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Foreword

POCKET STATISTICS is published for the use of NASA managers and their staff. Included is Administrative and Organizational information, summaries of Space Flight Activity including the NASA Major Launch Record, and NASA Procurement, Financial and Manpower data.

The NASA Major Launch Record includes all launches of Scout class and larger vehicles. Vehicle and spacecraft development flights are also included in the Major Launch Record. Shuttle missions are counted as one launch and one payload, where free flying payloads are not involved. Satellites deployed from the cargo bay of the Shuttle and placed in a separate orbit or trajectory are counted as an additional payload.

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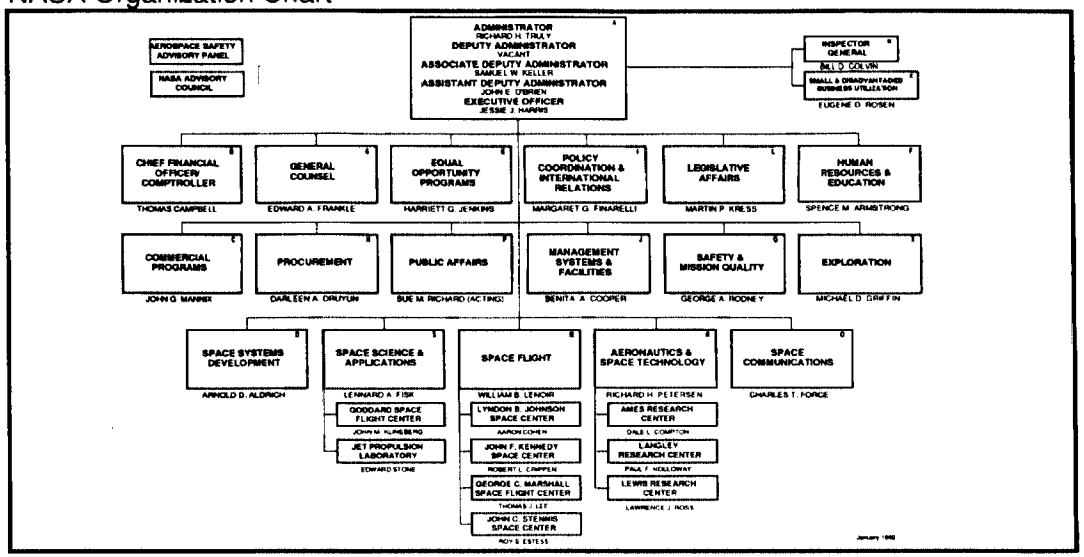
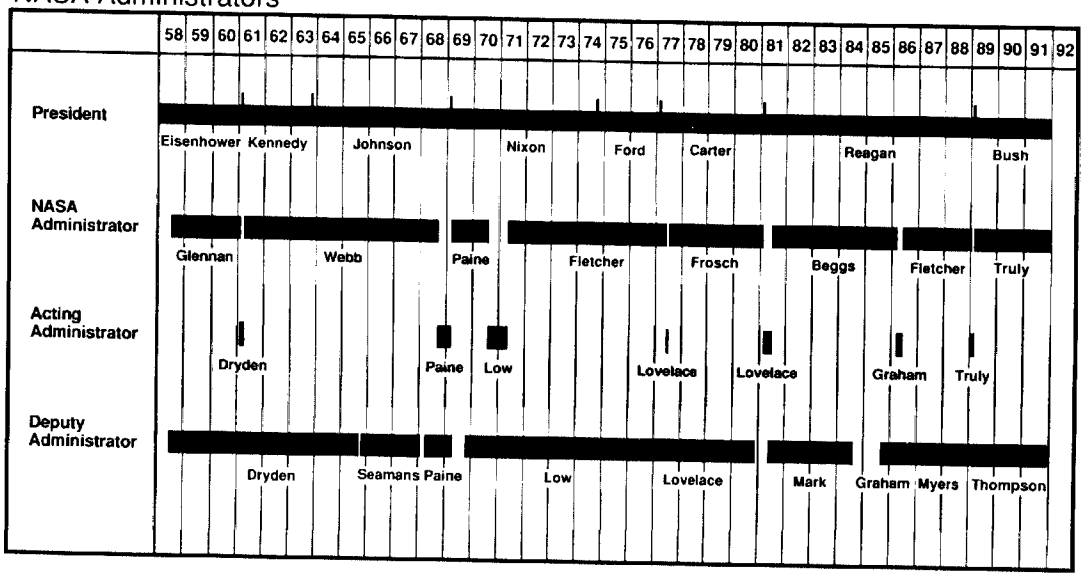
Section A

Administration and Organization

NASA Organization Chart



NASA Administrators



Excerpts From The National Aeronautics And Space Act Of 1958, As Amended

AN ACT To provide for research into problems of flight within and outside the Earth's atmosphere, and for other purposes.

DECLARATION OF POLICY AND PURPOSE

Sec. 102 (a) The Congress hereby declares that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind.

(b) The Congress declares that the general welfare and security of the United States require that adequate provision be made for aeronautical and space activities. The Congress further declares that such activities shall be the responsibility of, and shall be directed by, a civilian agency exercising control over aeronautical and space activities sponsored by the United States, except that activities peculiar to or primarily associated with the development of weapons systems, military operations, or the defense of the United States (including the research and development necessary to make effective provision for the defense of the United States) shall be the responsibility of, and shall be directed by, the Department of Defense; and that determination as to which such agency has responsibility for and direction of any such activity shall be made by the President in conformity with section 201(e).

(c) The Congress declares that the general welfare of the United States requires that the National Aeronautics and Space Administration (as established by title II of this act) seek and encourage to the maximum extent possible the fullest commercial use of space.

(d) The aeronautical and space activities of the United States shall be conducted so as to contribute materially to one or more of the following objectives:

(1) The expansion of human knowledge of phenomena in the atmosphere and space;

(2) The improvement of the usefulness, performance, speed, safety, and efficiency of aeronautical and space vehicles;

(3) The development and operation of vehicles capable of carrying instruments, equipment, supplies, and living organisms through space;

(4) The establishment of long-range studies of the potential benefits to be gained from, the opportunities for, and the problems involved in the utilization of aeronautical and space activities for peaceful and scientific purposes;

(5) The preservation of the role of the United States as a leader in aeronautical and space science and technology and in the application thereof to the conduct of peaceful activities within and outside the atmosphere;

(6) The making available to agencies directly concerned with national defense of discoveries that have military value or significance, and the furnishing by such agencies, to the civilian agency established to direct and control nonmilitary aeronautical and space activities, of information as to discoveries which have value or significance to that agency;

(7) Cooperation by the United States with other nations and groups of nations in work done pursuant to this Act and in the peaceful application of the results thereof; and

Excerpts From The National Aeronautics And Space Act Of 1958, As Amended

DECLARATION OF POLICY AND PURPOSE (Continued)

(8) The most effective utilization of the scientific and engineering resources of the United States, with close cooperation among all interested agencies of the United States in order to avoid unnecessary duplication of effort, facilities, and equipment.

(e) The Congress declares that the general welfare of the United States requires that the unique competence in scientific and engineering systems of the National Aeronautics and Space Administration also be directed toward ground propulsion systems research and development.

(f) The Congress declares that the general welfare of the United States requires that the unique competence in scientific and engineering systems of the National Aeronautics and Space Administration also be directed toward the development of advanced automobile propulsion systems.

(g) The Congress declares that the general welfare of the United States requires that the unique competence in scientific and engineering systems of the National Aeronautics and Space Administration also be directed to assisting in bioengineering research, development, and demonstration programs designed to alleviate and minimize the effects of disability.

FUNCTIONS OF THE ADMINISTRATION

Sec. 203 (a) The Administration, in order to carry out the purpose of this Act, shall --

(1) plan, direct, and conduct aeronautical and space activities;

(2) arrange for participation by the scientific community in planning scientific measurements and observations to be made through use of aeronautical and space vehicles, and conduct or arrange for the conduct of such measurements and observations; and

(3) provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof.

(b) (1) The Administration shall, to the extent of appropriated funds, initiate, support, and carry out such research, development, demonstration, and other related activities in ground propulsion technologies.

(2) The Administration shall initiate, support, and carry out such research, development, demonstration, and other related activities in solar heating and cooling technologies (to the extent that funds are appropriated therefor).

National Space Policy

On November 2, 1989, the President approved a national space policy that updates and reaffirms U.S. goals and activities in space. The policy is the result of a review undertaken by the National Space Council. The revisions clarify, strengthen, and streamline selected aspects of the policy. Areas affected include civil and commercial remote sensing, space transportation, space debris, federal subsidies of commercial space activities, and Space Station Freedom.

Overall, the President's national space policy revalidates the ongoing direction of U.S. space efforts and provides a broad policy framework to guide future U.S. space activities.

The policy reaffirms the nation's commitment to the exploration and use of space in support of our national well being. United States leadership in space continues to be a fundamental objective guiding U.S. space activities. The policy recognizes that leadership requires United States preeminence in key areas of space activity critical to achieving our national security, scientific, technical, economic, and foreign policy goals. The policy also retains the long-term goal of expanding human presence and activity beyond Earth orbit into the Solar System. This goal provides the overall policy framework for the President's human space exploration initiative, announced July 20, 1989, in which the President called for completing Space Station Freedom, returning permanently to the Moon, and exploration of the planet Mars.

INTRODUCTION

United States space activities are conducted by three separate and distinct sectors: two strongly interacting governmental sectors (Civil and National Security) and a separate, non-governmental Commercial Sector. Close coordination, cooperation, and technology and information exchange will be maintained among these sectors to avoid unnecessary duplication and promote attainment of United States space goals.

GOALS AND PRINCIPLES

A fundamental objective guiding United States space activities has been, and continues to be, space leadership. Leadership in an increasingly competitive international environment, does not require United States preeminence in all areas and disciplines of space enterprise. It does require United States preeminence in the key areas of space activity critical to achieving our national security, scientific, technical, economic, and foreign policy goals.

- The overall goals of United States space activities are: (1) to strengthen the security of the United States; (2) to obtain scientific, technological and economic benefits for the general population and to improve the quality of life on Earth through space-related activities; (3) to encourage continuing United States private-sector investment in space and related activities; (4) to promote international cooperative activities taking into account United States national security, foreign policy, scientific, and economic interests; (5) to cooperate with other nations in maintaining the freedom of space for all activities that enhance the security and welfare of mankind; and, as a long-range goal, (6) to expand human presence and activity beyond Earth orbit into the solar system.
- The United States space activities shall be conducted in accordance with the following principles:
  - The United States is committed to the exploration and use of outer space by all nations for peaceful purposes and for the benefit of all mankind. "Peaceful purposes" allow for activities in pursuit of national security goals.
  - The United States will pursue activities in space in support of its inherent right of self-defense and its defense commitments to its allies.

National Space Policy

- The United States rejects any claims to sovereignty by any nation over outer space or celestial bodies, or any portion thereof, and rejects any limitations on the fundamental right of sovereign nations to acquire data from space.
- The United States considers the space systems of any nation to be national property with the right of passage through and operations in space without interference. Purposeful interference with space systems shall be viewed as an infringement on sovereign rights.
- The United States shall encourage and not preclude the commercial use and exploitation of space technologies and systems for national economic benefit. These commercial activities must be consistent with national security interests, and international and domestic legal obligations.
- The United States will, as a matter of policy, pursue its commercial space objectives without the use of direct Federal subsidies.
- The United States shall encourage other countries to engage in free and fair trade in commercial space goods and services.
- The United States will conduct international cooperative space-related activities that are expected to achieve sufficient scientific, political, economic, or national security benefits for the nation. The United States will seek mutually beneficial international participation in space and space-related programs.

CIVIL SPACE POLICY

- The United States civil space sector activities shall contribute significantly to enhancing the Nation's science, technology, economy, pride, sense of well-being and direction, as well as United States world prestige and leadership. Civil sector activities shall comprise a balanced strategy of research, development, operations, and technology for science, exploration, and appropriate applications.
- The objectives of the United States civil space activities shall be (1) to expand knowledge of the Earth, its environment, the solar system, and the universe; (2) to create new opportunities for use of the space environment through the conduct of appropriate research and experimentation in advanced technology and systems; (3) to develop space technology for civil applications and, wherever appropriate, make such technology available to the commercial sector; (4) to preserve the United States preeminence in critical aspects of space science, applications, technology, and manned space flight; (5) to establish a permanently manned presence in space; and (6) to engage in international cooperative efforts that further United States overall space goals.

COMMERCIAL SPACE POLICY

The United States government shall not preclude or deter the continuing development of a separate non-governmental Commercial Space Sector. Expanding private sector investment in space by the market-driven Commercial Sector generates economic benefits for the Nation and supports governmental Space Sectors with an increasing range of space goods and services. Governmental Space Sectors shall purchase commercially available space goods and services to the fullest extent feasible and shall not conduct activities with potential commercial applications that preclude or deter Commercial Sector

space activities except for national security or public safety reasons. Commercial Sector space activities shall be supervised or regulated only to the extent required by law, national security, international obligations, and public safety.

NATIONAL SECURITY SPACE POLICY

The United States will conduct those activities in space that are necessary to national defense. Space activities will contribute to national security objectives by (1) deterring, or if necessary, defending against enemy attack; (2) assuring that forces of hostile nations cannot prevent our own use of space; (3) negating, if necessary, hostile space systems; and (4) enhancing operations of United States and Allied forces. Consistent with treaty obligations, the national security space program shall support such functions as command and control, communications, navigation, environmental monitoring, warning, surveillance, and force application (including research and development programs which support these functions).

INTER-SECTOR POLICIES

This section contains policies applicable to, and binding on, the national security and civil space sectors.

- The United States Government will maintain and coordinate separate national security and civil operational space systems where differing needs of the sectors dictate.
- Survivability and endurance of national security space systems, including all necessary system elements, will be pursued commensurate with the planned use in crisis and conflict, with the threat, and with the availability of other assets to perform the mission.
- Government sectors shall encourage to the maximum extent feasible, the development and use of United States private sector space capabilities.
- A continuing capability to remotely sense the Earth from space is important to the achievement of United States space goals. To ensure that the necessary capability exists, the United States government will: (a) ensure the continuity of LANDSAT-type remote sensing data; (b) discuss remote sensing issues and activities with foreign governments operating or regulating the private operation of remote sensing systems; (c) continue government research and development for future advanced remote sensing technologies or systems; and (d) encourage the development of commercial systems, which image the Earth from space, competitive with, or superior to, foreign-operated civil or commercial systems.
- Assured access to space, sufficient to achieve all United States space goals, is a key element of national space policy. United States space transportation systems must provide a balanced, robust, and flexible capability with sufficient resiliency to allow continued operations despite failures in any single system. The United States government will continue research and development on component technologies in support of future transportation systems. The goals of United States space transportation policy are: (1) to achieve and maintain safe and reliable access to, transportation in, and return from, space; (2) to exploit the unique attributes of manned and unmanned launch and recovery systems; (3) to encourage to the maximum extent feasible, the development and use of United States private sector space transportation capabilities; and (4) to reduce the costs of space transportation and related services.
- Communications advancements are critical to all United States space sectors. To ensure necessary capabilities exist, the United States

government will continue research and development efforts for future advanced space communications technologies.

- The United States will consider and, as appropriate, formulate policy positions on arms control measures governing activities in space, and will conclude agreements on such measures only if they are equitable, effectively verifiable, and enhance the security of the United States and our allies.

- All space sectors will seek to minimize the creation of space debris. Design and operations of space tests, experiments, and systems will strive to minimize or reduce accumulation of space debris consistent with mission requirements and cost effectiveness. The United States government will encourage other space-faring nations to adopt policies and practices aimed at debris minimization.

IMPLEMENTING PROCEDURES

Normal interagency procedures will be employed wherever possible to coordinate the policies enunciated in this directive.

Executive Order No 12675 established the National Space Council to provide a coordinated process for developing a national space policy and strategy and for monitoring its implementation.

The Vice President serves as the Chairman of the Council, and as the President's principal advisor on national space policy and strategy. Other members of the Council are the Secretaries of State, Treasury, Defense, Commerce, and Transportation; the Chief of Staff to the President, the Director of the Office of Management and Budget, the Assistant to the President for Science and Technology, the Director of Central Intelligence, and the Administrator of the National Aeronautics and Space Administration. The Chairman, from time to time, invites the Chairman of the Joint Chiefs of Staff, the heads of executive agencies, and other senior officials to participate in meetings of the Council.

NATIONAL SPACE LAUNCH STRATEGY

The National Space Launch Strategy is composed of four elements.

- Ensuring that existing space launch capabilities, including support facilities, are sufficient to meet U.S. Government manned and unmanned space launch needs.

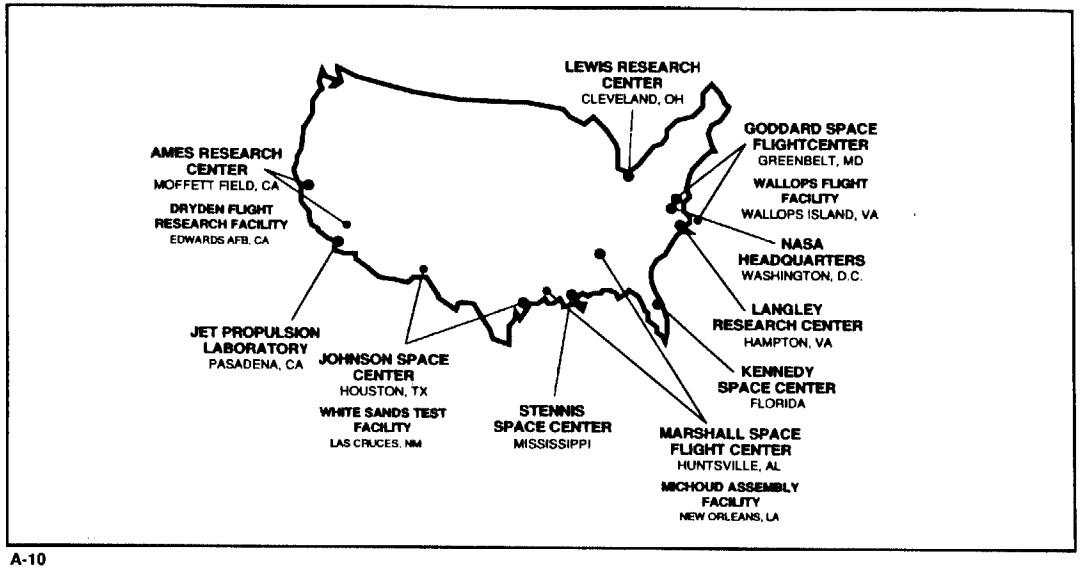
- Developing a new unmanned, but man-rateable, space launch system to greatly improve national launch capability with reductions in operating costs and improvements in launch system reliability, responsiveness, and mission performance.

- Sustaining a vigorous space launch technology program to provide cost effective improvements to current launch systems, and to support development of advanced launch capabilities, complementary to the new launch system.

- Actively considering commercial space launch needs and factoring them into decisions on improvements in launch facilities and launch vehicles.

These strategy elements will be implemented within the overall resource and policy guidance provided by the President.

NASA Installations



NASA Installations

NASA HEADQUARTERS
Washington, DC 20546

NASA Headquarters exercises management over the space flight centers, research centers, and other installations that constitute the National Aeronautics and Space Administration.

Responsibilities of Headquarters cover the determination of programs and projects; establishment of management policies; procedures and performance criteria; evaluation of progress; and the review and analysis of all phases of the aerospace program.

Planning, direction, and management of NASA's research and development programs are the responsibility of the program offices which report to and receive overall guidance and direction from an associate or assistant administrator.

AMES RESEARCH CENTER
Moffett Field, CA 94035

Ames Research Center was founded in 1939 as an aircraft research laboratory by the National Advisory Committee for Aeronautics (NACA) and was named for Dr. Joseph S. Ames, Chairman of NACA from 1927 to 1939. In 1958, Ames became part of NASA, along with other NACA installations and certain Department of Defense facilities. In 1981, NASA merged Ames with the Dryden Flight Research Facility.

Ames specializes in scientific research, exploration and applications aimed toward creating new technology for the nation.

The center's major program responsibilities are concentrated in computer science and applications, computational and experimental aerodynamics, flight simulation, flight research, hypersonic aircraft, rotorcraft and powered-lift technology, aeronautical and space human factors, life sciences, space sciences, solar system exploration, airborne science and applications, and infrared astronomy.

HUGH L. DRYDEN FLIGHT RESEARCH FACILITY
Edwards, CA 93523

Since 1947, Ames-Dryden has developed a unique and highly specialized capability for conducting flight research programs. Its test organization, consisting of pilots, scientists, engineers, technicians and mechanics, is unmatched anywhere in the world. This versatile organization has demonstrated its capability, not only with high-speed research aircraft, but also with such unusual flight vehicles as the Lunar Landing Research Vehicle and the wingless lifting bodies.

The facility's primary research tools are research aircraft, ranging from a B-52 carrier aircraft and high performance jet fighters to the X-29 forward swept wing aircraft. Ground-based facilities include a high temperature loads calibration laboratory that allows ground-based testing of complete aircraft and structural components under the combined effects of loads and heat; a highly developed aircraft flight instrumentation capability; a flight systems laboratory with a diversified capability for avionics system fabrication, development and operations; a flow visualization facility that allows basic flow mechanics to be seen of models or small components; a data analysis facility for processing of flight research data; a remotely piloted research vehicles facility and a test range communications and data transmission capability that links NASA's Western Aeronautical Test Range facilities at Ames-Moffett, Crows Landing and Ames-Dryden.

NASA Installations

GODDARD SPACE FLIGHT CENTER
Greenbelt, MD 20771

This NASA field center has put together a multitalented spaceflight team -- engineers, scientists, technicians, project managers and support personnel -- which is extending the horizons of human knowledge not only about the solar system and the universe but also about our Earth and its environment.

The Goddard mission is being accomplished through scientific research centered in six space and Earth science laboratories and in the management, development and operation of several near-Earth space systems.

After being launched into space, satellites fall under the 24-hour-a-day surveillance of a worldwide ground and spaceborne communications network, the nerve center of which is located at Goddard. One of the key elements of that network is the Tracking and Data Relay Satellite System (TDRSS) with its orbiting Tracking and Data Relay Satellite and associated ground tracking stations.

