring project responsibility for Remote Sensing of Smokestack Pollution and Air Pollution Source Identification to the Office of Applications.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

The funding for Energy Research and Technology supports 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

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
$2,000	$2,000	$2,000	$3,000	$750

OBJECTIVES AND STATUS

There are many foreseeable advancements in our methods of producing and conserving energy which can benefit from the integrated application of aeronautics and space technology. Within the Energy Applications program, investigations of potential advancements 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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

With the creation of the Office of Energy Programs, a review of the program direction, emphasis, planning and utilization of resources for energy-related activities previously under the cognizance of the Office of Applications was conducted. As a result of this review, further support of the Earth-based Solar Power Conversion and Delivery System Study was deferred pending the results of the FY 1974 funded effort and the establishment of the nature of possible funding support from other interested agencies. Further support of the Survey of Hydrogen Production Methods was deferred pending the results of a new program definition effort in hydrogen energy systems technology. Similarly, further support of the Space-based Solar Power Conversion and Power Relay Systems Study was reduced until the completion of an integrated Satellite Power System Program. These adjustments allowed a refocusing to put additional effort in areas of technology identification and verification and system analysis.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

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 Department 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.

Technology developed as a part of the space program offers a potential means for efficiently expediting the assessment of the nation's energy resources. 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. As the technology of remote sensing continues to mature, we anticipate its application to a broader range of problems dealing with the national energy supply.

Systems Analysis

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)			
---	$350	$400	$700	$200

OBJECTIVES AND STATUS

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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The Office of Energy Programs was established late in FY 1974 to better coordinate a variety of NASA-managed activities funded by this and other agencies. As a consequence of this reorganization, a number of previously identified energy-related projects that were to be accomplished or continued in FY 1975 were consolidated into more broadly applicable program areas. Many were funded by other agencies, which permitted the application of NASA resources to specific Systems Analysis efforts which are designed to identify and maintain the most appropriate NASA energy project data bases.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

In FY 1976, 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.

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1976 ESTIMATES

BUDGET SUMMARY

OFFICE OF TRACKING AND DATA ACQUISITION

TRACKING AND DATA ACQUISITION PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(In Thousands of Dollars)			
Operations.....	$191,900	$192,800	$192,900	$192,400	$51,200
Systems implementation.....	42,900	48,000	42,300	41,400	12,900
Advanced systems....	9,200	9,200	9,200	9,200	2,300
Tracking and data relay satellite system.....	---	---	3,600	---	---
Total.....	$244,000	$250,000	$248,000	$243,000	$66,400
Distrubution of Program Amounts by Installation:					
Goddard Space Flight Center....	$175,113	$180,900	$176,200	$169,100	$45,300
Wallops Flight Center.....	5,544	6,900	6,200	5,100	1,400
Jet Propulsion Laboratory.....	46,833	45,500	48,400	51,500	15,300
Flight Research Center.....	1,978	1,800	2,600	2,400	600
Langley Research Center.....	200	---	---	---	---
Headquarters.....	14,332	14,900	14,600	14,900	3,800
Total.....	$244,000	$250,000	$248,000	$243,000	$66,400

566-537 O - 75 - 3

OFFICE OF TRACKING AND DATA ACQUISITION

TRACKING AND DATA ACQUISITION PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION

The purpose of this program is to provide vital tracking and data acquisition support 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 research endeavors.

Support is provided for manned and unmanned flights; for spacecraft, sounding rockets, and research aircraft; for earth orbital and suborbital missions; for lunar and planetary missions; and for space probes.

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 scientific 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 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 the capability for 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 provided for support of sounding rocket launchings and flight testing of aeronautical research aircraft. The Research and Development appropriation provides funds 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; and (c) the investigation of advanced tracking and data acquisition techniques and the development of advanced tracking and data acquisition instrumentation.