Goddard's tracking responsibility extends to its Wallops Flight Facility. Wallops prepares, assembles, launches, and tracks satellites and suborbital space vehicles and manages the National Scientific Balloon Facility in Palestine, Texas.

JET PROPULSION LABORATORY
Pasadena, CA 91109

NASA's Jet Propulsion Laboratory (JPL) is a government-owned facility staffed by the California Institute of Technology. JPL operates under a NASA contract administered by the NASA Pasadena Office. In addition to the Pasadena site, JPL operates the Deep Space Communications Complex, a station of the worldwide Deep Space Network (DSN).

The laboratory is engaged in activities associated with deep space automated scientific missions -- engineering subsystem and instrument development, and data reduction and analysis required by deep space flight.

The laboratory also designs and tests flight systems, including complete spacecraft, and provides technical direction to contractor organizations.

LYNDON B. JOHNSON SPACE CENTER
Houston, TX 77058

Johnson Space Center was established in September 1961 as NASA's primary center for design, development and testing of spacecraft and associated systems for manned flight; selection and training of astronauts; planning and conducting manned missions; and extensive participation in the medical engineering and scientific experiments carried aboard space flights.

Johnson has program management responsibility for the Space Shuttle program, the nation's current manned space flight program. Johnson also has a major responsibility for the development of the Space Station, a permanently manned, Earth-orbiting facility to be constructed in space and operable within a decade. The center will be responsible for the interfaces between the Space Station and the Space Shuttle.

JOHN F. KENNEDY SPACE CENTER
Kennedy Space Center, FL 32899

Kennedy Space Center (KSC) was created in the early 1960's to serve as the launch site for the Apollo lunar landing missions. After the Apollo program ended in 1972, Kennedy's Complex 39 was used for the launch of the Skylab spacecraft, and later, the Apollo spacecraft for the Apollo Soyuz Test Project.

NASA Installations

Kennedy Space Center serves as the primary center within NASA for the test, checkout and launch of payloads and space vehicles. This presently includes launch of manned and unmanned vehicles at Kennedy, the adjacent Cape Canaveral Air Force Station, and at Vandenberg Air Force Base in California.

The center is responsible for the assembly, checkout and launch of Space Shuttle vehicles and their payloads, landing operations and the turn-around of Space Shuttle orbiters between missions, as well as preparation and launch of unmanned vehicles.

LANGLEY RESEARCH CENTER
Hampton, VA 23665-5225

Langley's mission is basic research in aeronautics and space technology. Major research fields include aerodynamics, materials, structures, flight controls, information systems, acoustics, aeroelasticity, atmospheric sciences, and nondestructive evaluation. Langley's goal is to develop technologies to enable aircraft to fly faster, farther, safer, and to be more maneuverable, quieter, less expensive to manufacture, and more energy efficient.

The majority of Langley's work is in aeronautics, working to improve today's aircraft and to develop concepts and technology for future aircraft. Over 40 wind tunnels, other unique research facilities, and testing techniques as well as computer modeling capabilities aid in the investigation of the full flight range, from general aviation and transport aircraft through hypersonic vehicles.

Researchers also study atmospheric and Earth sciences, develop technology for advanced space transportation systems, conduct research in laser energy conversion techniques for space applications and provide the focal point for design studies for large space systems technology and Space Station activities.

Langley also manages an extensive program in atmospheric sciences to better understand the origins, chemistry, and transport mechanisms that govern the Earth's atmospheric data using aircraft, balloon, and land- and space-based remote sensing instruments designed, developed, and fabricated at Langley.

LEWIS RESEARCH CENTER
Cleveland, OH 44135

Lewis Research Center was established in 1941 by the National Advisory Committee for Aeronautics (NACA). Named for George W. Lewis, NACA's Director of Research from 1924 to 1947, the center developed an international reputation for its research on jet propulsion systems.

Lewis is NASA's lead center for research, technology and development in aircraft propulsion, space propulsion, space power and satellite communication.

The center has been advancing propulsion technology to enable aircraft to fly faster, farther and higher and also focused its research on fuel economy, noise abatement, reliability, and reduced pollution.

Lewis has responsibility for developing the largest space power system ever designed to provide the electrical power necessary to accommodate the life support systems and research experiments to be conducted aboard the Space Station. In addition, the center will support the Station in other major areas such as auxiliary propulsion systems and communications.

Lewis is the home of the Microgravity Materials Science Laboratory, a unique facility to qualify potential space experiments. Other facilities include a zero-gravity drop tower, wind tunnels, space tanks, chemical rocket thrust stands, and chambers for testing jet engine efficiency and noise.

NASA Installations

MARSHALL SPACE FLIGHT CENTER
Marshall Space Flight Center, AL 35812

George C. Marshall Space Flight Center (MSFC) was formed on July 1, 1960, by the transfer to NASA of buildings and personnel comprising part of the U.S. Army Ballistic Missile Agency. Named for the famous soldier and statesman, General of the Army George C. Marshall, it was officially dedicated by President Dwight D. Eisenhower on September 8, 1960.

Marshall is a multiproject management, scientific and engineering establishment, with much emphasis on projects involving scientific investigation and application of space technology to the solution of problems on Earth.

In helping to reach the nation's goals in space, the center is working on many projects. Marshall had a significant role in the development of the Space Shuttle. It provides the orbiter's engines, the external tank that carries liquid hydrogen and liquid oxygen for those engines, and the solid rocket boosters that assist in lifting the Shuttle orbiter from the launch pad.

The center also plays a key role in the development of payloads to be flown aboard the Shuttle. One such payload is Spacelab, a reusable, modular scientific research facility carried in the Shuttle's cargo bay.

Marshall also is committed to the investigation of materials processing in space, which, in a gravity-free environment, promises to provide opportunities for understanding and improving Earth-based processes and for the formulation of space-unique materials. Exciting new techniques in materials processing have already been demonstrated in past Spacelab missions, such as the formation of alloys from normally immiscible products, and the growth of near-perfect large crystals impossible to grow on Earth.

MICHOUD ASSEMBLY FACILITY
New Orleans, LA 70189

The primary mission of the Michoud Assembly Facility is the systems engineering, engineering design, manufacture, fabrication, assembly, and related work for the Space Shuttle external tank. Marshall Space Flight Center exercises overall management control of the facility.

JOHN C. STENNIS SPACE CENTER
Stennis Space Center, MS 39529

The John C. Stennis Space Center (SSC) has grown into NASA's premier center for testing large rocket propulsion systems for the Space Shuttle and future generation space vehicles. Additionally, the center has developed into a scientific community actively engaged in research and development programs involving space, oceans, and the Earth.

The main mission of SSC is support the development testing of large propulsion systems for the Space Shuttle, Advanced Launch System, and the Advanced Solid Rocket Motor programs.

WALLOPS FLIGHT FACILITY
Wallops Island, VA 23337

Established in 1945, Wallops Flight Facility, a part of the Goddard Space Flight Center, is one of the oldest launch sites in the world. Wallops manages and implements NASA's sounding rocket program and the Scientific Balloon Program. The facility operates and maintains the Wallops launch range and data acquisition facilities. Approximately 100 rocket launches are conducted each year from the Wallops Island site.

The Year in Review

NASA Management

During 1991, several major management changes were initiated by NASA Administrator Richard H. Truly.

A Systems Analysis and Concepts Office was established in May, and James D. Bain was named the Director. In June, Darleen A. Druyun was named the new Assistant Administrator for the Office of Procurement.

In August, Dr. Michael D. Griffin was selected as Associate Administrator of the newly established Office of Exploration. Also in August, a new Office of Human Resources and Education was created and Lieutenant General Spence (Sam) M. Armstrong was appointed Associate Administrator.

Deputy Administrator J. R. Thompson Jr. announced his resignation in September and left the agency in November.

In September, an Office of Space Systems Development was established and Arnold D. Aldrich was selected as Associate Administrator.

In October, the Office of Management Systems and Facilities was created which consolidated the Offices of Management and Headquarters Operations. Benita A. Cooper was named the Associate Administrator.

Also in October, Paul F. Holloway succeeded Richard H. Petersen as Director of Langley Research Center. Petersen was appointed Associate Administrator for the Office of Aeronautics and Space Technology. John G. Mannix succeeded James T. Rose as Assistant Administrator for Commercial Programs.

Robert L. Crippen replaced Forrest S. McCartney as Director of Kennedy Space Center. In December, Leonard S. Nicholson was named Director, Space Shuttle Program, replacing Crippen.

Space Science and Applications

Mission To Planet Earth

The Upper Atmosphere Research Satellite (UARS), deployed from STS-48 in September, initiated Mission to Planet Earth by expanding NASA's research in ozone depletion. UARS data will be used to create three-dimensional maps of ozone and chemicals important in ozone depletion. Preliminary data has illustrated the link between low levels of ozone and high levels of chlorine monoxide, a key intermediate compound in the chemical chain reaction that leads to ozone depletion.

Data from the Total Ozone Mapping Spectrometer (TOMS) on the Nimbus-7 satellite indicated the problem continues to be serious. The 1991 ozone hole over Antarctica matched the geographic extent and low levels of the 3 previous years.

A second TOMS instrument was launched aboard a Soviet Meteor satellite on August 15, ensuring that ozone data will continue to be available for several years. In October, a 6-month campaign began using NASA aircraft loaded with instruments to look for signs of an ozone hole over the Arctic. The TOMS instrument also tracked the sulfur dioxide cloud emitted by June's eruption of Mount Pinatubo in the Philippines.

Astrophysics

The Hubble Space Telescope (HST) scientists discovered a forest of intergalactic hydrogen clouds -- often found at the outer reaches of the visible universe -- near the Milky Way. Another HST instrument resolved several hundred stars where ground-based images yielded only a few dozen in the core of the globular cluster 47 Tucanae.

The Compton Gamma Ray Observatory, deployed from STS-37 in April, discovered bursts of gamma radiation coming from outside the narrow plane of stars that make up our galaxy. In July, the observatory detected the most distant and most luminous source of gamma rays ever seen, Quasar 3C279, which emits about 10 million times the energy of the Milky Way galaxy.

The Year in Review

The NASA Soft X-Ray Telescope was launched aboard the Japanese Solar-A satellite in August Data from the Cosmic Background Explorer (COBE) was used to create galactic-scale maps of the distribution of nitrogen, carbon and interstellar dust, enabling astronomers to better understand the heating and cooling processes that take place in the galaxy.

Life Sciences

In June, the Space Shuttle Columbia (STS-40) carried the Spacelab Life Sciences-1 (SLS-1) in which seven astronauts conducted 9 days of experiments to study the effects of weightlessness on the human body.

Solar System Exploration

The Magellan mission to Venus completed its primary objective of mapping 70 percent of the Venusian surface more than a month ahead of schedule. Galileo passed by the asteroid Gaspra on its way toward Jupiter and returned the first close-up picture ever taken of an asteroid. A third attempt to free the high-gain antenna by cooling the antenna tower and "walking" the pins free, was conducted in December.

Work by a NASA-led team indicates that a series of sinkholes in the Mexican state of Yucatan is the impact crater of an asteroid that may have caused the extinction of dinosaurs about 65 million years ago.

Space Physics

The year began with a successful series of space physics experiments that lit up the night sky over North America and continued with summer releases over the Caribbean. Chemical releases from the Combined Release and Radiation Effects Satellite (CRRES) created electrically charged clouds that traced lines of the Earth's magnetic field, allowing scientists to study the interaction of energetic particles with the magnetic field, giving scientists a better understanding of how solar particles can disrupt terrestrial power and communications systems.

Ulysses, a joint mission with the ESA, on its way to study the Sun's poles, set its trajectory for Jupiter where it will investigate the planet's magnetic field and interaction with the solar wind. When Ulysses passed behind the Sun relative to Earth in August, scientists used radio signals from the spacecraft to investigate the outer atmosphere of the Sun.

Ground-Based Research

Complementing NASA's flight programs are the research efforts conducted here on Earth. NASA's space science program involves more than 5,000 scientists at 250 U.S. academic institutions, 3,500 scientists at NASA centers and non-academic institutions, more than 700 U.S. companies and more than 250 international cooperation agreements with approximately 120 foreign institutions.

Included in this diverse program are suborbital flights of sounding rockets and balloons supporting research in the Earth sciences, space physics and astrophysics. In 1991, NASA launched 24 sounding rockets and 18 research balloons.

Space Flight

Space Shuttle

NASA's fleet of reusable space planes returned to full strength in 1991 when the Space Shuttle program took delivery of Endeavour on April 25. Endeavour is capable of flying extended duration missions and has significant safety enhancements. Its first flight remains on target for May 1992.

Also added to the Shuttle program was a new Orbiter Processing Facility at KSC, which opened in September, giving NASA the ability to process three orbiters at the same time.

There were six Shuttle flights in 1991, each having unique qualities which demonstrated the remarkable versatility of the Space Shuttle.

The Year in Review

- STS-37/Gamma Ray Observatory (April 5-11) - An unplanned EVA took place to help with the deployment of GRO's high gain antenna. Also demonstrated were mobility aids which will be used on Space Station Freedom.
- STS-39/Air Force Payload-675 (April 28-May 6) - Discovery performed dozens of maneuvers, deploying canisters from the cargo bay, releasing and retrieving a payload with the RMS, allowing the Department of Defense to gather important plume observation data and information for the SDIO.
- STS-40/Spacelab Life Sciences (June 5-14) - Performed intensive investigations into the effects of weightlessness on humans. Data learned from this flight will be used in planning for longer Shuttle missions and in the planning of Space Station Freedom.
- STS-43/Tracking And Data Relay Satellite-E (August 2-11) - The heaviest mission flown to date. A TDRS satellite was deployed, keeping the network which supports Shuttle missions and other spacecraft, such as the Hubble Space Telescope, at full operational capability.
- STS-48/Upper Atmosphere Resaarch Satellite (September 12-18) - With the shuffling of missions that happened in the early part of the year, the Shuttle team launched the STS-48/UARS mission in September -- about 6 weeks earlier than the original November commitment date.
- STS-44/Defense Support Program (November 24-December 1) - A dedicated mission for the Department of Defense to gather data for their programs. Originally planned for 10 days, the mission was shortened when an inertial measurement unit failed on the 6th day of the mission.

Significant facility construction activities continued at the Yellow Creek Facility in Iuka, MS, in support of planned Advanced Solid Rocket Motor (ASRM) production. Successful continuous-mix propellant tests were conducted at Aerojet's pilot plant in California, and successful 48" motor firings involving potential ASRM nozzle materials were performed at NASA's Marshall Space Flight Center, AL.

Flight Systems

In April, the National Space Council directed NASA and the DOD to jointly develop and fund a new launch system to meet civil and national spacecraft requirements for the 21st century.

There were two expendable launches in 1991, an Atlas-E vehicle on May 14 from Vandenberg AFB to place a NOAA meteorological satellite into polar orbit and the June 29 launch from Vandenberg AFB of a USAF radiation experiment satellite on a Scout vehicle, the 114th launch of the NASA Scout vehicle.

Space Systems Development

Space Station Freedom

Preliminary design of Freedom's man-tended configuration was completed in 1991, and construction and testing of flight-like hardware at NASA centers and contractor facilities proceeded on schedule.

A Congressionally-mandated restructuring of the Freedom program was completed. Freedom's new design is less expensive, smaller, easier to assemble in orbit and requires fewer Shuttle flights to build.

The Italian Space Agency joined the international partnership by signing a memorandum of understanding with NASA to provide two mini logistics modules to the orbiting workshop.

Astronauts on the STS-37 mission tested equipment that will help astronauts traverse Space Station Freedom's 350-foot long truss.

At Johnson Space Center, construction of the Space Station Control Center, which will house the mission controllers, has been completed and underfloor power and data trays are being installed. At Lewis Research Center, where Freedom's power generation and distribution system is being developed, about half of the solar cells needed to generate the 18.75 kw for the man-tended configuration have been built.

The Year in Review

At Marshall Space Flight Center, volunteers have been helping engineers develop the water recycling system. NASA's Kennedy Space Center broke ground in April on a 457,000 square foot processing facility for prelaunch checkout of Freedom's flight hardware and experiments.

Exploration

The Office of Exploration has defined a plan for an initial set of missions to move aggressively forward in the near-term toward the ultimate objectives of the President's Space Exploration Initiative -- to return to the Moon permanently and to begin the human exploration of Mars.

These early automated missions will be relatively low-cost and will quickly increase scientific and technological knowledge in areas necessary to make long-range decisions about Moon and Mars activities, thus decreasing the cost and risk of the overall exploration program.

Aeronautics and Space Technology

Aeronautics

A NASA F-16 XL aircraft attained the first laminar (smooth) airflow over a large part of an airplane wing at supersonic speeds. Because reducing turbulence saves fuel, this was an important step toward more efficient future high-speed civil transports. An Ames-Dryden study showed that multi-engine planes with a special flight control system can land safely using just their engines if the hydraulic controls fail. A NASA flight test program proved that new sensors can warn airline pilots of the potentially dangerous weather phenomenon called windshear.

In the high-performance aircraft arena, NASA's F/A-18 High-Alpha Research Vehicle began flight tests with a special thrust vectoring system that makes it easier to fly at very high angles of attack, or "alpha." Another F/A-18 became the first full-size airplane to face the winds inside the world's largest wind tunnel. The unique X-29 made the last flight in its planned high-alpha research program. A revolutionary paint that measures aerodynamic surface pressures across large areas made its first successful test flight on a NASA F-104 aircraft.

X-30 National Aero-Space Plane

The X-30 National Aero-Space Plane (NASP), a joint NASA/DOD effort to develop a single-stage-to-orbit flight research vehicle, came closer to reality. A representative full-scale NASP wing control surface made of advanced carbon-carbon composites was completed and shipped to Ames-Dryden for structural tests.

Space Technology

NASA revealed the rich harvest of data from the Long Duration Exposure Facility (LDEF), a science and technology satellite that flew in Earth orbit from April 1984 to January 1990. LDEF exposed a set of materials to the space environment and gathered information on radiation, space debris, meteoroids, and life sciences.

NASA's In-Space Technology Experiments Program (IN-STEP) passed a major milestone as its first flight hardware flew on two successive Shuttle missions. Looking toward the day when humans will return to the Moon and then go onto Mars, scuba divers at Ames Research Center exercised on a unique underwater treadmill that simulated various gravity fields.

NASA also tested a small, 52-pound robotic vehicle dubbed "Rocky III" on a simulated Martian terrain as part of studies looking at low-cost approaches to Mars exploration. The arcjet thrusters selected for AT&T's Telstar 4 communications satellite were a product of research started at NASA's Lewis Research Center in 1983.

NASA has begun research on a carbon molecule shaped like a geodesic dome as a fuel for advanced rocket engines.

The "Grand Challenges" in computer science are the focus of a new federal research effort called the High-Performance Computing and Communications Program, in which NASA is a major player. The goal is to extend U.S. leadership in state-of-the-art computers and apply that technology to critical national scientific issues.

Commercial Programs

Commercial Use of Space

NASA initiated a new program to stimulate relevant industry activity in advanced telecommunications technology. Two new Centers for the Commercial Development of Space (CCDS) were selected through a competitive process to focus on the commercialization of advanced satellite communications and other space-based telecommunications technologies.

The University of Tennessee-Calspan's Center for Space Transportation and Applied Research (CSTAR), selected three industrial firms for the Commercial Experiment Transporter (COMET), a program to provide low-cost, recoverable access to space for microgravity experiments and to stimulate growth in U.S. commercial space business.

Consort 4, a commercial suborbital sounding rocket carrying nine materials processing and biotechnology experiments, was successfully launched from White Sands Missile Range.

Commercial experiments conducted aboard the Space Shuttle in 1991 included:

- Protein Crystal Growth (PCG), an experiment package provided by the Center for Macromolecular Crystallography, a NASA CCDS located at the University of Alabama-Birmingham, AL (STS-37, 43, and 48)
- BioServe ITA Materials Dispersion Apparatus (BIMDA), a payload jointly developed by the University of Colorado-Boulder's BioServe Space Technologies CCDS and Instrumentation Technology Associates, Inc., Exton, PA (STS-37 and 43).
- Consortium for Materials Development in Space Complex Autonomous Payload (CONCAP), a Getaway Special experiment payload of mixed materials science, sponsored by the UAH CMDS (STS-40).
- Investigations into Polymer Membrane Processing (IPMP), flown for the Battelle Advanced Materials CCDS, Columbus, Ohio (STS-43 and 48)
- Electronic Still Photography Test, an experiment based on a Technical Exchange Agreement between NASA and Autometric, Inc., Alexandria, VA, to assess the utility of the Johnson Space Center-developed Electronic Still Camera for potential commercial applications.

Technology Utilization

In an effort to upgrade and revitalize the agency's technology transfer network, NASA conducted an open competition to establish six new Regional Technology Transfer Centers (RTTC). It is anticipated that the restructuring to a regional approach will align the centers closer to the needs of particular industries, local business, and entrepreneurs.

The second national technology transfer conference and exposition, TECHNOLOGY 2001, featured 225 exhibits from all nine NASA field centers, other government agencies, universities, government research centers, and a diverse array of high-tech companies.

Small Business Innovation Research

Thirty-nine research proposals were selected for negotiation of Phase II contract awards in NASA's SBIR program. The selection of 301 research proposals for negotiation of Phase I contracts in the 1991 SBIR program was announced.

International Relations

NASA signed an agreement with the Italian Space Agency (ASI) under which ASI will design and develop two Mini Pressurized Logistics Modules for Space Station Freedom.

The Federal Republic of Germany contributed one of four instruments, COMPTEL, and key portions of a second instrument, EGRET, for the Compton Gamma Ray Observatory.

Under the 1987 civil space agreement, the U.S. and Soviet Union agreed to exchange flights by an astronaut and a cosmonaut on MIR and the Space Shuttle, increase cooperation in monitoring the global environment from space, and initiate annual space consultations. The agreement was announced at the Bush-Gorbachev Moscow Summit, July 30-31.