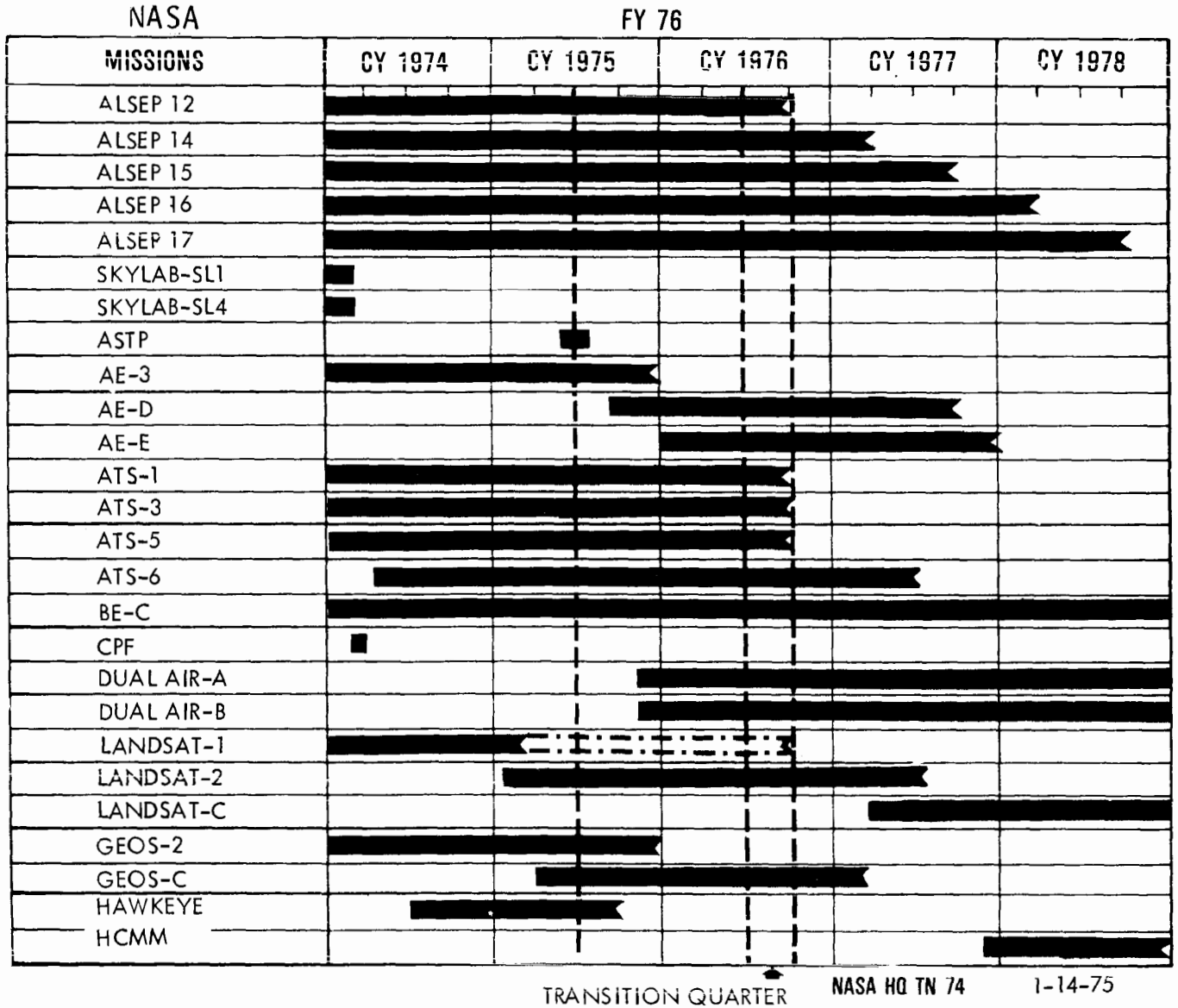
BASIS OF FUND REQUIREMENTS

Operations

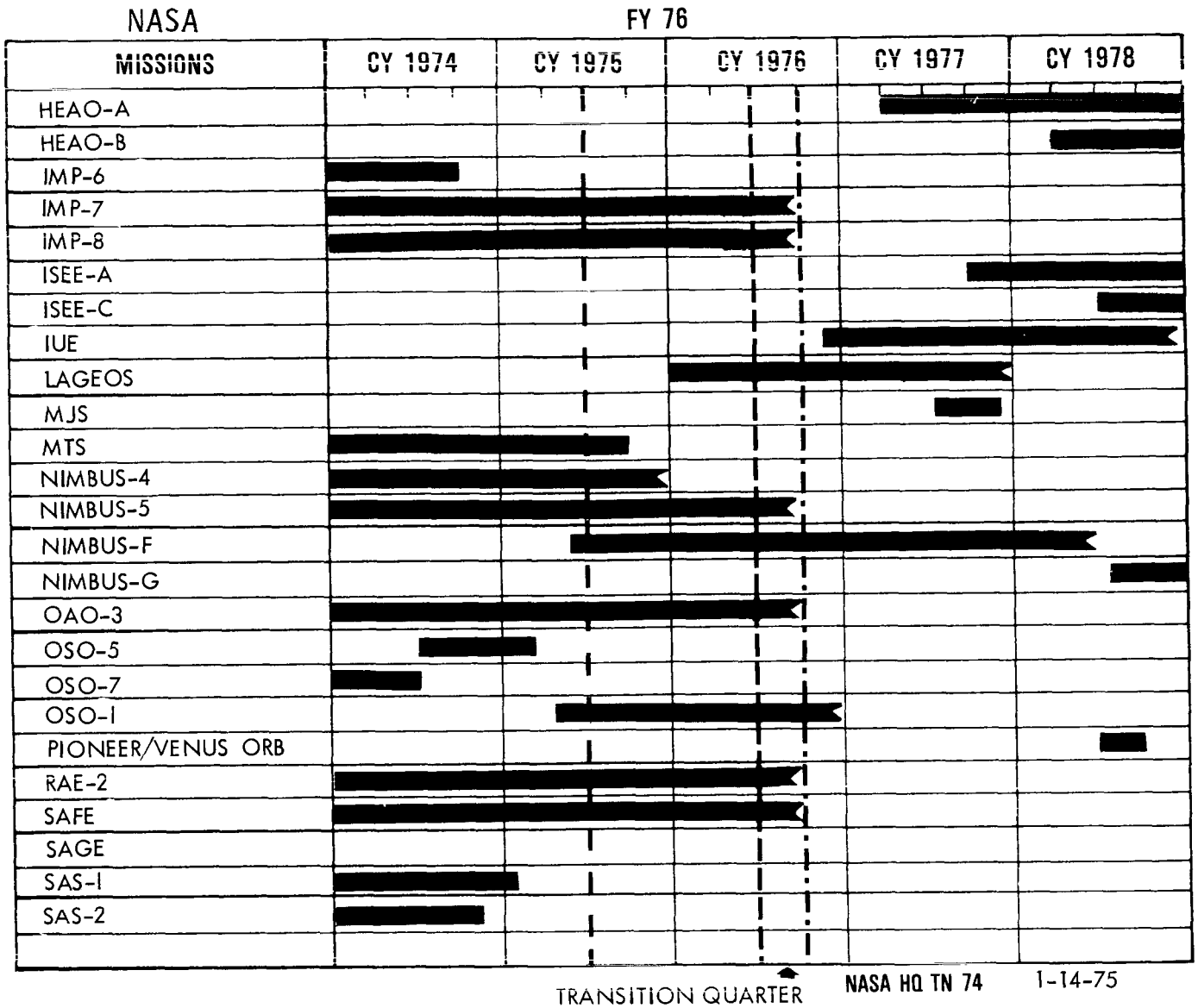
The FY 1976 request reflects a leveling off in funding requirements for network operations. Savings associated with the closing of stations are being offset by significant cost escalation in all program areas and, in particular, in the overseas operations area. In both the Spaceflight Tracking and Data 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.

		1975			
	1974	Budget Estimate	Current Estimate	1976	Transition Period
		(In Thousands of Dollars)			
Spaceflight tracking and data network.....	$ 99,525	$ 98,200	$ 98,500	$ 97,000	$26,000
Deep space network.	32,975	34,600	35,500	38,400	10,200
Aeronautics and sounding rocket support.....	4,300	5,500	5,200	4,100	1,100
Communciations.....	32,500	30,900	29,900	27,900	7,000
Data processing....	22,600	23,600	23,800	25,000	6,900
Total.....	$191,900	$192,800	$192,900	$192,400	$51,200

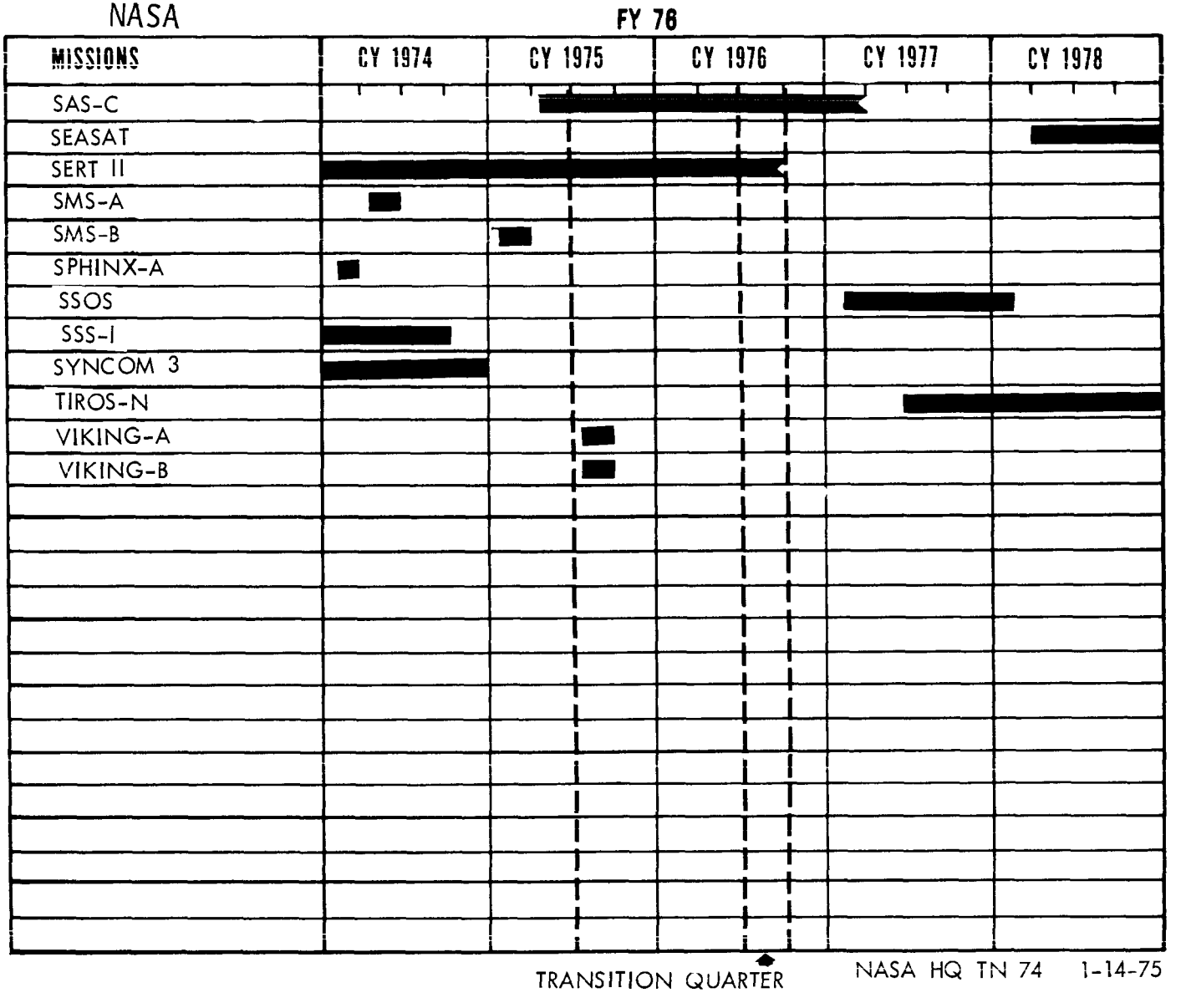
SPACEFLIGHT TRACKING AND DATA NETWORK WORKLOAD