The Year in Review

The U.S. Total Ozone Mapping Spectrometer was launched on the Soviet Meteor-3 spacecraft, the first flight of an active U.S. scientific instrument on a Soviet satellite.

NASA, NOAA, and the Canadian Space Agency agreed on cooperation in a 5-year RADARSAT Earth observation satellite mission.

NASA's Soft X-ray Telescope, one of four instruments on the Japanese Solar-A spacecraft, was launched from Japan's Kagoshima Space Center.

U.S. and Spanish officials extended their agreement on use of Spanish runways as emergency Space Shuttle landing sites. NASA and the Spanish Space Agency signed an umbrella agreement on cooperation in space science and technology.

Vice President Dan Quayle and Argentine President Carlos Menem signed an agreement for cooperation in the civil uses of space, with special emphasis on Earth and space science.

Space Communications

The fifth Tracking and Data Relay Satellite (TDRS-5) was launched in August aboard STS-43, joining three other TDRSs in the orbital constellation. TDRS-5 was positioned at 174 degrees west longitude, replacing TDRS-3 which was moved to 62 degrees west longitude, becoming an on-orbit emergency backup.

The on-orbit TDRSS constellation, linked to the ground by the White Sands Ground Terminal, NM, provided continuous communications coverage to network customers for over 85 percent of each orbit.

To meet the evolving needs for satellite tracking and communications through the first decade of the 21st century, a second generation TDRSS program was initiated and preliminary design studies are under review.

Education

President Bush joined NASA Administrator Truly for a back-to-school special, "Launching the School Year with President Bush," which was broadcast live on NASA Select TV. President Bush spoke with students and teachers about America 2000 and the national education goals.

Expanding NASA's National Space Grant College and Fellowship Program, 26 Space Grant State Consortia were selected for Program Grants or Capability Enhancement Grants under Phase II of the program, bringing the total number of states participating to 46 plus the District of Columbia.

NASA's Ames Research Center, Mountain View, CA, converted a portion of a supersonic wind tunnel into a unique aerospace education facility designed to capture young people's interest in math, science, and technology. The Ames "Aerospace Encounter" features numerous activity stations that explain a variety of aerospace concepts.

Nickelodeon, NASA, and the Astronauts Memorial Foundation launched a new educational television series called "Launch Box -- Your TV Connection to Outer Space." The 14 half-hour programs are created by teachers for classroom use and are broadcast commercial-free on Nickelodeon.

USA Today, in cooperation with NASA and the National Association of Elementary School Principals, launched "Visions of Exploration." This multi-media educational program is designed to bring the spirit of exploration into the classroom by motivating elementary and middle school students to learn about past and present explorers. The Discovery Channel, a television partner, broadcasts corresponding documentaries relating the Vision's themes.

Safety and Mission Quality

Significant contributions were made to the successful operation of this year's Space Shuttle and expendable launch vehicle missions. SMQ continued its efforts towards controlling major causes or sources of fatalities, lost time disabilities, and overall employee compensation costs. These efforts continue to result in lower incident rates in NASA activities.

The Year in Review

Safety 2000, a strategic long-range safety plan, was implemented to provide for the future safety needs during NASA mission operations. The primary goal of the plan is to standardize NASA safety processes to achieve a reduction in mishaps and ensure the safety of personnel and systems performing NASA operations.

A new NASA Safety Training Center (NSTC) was established at the Johnson Space Center to provide high-quality, cost-effective training to employees with the goal of retaining a pool of qualified safety professionals capable of conducting NASA operations in the safest possible manner.

A formal NASA metric policy was approved and a Metric Transition Plan developed requiring the use of the metric system.

Grumman Technical Services Division, Titusville, FL, and Thiokol Space Operations, Brigham City, UT, were announced as the winners of the 1991 George M. Low Trophy. The trophy recognizes NASA prime contractors, subcontractors, and suppliers for outstanding achievement in quality and productivity improvement and TQM.

Over 1,000 international, government, industry, academic, and contractor representatives from over 400 organizations attended the Eighth Annual NASA/Contractors Conference and National Symposium on Quality and Productivity held in Houston. The event, televised to hundreds of other participants conducting concurrent conferences in Colorado and Maryland, provided a forum where ideas and strategies were discussed to implement TQM, improve products and services, develop community partnerships, and improve America's educational system.

An Engineering Management Council was established to provide better focus on engineering standards and practices and systems engineering. The new organization is chaired by the NASA Deputy Administrator and is composed of Chief Engineers and Heads of SMQ at each NASA center.

FY 1992 NASA Appropriations

The FY 1992 VA-HUD-Independent Agencies Appropriations Bill cleared Congress on October 3 and was signed by President Bush on October 28. NASA's funding was set at $14.353 billion, a 3 percent increase over 1991 but $1.8 billion less than the President's request of $15.754 billion.

The Space Station Freedom program was extensively debated in both houses of Congress. The House Appropriations Subcommittee proposed that all funding for the station be deleted, but full funding of $2.029 billion was restored on the House floor. Full funding for Freedom survived a floor fight in the Senate as well.

Funding for Space Science and Applications increased 10 percent above the FY 1991 level. Funding for the major science projects, including the Earth Observing System, the Mars Observer, the Advanced X-Ray Astrophysics Facility, and the CRAF and Cassini missions was included. Funding to start development of Lifesat, the reusable biosatellite for which $15 million was requested in FY 1992, was deleted.

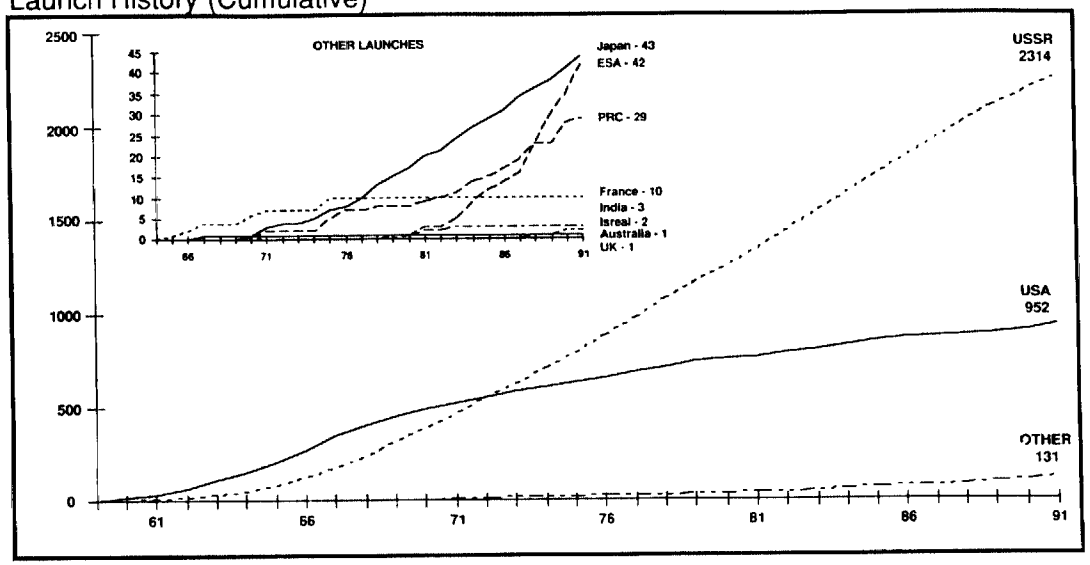
Significant reductions were made in the National Aero-Space Plane program, the National Launch System, and Space Shuttle Operations. Additional funding was provided for the Advanced Solid Rocket Motor program in an effort to preserve its scheduled availability for use in Space Station Freedom assembly.

In a statement following passage of the bill in Congress, NASA Administrator Richard H. Truly said the agency has mixed feelings about the bill. He said people in NASA were tremendously grateful to the many members on both sides of the aisle who worked very hard on NASA's behalf and particularly pleased with Space Station Freedom funding and the very significant percentage increase for space science, but were disappointed that, for the first time in many years, the total NASA appropriations does not keep up with inflation.

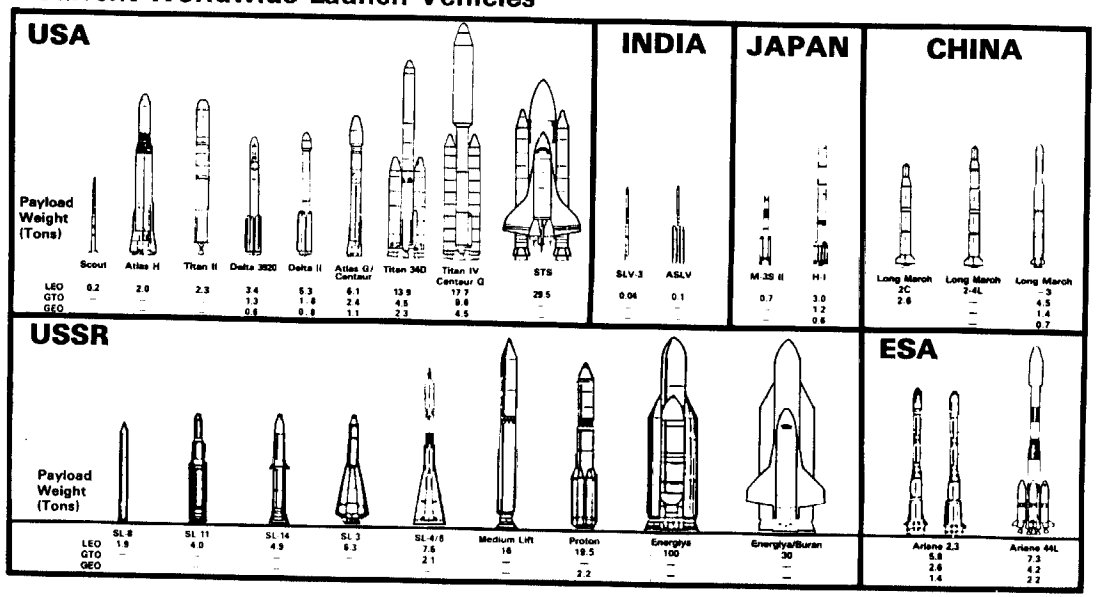
Section B

Space Flight Activity

Launch History (Cumulative)



Current Worldwide Launch Vehicles



Summary of Announced Launches

TOTAL		1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	Australia	--	--	--	--	--	--	--	--	--	--	1	0	0	0	0	0	0	0
484	DOD	--	5	6	11	19	34	27	35	39	42	32	26	19	17	17	13	10	8
42	ESA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
10	France	--	--	--	--	--	--	--	--	1	1	2	0	0	2	1	0	0	0
3	India	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2	Isreal	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
43	Japan	--	--	--	--	--	--	--	--	--	--	--	--	--	1	2	1	0	1
7	MDAC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3	MMarietta	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
457	NASA	--	2	5	5	10	18	11	22	24	31	26	19	21	12	15	18	13	16
1	Orbital Sciences	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
29	PRC	--	--	--	--	--	--	--	--	--	--	--	--	--	1	1	0	0	0
1	United Kingdom	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	0	0	0
2314	USSR	2	1	3	3	6	20	17	30	48	44	66	74	70	81	83	74	86	81
3397	TOTAL	2	8	14	19	35	72	55	87	112	118	127	119	110	114	120	106	109	106

NASA LAUNCHES

TOTAL		1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
262	NASA	--	2	5	5	10	15	9	20	21	26	18	12	13	6	6	9	9	2
33	Cooperative	--	--	--	--	--	2	0	2	2	0	2	3	2	0	5	1	0	5
30	DOD	--	--	--	--	--	--	1	0	0	1	0	0	0	0	0	1	1	0
92	USA	--	--	--	--	--	1	1	0	1	4	6	3	4	4	3	3	2	4
39	Foreign	--	--	--	--	--	--	--	--	--	--	--	1	2	2	1	4	1	5
456	TOTAL	--	2	5	5	10	18	11	22	24	31	26	19	21	12	15	18	13	16

Summary of Announced Launches

TOTAL		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	TOTAL
1	Australia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
484	DOD	9	11	10	12	7	6	5	6	7	10	3	1	5	4	10	10	8	484
42	ESA	--	--	--	--	1	0	2	0	2	4	3	2	2	7	7	5	7	42
10	France	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
3	India	--	--	--	--	--	1	1	0	1	0	0	0	0	0	0	0	0	3
2	Isreal	--	--	--	--	--	--	--	--	--	--	--	--	--	1	0	1	0	2
43	Japan	2	1	2	3	2	2	3	1	3	3	2	2	3	2	2	3	2	43
7	MDAC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	5	1	7
3	MMarietta	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3	0	3
457	NASA	19	15	14	20	9	7	13	12	15	12	14	5	3	8	7	8	8	457
1	Orbital Sciences	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	0	1
29	PRC	3	2	0	1	0	0	1	1	1	3	1	2	2	4	0	5	1	29
1	United Kingdom	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
2314	USSR	89	99	98	88	87	89	98	101	98	97	97	91	95	90	74	75	59	2314
3397	TOTAL	125	128	124	124	106	105	123	121	127	129	120	103	110	116	101	116	86	3397

NASA LAUNCHES

TOTAL		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	TOTAL
262	NASA	10	1	3	8	3	1	4	4	4	6	9	1	0	2	6	6	6	262
33	Cooperative	1	2	1	2	0	0	0	0	1	0	0	0	0	1	0	1	0	33
30	DOD	1	2	1	1	2	2	2	0	1	1	2	3	1	4	1	1	1	30
92	USA	4	8	2	4	3	4	7	6	8	4	3	1	1	1	0	0	1	92
39	Foreign	3	2	7	5	1	0	0	2	1	1	0	0	1	0	0	0	0	39
456	TOTAL	19	15	14	20	9	7	13	12	15	12	14	5	3	8	7	8	7	456

NASA Launches By Vehicle

TOTAL		1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
7	Atlas	–	–	–	–	2	3	1	0	0	1	0	0	0	0	0	0	0	0
29	Atlas Agena	–	–	–	–	2	4	0	5	2	9	6	1	0	0	0	0	0	0
10	Atlas E/F	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
61	Atlas Centaur	–	–	–	–	–	–	1	1	1	4	4	3	3	0	3	4	3	1
154	Delta	–	–	–	–	–	–	1	4	7	8	12	7	10	7	5	7	5	7
5	Juno II	–	1	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
6	Saturn I	–	–	–	–	–	–	–	3	3	0	0	0	0	0	0	0	0	0
7	Saturn IB	–	–	–	–	–	–	–	–	–	1	0	2	0	0	0	0	3	0
13	Saturn V	–	–	–	–	–	–	–	–	–	–	1	2	4	1	2	2	1	0
65	Scout	–	–	–	–	2	1	2	6	4	1	2	4	2	2	5	5	1	6
43	Shuttle	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4	Thor Able	–	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Thor Agena	–	–	–	–	–	1	0	2	2	2	1	0	2	2	0	0	0	0
21	Thor Delta	–	–	–	2	3	9	6	0	0	0	0	0	0	0	0	0	0	0
11	Titan II	–	–	–	–	–	–	–	1	5	5	0	0	0	0	0	0	0	0
7	Titan Centaur	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
2	Vanguard	–	–	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
457	TOTAL	–	2	5	5	10	18	11	22	24	31	26	19	21	12	15	18	13	16

NASA Launches By Vehicle

TOTAL		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	TOTAL
7	Atlas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
29	Atlas Agena	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29
10	Atlas E/F	--	--	--	2	1	1	1	0	1	1	0	1	0	1	0	0	1	10
61	Atlas Centaur	2	3	2	7	2	3	4	2	1	1	3	1	0	0	1	1	0	61
154	Delta	12	9	9	10	3	3	5	7	7	4	0	1	2	1	1	0	0	154
5	Juno II	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
6	Saturn I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
7	Saturn IB	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
13	Saturn V	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
65	Scout	2	2	1	1	3	0	1	0	1	1	2	1	1	4	0	1	1	65
43	Shuttle	--	--	--	--	--	--	2	3	4	5	9	1	0	2	5	6	6	43
4	Thor Able	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
12	Thor Agena	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
21	Thor Delta	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	21
11	Titan II	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
7	Titan Centaur	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
2	Vanguard	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
457	TOTAL	19	15	14	20	9	7	13	12	15	12	14	5	3	8	7	8	8	457

Summary of Announced Payloads

TOTAL		1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	Argentina	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1	AsiaSat	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2	ASCO	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5	Australia	--	--	--	--	--	--	--	--	--	--	1	0	0	1	0	0	0	0
3	Brazil	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
11	Canada	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	1	0
30	China	--	--	--	--	--	--	--	--	--	--	--	--	--	1	1	0	0	0
49	Cooperative *	--	--	--	--	--	2	0	2	3	0	2	3	2	0	6	1	1	7
2	Czechoslovakia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
30	ESA	--	--	--	--	--	--	--	--	--	--	--	1	1	0	0	3	0	0
27	France	--	--	--	--	--	--	--	--	1	1	2	0	0	2	1	1	0	0
11	Germany	--	--	--	--	--	--	--	--	--	--	--	--	--	1	0	0	0	1
13	India	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
6	Indonesia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1	InMarSat	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2	Isreal	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2	Italy	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
53	Japan	--	--	--	--	--	--	--	--	--	--	--	--	--	1	2	1	0	1
2	Mexico	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7	NATO	--	--	--	--	--	--	--	--	--	--	--	--	--	1	1	0	0	0
1	Pakistan	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1	PanAmSat	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2761	Soviet Union	2	1	3	3	4	20	17	35	66	44	66	74	70	88	96	88	106	95
2	Sweden	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
18	United Kingdom	--	--	--	--	--	--	--	--	--	--	--	--	1	1	1	0	0	3
1131	United States *	--	7	11	17	36	53	54	72	88	102	78	63	51	30	36	28	22	15
4172	TOTAL	2	8	14	20	40	75	71	109	158	147	149	141	125	126	144	123	130	122

* Separate Breakdowns Follow

Summary of Announced Payloads

TOTAL		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	TOTAL
1	Argentina	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	0	1
1	AsiaSat	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	0	1
2	ASCO	--	--	--	--	--	--	--	--	--	--	2	0	0	0	0	0	0	2
5	Australia	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	5
3	Brazil	--	--	--	--	--	--	--	--	--	--	1	1	0	0	0	1	0	3
11	Canada	1	0	0	1	0	0	0	2	1	1	1	0	0	0	0	0	2	11
30	China	3	2	0	1	0	0	3	1	1	3	1	3	1	3	0	5	1	30
49	Cooperative	2	2	2	2	0	0	1	0	2	0	0	0	0	1	0	3	5	49
2	Czechoslovakia	--	--	--	1	0	0	0	0	0	0	0	0	0	0	1	0	0	2
30	ESA	1	0	2	2	1	0	4	0	2	2	1	0	1	2	2	1	4	30
27	France	5	0	1	0	0	0	0	0	0	1	1	1	0	1	1	2	6	27
11	Germany	0	0	0	0	0	0	0	0	2	1	0	0	1	1	2	1	1	11
13	India	1	0	0	0	1	1	3	1	2	0	0	0	0	2	0	1	1	13
6	Indonesia	--	1	1	0	0	0	0	0	1	1	0	0	1	0	0	1	0	6
1	InMarSat	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	0	1
2	Isreal	--	--	--	--	--	--	--	--	--	--	--	--	--	1	0	1	0	2
2	Italy	--	--	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
53	Japan	2	1	4	4	2	2	3	1	3	3	2	3	3	2	4	7	2	53
2	Mexico	--	--	--	--	--	--	--	--	--	--	2	0	0	0	0	0	0	2
7	NATO	0	1	1	1	0	0	0	1	0	0	0	0	0	0	0	0	1	7
1	Pakistan	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	0	1
1	PanAmSat	--	--	--	--	--	--	--	--	--	--	--	--	--	1	0	0	0	1
2761	Soviet Union	109	121	104	119	101	110	123	119	115	115	118	114	116	107	95	96	101	2761
2	Sweden	--	--	--	--	--	--	--	--	--	--	--	1	0	0	1	0	0	2
18	United Kingdom	0	0	0	0	1	0	1	0	0	2	0	0	0	0	1	5	2	18
1131	United States	26	27	17	29	17	13	19	17	22	32	33	9	9	15	22	31	30	1131
4172	TOTAL	150	155	133	160	123	126	157	142	151	161	164	132	133	136	129	159	157	4172

Summary of USA Payloads

U.S. PAYLOADS

TOTAL		1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
5	AMSAT	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	0	1
5	AT&T	--	--	--	--	--	1	2	1	0	0	0	0	0	0	0	0	0	0
2	ASC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
48	COMSAT	--	--	--	--	--	--	--	--	1	1	3	1	3	3	2	2	1	1
705	DOD	--	5	6	12	23	39	44	50	66	71	57	43	32	18	24	14	11	8
8	GTE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
8	Hughes	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
296	NASA	--	2	5	5	13	13	8	21	21	27	15	17	15	8	9	10	9	2
31	NOAA	--	--	--	--	--	--	--	--	--	3	3	2	1	1	1	1	1	1
1	N. Utah Univ	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
11	RCA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
5	SBS	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
6	WU	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2
1131	TOTAL	--	7	11	17	36	53	54	72	88	102	78	63	51	30	36	28	22	15

COOPERATIVE PAYLOADS

TOTAL		1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
5	NASA/Canada	--	--	--	--	--	1	0	0	1	0	0	0	1	0	1	0	0	0
4	NASA/DOD	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7	NASA/ESA	--	--	--	--	--	--	--	--	--	--	--	2	0	0	0	0	0	0
6	NASA/France	--	--	--	--	--	--	--	--	1	0	0	0	0	0	2	0	1	0
2	France/Germany	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
5	NASA/Germany	--	--	--	--	--	--	--	--	--	--	--	--	1	0	0	1	0	1
5	NASA/Italy	--	--	--	--	--	--	--	1	0	0	1	0	0	0	1	0	0	1
2	NASA/Netherlands	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
3	NASA/NOAA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
3	NASA/NRL	--	--	--	--	--	--	--	--	1	0	0	1	0	0	1	0	0	0
1	NASA/Spain	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
6	NASA/UK	--	--	--	--	--	1	0	1	0	0	1	0	0	0	1	0	0	1
49	TOTAL	--	--	--	--	--	2	0	2	3	0	2	3	2	0	5	1	1	7

Summary of USA Payloads

U.S. PAYLOADS

TOTAL		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	TOTAL
5	AMSAT	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	5
5	AT&T	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	5
2	ASC	--	--	--	--	--	--	--	--	--	--	1	0	0	0	0	0	1	2
48	COMSAT	2	6	1	3	0	1	3	2	2	2	3	0	0	1	1	2	1	48
705	DOD	10	18	12	14	11	8	7	6	8	12	11	5	8	9	12	16	15	705
8	GTE	--	--	--	--	--	--	--	--	--	2	1	1	0	2	0	1	1	8
8	Hughes	--	--	--	--	--	--	--	--	2	3	2	0	0	0	0	1	0	8
296	NASA	12	1	3	10	3	1	5	4	6	9	12	1	0	2	9	7	11	296
31	NOAA	1	1	1	1	1	2	2	0	2	2	0	1	1	1	0	0	1	31
1	N. Utah Univ	--	--	--	--	--	--	--	--	--	--	1	0	0	0	0	0	0	1
11	RCA	1	1	0	0	1	0	1	2	2	0	1	1	0	0	0	1	0	11
5	SBS	--	--	--	--	--	1	1	1	0	1	0	0	0	0	0	1	0	5
6	WU	0	0	0	0	1	0	0	2	0	1	0	0	0	0	0	0	0	6
1131	TOTAL	26	27	17	29	17	13	19	17	22	32	33	9	9	15	22	31	30	1131

COOPERATIVE PAYLOADS

TOTAL		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	TOTAL
5	NASA/Canada	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
4	NASA/DOD	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	2	4
7	NASA/ESA	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	1	7
6	NASA/France	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	6
2	France/Germany	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
5	NASA/Germany	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	5
5	NASA/Italy	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	5
2	NASA/Netherlands	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2
3	NASA/NOAA	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
3	NASA/NRL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
1	NASA/Spain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
6	NASA/UK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6
49	TOTAL	2	2	2	2	0	0	1	0	2	0	0	0	0	1	0	3	5	49

Shuttle Approach and Landing Tests

Flight	Flight Date	Weight (kg)	Description of Flight
Captive Inert Flight 1	Feb 18, 1977	64,717.0	Unmanned inert Orbiter (Enterprise) mated to Shuttle Carrier Aircraft (SCA) to evaluate low speed performance and handling qualities of Orbiter/SCA combination. SCA Crew: Fitzhugh L. Fulton, Jr., Thomas C. McMurtry, Vic Horton, and Skip Guidry. Flight Time: 2 hours 10 minutes.
Captive Inert Flight 2	Feb 22, 1977	64,717.0	Unmanned inert Orbiter (Enterprise) mated to SCA to demonstrate flutter free envelope. SCA Crew: Fitzhugh L. Fulton, Jr., Thomas C. McMurtry, Vic Horton, and Skip Guidry. Flight Time: 3 hours 15 minutes.
Captive Inert Flight 3	Feb 25, 1977	64,717.0	Unmanned inert Orbiter (Enterprise) mated to SCA to complete flutter and stability testing. SCA Crew: Fitzhugh L. Fulton, Jr., Thomas C. McMurtry, Vic Horton, and Skip Guidry. Flight Time: 2 hours 30 minutes.
Captive Inert Flight 4	Feb 28, 1977	64,717.0	Unmanned inert Orbiter (Enterprise) mated to SCA to evaluate configuration variables. SCA Crew: Fitzhugh L. Fulton, Jr., Thomas C. McMurtry, Vic Horton, and Skip Guidry. Flight Time: 2 hours 11 minutes.
Captive Inert Flight 5	Mar 2, 1977	65,142.0	Unmanned inert Orbiter (Enterprise) mated to SCA to evaluate maneuver performance and procedures. SCA Crew: Fitzhugh L. Fulton, Jr., A. J. Roy, Vic Horton, and Skip Guidry. Flight Time: 1 hour 40 minutes.
Captive Active Flight 1A	Jun 18, 1977	68,462.3	First manned captive active flight with Fred W. Haise, Jr. and C. Gordon Fullerton, Jr. Manned active Orbiter (Enterprise) mated to SCA for initial performance checks of Orbiter Flight Control System. SCA Crew: Fitzhugh L. Fulton, Jr., Thomas C. McMurtry, Vic Horton, and Skip Guidry. Flight Time: 56 minutes.
Captive Active Flight 1	Jun 28, 1977	68,462.3	Manned captive active flight with Joe H. Engle and Richard H. Truly. Manned active Orbiter (Enterprise) mated to SCA to verify conditions in preparation for free flight. SCA Crew: Fitzhugh L. Fulton, Jr. and Thomas C. McMurtry. Flight Time: 1 hour 3 minutes.
Captive Active Flight 3	Jul 26, 1977	68,462.3	Manned captive active flight with Fred W. Haise, Jr. and C. Gordon Fullerton, Jr. Manned active Orbiter (Enterprise) mated to SCA to verify conditions in preparation for free flight. SCA Crew: Fitzhugh L. Fulton, Jr. and Thomas C. McMurtry. Flight Time: 59 minutes.
Free Flight 1	Aug 12, 1977	68,039.6	First manned free flight with Fred W. Haise, Jr. and C. Gordon Fullerton, Jr. Manned Orbiter (Enterprise) with tailcone on, released from SCA to verify handling qualities of Orbiter. SCA Crew: Fitzhugh L. Fulton, Jr. and Thomas C. McMurtry. Flight Time: 53 minutes 51 seconds.
Free Flight 2	Sep 13, 1977	68,039.6	Manned free flight with Joe H. Engle and Richard H. Truly. Manned Orbiter (Enterprise) released from SCA to verify characteristics of Orbiter. SCA Crew: Fitzhugh L. Fulton, Jr. and Thomas C. McMurtry. Flight Time: 54 minutes 55 seconds.
Free Flight 3	Sep 23, 1977	68,402.4	Manned free flight with Fred W. Haise, Jr. and C. Gordon Fullerton, Jr. Manned Orbiter (Enterprise) released from SCA to evaluate Orbiter handling characteristics. SCA Crew: Fitzhugh L. Fulton, Jr. and Thomas C. McMurtry. Flight Time: 51 minutes 12 seconds.
Free Flight 4	Oct 12, 1977	68,817.5	Manned free flight with Joe H. Engle and Richard H. Truly. Manned Orbiter (Enterprise) with tailcone off and three simulated engine bells installed, released from SCA to evaluate Orbiter handling characteristics. SCA Crew: Fitzhugh L. Fulton, Jr. and Thomas C. McMurtry. Flight Time: 1 hour 7 minutes 48 seconds.
Free Flight 5	Oct 26, 1977	68,825.2	Manned free flight with Fred W. Haise, Jr. and C. Gordon Fullerton, Jr. Manned Orbiter (Enterprise) with tailcone off, released from SCA to evaluate performance of landing gear on paved runway. SCA Crew: Fitzhugh L. Fulton, Jr. and Thomas C. McMurtry. Flight Time: 54 minutes 42 seconds.

Soviet Spacecraft Designations

ALMAZ: Study geology, cartography, oceanography, ecology, and agriculture.

BURAN (Snowstorm): Reusable orbital space shuttle.

COSMOS: Designation given to many different activities in space.

EKRAN (Screen): Geosynchronous comsat for TV services.

ELEKTRON: Dual satellites to study the radiation belts.

FOTON: Scientific satellite to continue space materials studies.

GAMMA: Radiation detection satellite.

GORIZONT (Horizon): Geosynchronous comsat for international relay.

GRANAT: Astrophysical orbital observatory.

INFORMATOR: Collect and transmit information for the Ministry of Geology.

INTERCOSMOS: International scientific satellite.

ISKRA: Amateur radio satellite.

KRISTALL: Module carrying technical and biomedical instruments to MIR.

KVANT: MIR space station astrophysics module.

LUNA: Lunar exploration spacecraft.

MARS: Spacecraft to explore the planet Mars.

METEOR: Polar orbiting meteorological satellite.

MIR (Peace): Advanced manned scientific space station in Earth orbit.

MOLNIYA (Lightning): Part of the domestic communications satellite system.

NADEZHDA: Navigation satellite.

OKEAN: Oceanographic satellite to monitor ice conditions.

PHOBOS: International project to study Mars and its moon Phobos.

POLYOT: Maneuverable satellite capable of changing orbits.

PROGNOZ (Forecast): Scientific interplanetary satellite.

PROGRESS: Unmanned cargo flight to resupply manned space stations.

PROTON: Scientific satellite to investigate the nature of Cosmic Rays.

RADIO: Small radio relay satellite for use by amateurs.

RADUGA (Rainbow): Geosynchronous comsat for telephone, telegraph, and domestic TV.

RESURS: Earth resources satellite.

SALYUT: Manned scientific space station in Earth orbit.

SOYUZ (Union): Manned spacecraft for flight in Earth orbit.

SPUTNIK: Early series of satellites to develop manned spaceflight.

VEGA: Two spacecraft international project to study Venus and Halley's Comet.

VENERA: Spacecraft to explore the planet Venus.

VOSKHOD: Modified Vostok capsule for two and three Cosmonauts.

VOSTOK (East): First manned capsule; placed six Cosmonauts in orbit.

ZOND: Automatic spacecraft development tests. Zond 5 was the first spacecraft to make a circumlunar flight and return safely to Earth.

Unofficial Tabulation of USSR Payloads

TOTAL		1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	Almaz	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1	Buran	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2174	Cosmos	–	–	–	–	–	12	12	27	52	34	61	64	55	72	81	72	85	74
19	Ekran	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4	Electron	–	–	–	–	–	–	–	4	0	0	0	0	0	0	0	0	0	0
4	Foton	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1	Gamma	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
24	Gorizont	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1	Granat	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
24	Informator	–	–	–	–	–	–	–	–	–	–	–	–	2	2	1	3	2	2
1	Intercosmos	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3	Iskra	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1	Kristall	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2	Kvant	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
24	Luna	–	–	3	0	0	0	1	0	4	5	0	1	1	2	2	1	1	2
7	Mars	–	–	–	–	–	1	0	0	0	0	0	0	0	0	2	0	4	0
56	Meteor	–	–	–	–	–	–	–	–	–	–	–	–	2	4	4	3	2	5
1	Mir	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
141	Molniya	–	–	–	–	–	–	–	–	2	2	3	3	2	5	3	6	8	7
3	Nadezhda	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3	Okean	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2	Phobos	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2	Polyot	–	–	–	–	–	–	1	1	0	0	0	0	0	0	0	0	0	0
10	Prognoz	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1	0
51	Progress	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4	Proton	–	–	–	–	–	–	–	–	2	1	0	1	0	0	0	0	0	0
8	Radio	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
30	Raduga	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
13	Resurs	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7	Salyut	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	0	1	2
66	Soyuz	–	–	–	–	–	–	–	–	–	–	1	2	5	1	2	0	2	3
12	Sputnik	2	1	0	3	4	2	0	0	0	0	0	0	0	0	0	0	0	0
2	Vega	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
16	Venera	–	–	–	–	–	–	–	–	2	0	1	0	2	1	0	1	0	0
2	Voskhod	–	–	–	–	–	–	–	1	1	0	0	0	0	0	0	0	0	0
4	Vostok	–	–	–	–	–	2	2	0	0	0	0	0	0	0	0	0	0	0
10	Zond	–	–	–	–	–	–	–	2	3	0	0	3	1	1	0	0	0	0
6	No Designation	–	–	–	–	–	3	1	0	0	2	0	0	0	0	0	0	0	0
2741	TOTAL	2	1	3	3	4	20	17	35	66	44	66	74	70	88	96	88	106	95

Unofficial Tabulation of USSR Payloads

TOTAL		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	TOTAL
1	Almaz	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	1
1	Buran	--	--	--	--	--	--	--	--	--	--	--	--	--	1	0	0	0	1
2174	Cosmos	85	101	86	96	79	88	94	97	94	94	99	96	97	79	68	66	54	2174
19	Ekran	--	1	1	0	2	2	1	2	2	2	1	1	2	2	0	0	0	19
4	Electron	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
4	Foton	--	--	--	--	--	--	--	--	--	--	--	--	--	1	1	1	1	4
1	Gamma	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	0	1
24	Gorizont	--	--	--	1	2	1	0	2	2	2	1	2	1	2	3	3	2	24
1	Granat	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	0	0	1
24	Intercosmos	2	2	1	1	2	0	2	0	0	0	0	0	0	0	1	0	1	24
1	Informator	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	1
3	Iskra	--	--	--	--	--	--	1	2	0	0	0	0	0	0	0	0	0	3
1	Kristall	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	0	1
2	Kvant	--	--	--	--	--	--	--	--	--	--	--	--	1	0	1	0	0	2
24	Luna	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24
7	Mars	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
56	Meteor	4	3	4	0	3	2	2	2	1	1	3	1	2	2	2	2	2	56
1	Mir	--	--	--	--	--	--	--	--	--	--	--	1	0	0	0	0	0	1
141	Molniya	10	7	6	6	5	4	8	5	7	4	8	7	1	7	4	6	5	141
3	Nadezhda	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	1	1	3
3	Okean	--	--	--	--	--	--	--	--	--	--	--	--	--	1	0	1	1	3
2	Phobos	--	--	--	--	--	--	--	--	--	--	--	--	--	2	0	0	0	2
2	Polyot	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
10	Prognoz	1	1	1	1	0	1	0	0	1	0	1	0	0	0	0	0	0	10
51	Progress	--	--	--	4	3	4	1	4	2	5	1	2	7	6	4	4	4	51
4	Proton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
8	Radio	--	--	--	2	0	0	6	0	0	0	0	0	0	0	0	0	0	8
30	Raduga	1	1	1	1	1	2	3	1	2	2	2	2	2	1	3	3	2	30
13	Resurs	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5	4	4	13
7	Salyut	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	7
68	Soyuz	4	3	3	5	4	6	3	3	2	3	2	2	3	3	1	3	2	68
12	Sputnik	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
2	Vega	--	--	--	--	--	--	--	--	--	2	0	0	0	0	0	0	0	2
15	Venera	2	0	0	2	0	0	2	0	2	0	0	0	0	0	0	0	0	15
2	Voskhod	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
4	Vostok	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
10	Zond	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
6	No Designation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
2741	TOTAL	109	121	104	119	101	110	123	119	115	115	118	114	116	107	95	96	81	2741

NASA Astronauts

NAME	SERVICE	MISSION	POSITION	FLIGHT TIME (HR:MIN:SEC)	EVA (HR:MIN)	TOTAL FLIGHT TIME (HR:MIN:SEC)
Acton, Loren W., PhD	Civ	STS-51F	PS	190:45:26		190:45:26
Adamson, James C. Lt.Col	USA	STS-28	MS	121:00:09		334:22:35
		STS-43	MS	213:22:26		
Akers, Thomas D. Maj	USAF	STS-41	MS	98:11:00		98:11:00
Aldrin, Edwin E., Jr., Col.	USAF Ret	Gemini 12	Plt	68:34:31	05:37	289:53:06
		Apollo 11	LMP	195:18:35	02:15 *	
Allen, Joseph P. PhD	Civ	STS-5	MS	122:14:26		313:59:22
		STS-51A	MS	191:44:56	12:14	
Al-Saud, Salman	Civ	STS-51G	PS	169:38:52		169:38:52
Anders, William A., B. Gen.	USAF	Apollo 8	LMP	147:00:42		206:00:01
Apt, Jerome PhD	Civ	STS-37	MS	143:33:40	10:49	143:33:40
Armstrong, Neal	Civ	Gemini 8	Cdr	10:41:26		
		Apollo 11	Cdr	195:18:35	02:32 *	
Bagian, James P. MD	Civ	STS-29	MS	119:38:52		337:54:06
		STS-40	MS	218:15:14		
Baker, Ellen S., MD	Civ	STS-34	MS	119:39:24		119:39:24
Baker, Michael A. Capt	USN	STS-43	Plt	213:22:26		213:22:26
Bartoe, John-David F., PhD	Civ	STS-51F	PS	190:45:26		190:45:26
Baudry, Patrick, Lt. Col.	FAF	STS-51G	PS	169:38:52		169:38:52
Bean, Alan F., Capt	USN Ret	Apollo 12	LMP	244:36:25	07:45 *	1671:45:29
		Skylab 3	Cdr	1427:09:04	02:45	
Blaha, John E., Col	USAF	STS-29	Plt	119:38:52		453:08:07
		STS-33	Plt	120:06:49		
		STS-43	Cdr	213:22:26		
Bluford, Guion S., Col	USAF	STS-8	MS	145:08:43		513:19:50
		STS-61A	MS	168:44:51		
		STS-39	MS	199:26:16		

NAME	SERVICE	MISSION	POSITION	FLIGHT TIME (HR:MIN:SEC)	EVA (HR:MIN)	TOTAL FLIGHT TIME (HR:MIN:SEC)
Bobko, Karol J., Col	USAF	STS-6	Plt	120:23:42		386:03:43
		STS-51D	Cdr	167:55:23		
		STS-51J	Cdr	97:44:38		
Bolden, Charles F., Col	USMC	STS 61-C	Plt	146:03:51		267:19:56
		STS-31	Plt	121:16:05		
Borman, Frank, Col.	USAF Ret	Gemini 7	Cdr	330:35:31		477:36:13
		Apollo 8	Cdr	147:00:42		
Brand, Vance D.	Civ	Apollo Soyuz	CMP	217:28:23		763:54:44
		STS-5	Cdr	122:14:26		
		STS-41B	Cdr	191:15:55		
		STS-35	Cdr	215:06:00		
Brandenstein, Daniel C., Capt	USN	STS-8	Plt	145:08:43		575:48:12
		STS-51G	Cdr	169:38:52		
		STS-32	Cdr	120:06:49		
Bridges, Roy D., Col	USAF	STS-51-F	Plt	190:45:26		190:45:26
Brown, Mark F., Lt. Col	USAF	STS-28	MS	121:00:09		249:28:26
		STS-48	MS	128:28:17		
Buchli, James F., Col	USMC	STS-51C	MS	73:33:23		490:25:23
"		STS-61A	MS	168:44:51		
		STS-29	MS	119:38:52		
		STS-48	MS	128:28:17		
Cabana, Robert D., Lt. Col	USMC	STS-41	Plt	98:11:00		98:11:00
Cameron, Kenneth D. Col.	USMC	STS-37	Plt	143:33:40		143:33:40
Carpenter, M. Scott, Cdr.	USN Ret	Aurora 7	Cdr	4:56:05		4:56:05
Carr, Gerald P., Col	USMC Ret	Skylab 4	Cdr	2017:15:32	15:48	2017:15:32
Carter, Manley, Cdr.	USN	STS-33	MS	120:06:49		120:06:49
Casper, John H., Col	USAF	STS 36	Plt	106:18:23		106:18:23

*Lunar Surface EVA

** Suborbital Flight

NASA Astronauts

NAME	SERVICE	MISSION	POSITION	FLIGHT TIME (HR:MIN:SEC)	EVA (HR:MIN)	TOTAL FLIGHT TIME (HR:MIN:SEC)
Center, Robert J.	Civ	STS-61C	PS	146:03:51		146:03:51
Cernan, Eugene A., Capt.	USN Ret	Gemini 9A	Plt	72:21:00	02:08	566:16:32
		Apollo 10	LMP	192:03:23		
		Apollo 17	Cdr	301:51:59	22:04 *	
Chang-Diaz, Franklin R., PhD.	Civ	STS-61C	MS	146:03:51		265:43:15
		STS-34	MS	119:39:24		
Cleave, Mary L., PhD	Civ	STS-61B	MS	165:04:49		262:02:20
		STS-30	MS	96:56:25		
Coats, Michael L., Capt.	USN	STS-41D	Plt	144:56:04		463:51:12
		STS-29	Cdr	119:38:52		
		STS-39	Cdr	199:26:16		
Collins, Michael, M. Gen	USAF	Gemini 10	Plt	70:46:39	01:30	266:11:14
		Apollo 11	CMP	195:18:35		
Conrad, Charles (Pete), Capt	USN Ret	Gemini 5	Plt	190:55:14		1179:28:36
		Gemini 11	Cdr	71:17:08		
		Apollo 12	Cdr	244:36:25	07:45 *	
		Skylab 2	Cdr	672:49:49	05:51	
Cooper, L. Gordon, Jr., Col.	USAF Ret	Faith 7	Plt	34:19:49		226:18:03
		Gemini 5	Cdr	190:55:14		
Covey, Richard O., Col	USAF	STS-51I	Plt	170:17:42		485:12:53
		STS-26	Plt	97:00:11		
		STS-38	Cdr	117:55:00		
Creighton, John O., Capt	USN	STS-51G	Plt	169:38:52		404:25:32
		STS-36	Cdr	106:18:23		
		STS-48	Cdr	128:28:17		
Crippen, Robert L, Capt	USN	STS-1	Plt	54:20:32		565:48:11
		STS-7	Cdr	146:23:59		
		STS-41C	Cdr	167:40:07		
		STS-41G	Cdr	197:23:33		
Culbertson, Frank L.		STS-38	Plt	117:55:00		117:55:00
Cunningham, Walter	Civ	Apollo 7	LMP	260:09:03		260:09:03
Duke, Charles M., B. Gen.	USAF	Apollo 16	LMP	265:51:05	20:14 *	265:51:05
Dunbar, Bonnie J., PhD	Civ	STS-61A	MS	168:44:51		429:45:28
		STS-32	MS	261:00:37		
Durrance, Samuel T.		STS-35	PS	215:06:00		215:06:00
Eisele, Donn F., Col.	USAF Ret	Apollo 7	CMP	260:09:03		260:09:03
England, Anthony W., PhD	Civ	STS-51F	MS	190:45:26		190:45:26
Engle, Joe H., Col	USAF	STS-2	Cdr	54:13:13		244:30:55
		STS-51I	Cdr	170:17:42		
Evans, Ronald R., Capt	USN Ret	Apollo 17	CMP	301:51:59	01:06	301:51:59
Fabian, John M. Col.	USAF	STS-7	MS	146:23:59		316:02:51
		STS-51G	MS	169:38:52		
Fisher, Anna L., MD	Civ	STS-51A	MS	191:44:56		191:44:56
Fisher, William F., MD	Civ	STS-51I	MS	170:17:42	11:51	170:17:42
Fullerton, C. Gordon, Col.	USAF	STS-3	Plt	192:04:45		382:50:11
		STS-51F	Cdr	190:45:26		
Furrer, Reinhard, PhD	Civ	STS-61A	PS	186:44:51		186:44:51
Gaffney, F. Drew Dr.	Civ	STS-40	PS	218:15:14		218:15:14
Gardner, Dale A.,	USN	STS-8	MS	145:08:43		336:53:39
		STS-51A	MS	191:44:56	12:14	
Gardner, Guy S., Lt. Col.	USAF	STS-27	Plt	105:05:37		320:11:37
		STS-35	Plt	215:06:00		