SPACEFLIGHT TRACKING AND DATA NETWORK WORKLOAD



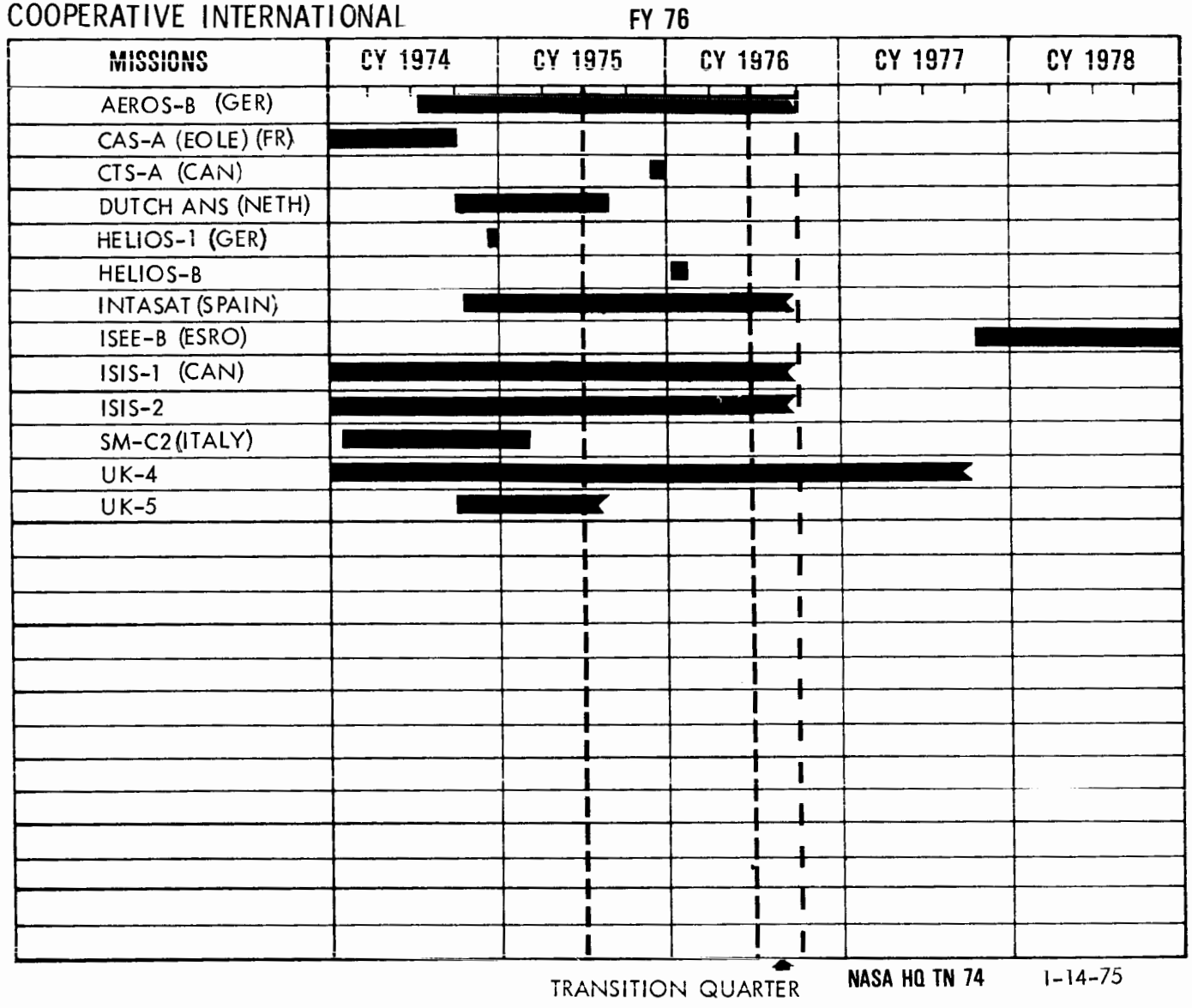
SPACEFLIGHT TRACKING AND DATA NETWORK WORKLOAD



NASA HQ TN 74 1-14-75

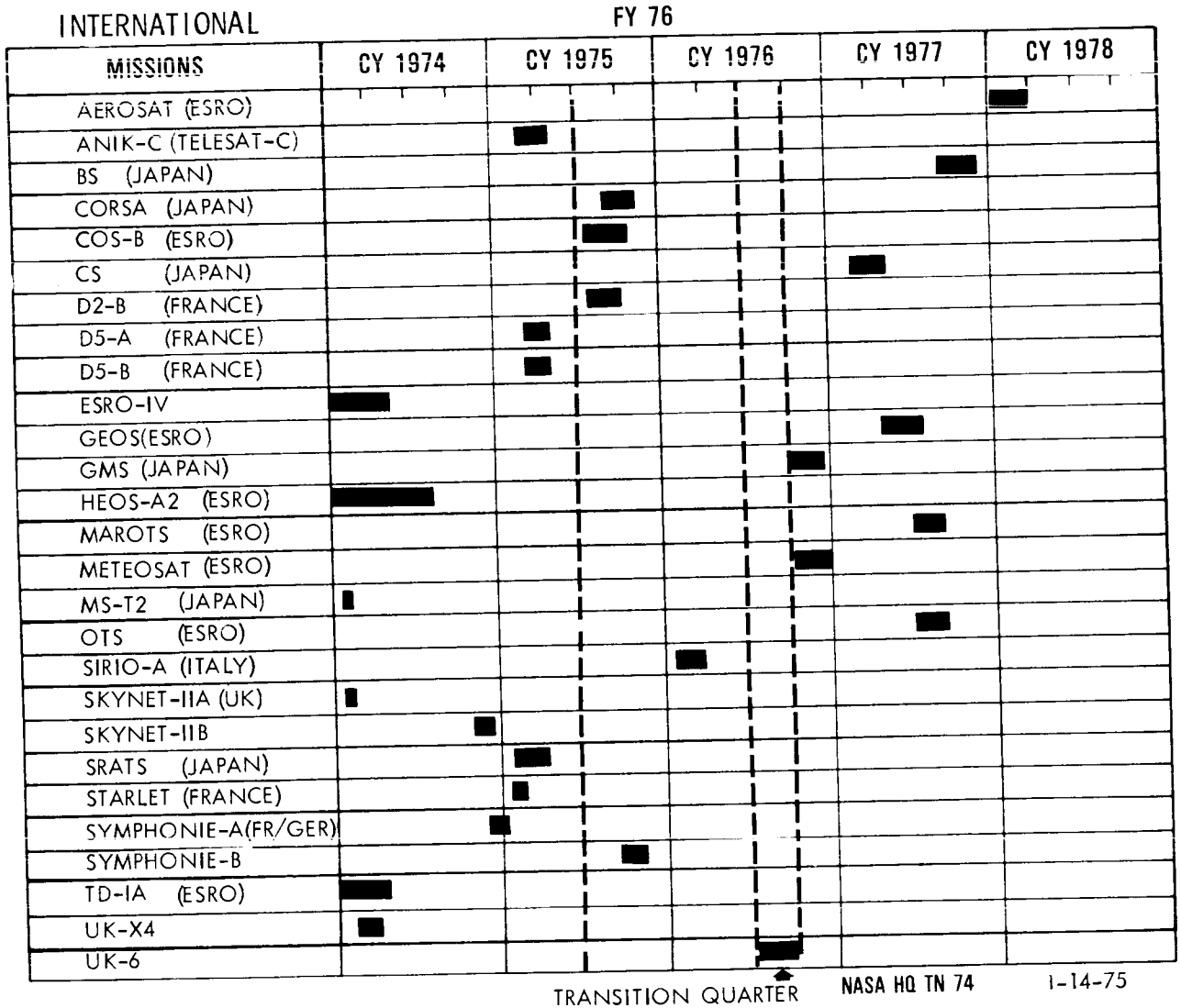
SPACEFLIGHT TRACKING AND DATA NETWORK WORKLOAD