*Lunar Surface EVA

** Suborbital Flight

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NAME	SERVICE	MISSION	POSITION	FLIGHT TIME (HR:MIN:SEC)	EVA (HR:MIN)	TOTAL FLIGHT TIME (HR:MIN:SEC)
Garn, E. J. "Jake"	Civ	STS-51D	PS	167:55:23		167:55:23
Garneau, Marc, PhD	Civ	STS-41G	PS	197:23:33		197:23:33
Garriott, Owen K., PhD	Civ	Skylab 3	Plt	1427:09:04	13:44	1674:56:28
		STS-9	MS	247:47:24		
Gemar, Charles D.		STS-38	MS	117:55:00		246:23:17
		STS-48	MS	128:28:17		
Gibson, Edward G., PhD	Civ	Skylab 4	Plt	2017:15:32	15:20	2017:15:32
Gibson, Robert L., Cdr.	USN	STS-41B	Plt	191:15:55		442:25:23
		STS-61C	Cdr	146:03:51		
		STS-27	Cdr	105:05:37		
Glenn, John H., Jr., Col	USMC Ret	Friendship 7	Cdr	4:55:23		4:55:23
Godwin, Linda M. PhD	Civ	STS-37	MS	143:33:40		143:33:40
Gordon, Richard F., Jr., Capt.	USN Ret	Gemini 11	Plt	71:17:08	01:57	315:53:33
		Apollo 12	CMP	244:36:25		
Grabe, Ronald J., Col	USAF	STS-51J	Plt	97:44:38		194:42:09
		STS-30	Plt	96:56:25		
Gregory, Frederick D., Col	USAF	STS-51B	Plt	168:08:46		459:06:11
		STS-33	Cdr	120:06:49		
		STS-44	Cdr	170:52:36		
Griggs, S. David	Civ	STS-51D	MS	167:55:23	03:10	167:55:23
Grissom, Virgil I., Lt. Col.	USAF	**Liberty Bell	Plt	15:37		5:08:37
		Gemini 3	Cdr	4:53:00		
Gutierrez, Sidney M. Lt. Col.	USAF	STS-40	Plt	218:15:14		218:15:14
Haise, Fred W.	Civ	Apollo 13	LMP	142:54:41		142:54:41
Hammond, L. Blaine, Jr. Col	USAF	STS-39	Plt	199:26:16		199:26:16
Harbaugh, Gregory J.	Civ	STS-39	MS	199:26:16		199:26:16
Hart, Terry J	Civ	STS-41C	MS	167:40:07		167:40:07
Hartsfield, Henry W	USAF Ret	STS-4	Plt	169:09:40		482:50:35
		STS-41D	Cdr	144:56:04		
		STS-61A	Cdr	168:44:51		
Hauck, Frederick H., Capt	USN	STS-7	Plt	146:23:59		435:09:06
		STS-51A	Cdr	191:44:56		
		STS-26	Cdr	97:00:11		
Hawley, Steven A., PhD	Civ	STS-41D	MS	144:56:04		412:16:00
		STS-61C	MS	146:03:51		
		STS-31	MS	121:16:05		
Henize, Karl G., PhD	Civ	STS-51F	MS	190:45:26		190:45:26
Hennen, Thomas J.	USA	STS-44	PS	170:52:36		170:52:36
Hennicks, Terence T. Col.	USAF	STS-44	Plt	170:52:36		170:52:36
Hieb, Richard J	Civ	STS-39	MS	199:26:16		199:26:16
Hilmers, David C., Lt. Col.	USMC	STS-51J	MS	97:44:38		301:03:11
		STS-26	MS	97:00:11		
		STS-36	MS	106:18:23		
Hoffman, Jeffery A., PhD	Civ	STS-51D	MS	167:55:23	03:10	383:01:23
		STS-35	MS	215:06:00		
Hughes-Fulford, Millie Dr.	Civ	STS-40	PS	218:15:14		218:15:14
Irwin, James B., Col	USAF Ret	Apollo 15	LMP	295:11:53	18:35 *	295:11:53
Ivins, Marsha S.	Civ	STS-32	MS	261:00:37		261:00:37
Jarvis, Gregory B	Civ	STS-51L	PS	N/A		N/A
Jernigan, Tamara E. PhD	Civ	STS-40	MS	218:15:14		218:15:14
Kerwin, Joseph P., Capt	USN Ret	Skylab 2	Plt	672:49:49	03:30	672:49:49
Lee, Mark C. Maj	USAF	STS-30	MS	96:56:25		96:56:25
Leetsma, David C., Cdr	USN	STS-41G	MS	197:23:33	03:29	318:23:42
		STS-28	MS	121:00:09		121:00:09

*Lunar Surface EVA

** Suborbital Flight

NASA Astronauts

NAME	SERVICE	MISSION	POSITION	FLIGHT TIME (HR:MIN:SEC)	EVA (HR:MIN)	TOTAL FLIGHT TIME (HR:MIN:SEC)
Lenoir, William B., PhD	Civ	STS-5	MS	122:14:26		122:14:26
Lichtenberg, Bryon K., PhD	Civ	STS-9	PS	247:47:24		247:47:24
Lind, Don Leslie, PhD	Civ	STS-51B	MS	168:08:46		168:08:46
Lounge, John M.	Civ	STS-51I	MS	170:17:42		482:23:53
		STS-26	MS	97:00:11		
Lousma, Jack R., Col	USMC	Skylab 3	Plt	1427:09:04	10:59	1619:13:49
		STS-3	Cdr	192:04:45		
Lovell, James A., Jr., Capt	USN Ret	Gemini 7	Plt	330:35:31		715:05:25
		Gemini 12	Cdr	94:34:31		
		Apollo 8	CMP	147:00:42		
		Apollo 13	Cdr	142:54:41		
Low, G. David	Civ	STS-32	MS	261:00:37		474:23:03
		STS-43	MS	213:22:26		
Lucid, Shannon W., PhD	Civ	STS-51G	MS	169:38:52		502:40:42
		STS-34	MS	119:39:24		
		STS-43	MS	213:22:26		
Mattingly, Thomas K., Capt	USN	Apollo 16	CMP	265:51:05	01:24	508:34:08
		STS-4	Cdr	169:09:40		
		STS-51C	Cdr	73:33:23		
McAuliffe, S. Christa	Civ	STS-51L	PS	N/A		N/A
McBride, Jon A., Cdr	USN	STS-41G	Plt	197:23:33		197:23:33
McCandless, Bruce, Capt.	USN	STS-41B	MS	121:16:05	11:37	121:16:05
McCulley, Michael, Cdr	USN	STS-34	Plt	119:39:24		119:39:24
McDivitt, James A., B. Gen	USAF Ret	Gemini 4	Cdr	97:56:11		338:57:05
		Apollo 9	Cdr	241:00:54		
McMonagle, Donald R. Lt.Col.	USAF	STS-39	MS	199:26:16		199:26:16
McNair, Ronald E., PhD	Civ	STS-41B	MS	191:15:55		191:15:55
		STS-51L	MS	N/A		
Meade, Carl J.		STS-38	MS	117:55:00		117:55:00
Melnick, Bruce E., Cdr	USCG	STS-41	MS	98:11:00		98:11:00
Merbold, Ulf, PhD	Civ	STS-9	PS	247:47:24		247:47:24
Messerschmid, Ernest, PhD	Civ	STS-61A	PS	168:44:51		168:44:51
Mitchell, Edgar D., Capt	USN Ret	Apollo 14	LMP	216:01:57	09:23 *	216:01:57
Mullane, Richard M., Col	USAF	STS-41D	MS	144:56:04		356:20:04
		STS-27	MS	105:05:37		
		STS-36	MS	106:18:23		
		STS-35	MS	215:06:00		
Musgrave, F. Story, MD, PhD	Civ	STS-6	MS	120:23:42	03:54	602:08:33
		STS-51F	MS	190:45:26		
		STS-33	MS	120:06:49		
		STS-44	MS	170:52:36		
Nagel, Steven R., Col.	USAF	STS-51G	MS	169:38:52		481:57:23
		STS-61A	Plt	168:44:51		
		STS-37	Cdr	143:33:40		
Nelson, Bill	Civ	STS-61C	PS	146:03:51		146:03:51
Nelson, George D., PhD	Civ	STS-41C	MS	167:40:07	10:06	410:44:09
		STS-61C	MS	146:03:51		
		STS-26	MS	97:00:11		
Nen Vela, Rodolpho, PhD	Civ	STS-61B	PS	165:04:49		165:04:49
Ockels, Wubbo J., PhD	Civ	STS-61A	PS	168:44:51		168:44:51
O'Connor, Bryan O., Col	USMC	STS-61B	Plt	165:04:49		383:20:03
		STS-40	Cdr	218:15:14		

*Lunar Surface EVA

** Suborbital Flight

NASA Astronauts

NAME	SERVICE	MISSION	POSITION	FLIGHT TIME (HR:MIN:SEC)	EVA (HR:MIN)	TOTAL FLIGHT TIME (HR:MIN:SEC)
Onizuka, Ellison S., Lt. Col	USAF	STS-51C	MS	73:33:23		73:33:23
		STS-51L	MS	N/A		
Overmyer, Robert F., Col	USMC	STS-5	Plt	122:14:26		290:23:12
		STS-51B	Cdr	168:08:46		
Pailes, William A., Maj	USAF	STS-51J	PS	97:44:38		97:44:38
Parise, Ronald A.		STS-35	PS	215:06:00		215:06:00
Parker, Robert A., PhD	Civ	STS-9	MS	247:47:24		462:53:24
		STS-35	MS	215:06:00		
Payton, Gary E., Maj	USAF	STS-51C	PS	73:33:23		73:33:23
Peterson, Donald H.	USAF Ret	STS-6	MS	120:23:42	03:54	120:23:42
Pogue, William R., Col.	USAF Ret	Skylab 4	Plt	2017:15:32	13:34	2017:15:32
Reighler, Kenneth S., Jr. Cdr	USN	STS-48	Plt	128:28:17		128:28:17
Resnik, Judith A., PhD	Civ	STS-41D	MS	144:56:04		144:56:04
		STS-51L	MS	N/A		
Richards, Richard N., Cdr	USN	STS-28	Plt	121:00:09		219:11:09
		STS-41	Cdr	98:11:00		
Ride, Sally K., PhD	Civ	STS-7	MS	146:23:59		343:47:32
		STS-41G	MS	197:23:33		
Roosa, Stuart A., Col	USAF Ret	Apollo 14	CMP	216:10:57		216:10:57
Ross, Jerry L., Lt. Col	USAF	STS-61B	MS	165:04:49	12:20	413:44:06
		STS-27	MS	105:05:37		
		STS-37	MS	143:33:40	10:49	
Runco, Mario Jr. Lt.Cdr.	USN	STS-44	MS	170:52:36		170:52:36
Schirra, Walter M., Jr., Capt	USN Ret	Sigma 7	Plt	9:13:11		295:13:38
		Gemini 6A	Cdr	25:51:24		
		Apollo 7	Cdr	260:09:03		
Schmitt, Harrison H., PhD	Civ	Apollo 17	LMP	301:51:59	22:04 *	301:51:59
Schweickart, Russell	Civ	Apollo 9	LMP	241:00:54	01:07	241:00:54
Scobee, Francis R. (Dick)	USAF Ret	STS-41C	Plt	167:40:07		167:40:07
		STS-51L	Cdr	N/A		
Scott, David R., Col	USAF Ret	Gemini 8	Plt	10:41:26		546:54:13
		Apollo 9	CMP	241:00:54	01:01	
		Apollo 15	Cdr	295:11:53	19:08 *	
Scully-Power, Paul D.	Civ	STS-41G	PS	197:23:33		197:23:33
Seddon, M. Rhea, MD	Civ	STS-51D	MS	167:55:23		386:10:37
		STS-40	MS	218:15:14		
Shaw, Brewster H., Col	USAF	STS-9	Plt	247:47:24		533:52:22
		STS-61B	Cdr	165:04:49		
		STS-28	Cdr	121:00:09		
Shepard, Alan B., Jr., R. Adm.	USN Ret	**Freedom 7	Plt	15:22		216:17:19
		Apollo 14	Cdr	216:01:57	09:23 *	
Shepherd, William M., Capt	USN	STS-27	MS	105:05:37		203:16:37
		STS-41	MS	98:11:00		
Shriver, Loren J., Col	USAF	STS-51C	Plt	73:33:23		194:49:28
		STS-31	Cdr	121:16:05		
Slayton, Donald K., Maj	USAF Ret	Apollo Soyuz	CMP	217:28:23		217:28:23
Smith, Michael J., Cdr	USN	STS-51L	Plt	N/A		N/A
Spring, Sherwood C., Lt. Col	USA	STS-61B	MS	165:04:49	12:20	165:04:49
Springer, Robert C., Col	USMC	STS-29	MS	119:38:52		237:33:52
		STS-38	MS	117:55:00		
Stafford, Thomas P., Lt. Gen	USAF Ret	Gemini 6A	Plt	25:51:24		507:44:10
		Gemini 9A	Cdr	72:21:00		
		Apollo 10	Cdr	192:03:23		
		Apollo Soyuz	Cdr	217:28:23		

*Lunar Surface EVA

**Suborbital Flight

NASA Astronauts

NAME	SERVICE	MISSION	POSITION	FLIGHT TIME (HR:MIN:SEC)	EVA (HR:MIN)	TOTAL FLIGHT TIME (HR:MIN:SEC)
Stewart, Robert L., Col	USA	STS-41B	MS	191:15:55	11:37	289:00:33
		STS-51J	MS	97:44:38		
Sullivan, Kathryn D., PhD	Civ	STS-41G	MS	197:23:33	03:29	318:39:38
		STS-31	MS	121:16:05		
Swigert, John L., Jr.	Civ	Apollo 13	CMP	142:54:41		142:54:41
Thagard, Norman E., MD	Civ	STS-7	MS	146:23:59		411:30:16
		STS-51B	MS	168:08:46		
		STS-30	MS	96:56:25		
Thornton, Kathryn	Civ	STS-33	MS	120:06:49		120:06:49
Thornton, William E., MD	Civ	STS-8	MS	145:08:43		313:17:29
		STS-51B	MS	168:08:46		
Thuot, Pierre J., Lt. Cdr	USG	STS-36	MS	106:18:23		106:18:23
Truly, Richard H., Capt	USN	STS-2	Plt	54:13:13		199:21:56
		STS-8	Cdr	145:08:43		
van den Berg, Lodewijk, PhD	Civ	STS-51B	PS	168:08:46		168:08:46
van Hoften, James D., PhD	Civ	STS-41C	MS	167:40:07	10:06	377:57:49
		STS-51I	MS	170:17:42	11:51	
Veach, Charles Lacy	USAF	STS-39	MS	199:26:16		199:26:16
Voss, James S. Lt.Col.	USA	STS-44	MS	170:52:36		170:52:36
Walker, Charles D.	Civ	STS-41D	PS	144:56:04		477:56:16
		STS-51D	PS	167:55:23		
		STS-61B	PS	165:04:49		
Walker, David M., Capt	USN	STS-51A	Plt	191:44:56		288:42:27
		STS-30	Cdr	96:56:25		
Wang, Taylor G., PhD	Civ	STS-51B	PS	168:08:46		168:08:46
Weitz, Paul J., Capt	USN Ret	Skylab 2	Plt	672:49:49	01:44	793:13:31
		STS-6	Cdr	120:23:42		
Wetherbee, James, Cdr	USN	STS-32	Plt	261:00:37		261:00:37
White, Edward H., Lt. Col	USAF	Gemini 4	Plt	97:56:11	00:23	97:56:11
Williams, Donald E., Capt	USN	STS-51D	Plt	167:55:23		287:34:47
		STS-34	Cdr	119:39:24		
Worden, Alfred M., Col	USAF Ret	Apollo 15	CMP	295:11:53	00:39	295:11:53
Young, John W., Capt	USN Ret	Gemini 3	Plt	4:53:00		835:41:33
		Gemini 10	Cdr	70:46:39		
		Apollo 10	CMP	192:03:23		
		Apollo 16	Cdr	265:51:05	20:14 *	
		STS-1	Cdr	54:20:32		
		STS-9	Cdr	247:47:24		

*Lunar Surface EVA

~ Suborbital Flight

Summary of United States Manned Space Flight

MISSION	CREW MEMBERS	MISSION DURATION (HR:MIN:SEC)	CREW HOURS (HR:MIN:SEC)
MERCURY REDSTONE (Suborbital)			
Freedom 7	Shepard	15:22	15:22:00
Liberty Bell 7	Grissom	15:37	15:37:00
Total Flights - 2		30:59	30:59
MERCURY ATLAS (Orbital)			
Friendship 7	Glenn	4:55:23	4:55:23
Aurora 7	Carpenter	4:56:05	4:56:05
Sigma 7	Schirra	9:13:11	295:13:38
Faith 7	Cooper	34:19:49	226:18:03
Total Flights - 4		53:24:28	53:24:28
TOTAL MERCURY FLIGHTS - 6		53:55:27	53:55:27
GEMINI TITAN			
Gemini 3	Grissom, Young	4:53:00	9:46:00
Gemini 4	McDivitt, White	97:56:11	195:52:22
Gemini 5	Cooper, Conrad	190:55:14	381:50:28
Gemini 6A	Schirra, Stafford	25:51:24	51:42:48
Gemini 7	Borman, Lovell	330:35:31	661:11:02
Gemini 8	Armstrong, Scott	10:41:26	21:22:52
Gemini 9A	Stafford, Cernan	72:21:00	144:42:00
Gemini 10	Young, Collins	70:46:39	141:33:18
Gemini 11	Conrad, Gordon	71:17:08	142:34:16
Gemini 12	Lovell, Aldrin	94:34:31	189:09:02
TOTAL GEMINI FLIGHTS - 10		969:52:04	1939:44:08

MISSION	CREW MEMBERS	MISSION DURATION (HR:MIN:SEC)	CREW HOURS (HR:MIN:SEC)
APOLLO SATURN I			
Apollo 7	Schirra, Eisele, Cunningham	260:09:03	780:27:09
APOLLO SATURN V			
Apollo 8	Borman, Lovell, Anders	147:00:42	441:02:06
Apollo 9	McDivitt, Scott, Schweickart	241:00:54	723:02:42
Apollo 10	Stafford, Young, Cernan	192:03:23	576:10:09
Apollo 11	Armstrong, Collins, Aldrin	195:18:35	585:55:45
Apollo 12	Conrad, Gordon, Bean	244:36:25	733:49:15
Apollo 13	Lovell, Swigert, Haise	142:54:41	428:44:03
Apollo 14	Shepard, Roosa, Mitchell	216:01:57	648:05:51
Apollo 15	Scott, Worden, Irwin	295:11:53	885:35:39
Apollo 16	Young, Mattingly, Duke	265:51:05	797:33:15
Apollo 17	Cernan, Evans, Schmitt	301:51:59	905:35:57
Total Flights - 10		2241:51:34	7506:01:51
TOTAL APOLLO - 11		2502:00:37	7506:01:51
SKYLAB SATURN IB			
Skylab 2	Conrad, Kerwin, Weitz	672:49:49	2018:29:27
Skylab 3	Bean, Garrott, Lousma	1427:09:04	4281:27:12
Skylab 4	Carr, E. Gibson, Pogue	2017:15:32	6051:46:36
TOTAL SKYLAB FLIGHTS - 3		4117:14:25	12351:43:15
APOLLO SATURN IB			
ASTP	Stafford, Brand, Slayton	217:28:23	652:25:09