COOPERATIVE INTERNATIONAL

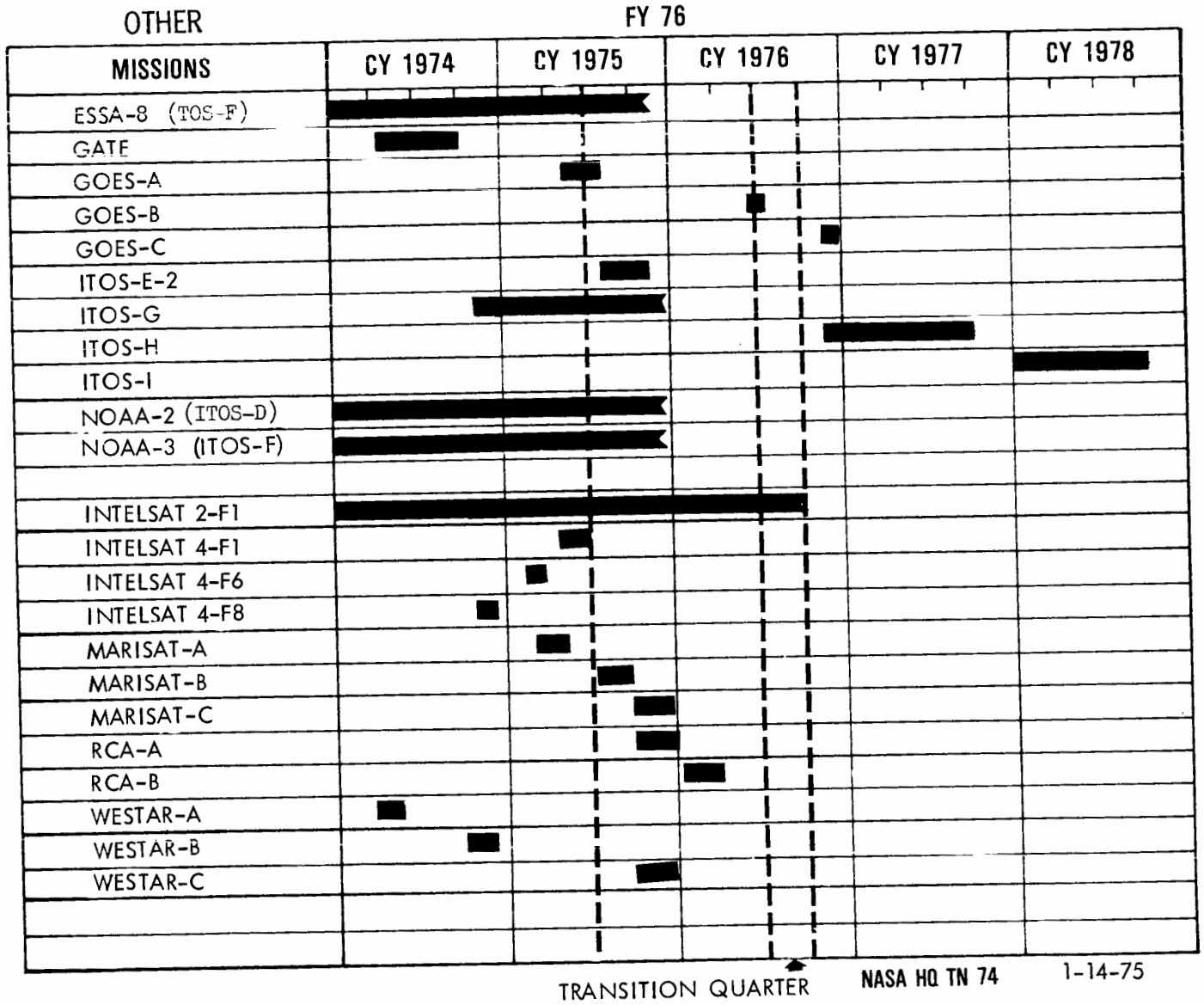


NASA HQ TN 74 1-14-75

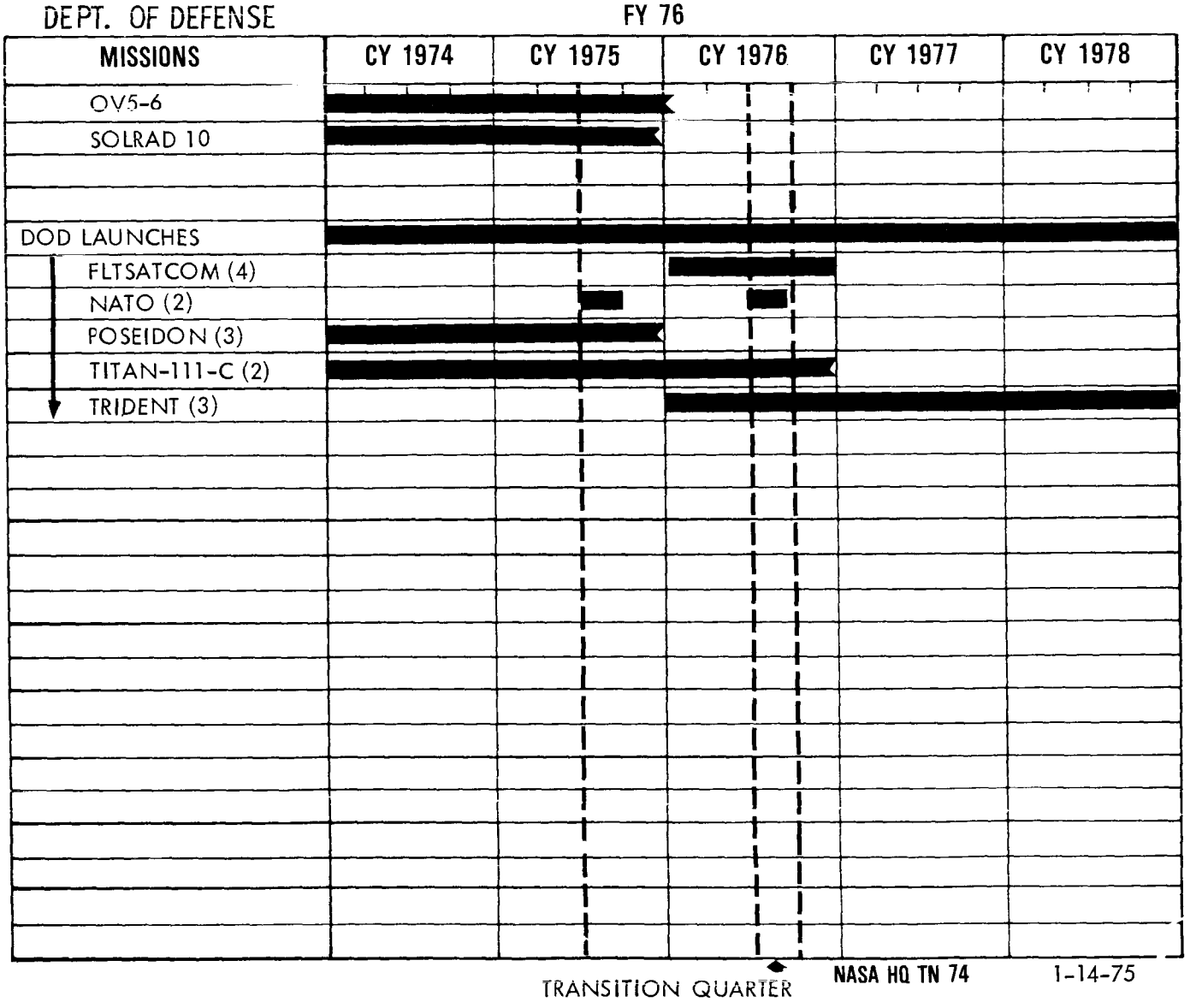
SPACEFLIGHT TRACKING AND DATA NETWORK WORKLOAD



SPACEFLIGHT TRACKING AND DATA NETWORK WORKLOAD



SPACEFLIGHT TRACKING AND DATA NETWORK WORKLOAD



Spaceflight Tracking and Data Network Operations

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$99,525	$98,200	$98,500	$97,000	$26,000

OBJECTIVES AND STATUS

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 and other U.S. agencies.

The Spaceflight Tracking and Data 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.

The Spaceflight Tracking and Data Network presently consists of sixteen geographically dispersed land stations, 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 electronically 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 these 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 Program. A second transportable facility has been relocated to Madrid for Applications Technology Satellite 6 support.

Due to changing requirements 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 support of 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 support of the launch phase of Viking.

The Spaceflight Tracking and Data Network is currently supporting on a continuing basis an average of approximately 40 unmanned scientific spacecraft including such missions as the first Earth Resources Technology Satellite (LANDSAT), several Applications Technology Satellites and Interplanetary Monitoring Platform satellites, 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 Synchronous Meteorological Satellite (SMS) B, Nimbus F, Geodynamic Experimental Ocean Satellite (GEOS) C, Earth Resources Technology Satellite (LANDSAT) B, 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, which is expected to continue to average approximately 40 spacecraft during FY 1976, is indicated on the accompanying charts.