Summary of United States Manned Space Flight

MISSION	CREW MEMBERS	MISSION DURATION (HR:MIN:SEC)	CREW HOURS (HR:MIN:SEC)
STS-1 - Columbia	Young, Crippen	54:20:32	108:41:04
STS-2 - Columbia	Engle, Truly	54:13:13	108:26:26
STS-3 - Columbia	Lousma, Fullerton	192:04:45	384:09:30
STS-4 - Columbia	Mattingly, Hartsfield	169:09:40	338:19:20
STS-5 - Columbia	Brand, Overmyer, Allen, Lenoir	122:14:26	488:57:44
STS-6 - Challenger	Weitz, Bobko, Peterson, Musgrave	120:23:42	481:34:48
STS-7 - Challenger	Crippen, Hauch, Ride, Fabian, Thagard	146:23:59	731:59:55
STS-8 - Challenger	Truly, Brandenstein, D. Gardner, Bluford, W. Thornton	145:08:43	725:43:35
STS-9 - Columbia	Young, Shaw, Garriott, Parker, Lichtenberg, Merbold	247:47:24	1486:44:24
STS-41B - Challenger	Brand, Gibson, McCandless, McNair, Stewart	191:15:55	956:19:35
STS-41C - Challenger	Crippen, Scobee, van Hoften, G. Nelson, Hart	167:40:07	838:20:35
STS-41D - Discovery	Hartsfield, Coats, Resnik, Hawley, Mullane, C. Walker	144:56:04	869:36:24
STS-41G - Challenger	Crippen, McBride, Ride, Sullivan, Leetsma, Garneau, Scully-Power	197:23:33	1381:44:51
STS-51A - Discovery	Hauck, D. Walker, Gardner, A. Fisher, Allen	191:44:56	958:44:40
STS-51C - Discovery	Mattingly, Shriver, Onizuka, Buchli, Payton	73:33:23	367:46:55
STS-51D - Discovery	Bobko, Williams, Seddon, Hoffman, Griggs, C. Walker, Garn	167:55:23	1175:27:41
STS-51B - Challenger	Overmyer, Gregory, Lind, Thagard, W. Thornton, van den Berg, Wang	168:08:46	1177:01:22
STS-51G - Discovery	Brandenstein, Creighton, Lucid, Fabian, Nagel, Baudry, Al-Saud	169:38:52	1187:32:04
STS-51F - Challenger	Fullerton, Bridges, Musgrave, England, Henize, Acton, Bartoe	190:45:26	1335:18:02
STS-51I - Discovery	Engle, Covey, van Hoften, Lounge, W. Fisher	170:17:42	851:28:30
STS-51J - Atlantis	Bobko, Grabe, Hilmers, Stewart, Pailes	97:44:38	488:53:10
STS-61A - Challenger	Hartsfield, Nagel, Buchli, Bluford, Dunbar, Furrer, Messerschmid, Ockels	168:44:51	1349:58:48
STS-61B - Atlantis	Shaw, O'Connor, Cleave, Spring, Ross, Neri Vela, C. Walker	165:04:49	1155:33:43
STS-61C - Columbia	R. Gibson, Bolden, Chang-Diaz, Hawley, G. Nelson, Cenker, B. Nelson	146:03:51	1022:26:57
STS-51L - Challenger	Scobee, Smith, Resnik, Onizuka, McNair, Jarvis, McAuliffe	N/A	N/A
STS-26 - Discovery	Hauck, Covey, Lounge, Hilmers, G. Nelson	97:00:11	485:00:55
STS-27 - Atlantis	R. Gibson, Gardner, Mullane, Ross, Shepherd	105:05:37	525:28:05
STS-29 - Discovery	Coats, Blaha, Bagian, Buchli, Springer	119:38:52	598:14:20
STS-30 - Atlantis	Walker, Grabe, Thagard, Cleave, Lee	96:56:25	484:47:35
STS-28 - Columbia	Shaw, Richards, Leetsma, Adamson, Brown	121:00:09	605:00:45
STS-34 - Atlantis	Williams, McCully, Baker, Chang-Diaz, Lucid	119:39:24	598:17:00
STS-33 - Discovery	Gregory, Blaha, Musgrave, K. Thornton, Carter	120:06:49	600:34:05
STS-32 - Columbia	Brandenstein, Wetherbee, Dunbar, Ivins, Low	261:00:37	1305:03:05
STS-36 - Atlantis	Creighton, Casper, Hilmers, Mullane, Thuot	106:18:23	531:31:55
STS-31 - Discovery	Shriver, Bolden, McCandless, Hawley, Sullivan	121:16:05	606:20:25
STS-41 - Discovery	Richards, Cabana, Melnick, Shepard, Akers	98:11:00	490:45:00
STS-38 - Atlantis	Covey, Springer, Meade, Culbertson, Gemar	117:55:00	589:35:00
STS-35 - Columbia	Brand, Lounge, Hoffman, Parker, G. Gardner, Panse, Durrance	215:08:00	1505:42:00
STS-37 - Atlantis	Nagel, Cameron, Ross, Apt, Godwin	143:33:40	717:48:20
STS-39 - Discovery	Coats, Hammond, Harbaugh, Hieb, McMonagle, Bluford, Veach	199:23:16	1394:42:52
STS-40 - Columbia	Gutierrez, Seddon, Bagian, Jernigan, Gaffney, Hughes-Fulford, O'Connor	218:15:14	1527:46:38
STS-43 - Atlantis	Blaha, Baker, Lucid, Low, Adamson	213:22:26	1066:52:10
STS-48 - Discovery	Creighton, Reightler, Buchli, Brown, Gemar	128:28:17	642:21:25
STS-44 - Atlantis	Gregory, Hennicks, Musgrave, Runco, Voss, Hennen	170:52:36	1025:15:36
TOTAL SHUTTLE FLIGHTS 38		6437:48:31	35271:47:14

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-1 Columbia Mission Duration: 54 hrs 20 min 32 sec	Apr 12, 1981 KSC	Apr 14, 1981 DFRF	Cdr: John W. Young Plt: Robert L. Crippen	**Deployable Payloads: None** **Attached PLB Payloads:** 1. Passive Sample Array 2. DFI (Development Flight Instrumentation) Pallet	3. ACIP (Aerodynamic Coefficient Identification Package) Package) **GAS (Getaway Special): None** **Crew Compartment Payloads: None** **Special Payload Mission Kits: None**
STS-2 Columbia Mission Duration: 54 hrs 13 min 13 sec	Nov 12, 1981 KSC	Nov 14, 1981 DFRF	Cdr: Joe Henry Engle Plt: Richard H. Truly	**Deployable Payloads: None** **Attached PLB Payloads:** 1. OFT (Orbital Flight Test) Pallet: a. MAPS (Measurement of Air Pollution From Satellite) b. SMIRR (Shuttle Multispectral Infrared Radiometer) c. SIR (Shuttle Imaging Radar) d. FILE (Features Identification and Location Experiment) e. OCE (Ocean Color Experiment)	2. DFI (Development Flight Instrumentation) Pallet 3. ACIP (Aerodynamic Coefficient Identification Package) 4. IECM (Induced Environment Contamination Monitor) 5. OSTA-1 (Office of Space and Terrestrial Applications) **GAS (Getaway Special): None** **Crew Compartment Payloads: None** **Special Payload Mission Kits:** 1. RMS (Remote Manipulator System) S/N 201
STS-3 Columbia Mission Duration: 192 hrs 4 min 45 sec	Mar 22, 1982 KSC	Mar 30, 1982 White Sands	Cdr: Jack R. Lousma Plt: Charles G. Fullerton	**Deployable Payloads:** 1. Plasma Diagnostic Package **Attached PLB Payloads:** 1. OSS (Office of Space Science)-1 Pallet a. Plant Lignificantion Experiment b. SMIRR (Shuttle Multispectral Infrared Radiometer) c. SIR (Shuttle Imaging Radar) d. FILE (Features Identification and Location Experiment) e. OCE (Ocean Color Experiment)	2. DFI (Development Flight Instrumentation) Pallet 3. ACIP (Aerodynamic Coefficient Identification Package) 4. IECM (Induced Environment Contamination Monitor) 5. OSTA-1 (Office of Space and Terrestrial Applications) **GAS (Getaway Special): None** **Crew Compartment Payloads: None** **Special Payload Mission Kits** 1. RMS (Remote Manipulator System) S/N 201

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-4 Columbia	Jun 27, 1982 KSC	Jul 4, 1982 DFRF	Cdr: Thomas K. Mattingly II Plt: Henry W. Hartsfield, Jr. Mission Duration: 169 hrs 9 min 40 sec	**Deployable Payloads:** 1. IECM (Induced Environment Contamination Monitor) deployed/reberthed by RMS **Attached PLB Payloads:** 1. DFI (Development Flight Instrumentation) Pallet **Department of Defense** 1. DOD 82-1 **GAS (Getaway Special)** 1. Utah State University a. Drosophila Melanogaster (fruit fly) Growth Experiment b. Artemia (Brine Shrimp) Growth Experiment c. Surface Tension Experiments d. Composite Curing Experiment e. Thermal Conductivity Experiment f. Microgravity Soldering Experiment	g. Root growth of Lemna Minor L. (Duckweed) in Microgravity h. Homogeneous Alloy Experiment i. Algal Microgravity Bioassay Experiment **Crew Compartment Payloads** 1. MLR (Monodisperse Latex Reactor) 2. CFES (Continuous Flow Electrophoresis System) 3. SSIP (Shuttle Student Involvement Program) S404: Effect of Prolonged Space Travel on Levels of Trivalent Chromium in the Body S405: Effect of Diet, Exercise, and Zero Gravity on Lipoprotein Profiles 4. VPCF (Vapor Phase Compression Freezer) **Special Payload Mission Kits** 1. RMS (Remote Manipulator System) S/N 201
STS-5 Columbia	Nov 11, 1982 KSC	Nov 16, 1982 DFRF	Cdr: Vance DeVoe Brand Plt: Robert F. Overmyer MS: Joseph P. Allen MS: William B. Lenoir Mission Duration: 192 hrs 4 min 45 sec	**Deployable Payloads:** 1. SBS-C/PAM-D (Satellite Business Systems/ Payload Assist Module) 2. ANIK-C/PAM-D (Telesat Canada, Ltd/Payload Assist Module) **Attached PLB Payloads:** 1. DFI (Development Flight Instrumentation) a. EIOM (Effects of Interaction of Oxygen with Materials) b. ISAL (Investigation of STS Atmospheric Luminosities)	**GAS (Getaway Special)** 1. G-026: ERNO/Stability of Metallic Dispersions (JSC PIP 14021) **Crew Compartment Payloads** 1. SSIP (Shuttle Student Involvement Program) a. SE81-5 - Crystal Formation in Zero Gravity b. SE81-9 - Convection in Zero Gravity c. SE81-2 - Growth of Porifera **Special Payload Mission Kits** 1. Mission Specialist Seats (2)

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-6 Challenger	Apr 4, 1983 KSC	Apr 9, 1983 DFRF	Cdr: Paul J. Weitz Plt: Karol J. Bobko MS: Donald H. Peterson MS: Story Musgrave Mission Duration: 120 hrs 23 min 42 sec	**Deployable Payloads:** 1. TDRS-A/IUS (Tracking and Data Relay Satellite/ Inertial Upper Stage) **Attached PLB Payloads:** 1. CBSA (Cargo Bay Stowage Assembly **GAS (Getaway Special)** 1. G-005: Asahi Shimban, Japan 2. G-049: U.S. Air Force Academy 3. G-381: Park Seed Company	**Crew Compartment Payloads** 1. CFES (Continuous Flow Electrophoresis System) 2. MLR (Monodisperse Latex Reactor) 3. RME (Radiation Monitoring Experiment) 4. NOSL (Night/Day Optical Survey of Lightning) **Special Payload Mission Kits** 1. Mini-MADS (Modular Auxiliary Data System) 2. EMU (Extravehicular Mobility Unit)
STS-7 Challenger	Jun 18, 1983 KSC	Jun 24, 1983 DFRF	Cdr: Robert L. Crippen Plt: Frederick H. Hauck MS: John M. Fabian MS: Sally K. Ride MS: Norman E. Thagard Mission Duration: 146 hrs 23 min 59 sec	**Deployable Payloads:** 1. ANIK-C/PAM-D: Telesat Canada Satellite Upper Stage) 2. Palapa-B1/PAM-D: Indonesian Satellite 3. SPAS (Shuttle Pallet Satellite)-01 Unberthing/Berthing Tests **Attached PLB Payloads:** 1. OSTA (Office of Space and Terrestrial Applications)-2 2. CBSA (Cargo Bay Stowage Assembly) **GAS (Getaway Special)** 1. G-033: California Institute of Tech - Plant Gravireception and Liquid Dispersion 2. G-088: Edsyn, Inc. - Soldering of Material 3. G-002: Kayser Threde, W. Germany - Youth Fair Experiment	4. G-009: Purdue University - Geotropism Fluid Dynamics and Nuclear Particle Velocity 5. G-305: U.S. Air Force and National Research Labs - Ultraviolet Spectrometer 6. G-012: RCA, Camden, NJ Schools - Ant Colony 7. G-345: Goddard Space Flight Center and National Research Labs - Payload Bay Environment **Crew Compartment Payloads** 1. CFES (Continuous Flow Electrophoresis System) 2. MLR (Monodisperse Latex Reactor) 3. SSIP (Shuttle Student Involvement Program) **Special Payload Mission Kits** 1. RMS (Remote Manipulator System) S/N 201 2. TAGS (Text and Graphics System) 3. Mini-MADS (Modular Auxiliary Data System)

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-8 Challenger	Aug 30, 1983 KSC	Sep 5, 1983 DFRF	Cdr: Richard H. Truly Plt: Daniel C. Brandenstein MS: Dale A. Gardner MS: Guion S. Bluford, Jr. MS: William E. Thornton Mission Duration: 145 hrs 8 min 43 sec	**Deployable Payloads:** 1. Insat/PAM-D: Indian National Satellite 2. PFTA (Payload Flight Test Article) Unberthing/ Berthing Tests **Attached PLB Payloads:** 1. DFI (Development Flight Instrumentation) a. Oxygen Interaction and Heat Pipe Experiment b. Postal Covers (2 boxes) 2. CBSA (Cargo Bay Stowage Assembly) 3. SPAS (Shuttle Pallet Satellite)-01 Umbilical Disconnect **GAS (Getaway Special)** 1. U.S. Postal Service - 8 cans of philatelic covers 2. G-475: Asahi Shimban - Artificial Snow Crystal Experiment 3. G-348: Office of Space Science - Atomic Oxygen Erosion 4. G-347: Navy Research Lab - Ultraviolet Photo Film Test	5. G-346: Goddard Space Flight Center - Cosmic Ray Upset Experiment **Crew Compartment Payloads** 1. CFES (Continuous Flow Electrophoresis System) 2. ICAT (Incubator-Cell Attachment Test) 3. ISAL (Investigation of STS Atmospheric Luminosities) 4. AEM (Animal Enclosure Module) - Evaluation of AEM using rate 5. RME (Radiation Monitoring Experiment) 6. SSIP (Shuttle Student Involvement Program) - Biofeedback **Special Payload Mission Kits** 1. RMS (Remote Manipulator System) S/N 201 2. MADS (Modular Auxiliary Data System) II 3. COMSEC (Communication Security) 4. TAGS (Text and Graphics System)
STS-9 Columbia	Nov 28, 1983 KSC	Dec 8, 1983 DFRF	Cdr: John W. Young Plt: Brewster W. Shaw MS: Owen K. Garriott MS: Robert A. R. Parker PS: Byron K. Lichtenberg PS: Ulf Merbold Mission Duration: 247 hrs 47 min 24 sec	**Deployable Payloads: None** **Attached PLB Payloads:** 1. Spacelab-1: a. Spacelab Long Module b. Spacelab Pallet c. Tunnel d. Tunnel Extension e. Tunnel Adapter 2. Experiments a. Astronomy and Physics (6) b. Atmospheric Physics (4) c. Earth Observations (2)	d. Life Sciences (16) e. Materials Sciences (39) f. Space Plasma Physics (5) g. Technology (1) **GAS (Getaway Special): None** **Crew Compartment Payloads: None** **Special Payload Mission Kits** 1. Cryogenic sets 4 and 5 2. Spacelab Utility Kit 3. TAGS (Text and Graphics System) 4. Galley

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-41B Challenger	Feb 3, 1984 KSC	Feb 11, 1984 KSC	Cdr: Vance D. Brand Plt: Robert L. Gibson MS: Bruce McCandless MS: Robert L. Stewart MS: Ronald E. McNair Mission Duration: 191 hrs 15 min 55 sec	**Deployable Payloads:** 1. Westar VI/PAM-D - Western Union Communications Satellite/Payload Assist Module 2. Palapa-B/PAM-D - Indonesian Communications Satellite/Payload Assist Module 3. SPAS (Shuttle Pallet Satellite)-01 - Not Deployed due to RMS anomaly 4. IRT (Integrated Rendezvoud Target) - Failed to inflate due to internal failure **Attached PLB Payloads:** 1. MFR (Manipulator Foot Restraint) 2. SESA (Special Equipment Stowage Assembly) 3. Cinema 360 - High Quality Motion Picture Camera **GAS (Getaway Special)** 1. G-004: Utah State University/Aberdeen University 2. G-008: Utah State University/University of Utah/ Brighton High School 3. G-051: General Telephone Labs 4. G-309: U.S. Air Force 5. G-349: Goddard Space Flight Center (re: flight STS-8)	**Crew Compartment Payloads** 1. ACES (Acoustic Containerless Experiment System) 2. IEF (Isoelectric Focusing) 3. Cinema 360 Camera 4. Student Experiment SEB1-10 - Effects of Zero g on Arthritis 5. MLR (Monodisperse Latex Reactor) 6. RME (Radiation Monitoring Experiment) **Special Payload Mission Kits** 1. RMS (Remote Manipulator System) S/N 201 2. MMU (Manned Maneuvering Unit) - 2 3. Mini-MADS (Modular Auxiliary Data System) 4. Galley

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-41C Challenger	Apr 6, 1984 KSC	Apr 13, 1984 DFRF	Cdr: Robert L. Crippen Plt: Francis R. Scobee MS: Terry J. Hart MS: James D. Van Hoften MS: George D. Nelson Mission Duration: 167 hrs 40 min 7 sec	**Deployable Payloads:** 1. LDEF (Long Duration Exposure Facility) - Office of Aeronautics and Space Technology 2. SMM (Solar Maximum Mission) Spacecraft - Rendezvous/Retrieve/Repair/Deploy **Attached PLB Payloads:** 1. SMRM (Solar Maximum Repair Mission) - Flight Support System 2. Cinema 360 - High Quality Motion Picture Camera 3. CBSA (Cargo Bay Stowage Assembly) - Bay 2, starboard side **GAS (Getaway Special): None**	**Crew Compartment Payloads** 1. RME (Radiation Monitoring Experiment) 2. IMAX Camera - Canadian Commercial Company color film camera using 70mm x 280mm film 3. SSIP (Shuttle Student Involvement Program) - Comparison of honeycomb structure of bees in low g and bees in 1g **Special Payload Mission Kits** 1. MMU (Manned Maneuvering Units) - 2 2. EMU (Extravehicular Mobility Units) - 3 3. RMS (Remote Manipulator System) S/N 302
STS-41D Discovery	Aug 30, 1984 KSC	Sep 5, 1984 EAFB	Cdr: Henry W. Hartsfield Plt: Michael L. Coats MS: Richard M. Mullane MS: Steven A. Hawley MS: Judith A. Resnik PS: Charles D. Walker Mission Duration: 144 hrs 56 min 4 sec	**Deployable Payloads:** 1. SBS/PAM-D (Satellite Business System/Payload Assist Module) 2. Syncom IV-2 (Leased to DOD for UHF and SHF communications, also called Leasat) 3. Telstar/PAM-D (American Telephone and Telegraph/Payload Assist Module) **Attached PLB Payloads:** 1. OAST-1 (Office of Aeronautics and Space Technology) a. SAE (Solar Array Experiment) b. DAE (Dynamic Augmentation Experiment) c. SCCF (Solar Cell Calibration Facility) **GAS (Getaway Special): None**	**Crew Compartment Payloads** 1. CFES III (Continuous Flow Electrophoresis System) 2. IMAX Camera - IMAX System Corporation (Canadian Company) 70mm x 280mm film 3. RME (Radiation Monitoring Experiment) USAF Space Division 4. Clouds - USAF Mikon F 3/T with 105mm lens 5. SSIP - (Shuttle Student Involvement Program) - Grow single crystal of Indium, Shawn Murphy, Hiram, OH; Rockwell Intl, Sponsor **Special Payload Mission Kits** 1. RMS (Remote Manipulator System) S/N 301 2. MADS (Modular Auxiliary Data System)

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-41G Challenger	Oct 5, 1984 KSC	Oct 13, 1984 KSC	Cdr: Robert L. Crippen Plt: Jon A. McBride MS: Kathryn D. Sullivan MS: Sally K. Ride MS: David D. Leetsma PS: Marc D. Garneau PS: Paul D. Scully-Power	**Deployable Payloads:** 1. ERBS (Earth Radiation Budget Satellite) **Attached PLB Payloads:** 1. OSTA-3 (Office of Space and Terrestrial Applications) a. SIR-B (Shuttle Imaging Radar) b. FILE (Feature Identification and Location Experiment) c. MAPS (Measurement of Air Pollution from Satellite) 2. LFC (Large Format Camera) 3. ORS (Orbital Refueling System) a. SAE (Solar Array Experiment) b. DAE (Dynamic Augmentation Experiment) c. SCCF (Solar Cell Calibration Facility) **Crew Compartment Payloads** 1. APE (Auroral Photography Experiment) 2. CANEX (Canadian Experiments) a. VISET b. ACOMEX c. OGLOW (Orbital Glow and Atmospheric Emissions) d. SPEAM (Sun Photometer Earth Atmosphere Measurement) 3. IMAX Camera 4. RME (Radiation Monitoring Experiment) 5. TLD (Thermoluminescent Dosimeter)	**GAS (Getaway Special)** 1. G007: Alabama Space and Rocket Center - Solidification of lead-antimony; and aluminum-copper student experiment 2. G032: ASAHI National Broadcasting Corp. Japan - Surface tension and viscosity; and materials experiment 3. G306: Air Force and U.S. Naval Research Laboratory Magnetosphere Energy Heavy Ions Search in the Inner Magnetosphere 4. G469: Goddard Space Flight Center - Cosmic Ray Upset Experiment (CRUX) 5. G038: Marshall-McShane - Vapor Deposition of Metals And Non-Metals 6. G074: McDonnell Douglas Company - Study Proposed Propellant Acquisition System 7. G013: Kayser Threde, West Germany - Verify Transport Mechanism in Halogen Lamps Performance in Extended Micro-g 8. G518: Utah State Univsersity - Study Solar Flux Separation, Capillary Waves on Water Surface, and Thermo-Capillary Flow in Liquid Columns **Special Payload Mission Kits** 1. RMS (Remote Manipulator System) S/N 302 2. Galley 3. MMU (Manned Maneuvering Units) - 2 4. EMU (Extravehicular Mobility Units) - 3 5. PSA (Provisions Stowage Assembly)

Mission Duration: 197 hrs 23 min 33 sec

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-51A Discovery	Nov 8, 1984 KSC	Nov 16, 1984 KSC	Cdr: Frederick H. Hauck Plt: David M. Walker MS: Joseph P. Allen MS: Anna L. Fisher MS: Dale A. Gardner Mission Duration: 191 hrs 44 min 56 sec	**Deployable Payloads:** 1. Telesat-H (ANIK)-D2/PAM-D - Canadian 24 channel communications satellite. 2. Syncom IV-1 - Synchronous Communications Satellite, also called Leasat, leased to U.S. Navy **Retrieved Payloads:** 1. Palapa-B2 - Deployed during mission STS 41-B, failed to achieve proper transfer orbit due to PAM-D failure 2. Westar-VI - Deployed during mission 41-B, failed to achieve proper transfer orbit due to PAM-D failure **Attached PLB Payloads: None** **Crew Compartment Payloads** 1. DMOS (Diffusive Mixing of Organic Solutions) 3M Corp 2. RME (Radiation Monitoring Experiment)	**GAS (Getaway Special): None** **Special Payload Mission Kits** 1. RMS (Remote Manipulator System) S/N 301 2. MMU (Manned Maneuvering Units) (2) 3. EMU (Extravehicular Mobility Units) (3) 4. PSA (Provisions Stowage Assembly) (2) 5. Satellite Retrieval Hardware: a. Modified Spacelab Pallet (2) b. MFR (Manipulator Foot Restraint) (2) c. Stinger Adapter (2) d. Satellite Adapter Trunnion (2) e. Berthing A Frame
STS-51C Discovery	Jan 24, 1985 KSC	Jan 27, 1985 KSC	Cdr: Thomas K. Mattingly Plt: Loren J. Shriver MS: Ellison S. Onizuka MS: James F. Buchli PS: Gary E. Payton Mission Duration: 73 hrs 33 min 23 sec	**Deployable Payloads:** Data not available, DOD Classified Mission **Attached PLB Payloads:** Data not available, DOD Classified Mission **GAS (Getaway Special)** Data not available, DOD Classified Mission	**Crew Compartment Payloads** Data not available, DOD Classified Mission **Special Payload Mission Kits** 1. RMS (Remote Manipulator System) S/N 301 2. Other data not available, DOD Classified Mission

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-51D Discovery	Apr 12, 1985 KSC	Apr 19, 1985 KSC	Cdr: Karol J. Bobko Plt: Donald E. Williams MS: M.Rhea Seddon MS: S. David Griggs MS: Jeffrey A. Hoffman PS: Charles D. Walker PS: E. J. Garn	**Deployable Payloads:** 1. Syncom IV-3 - Synchronous Communications Satellite, built by Hughes, third in a series of 4, leased to the Navy. Failed to activate after nominal deploy from Orbiter. 2. Telesat I (Anik C-1)/PAM-D - Canadian communications satellite. Placed in 3 year storage orbit. **Attached PLB Payloads: None** **GAS (Getaway Special)** 1. G035 - Asahi National Broadcasting Corp, Japan a. Surface tension and viscosity b. Alloy, lead oxide and carbon fiber 2. G471 - Goddard Space Flight Center, Thermal Engineering Branch. Capillary Pump Loop (CPU) Priming Experiment	**Crew Compartment Payloads** 1. CFES III (Continuous Flow Electrophoresis System) 2. AFE (American Flight Echocardiograph) 3. PPE (Phase Partitioning Experiment) 4. SSIP (Shuttle Student Involvement Program) (2) a. Corn Statolith b. Brain Cell **Special Payload Mission Kits** 1. RMS (Remote Manipulator System) S/N 301 2. PSA (Provision Stowage Assembly) 3. MADS III (Modular Auxiliary Data System)
Mission Duration: 167 hrs 55 min 23 sec					

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-51B Challenger	Apr 29, 1985 KSC	May 6, 1985 DFRF	Cdr: R. F. Overmyer Plt: F. D. Gregory MS: Don L. Lind MS: Norman E. Thagard MS: William E. Thornton PS: Lodewijk Vandenberg PS: Taylor Wang	**Deployable Payloads:** Refer to GAS Section **Attached PLB Payloads: Spacelab 3** 1. Materials Processingin Space a. Solution Growth of Crystals in Zero Gravity b. Mercuric Iodide Crystal Growth, Vapor Crystal Growth System (VCGS) c. Mercury Iodide Crystal Growth (MICG) 2. Technology a. Dynamics of Rotating and Oscillating Free Drops (DROP) 3. Environmental Observations a. Geophysical Fluid Flow Cell Experiment (GFFC) b. Atmospheric Trace Molecule Spectroscopy (ATMOS) c. Very Wide Field Galactic Camera (VWFGC) d. Aurora Observation 4. Astro Physics a. Studies of the Ionization States of Solar and Galactic Cosmic Ray Heavy Nuclei (ION) 5. Life Sciences a. Research Animal Holding Facility (RAHF) b. Urine Monitoring Investigation (UMI) c. Autogenic Feedback Training (AFT)	**GAS (Getaway Special)** 1. G010 - NUSAT, Northern Utal Satellite. Weber State College, Utah, Utah State University, and New Mexico State University. First successful payload ejection from a GAS canister. 2. G303 - GLOMR, Global Low Orbiting Message Relay Satellite. Defense Systems, Inc., McLean, VA. Failed to eject from GAS canister. **Crew Compartment Payloads** 1. UMS: Urine Monitoring System **Special Payload Mission Kits** 1. Airlock 2. Long Transfer Tunnel 3. Galley 4. MPESS - Mission Peculiar Equipment Support Structure, carried ATMOS and ION.

Mission Duration: 168 hrs 8 min 46 sec

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments
STS-51G Discovery	Apr 29, 1985 KSC	May 6, 1985 EDW	Cdr: Daniel Brandenstein Plt: John O. Creighton MS: John M. Fabian MS: Steven R. Nagel MS: Shannon W. Lucid PS: Patrick Baudry PS: Prince Sultan Salman Al-Saud Mission Duration: 168 hrs 8 min 46 sec	**Deployable Payloads:** 1. Telstar-3D/PAM-D: Hughes 376 Communications Satellite with McDac Payload Assist Module Booster. Owned by AT&T Co 2. ARABSAT-A/PAM-D: Aerospatiale Communication Satellite with McDac Payload Assist Module Booster. Owned by Saudi Arabian Communications Organization c. Mercury Iodide Crystal Growth (MICG) 3. MORELOS-A/PAM-D: Hughes 376 Communications Satellite with McDac Payload Assist Module Booster. Owned by Mexican Communications and Transportation Agency 4. Spartan-1: Shuttle Pointed Autonomous Research Tool for Astronomy a. SPSS: Spartan Flight Support Structure b. REM: Release/Engage Mechanism c. SEC: Scientific Experiment Carrier The SEC was released and retrieved using REM and RMS (Remote Manipulator System) **Attached PLB Payloads: None** **GAS (Getaway Special)** 1. G007 - Alabama Space and Rocket Center/Marshall Amateur Radio Club - a. Solidification of Metals b. Crystal Growth c. Radish Seed Root Study d. Radio Transmission Experiment 2. G025 - ERNO - Dynamic Behavior of Liquid Propellants in low-g 3. G027: DFVLR of West Germany - Manganese - Bismuth production in micro-g. 4. G034: Dickshire Coors, Texas High School Students a. 12 Biological/physical science eperiments b. 1 Microprocessor controller 5. G314: USAF and USNRL - SURE (Space Ultraviolet Radiation Experiment) **Crew Compartment Payloads** 1. ADSF - Automated Directional Solidification Furnace 2. FEE - French Echocardiograph Experiment 3. FPE - French Postural Experiment 4. HPTE - High Precision Tracking Experiment **Special Payload Mission Kits** 1. RMS (Remote Manipulator System) S/N 301

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments
STS-51F Challenger	Jul 29, 1985 KSC	Aug 6, 1985 EDW	Cdr: Charles Fullerton Plt: Roy D. Bridges MS: F. Story Musgrave MS: Anthony W. England MS: Karl G. Henize PS: Loren W. Acton PS: John-David Bartoe	**Deployable Payloads:** 1. Ejectable Plasma Diagnostic Package, Exp No 3, second flight of PDP (STS-3 first flight). First flight as free flyer to sample plasma away from Shuttle **Attached PLB Payloads: Spacelab 2** 1. Plasma Physics a. Deployable/Retrievable Plasma Diagnostic Package (PDP) (Exp 3) b. Plassma Depletion Experiments for Ionospheric and Radio astronomical Studies (Exp 4) 2. Astrophysical Research a. Small Helium Cooled Infrared Telescope (IRT) (Exp 5) b. Hard X-ray Imaging of Cluster of Galaxies and Other Extended X-ray Sources (XRT) (Exp 7) c. Elemental Composition and Energy Spectra of Cosmic Ray Nuclei (CRNE) (Exp 4) 3. Solar Astronomy a. Solar Magnetic and Velocity Field Measurement System (SOUP) (Exp 8) b. Coronal Helium Abundance Spacelab Experiment (CHASE) (Exp 9) c. High Resolution Telescope and Spectrograph (HRTS) (Exp 10) d. Solar Ultraviolet Spectral Irradiance Monitor (SUSIM) (Exp 11) 4. Technology a. Properties of Superfluid Helium Zero-g (SFHe) (Exp 13) **GAS (Getaway Special): None** **Crew Compartment Payloads** 1. Life Sciences a. Vitamin D Metabolites and Bone Demineralization (Exp 1) b. The Interaction of Oxygen and Gravity Induced Lignification (Exp 2) c. Shuttle Amateur Radio Experiment (SAREX) d. Dispenser Technology Experiment Dispensing Carbonated beverages in Micro-g e. Protein Crystal Growth **Special Payload Mission Kits** 1. RMS (Remote Manipulator System) S/N 302 2. Galley

Mission Duration: 190 hrs 45 min 26 sec

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-51I Discovery	Aug 27, 1985 KSC	Sep 3, 1985 EDW	Cdr: Joe H. Engle Plt: Richard O. Covey MS: James van Hoften MS: John M. Lounge MS: William F. Fisher Mission Duration: 97 hrs 44 min 38 sec	**Deployable Payloads:** 1. ASC-1/PAM-D: American Satellite Company, first of two satellites built by RCA and owned by a partnership between Fairchild Industries and Continental Telecon Inc. PAM-D Payload Assist Module built by McDonnell Douglas. "D" indicates used for lightweight satellites, less than 2,250 lbs. 2. AUSSAT-1/PAM-D: Australian Communications Satellite, owned by Aussat Proprietary Ltd., built by Hughes Communications International, Model HS376. 3. SYNCOM IV-4: Synchronous Communications Satellite. Last in a series of four satellites built by Hughes Communication Services and leased to the Navy. Referred to as LEASAT when deployed. Failed to function after reaching correct geosynchronous orbit.	**Attached PLB Payloads: None** **GAS (Getaway Special): None** **Crew Compartment Payloads** 1. PVTOS - Physical Vapor Transport Organic Solid Experiment, 3M Corporation. **Special Payload Mission Kits** 1. RMS (Remote Manipulator System) S/N 301 2. Galley 3. Leasat-3 Salvage Equipment. Leasat-3 was successfully retrieved, repaired, and redeployed.
STS-51J Atlantis	Oct 3, 1985	Oct 7, 1985	Cdr: Karol Bobko Plt: Ronald J. Grabe MS: Robert C. Stewart MS: David C. Hilmers PS: William A. Pailes Mission Duration: 73 hrs 33 min 23 sec	**Deployable Payloads:** Data not available, DOD Classified Mission **Attached PLB Payloads:** Data not available, DOD Classified Mission **GAS (Getaway Special)** Data not available, DOD Classified Mission	**Crew Compartment Payloads** Data not available. DOD Classified Mission **Special Payload Mission Kits** Data not available, DOD Classified Mission

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments
STS-61A Challenger	Oct 30, 1985 KSC	Nov 6, 1985 EDW	Cdr: Henry Hartsfield Plt: Steven Nagel MS: Bonnie Dunbar MS: James Buchli MS: Guion Bluford PS: Ernst Messerschmid PS: Reinhard Furrer PS: Wubbo Ockels	**Deployable Payloads:** 1. GLOMR - Global Low Orbiting Message Relay Satellite. Built by Defense Systems, Inc, for DARPA. First launch attempt was on STS 51B which failed. Deployed from GAS canister. **Attached PLB Payloads: Spacelab D-1** First completed Spacelab mission under German Mission Management. Joint control by BMFT (Federal Ministry of Research and Technology) and DFVLR (Deutsche Forschugs-und Versurchanstalt Fur Luft-und Raumfahrt). 1. WL-Werkstoff Labor; experiments relating to metallurgy, crystal growth, glasses/ceramics, and fluid physics. Experiment facilities include: a. Mirror Heating Facility b. Isothermal Heating Facility c. Gradient Heating Facility d. High Temperature Thermostat e. Fluid Physics Module f. Cryostat 2. PK-Progresskammer; experiment relating to Bubble Transport Media. Experiment Facilities include: a. Holographic Interferometric Apparatus b. Marangoni Convention Boat c. Interdiffusion in Salt Melt 3. MD-MEDEA: A material science double rack. Experiment facilities include: a. Gradient Heating Facility b. Mono-ellipsoid Mirror Heating Facility c. High Precision Thermostat Facility 4. BW-Biowissenschaften: Experiments relating to Life Sciences. Experiments include: a. Biological (1) b. Medical (2) c. Botanical (3) 5. VS-Vestibular Sled: Experiments in Life Science regarding visio-vestibular coordination system and sensory preception process. Experiment facilities include: a. Mechanically accelerated sled b. Instrumented helmet 6. BR-Biorack: Multipurpose facility for biological research in cell development physiology, cell fertilization, and radiobiology. Facilities include: a. 2 Incubators b. Cooler freeze c. Glove box 7. NX-NAVEX: Navigation Experiment; located in payload bay attached to USS (Unique Support Structure) 8. ME-MEA: Materials Experiment Assembly: mounted on USS containing three materials, processing experiments. **GAS (Getaway Special): None** **Crew Compartment Payloads: None** **Special Payload Mission Kits** 1. Airlock 2. Long Transfer Tunnel 3. Galley 4. USS - Unique Support Structure 5. RMS (Remote Manipulator System) S/N 302

Mission Duration: 168 hrs 44 min 51 sec

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-61B Discovery	Nov 26, 1985 KSC	Dec 3, 1985 EAFB	Cdr: Brewster H. Shaw Plt: Bryan D. O'Connor MS: Mary L. Cleave MS: Sherwood C. Spring MS: Jerry L. Ross PS: Rudolfo Neri Vela PS: Charles Walker	**Deployable Payloads:** 1. MORELOS-B/PAM-D: Hughes 376 Comm Satellite with McDAC Payload Assist Module booster. Owned by Mexican Communications and Transportation Agency. 2. AUSSAT-2/PAM-D: Hughes 376 Comm Satellite with McDAC Payload Assist Module booster. Owned by Aussat Proprietary Ltd 3. SYNCOM KU-2/PAM-D: RCA built/owned 16 channel Ku-band communication satellite. First of four satellites. McDAC Payload Assist Module D2 is an uprated version of the PAM-D used for heavier payloads. **Attached PLB Payloads:** 1. EASE (Experiment Assembly of Structures in Extravehicular Activity: A study of EVA dynamics and human factors in construction of structures in space. An inverted tetrahedron consisting of six 12-feet beams was constructed by EV-1 and EV-2. 2. ACCESS (Assembly Concept for Construction of Erectable Space Structures): A validation of ground based timelines based on simulations. A 45-feet truss was assembled/disassembled by the two EV crew members. 3. ICBC (IMAX Cargo Bay Camera): A joint effort between the Canadian IMAX Corp and NASA, consists of a 70mm film camera in pressurized container used to document EASE/ACCESS experiments.	**GAS (Getaway Special)** 1. G-479 - Telesat-Canada a. Primary surface mirror production b. Metallic crystal production **Crew Compartment Payloads** 1. CFES (Continuous Flow Electrophoresis System): Owned by McDonnell Douglas; separates biological samples using electrophoretic process. Third flight of this experiment. 2. DMOS (Diffusive Mixing of Organic Solutions); Sponsored by 3M Corporation, used to study organic crystal growth/kinetics, test molecular orbital model, and produce new materials for electro-optical applications. 3. MPSE (Morelos Payload Specialist Experiments): includes experiments in transportation of nutrients inside bean plants, innoculation of group bacteria viruses, germination of three seed types, and medical experiments testing internal equilibrium and volume change of the leg due to fluid shifts in zero-g. 4. OEX (Orbiter Experiments): An onboard experimental digital autopilot software package designed to provide precise stationkeeping capabilities between space vehicles. **Special Payload Mission Kits** 1. Food Warmers (2), galley not flown. 2. RMS (Remote Manipulator System) S/N 301 3. PSA (Provision Stowage Assembly)

Mission Duration: 165 hrs 4 min 49 sec

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	
STS-61C	Jan 12, 1986	Jan 18, 1986	Cdr:	Robert L. Gibson
Columbia	KSC	KSC	Plt:	C. F. Bolden, Jr.
			MS:	F. R. Chang Diaz
			MS:	George D. Nelson
			MS:	Steven A. Hawley
			PS:	Robert J. Cenker
			PS:	C. William Nelson

Mission Duration: 146 hrs 3 min 51 sec

Payloads and Experiments

Deployable Payloads:

1. SATCOM KU-1/PAM D-2. RCA built/owned 16 channel Ku-band communications satellite. Second of four satellites. McDAC Payload Assist Module D2 is an uprated version of the PAM-D which is used for heavier payloads.

Attached PLB Payloads:

1. MSL-2 (Materials Science Laboratory) consisting of MSL carrier, MPE (Mission Peculiar Equipment), and 3 experiments:
   a. 3AAL (3-Axis Acoustic Levitator)
   b. ADSF (Automated Directional Solidification Furnace)
   c. SEECM (Shuttle Environmental Effects of Coated Mirror)
2. Hitchhiker G-1. A Goddard Space Flight Center (GSFC) managed program consisting of 3 experiments:
   a. PACS (Particle Analysis Camera for Shuttle)
   b. CPL (Capillary Pump Loop)
   c. SEECM (Shuttle Environmental Effects of Coated Mirror)
3. IR-IE (Infrared-Imaging Experiment consisting of a RCA IR TV camera mounted in Orbiter CCTV pan/tilt unit.

GAS (Getaway Special)

1. G-464. UVX (Ultraviolet Experiment), referred to as UCB University of California at Berkley) contains a Bowyer UV spectrometer. GSFC experiment.
2. G463. UVX, referred to as JHU (John Hopkins University) contains a Feldman Spectrophotometer. GSFC experiment. ACCESS experiments.
3. G462: UVX, referred to as GAP (GSFC Avionics Package) contains Telemetry System, Tape Recorder, and Battery. GSFC experiment.
4. G007: Alabama Space and Rocket Center/Marshall Amateur club. Contains 3 student experiments and 1 radio transmission experiment.
5. G446: HPLC (High Performance Liquid Chromatography) analytical columns. All Tech Assoc. Inc.
6. G494: PHOTONS (Photometric Thermospheric Oxygen Nightglow Study). Canada Centre for Space Science, National Research Council of Canada.
7. Not Numbered: EMP (Environmental Monitoring Package) measures the environment for GSFC.
8. G481: Unprimed, Prepared linen and painted canvas reactions to space travel. Vertical Horizons.
9. G062: 4 part experiment from PA State University/GE.
10. G449: JULIE (Joint Utilization of Laser Integrated Experiments) 4 part experiment from St. Mary's Hospital, Milwaukee, WI.
11. G332: 2 part experiment from Booker T. Washington Senior High School and High School for Engineering, Houston, TX.
12. G310: USAF Academy experiment.

Note: Above 12 listed GAS canisters mounted on GAS Bridge Carrier

13. G470: Experiment from GSFC and U.S. Dept of Agriculture

Crew Compartment Payloads

1. IBSE (Initial Blood Storage Experiment) package in 4 middeck lockers
2. CHAMP (Comet Halley Active Monitoring Program) uses cameras, spectroscopic grating, and filters to observe comet through aft flight deck overheat window.
3. HPCG (Handheld Protein Crystal Growth) experiment.
4. SSIP (Shuttle Student Involvement Program)
   a. SE83-4, Production of Paper Fiber in Space
   b. SE83-6, Argon Injection as an Alternative to Honeycombing.
   c. SE82-19, Measurement of Auxin Levels and Starch Grains in Plant Roots.