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The adjustment in the FY 1975 funding level was required due to higher than anticipated cost escalation for the operation of the Spaceflight Tracking and Data Network.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

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

Deep Space Network Operations

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transistion Period
	(In Thousands of Dollars)			
$32,975	$34,600	$35,500	$38,400	$10,200

OBJECTIVES AND STATUS

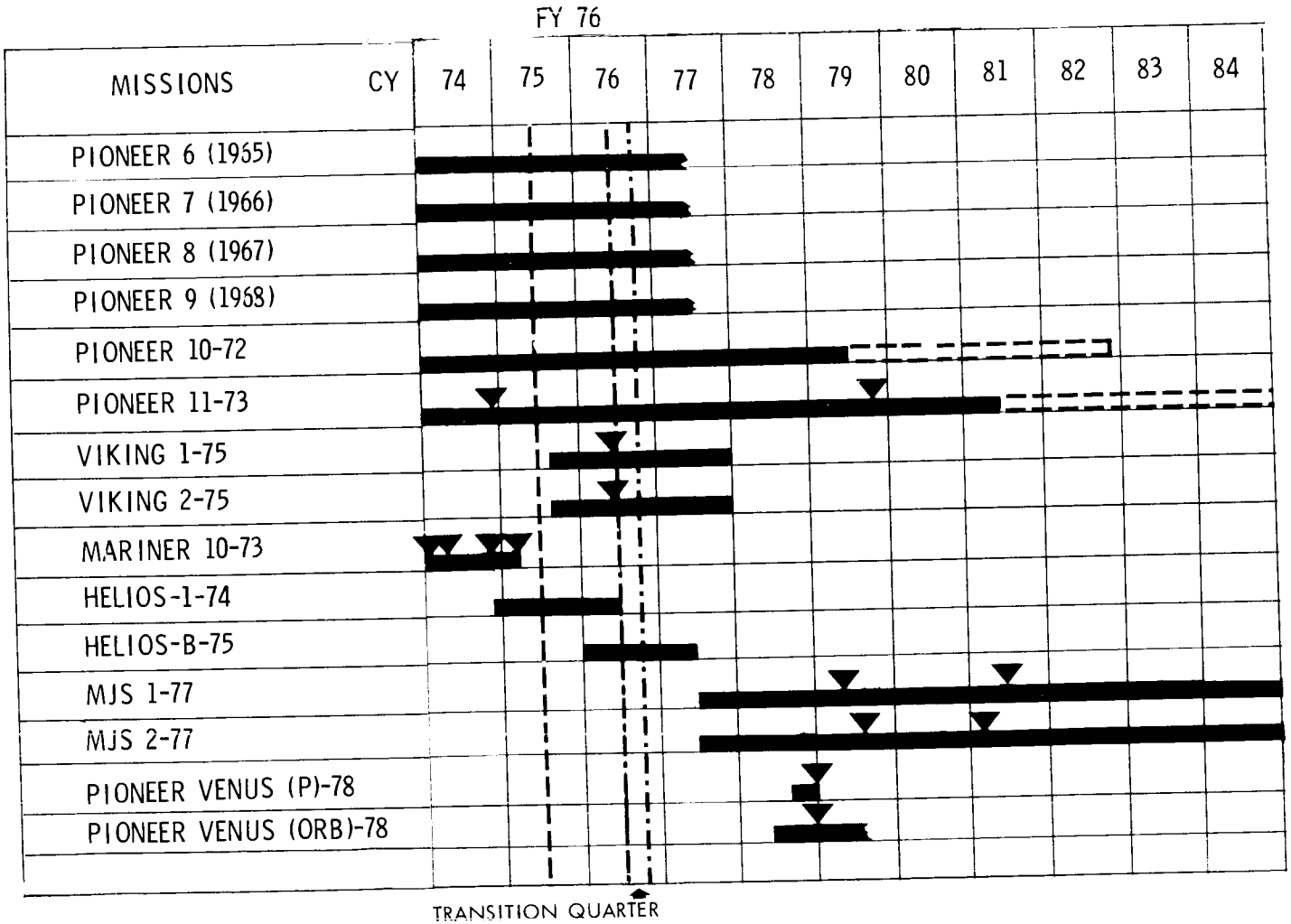
The primary fuction of the Deep Space Network is to support planetary and interplanetary space flight missions. The recently launched Helios 1 mission is on a trajectory that will take the spacecraft within forty-five million kilometers of the Sun. The Pioneer 11 flyby of Jupiter occurred December 2, 1974, and the spacecraft is scheduled to reach Saturn in the last half of 1979. The flyby of Saturn by Pioneer 11 will occur nearly 1.5 billion kilometers from the Earth. 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 Deep Space Network stations are located at Goldstone, California; Canberra, Australia; and Madrid, Spain. The stations consist of one 64-meter and two 26-meter antennas at each location. The Deep Space Network station at 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 FY 1975, the Deep Space Network support workload consists of six ongoing Pioneer spacecraft, the Helios 1 and Mariner 10 missions. This workload, as reflected in the accompanying chart, will continue essentially through FY 1976. In addition, the Viking 1975 A and B missions will be launched in the first quarter of FY 1976. These missions will be the most complex the Deep Space Network has ever supported. The Helios B spacecraft is also scheduled for launch during FY 1976 and will add to the ongoing network workload.

DEEP SPACE NETWORK WORKLOAD



The Deep Space Network facilities are also utilized for ground-based measurements in support of experiments in the field of radio astronomy. The extra-sensitive network antennas are being used in man's attempt to learn more about such phenomena as the mysterious Quasar energy sources and the possibility of dying stars generating black holes in space. Support of these experiments will continue on a noninterference basis to the flight missions in FY 1976.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The difference in the current FY 1975 funding level from the budget estimate is due primarily to the impact of cost escalation.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

The FY 1976 funds requested for operation of the Deep Space Network facilities are greater than were required in FY 1975 due to escalation and the increasing workload associated with Viking and Helios. In addition to the mission support as indicated on the workload chart, 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 estimate for the transition period is the funding needed to continue to operate the Deep Space Network to meet operational requirements during the period from July 1 through September 30, 1976.

Aeronautics and Sounding Rocket Support

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$4,300	$5,500	$5,200	$4,100	$1,100

OBJECTIVES AND STATUS

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 continues to be very active with close to three hundred missions being launched last year. This workload is expected to remain approximately the same in FY 1976 with launches ranging 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 the Edwards Air Force Base and the up-range site at Ely, Nevada. These facilities are composed of precision radar tracking, telemetry, and communications equipments 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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The difference in the current FY 1975 funding level from the budget submission is due primarily to the slippage of the GEOS-C launch date and related project support at Wallops.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATE

The FY 1976 request in this area is reduced as compared to FY 1975 due to the transfer of funding of some activities at Wallops to more appropriate programs, principally those conducted by the Office of Space Science and the Office of Applications.

The funding request for the transition period is the amount needed to continue the activities discussed above to meet operational requirements during the period from July 1 through September 30, 1976.

Communications Operations

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$32,500	$30,900	$29,900	$27,900	$7,000

OBJECTIVES AND STATUS

NASA's global communications network (NASCOM) interconnects the NASA tracking and data acquisition facilities in operational support of 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 Goddard Space Flight Center operates the network and serves as its major switching control point. 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.

In order to meet the higher data transfer rates new communications technology has been implemented in the NASA communications network such as electronic circuit switching and the capability for sending an increased amount of data over a normal voice circuit. Another development which has been implemented in the NASCOM allows for the transmission of data over a lesser number of circuits through the use of digital techniques and specially modified voice channels. This system will continue to be expanded to those NASA facilities which require this type of data and where the commercial common carriers have the capability available.

While technology developments have reduced data transmission unit costs, some additional circuits are required on a routine basis 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 & E.

CHANGES FROM FY 1975 BUDGET ESTIMATES

The reduction in FY 1975 from the budget estimate resulted from tariff reductions for communications circuits and adjustments in program support requirements.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

The FY 1976 budget request for this operational area reflects an overall reduction from FY 1975 due to the closure of the Carnarvon, Australia,

566-537 O - 75 - 33

Canary Island and Johannesburg, South Africa stations along with the continuing application of technology improvements. Funds requested will be used for the procurement of communications circuits and services required to operate and maintain the NASA communications network including the various domestic and overseas facilities.

The estimate for the transition period is the funding needed to continue the operation of the NASCOM Network to meet operational requirements during the period from July 1 through September 30, 1976.

Data Processing Operations

1974	1975 Budget Estimates	1975 Current Estimates	1976	Transition Period
	(In Thousands of Dollars)			
$22,600	$23,600	$23,800	$25,000	$6,900

OBJECTIVES AND STATUS

Information received in the form of 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. Support must be given to a wide variety of programs which vary from the small Explorer satellites to large and complex Solar and Astronomical Observatories and the Applications and Earth Resources Technology Satellites.

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 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 projects 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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The adjustment in the FY 1975 funding level was necessitated by higher than anticipated increases in the cost of logistics required for the operation of the data processing capability at the Goddard Space Flight Center.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

The FY 1976 budget 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 or spacecraft experiments fail. These support reductions are making possible the support of new satellites, without major increases in data processing capability. New satellites often 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 from the stations be transmitted to the control center at Goddard Space Flight Center where it is fed directly into interconnected computers. Computations are made and scientific data are processed and placed in computer memory units. These data are used in near real time as the basis for determining commands to be sent to the spacecraft for orbit adjustment and experiment operation. Data are available to scientists for analysis within hours after initial data acquisition by the ground stations. 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 new LANDSAT-B spacecraft in FY 1976. This facility is expected to continue operations through the next several years, at approximately the same level of effort, to support the continuing Earth Resources program.

The estimate for the transition period is based upon the continued operation of the data processing facilities and the projected computer and software support required during the period from July 1 through September 30, 1976.

Systems Implementation

The objectives of the NASA networks tracking and data systems implementation program are to maintain the existing ground support capability at a high level of proficiency and reliability in order to meet the aggregate support needs of the many and varied space missions, and to provide augmentation to this capability, as necessary, to meet the special requirements of individual flight projects. These ground 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 also 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 required to maintain adequate 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.

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
		(In Thousands of Dollars)			
Spaceflight tracking and data network.....	$ 19,400	$ 25,600	$ 19,300	$ 17,400	$ 5,100
Deep space network.....	$ 13,283	$ 12,000	$ 12,800	$ 14,300	$ 5,400
Aeronautics and sounding Rocket support.....	3,007	3,300	3,100	2,700	700
Communications.....	2,274	3,200	3,200	3,000	800
Data processing....	4,936	3,900	3,900	4,000	900
Total.....	$ 42,900	$ 48,000	$ 42,300	$ 41,400	$12,900

Spaceflight Tracking and Data Network Systems Implementation

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$19,400	$25,600	$19,300	$17,400	$5,100

OBJECTIVES AND STATUS

During FY 1976 the network will continue to support approximately forty spacecraft on an around-the-clock basis, including many ongoing missions with highly complex requirements -- such as Applications Technology Satellite 6, Earth Resources Satellites (LANDSAT) 1 and B, Atmosphere Explorer C, and Synchronous Meteorological Satellites. In addition to supporting ongoing missions, the network will also provide support to a number of new missions. Among those are the Apollo/Soyuz Test Project, the Geodynamic Experimental Ocean Satellite C, the NIMBUS-F, the Orbiting Solar Observatory I, the Atmosphere Explorer D and E, and the Small Astronomy Satellite C.

The Spaceflight Tracking and Data Network systems implementation program encompasses the procurement and implementation of systems and services necessary to sustain the network's continuing capability for reliable support to these 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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The adjustment in the FY 1975 funding level from the budget estimate resulted from the agency 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 is 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 restrict the investigation of earth surface phenomona, thereby delaying the understanding of any correlation between earth surface motion and earthquakes.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

Equipment modification is required in FY 1976 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 replacement of worn-out systems with more reliable units, for equipment modifications to correct operational deficiencies, and for equipment to be used in operational control of the network. Funds are also requested for subsystems spares, for provision and modification of test equipment, and for minor equipment modifications resulting from changes in support requirements from one mission to the next.

Network system augmentations are planned for support of the approach and landing and orbital flight test phase of the Space Shuttle program. Digital voice demodulation systems will be provided at certain core network stations for relaying voice 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 requested for implementation of the displays, consoles, and computer peripherals necessary to complete the control center for the International Ultraviolet Explorer. Control center modifications to the existing Orbiting Astronomy Observatory control center for the High Energy Astronomy Observatory include console replacements, display and computer modifications, and provision of additional communications interface equipment. In addition, some improvements and augmentation to laser tracking systems necessary to support the LAGEOS satellite and other elements of the Earth and Ocean Physics Applications program are included in the FY 1976 funding request.

The estimate for the transition period is the funding required during the period from July 1 through September 30, 1976 to sustain the network capabilities and to continue the implementation of capabilities for support of ongoing and approved programs.

Deep Space Network Systems Implementation

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$13,283	$12,000	$12,800	$14,300	$5,400

OBJECTIVES AND STATUS

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

Due to the extreme distances of planetary spacecraft from earth 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 systems require a continuing effort of replacement, modification and augmentation to maintain a high degree of reliability and operational integrity and to incorporate state-of-the-art improvements in telecommunications which are the key to achieving and maximizing the scientific return from these missions.

CHANGE FROM FY 1975 BUDGET ESTIMATE

The adjustment in the FY 1975 budget estimate for the Deep Space Network Systems is due primarily to the increased funding requirements resulting from the refinement of support requirements for upcoming approved missions such as Viking and Mariner Jupiter/Saturn.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

In support of 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 to assure longer term network reliability and operational integrity. 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. Funds are requested in FY 1976 for replacement hardware and spares so that the network systems can provide uninterrupted support to these extended ongoing missions and to incorporate changes to maximize the scientific return of these missions.

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

In preparation for the dual Mariner missions to Jupiter and Saturn in 1977, long lead time development of prototype equipment has been initiated in prior years. Equipment changes include those needed to accommmodate the increased command transmission data rate required by the spacecraft computer in order 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 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 science and engineering data with minimal error during the planetary flyby phases which will occur at distances beyond 1 1/2 billion kilometers (9.5 A.U.) from earth.

In addition, to precisely control the spacecraft trajectory for close flyby to 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 communication distance from two widely spaced earth stations simultaneously. In FY 1976, as part of a time-phased implementation program, it is planned to provide equipment to stations of the Deep Space Network which will be used for early prelaunch testing with the spacecraft and for launch and early cruise support. Accordingly, funds are requested to initiate systems implementation for support of the early phase of the Mariner Jupiter/Saturn missions.

The estimate for the transition period is the funding required from July 1 to September 30, 1976 to sustain the network for ongoing mission support

and to implement the network, in a timely manner, for the Mariner Jupiter/ Saturn mission which is scheduled for launch in 1977.

Aeronautics and Sounding Rocket Support System Implementation

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Peroid
	(In Thousands of Dollars)			
$3,007	$3,300	$3,100	$2,700	$700

OBJECTIVES AND STATUS

The aeronautics and sounding rocket programs are supported at the Wallops Flight Center in Virginia and the Flight Research Center in California.

The aeronautics program supported at Wallops consists of space component tests utilizing helicopter or aircraft drops, aircraft noise abatement projects, slow speed landing techniques for jet aircraft, anti-skid tests on grooved runways, V/STOL terminal area research, microwave landing system development tests, collision avoidance programs and remote (airborne) sensing developments in support of the earth resources programs.

The sounding rocket programs supported at Wallops cover all of the atmospheric and space disciplines in which research is undertaken, utilizing a family of launch vehicles varying in size and power from the small meteorological rockets to the 72-foot Scout with an orbital launch capability. The experiments are launched not only from Wallops Island but also from remote sites around the world.

To provide instrumentation support to these programs, fixed and mobile ground support equipments are provided by Wallops. 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 aeronautical programs supported by the Flight Research Center (FRC) consist of high altitude and terminal area tests involving high performance

566-537 O - 75 - 39

aircraft and lifting bodies such as the F-111, X-24B, YF-12, 747 Shuttle Carrier, and various other aircraft and helicopters. The FRC also will be responsible for the approach and landing tests for the Shuttle Orbiter. The ground support equipment is located on the Aerodynamics Test Range which consists of stations at Edwards, California and Ely, Nevada. High precision radar, telemetry, data handling, and associated timing, communications and command systems are maintained and modified to meet the changing requirements of the approved flight projects.

CHANGES FROM FY 1975 BUDGET ESTIMATE

The adjustment in the FY 1975 funding level resulted from changes in support requirements at Wallops Flight Center and the Flight Research Center.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

Funds are requested in FY 1976 to provide the sustaining equipment and modifications necessary to support the sounding rocket and aeronautics programs.

The estimate for the transition period is the funding needed to continue these activities to meet operational requirements during the period from July 1 through September 30, 1976.

Communications Systems Implementation

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$2,274	$3,200	$3,200	$3,000	$800

OBJECTIVES AND STATUS

Funds requested for communications equipment are used for the procurement of hardware for the NASA communications network to meet new program support requirements, to increase the efficiency of the network and to sustain the network at a high level of reliability.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

In FY 1976 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. Another modification effort will provide the capability for transmitting bulk data over a specially modified voice circuit in lieu of using multiple circuits to transmit the same data.

To maintain system reliability a continuing program to procure replacement parts, spares, test and monitoring equipment is necessary. This hardware assures that the data circuits can be maintained within prescribed limits, thus ensuring the necessary level of system reliability.

For the transition period the funds requested will provide for the continuation of the efforts discussed above to meet ongoing program requirements and to sustain the network at the required level of reliability.

Data Processing Systems Implementation

1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$4,936	$3,900	$3,900	$4,000	$900

OBJECTIVES AND STATUS

The FY 1976 estimate includes funds to modify and augment the existing NASA image data processing facility at the Goddard Space Flight Center in order to meet the image accuracy and resolution requirements of upcoming approved missions. Initially, this facility was established for the Earth Resources Technology Satellite (LANDSAT) 1 and B missions and operated as an analog system doing the great majority 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 computer compatible form.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

With the augmented system digital data acquired by the network stations will be entered into computers for processing and data correction in digital form. This will provide higher quality data by a factor of two to three over the present approach. The product 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 B mission.

In addition, funds are required in FY 1976 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 peripherals associated with its operation including drums,

566-537 O - 75 - 40

displays and line printers; (2) the addition of power source monitors and (3) the purchase of routine and special spare components and hardware.

The estimate for the transition period is the funding needed for continuation of the activities discussed above to meet operational requirements during the period from July 1 through September 30, 1976.

Advanced Systems

The OTDA Advanced Systems program, formerly designated 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.

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
$9,200	$9,200	$9,200	$9,200	$2,300

OBJECTIVES AND STATUS

The program to meet the above objectives for FY 1976 is comprised of activities in four basic areas:

1. Tracking, orbit determination and ground-based navigation
2. Spacecraft/ground communications, telemetry and command
3. Network control and operations technology
4. Data handling and processing

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES

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.

These techniques are also being studied as a method to determine spacecraft position against a background of extraterrestrial radio sources, known as quasars. This technique will 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 in FY 1976 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 multiple attitude determination systems.

Radio telecommunications techniques will continue to be developed in FY 1976 in order to provide reliable and economical support of future spacecraft command and data acquisition requirements.

Future planetary missions will require data rates in excess of 100 kilobits per second from the vicinity of Jupiter, approximately 900 million kilometers away. 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. The capabilities of our large aperture antennas will be further improved by the use of higher frequencies, the development of techniques for arraying several antennas, the study of dish-surface shaping, and by development of 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. Effort is required on ground antenna feed systems and telemetry receivers as well as on network station techniques for handling high data rates. Network support analyses will be made to plan for support of future missions such as the Large Space Telescope and the Earth Observation Satellite.

Effort will continue on 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. Features for automated monitoring and control will be examined and developed for those applications which are determined to be cost effective and necessary to meet real time operations requirements. Techniques for 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. Work also will be continued in FY 1976 to develop and apply new techniques necessary to maintain low cost, reliable software.

Studies and development will be conducted on data handling and data processing systems and techniques to meet the increasing requirements for real time mission control and user-interactive information systems. Our studies 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.

The funds requested for the transition period are required to continue the developments and studies in the areas discussed above during the period from July 1 to September 30, 1976.

Tracking and Data Relay Satellite System

A major aspect of the Tracking and Data Acquisition Program in future years will be the Tracking and Data Relay Satellite System (TDRSS).

The TDRSS will consist of two specialized relay spacecraft 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 spacecraft will be positioned in geosynchronous orbit, one over the mid-Atlantic Ocean and the other over the mid-Pacific Ocean. A spare relay spacecraft will be positioned in orbit midway between the two active spacecraft.

	1975			
1974	Budget Estimate	Current Estimate	1976	Transition Period
	(In Thousands of Dollars)			
---	---	$3,600	---	---

OBJECTIVES AND STATUS

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 eliminiation of many of the ground stations in the present Spaceflight Tracking and Data Netwrok 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 contract for services arrangement, NASA funding for services will not be required until service actually commences in FY 1979.

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.

CHANGES FROM FY 1975 BUDGET ESTIMATE

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 definitive system design and technical and cost proposals. Phase II will involve the competitive selection of a single contractor for final design, implementation and operation.

The difference in the current FY 1975 funding level from the budget estimate represents the amount that has been reprogrammed to fund the Phase I contracts. These funds are a part of the NASA deferral actions included in the President's Special Message on Budget Restraint (November 26, 1974). These deferred funds will be used for the Phase I contracts in early FY 1976. No additional funding requirements are anticipated until TDRSS service begins in FY 1979.

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1976 ESTIMATES

BUDGET SUMMARY

OFFICE OF INDUSTRY AFFAIRS AND TECHNOLOGY UTILIZATION

TECHNOLOGY UTILIZATION PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS

	1974	1975 Budget Estimate	1975 Current Estimate	1976	Transition Period
	(Thousands of Dollars)				
Industrial applications....	$1,985	$2,900	$2,900	$3,220	$850
Technology applications....	1,845	2,000	2,000	3,025	950
Program control and evaluation.....	670	600	600	755	200
Total.....	$4,500	$5,500	$5,500	$7,000	$2,000
Distribution of Program Amount by Installation:					
NASA Headquarters.....	$4,500	$5,500	$5,500	$7,000	$2,000

OBJECTIVES AND STATUS:

New advances and innovative technologies resulting from aerospace research and development programs are transferred and applied to non-aerospace needs through the NASA Technology Utilization program. Since its inception the Technology Utilization program has been instrumental in linking NASA/aerospace technology to additional uses in the nation's industrial and public sector communities through a variety of established and proven transfer mechanisms. With each passing year NASA has strived to make these mechanisms more effective by strengthening interactive relationships with the non-aerospace user communities.

In FY 1976, the Technology Utilization program plans to broaden its 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 NASA Industrial Application Centers (formerly known as Regional Dissemination Centers) are somewhat limited geographically due to cost constraints and operational considerations, NASA proposes during FY 1976 to institute an "outreach program" that will enable the IAC's to

effectively serve new user markets in cities of high industrial concentration (e.g., Chicago, Atlanta, Seattle, etc.). IAC Divisional Offices to be established at these and other sites will provide greater insight into the technological needs of industry in those regions, and will also provide a more viable and substantive base for interaction with State and local governments.

At the same time, NASA plans to further strengthen interactive ties between public and private users and the problem-solving capabilities of aerospace technologists located at the various NASA Field Centers. The anticipated growth in problem-solving opportunities in FY 1976 will require additional emphasis in applications engineering in order to demonstrate the feasibility and application of NASA-derived technologies to public sector needs. NASA experience in technology transfer indicates that these outreach efforts will materially enhance and effectively multiply the resultant transfer and use of aerospace technology in the U.S. industrial and public sectors.

CHANGES FROM FY 1975 BUDGET ESTIMATE: None.

BASIS OF FY 1976 AND TRANSITION PERIOD ESTIMATES:

Industrial Applications

Pursuant to Section 305(b) of the National Aeronautics and Space Act of 1958, Technology Utilization Officers at all 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, bio-engineering, and fabrication/manufacturing technology, are evaluated and published in NASA Tech Briefs, Compilations, Handbooks, and other dissemination media. In FY 1976 and the subsequent Transition Period, special emphasis will be directed toward increased market relevance of the technology and improved distribution methods to broaden availability and use.

During FY 1976 and the transition period, NASA will also continue to move forward toward an interactive network of Industrial Application Centers. The current six Centers will form the basis of the IAC network. These six are presently unable to effectively interact with industrial communities outside their immediate respective geographical locations due to the costs of extended travel. It is proposed that IAC Divisional Offices be established in FY 1976 to extend in a cost-effective manner the visible outreach of NASA's technology transfer efforts and its support to industry. Divisional Offices are being considered for highly industrialized urban areas, such as the San Francisco Bay Area, Houston, Chicago, Atlanta, and/or St. Louis. The foregoing fully supports the program intent of developing a national

network of technology transfer centers to serve the technological needs of U.S. industry as well as State and local governments. More specifically, 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 (e.g., conferences, seminars, etc.) for selected user groups located in strategic geographic areas.

Public sector problems identified in cooperation with user agencies are matched with existing aerospace technology via Application Teams, Industrial Application Centers, and NASA Field Centers. This 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, upwards of seventy active applications engineering projects are underway at eight NASA Field Centers and at NASA Headquarters.

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. 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.

Program Control and Evaluation

NASA will continue its efforts to document and analyze specific evidence of technology transfer as a means to (1) a better understanding of the transfer process, and (2) effective modification to existing transfer mechanisms and programs. Such factors as time lag, industrial receptivity, technology matching characteristics, etc., will be analyzed and evaluated to determine relative impact and effectiveness of NASA's technology transfer efforts.

Further efforts will be continued in FY 1976 to document impacts and benefits (technological, societal and economic) of NASA R&D programs and their respective influence on the nation's capabilities and future growth. Such efforts are intended to provide greater insight to furthering the use of Federally sponsored R&D through technology transfer and application programs.

U.S. GOVERNMENT PRINTING OFFICE :1975 O - 566-537