Special Payload Mission Kits

1. GAS Bridge Carrier
2. Galley

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments
STS-51L Challenger	Jan 28, 1986 KSC	Jan 28, 1986	Cdr: Francis R. Scobee Plt: Michael J. Smith MS: Judith A. Resnik MS: Ellison S. Onizuka MS: Ronald E. McNair PS: Gregory Jarvis PS: S. Christa McAuliffe (Teacher)	**Deployable Payloads:** 1. TDRS-B/IUS: Tracking and Data Relay Satellite/ Inertial Upper Stage 2. SPARTAN-203/Halley: Shuttle pointed Autonomous Research Tool for Astronomy/Halley's Comet Experiment Deployable/retrieval packages using RMS: a. SPARTAN experiment package: 1) 2 UV Spectrometers from Univ of Colorado 2) 2 Nikon F-3 Cameras 3) Optic Bench b. Halley's Comet Experiment; measure Halley's Comet composition/activity **Attached PLB Payloads: None** **GAS (Getaway Special): None** **Crew Compartment Payloads** 1. Fluid Dynamics Experiment (FDE) - Hughes Aircraft Company Experiment composed of 6 experiments: a. Fluid position and ullage b. Fluid motion due to spin c. Fluid self-inertia d. Fluid motion due to payload deployment e. Energy dissipation due to fluid motion f. Fluid transfer 2. Comet Halley Active Monitoring Program (CHAMP), second flight. 3. Phase Partitioning Experiment (PPE) dissolves two polymer solutions in water to observe their separation. 4. Teacher in Space: Six experiments including hydrophonics, magnetism, Newton's laws, effervescence, chromatography, and simple machines. 5. SSIP (Shuttle Student Involvement Program) packages: a. SE82-4: "The effects of weightlessness on grain formation and strength in metals" - L. Bruce, St. Louis, MO - Sponsor: McDonnell Douglas b. SE82-5: "Utilizing a semi-permeable membrane to direct crystal growth in zero gravity" - S. Cavou, Marlboro, NY - Sponsor: Union College c. "Chicken Embryo Development in Space" - J. Vellinger, Lafayette, IN - Sponsor: Kentucky Fried Chicken Corporation **Special Payload Mission Kits** 1. RMS (Remote Manipulator System) 2. Galley 3. MADS
Mission Duration: N/A				

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments
STS-26	Sep 29, 1988	Oct 3, 1988	Cdr: Frederick H. Hauck	**Deployable Payloads:** 1. TDRS-C/IUS: Tracking and Data Relay Satellite/ InertialUpper Stage. **Attached PLB Payloads:** 1. OASIS-1: Orbiter Experiment Autonomous Supporting Instrumentation System measures and records payload bay environmental data. 1) 2 UV Spectrometers from Univ of Colorado 2) 2 Nikon F-3 Cameras 3) Optic Bench b. Halley's Comet Experiment; measure Halley's Comet composition/activity **Crew Compartment Payloads** 1. PVTOS - Physical Vapor Transport of Organic Solids, 3M Corporation. Second flight. 2. ADSF - Automated Directional Solidification Furnace, MSFC, third flight, test material solidification in zero g. 3. IRCFE - Infrared Communication Flight Experiment, JSC, first flight. Test infrared transmitting crew headsets. 4. PCG - Protein Crystal Growth, MSFC, flown four previous flights in less complicated configurations to examine growth of protein crystals in zero g. 5. IEF - Isoelectric Focusing, MSFC, second flight, test isoelectric transport through a permeable membrane in zero g. 6. PPE - Phase Partitioning Experiment, MSFC, second flight, photograph fluid phase partitioning phenomena in zero g. 7. ARC - Aggregation of Red Blood Cells. MSFC and Australia, investigate aggregation characteristics of human red blood cells in zero g. 8. MLE - Mesoscale Lightning Experiment, MSFC, first flight, photograph atmospheric lightning activity from orbit. 9. ELRAD - Earth Limb Radiance Experiment. JSC, first flight, photograph earth limb radiance pre-sunrise/ post-sunset. 10. Student Experiment SE82-4 - "Effects of weightlessness on Ti grain formation and strength." L. Bruce, St. Louis, MO, Sponsor: McDonnell Douglas 11. Student Experiment SE82-5 - "Utilizing a semi-permeable membrane to direct crystal growth in zero gravity." S. Cavou, Marlboro, NY, Sponsor: Union College **GAS (Getaway Special): None** **Special Payload Mission Kits** 1. Galley 2. MADS
Discovery	KSC	EAFB	Plt: Richard O. Covey MS: John M. Lounge MS: David C. Hilmers MS: George D. Nelson	
Mission Duration: 97 hrs 0 min 11 sec				

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-27 Atlantis Mission Duration: 105 hrs 5 min 37 sec	Dec 2, 1988 KSC	Dec 6, 1988 EAFB	Cdr: Robert L. Gibson Plt: Guy S. Gardner MS: Richard M. Mullane MS: Jerry L. Ross MS: William M. Shepherd	**Deployable Payloads:** Data not available, DOD Classified Mission. **Attached PLB Payloads:** Data not available, DOD Classified Mission. **GAS (Getaway Special): None** Data not available, DOD Classified Mission.	**Crew Compartment Payloads** Data not available, DOD Classified Mission. **Special Payload Mission Kits** Data not available, DOD Classified Mission.
STS-29 Discovery Mission Duration: 119 hrs 38 min 52 sec	Mar 13, 1989 KSC	Mar 17, 1989 EAFB	Cdr: Michael L. Coats Plt: John E. Blaha MS: James P. Gabian MS: James F. Buchli MS: Robert C. Springer	**Deployable Payloads:** 1. TDRS-D/IUS: Tracking and Data Relay Satellite/ Inertial Upper Stage. One of four identical communications satellites providing support for STS and other customers **Attached PLB Payloads:** 1. SHARE (Space Station Heat Pipe Advanced Radiator Element) 2. OASIS-1 (Orbiter Experiments Autonomous Supporting Instrumentation System	**GAS (Getaway Special):** 1. Chicken Embryo Development (CHIX) in space 2. Effects of Weightlessness of Bones (SSIP 82-08) **Crew Compartment Payloads** 1. Protein Crystal Growth (PCG-111-1) 2. Chromosome and Plant Cell Division in Space (CHROMEX) 3. IMAX Camera 4. Air Force Maui Optical Site Calibration Test (AMOS) **Special Payload Mission Kits: None**
STS-30 Atlantis Mission Duration: 121 hrs 0 min 9 sec	May 4, 1989 KSC	May 8, 1989 EAFB	Cdr: David M. Walker Plt: Ronald J. Grabe MS: Norman E. Thagard MS: Mary L. Cleave MS: Mark C. Lee	**Deployable Payloads:** 1. Magellan/IUS - Unmanned three-axis attitude-controlled exploration spacecraft containing systems required to achieve orbit of Venus and map its surface. **Attached PLB Payloads: None**	**GAS (Getaway Special): None** **Crew Compartment Payloads** 1. Fluids Experiment Apparatus (FEA) 2. Mesoscale Lightning Experiment (MLE) 3. Air Force Maui Optical Site Calibration Test (AMOS) **Special Payload Mission Kits: None**
STS-28 Columbia Mission Duration: 121 hrs 0 min 9 sec	Aug 8, 1989 KSC	Aug 13, 1989 EAFB	Cdr: Brewster H. Shaw Plt: Richard N. Richards MS: David C. Leetsma MS: James C. Adamson MS: Mark N. Brown	**Deployable Payloads:** Data not available, DOD Classified Mission. **Attached PLB Payloads:** Data not available, DOD Classified Mission. **GAS (Getaway Special):** Data not available, DOD Classified Mission.	**Crew Compartment Payloads** Data not available, DOD Classified Mission. **Special Payload Mission Kits** Data not available, DOD Classified Mission.

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-34 Atlantis	Oct 18, 1989 KSC	Oct 23, 1989 EAFB	Cdr: Donald E. Williams Plt: Michael McCulley MS: Ellen S. Baker MS: Franklin R. Chang-Diaz MS: Shannon W. Lucid Mission Duration: 119 hrs 39 mins 24 secs	**Deployable Payloads:** 1. Galileo/IUS - Unmanned spin-stabilized exploration spacecraft comprising a Jupiter orbiter and a Jupiter atmospheric entry probe mated to the IUS. **Attached PLB Payloads:** 1. Shuttle Solar Backscatter Ultraviolet (SSBUV) **GAS (Getaway Special):** 1. Zero Gravity Growth of Ice Crystals	**Crew Compartment Payloads** 1. Polymer Morphology 2. Growth Hormone Concentration & Distribution in Plants 3. Sensor Technology Experiment 4. IMAX Camera 5. Mesoscale Lightning Experiment 6. Air Force Maui Optical Site Calibration Test (AMOS) **Special Payload Mission Kits: None**
STS-33 Discovery	Nov 22, 1989 KSC	Nov 27, 1989 EAFB	Cdr: Frederick D. Gregory Plt: John E. Blaha MS: Manley L. Carter MS: Franklin Musgrave MS: Kathryn C. Thornton Mission Duration: 120 hrs 6 mins 49 secs	**Deployable Payloads:** Data not available, DOD Classified Mission. **Attached PLB Payloads:** Data not available, DOD Classified Mission. **GAS (Getaway Special):** Data not available, DOD Classified Mission.	**Crew Compartment Payloads** Data not available, DOD Classified Mission. **Special Payload Mission Kits** Data not available, DOD Classified Mission.
STS-32 Columbia	Jan 9, 1990 KSC	Jan 20, 1990 EAFB	Cdr: Daniel C. Brandenstein Plt: James D. Wetherbee MS: Bonnie J. Dunbar MS: Marsha S. Ivins MS: G. David Low Mission Duration: 261 hrs 0 mins 37 secs	**Deployable Payloads:** 1. Syncom IV-5, a geostationary communications satellite also known as Leasat; leased to U.S. Navy **Attached PLB Payloads: None** **Returned Cargo:** 1. LDEF, a non-powered space vehicle containing experiments - Deployed on STS-41C. **Crew Compartment Payloads** 1. American Flight Echocardiograph (AFE) 2. Air Force Maui Optical Site Calibration Test (AMOS) 3. Characterization of Neurospora Circadian Rhythms (CNCR)	4. Fluids Experiment Apparatus 5. IMAX Camera 6. Latitude/Longitude Locator (L3) 7. Mesoscale Lightning Experiment (MLE) 8. Protein Crystal Growth (PCG) **GAS (Getaway Special): None** **Special Payload Mission Kits** 1. Remote Manipulator System (RMS) 2. Galley 3. MADS

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-36 Atlantis	Feb 28, 1990 KSC	Apr 14, 1990 DFRF	Cdr: John D. Creighton Plt: John H. Casper MS: David C. Hilmers MS: Richard M. Mullane MS: Pierre J. Thuot Mission Duration: 106 hrs 18 mins 23 secs	**Deployable Payloads:** Data not available, DOD Classified Mission. **Attached PLB Payloads:** Data not available, DOD Classified Mission. **GAS (Getaway Special):** Data not available, DOD Classified Mission.	**Crew Compartment Payloads** Data not available, DOD Classified Mission. **Special Payload Mission Kits** Data not available, DOD Classified Mission.
STS-31 Discovery	Apr 24, 1990 KSC	Apr 29, 1990 EAFB	Cdr: Loren J. Shriver Plt: Charles F. Bolden MS: Bruce McCandless MS: Steven A. Hawley MS: Kathryn D. Sullivan Mission Duration: 121 hrs 16 mins 5 secs	**Deployable Payloads:** 1. Hubble Space Telescope (HST), a large aperture optical telescope **Attached PLB Payloads:** 1. IMAX Cargo Bay Camera (ICBC) 2. Ascent Particle Monitor (APM) **GAS (Getaway Special): None** **Crew Compartment Payloads** 1. Air Force Maui Optical Site Calibration Test (AMOS)	2. IMAX Camera 3. Investigation into Polymer Membrane Processing (IPMP) 4. Protein Crystal Growth (PCG) 5. Radiation Monitoring Experiment (RME) 6. Investigation of Arc and Ion Behavior in Microgravity (Student Experiment 82-16) **Special Payload Mission Kits** 1. Remote Manipulator System (RMS) 2. Galley 3. HST EVA Tools
STS-41 Discovery	Oct 6, 1990 KSC	Oct 10, 1990 DFRF	Cdr: Richard N. Richards Plt: Robert D. Cabana MS: Bruce E. Melnick MS: William M. Shepherd MS: Thomas D. Akers Mission Duration: 98 hrs 11 mins	**Deployable Payloads:** 1. Ulysses/IUS/PAM-S **Attached PLB Payloads:** 1. Shuttle Solar Backscatter Ultraviolet (SSBUV) 2. Intelsat Solar Array Coupon (ISAC) - Attached to RMS arm **GAS (Getaway Special): None** 1. Chromosome and Plant Cell Division in Space (CHROMEX) 2. Solid Surface Combustion Experiment (SSCE)	3. Voice Command System (VCS) 4. Physiological Systems Experiment (PSE) 5. Radiation Monitor Experiment (RME-III) 6. Investigation into Polymer Membrane Processing (IPMP) 7. Air Force Maui Optical Site (AMOS) **Special Payload Mission Kits** 1. Remote Manipulator System (RMS) 2. Galley 3. Radioisotope Generator (TRG) Cooling System

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-38 Atlantis Mission Duration: 117 hrs 55 mins	Nov 15, 1990 KSC	Nov 20, 1990 KSC	Cdr: Richard O. Covey Plt: Frank L. Culbertson MS: Robert C. Springer MS: Carl J. Meade MS: Charles D. Gemar	**Deployable Payloads:** Data not available, DOD Classified Mission. **Attached PLB Payloads:** Data not available, DOD Classified Mission. **GAS (Getaway Special):** Data not available, DOD Classified Mission.	**Crew Compartment Payloads** Data not available, DOD Classified Mission. **Special Payload Mission Kits** Data not available, DOD Classified Mission.
STS-35 Columbia Mission Duration: 215 hrs 6 mins	Dec 2, 1990 KSC	Dec 11, 1990 DFRF	Cdr: Vance Brand Plt: Guy S. Gardner MS: John M. Lounge MS: Jeffrey A. Hoffman MS: Robert A. R. Parker PS: Ronald A. Parise PS: Samuel T. Durrance	**Deployable Payloads: None** **Attached PLB Payloads:** 1. Astro-1 - Three ultraviolet telescopes attached to an Instrument Pointing System (IPS): a. Wisconsin UV Photopolarimeter Experiment (WUPPE) b. UV Imaging Telescope (UIT) c. Jopkins UV Telescope (HUT) 2. BBXRT - Broad Band X-ray Telescope. Attached to its own two-axis pointing system (TAPS)	**GAS (Getaway Special): None** **Crew Compartment Payloads** 1. Shuttle Amateur Radio Experiment (SAREX) 2. Air Force Maui Optical Site (AMOS) 3. Ultraviolet Plume Instrument (UVPI) **Special Payload Mission Kits** 1. Galley 2. Aerodynamic Coefficient Identification Package (ACIP)
STS-37 Atlantis Mission Duration: 143 hrs 33 mins 40 sec	Apr 5, 1991 KSC	Apr 11, 1991 EAFB	Cdr: Steven R. Nagel Plt: Kenneth D. Cameron MS: Linda M.Godwin MS: Jerome Apt MS: Jerry L. Ross	**Deployable Payloads:** 1. Gamma Ray Observatory (GRO), an unmanned astronomical observatory designed to image objects at high energy (gamma ray) wavelengths. **Attached PLB Payloads:** 1. Crew and Equipment Translation Aids (CETA) - designed to evaluate candidate techniques/equipment for EVA crewmember translation 2. Ascent Particle Monitor (APM) - designed to assess the particulate contamination in the Orbiter PLB during ascent.	**GAS (Getaway Special): None** **Crew Compartment Payloads** 1. Protein Crystal Growth (PCG)-II 2. Air Force Maui Optical Site (AMOS) 3. Radiation Monitoring Equipment (RME)-III 4. Shuttle Amateur Radio Experiment (SAREX)-II 5. Bioserve/Instrumentation Technology 6. Associates Materials Dispersion Apparatus (BIMDA) **Special Payload Mission Kits** 1. Remote Manipulator System (RMS) S/N 301

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-39 Discovery	Apr 28, 1991 KSC	May 6, 1991 EAFB	Cdr: Michael L. Coats Plt: Blaine L. Hammond, Jr. MS: Guion S. Bluford MS: Gregory J. Harbaugh MS: Richard J. Hieb MS: Donald R. McMonagle MS: Charles L. Veach Mission Duration: 199 hrs 26 mins 16 sec	**Deployable Payloads:** 1. Shuttle Payload Autonomous Satellite (SPAS)-III/ Infrared Background Signature Survey (IBSS) - SPAS-II - IBSS was designed to observe rocket plume firings at infrared wavelengths. **Attached PLB Payloads:** 1. Air Force Program (AFP)-675 - The objective of AFP-675 was to observe near-Earth space and celestial objects at infrared & ultraviolet wavelengths. 2. Space Test Payload (STP)-1 - Five USAF experiments mounted on a Hitchhiker-M carrier.	3. Multi-Purpose Experiment Container (MPEC) - An additional USAF experiment mounted on STP-1. **GAS (Getaway Special): None** **Crew Compartment Payloads** 1. Cloud Logic to Optimize Use of Defense Systems (CLOUDS)-1A 2. Radiation Monitoring Equipment (RME)-III **Special Payload Mission Kits** 1. Remote Manipulator System (RMS) S/N 301 2. Bioserve/Instrumentation Technology 3. Associates Materials Dispersion Apparatus (BIMDA)
STS-40 Columbia	Jun 5, 1991 KSC	Jun 14, 1991 DFRF	Cdr: Bryan O. O'Connor Plt: Sidney M. Gutierrez MS: James P. Bagian MS: Tamara E. Jernigan MS: M. Rhea Seddon PS: Drew F. Gaffney PS: Millie Hughes-Fulford Mission Duration: 218 hrs 15 mins 14 sec	**Deployable Payloads: None** **Attached PLB Payloads: Spacelab Life Sciences (SLS)-1** a. Spacelab Long Module b. Tunnel c. Tunnel Extension d. Tunnel Adapter Experiments a. 6 Body Systems b. 6 Cardiovascular/Cardiopulmonary c. 3 Blood System d. 6 Musculoskeletal e. 3 Neurovestibular f. 1 Immune System g. 1 Renal/Endocrine System Gas Bridge Assembly - 12 - GAS experiments mounted on a truss sturcture in the PLB. **GAS (Getaway Special):** 12 Experiments on GBA 1. Solid State Microaccelerometer Experiment	2. Experiment in Crystal Growth 3. Orbital Ball Bearing Experiment 4. In-Space Commercial Processing 5. Foamed Ultralight Metals 6. Chemical Precipitate Formation 7. Microgravity Experiments 8. Flower and vegetable seeds exposure to Space 9. Semiconductor Crystal Growth Experiment 10. Active Soldering Experiments 11. Orbiter Stability Experiment 12. Effects of cosmic Ray Radiation on Floppy Disks and Plant Seeds Exposure to Microgravity **Crew Compartment Payloads** 1. Physiological Monitoring System (PMS) 2. Urine Monitoring System (UMS) 3. Animal Enclosure Modules (AEM) 4. Middeck Zero-Gravity Experiment (MODE) **Special Payload Mission Kits** 1. Airlock Transfer Tunnel

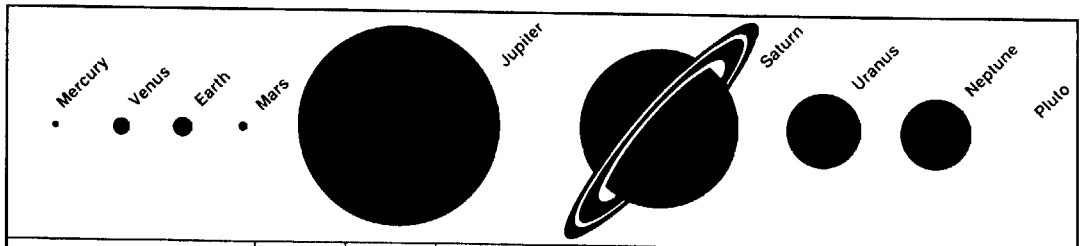
Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-43 Atlantis	Aug 2, 1991 KSC	Aug 11, 1991 KSC	Cdr: John E. Blaha Plt: Michael A. Baker MS: James C. Adamson MS: G. David Low MS: Shannon E. Lucid Mission Duration: 213 hrs 22 mins 26 sec	**Deployable Payloads:** 1. TDRS-D/IUS: Tracking and Data Relay Satellite/ Inertial Upper Stage. One of four identical communications satellites providing support for STS and other customers. **Attached PLB Payloads:** 1. Space Station Heatpipe Advanced Radiator Element (SHARE-II) 2. Shuttle Solar Backscatter Ultraviolet (SSBUV) 3. Optical Communications Through the Window (OCTW) Experiments 1. Gas Bridge Assembly (GBA) **GAS (Getaway Special):** 1. Tank Pressure Control Experiment (TPCE)	**Crew Compartment Payloads** 1. Air Force Maui Optical Site (AMOS) 2. Auroral Photography Experiment (APE) 3. Bioserve/Instrumentation Technology Associates Materials Dispersion Apparatus (BIMDA) 4. Investigations into Polymer Membrane Processing (IPMP) 5. Protein Crystal Growth (PCG) 6. Space Acceleration Measurement System (SAMS) 7. Solid Surface Combustion System (SSCS) 8. Ultraviolet Plume Instrument **Special Payload Mission Kits: None**
STS-48 Discovery	Sep 12, 1991 KSC	Sep 18, 1991 EAFB	Cdr: John O. Creighton Plt: Kenneth S. Reightler MS: Mark F. Brown MS: James F. Buchli MS: Charles D. Gemar Mission Duration: 128 hrs 28 mins 17 sec	**Deployable Payloads:** 1. Upper Atmosphere Research Satellite (UARS) **Attached PLB Payloads:** Experiments 1. Gas Bridge Assembly (GBA) **Crew Compartment Payloads** 1. Ascent Particle Monitor (APM) 2. Cosmic Radiation Effects and Activation Monitor (CREAM)	3. Radiation Monitoring Experiment (RME) 4. Investigations into Polymer Membrane Processing (IPMP) 5. Protein Crystal Growth (PCG) 6. Middeck 0-Gravity Dynamics Experiment (MODE) 7. Shuttle Activation Monitor (SAM) 8. Physiological and Anatomical Rodent Experiment (PARE) **GAS (Getaway Special): None** **Special Payload Mission Kits: None**

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-44	Nov 14, 1991	Dec 1, 1991	Cdr: Frederick D. Gregory	**Deployable Payloads:**	
Atlantis	KSC	EAFB	Plt: Terence T. Henricks	1. Defense Support Program/Inertial Upper Stage satellite (DSP/IUS)	3. Air Force Maui Optical Site (AMOS)
			MS: F. Story Musgrave	**Attached PLB Payloads:**	4. Cosmic Radiation Effects and Activation Monitor (CREAM)
			MS: Mario Runco, Jr.	1. Interim Operational Contamination Monitor (IOCM) Experiments	5. Shuttle Activation Monitor (SAM)
			MS: James S. Voss	1. Gas Bridge Assembly (GBA)	6. Radiation Monitoring Experiment (RME-III)
			PS: Thomas J. Hennen	**Crew Compartment Payloads**	7. Visual Function Monitor (VFT-1)
Mission Duration: 170 hrs 52 mins 36 sec				1. Terra Scout	8. Ultraviolet Plume Instrument (UVPI)
				2. Military Man in Space (M88-1)	**GAS (Getaway Special): None**
					Special Payload Mission Kits: None

The Planets



	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
Mean Distance from Sun Millions of Kilometers Millions of Miles	57.9 36	108.2 67.2	149.6 93	227.9 141.6	778.3 483.6	1,429 888.2	2,875 1,786	4,504 2,799	5,900 3,666
Period of Revolution (in Earth time)	87.97 days	224.7 days	365.26 days	686.98 days	11.86 years	29.46 years	84.07 years	164.82 years	248.6 years
Period of Rotation (in Earth time)	58.65 days	243.01 days, Retrograde	23 hrs 56 mins	24 hrs 37 mins	9 hrs 56 mins	10 hrs 40 mins	17 hrs 14 mins	16 hrs 6 mins	6.39 days, Retrograde
Inclination of Axis (Degrees)	0.0	177.3	23.5	25.2	3.08	26.7	97.9	29.6	122
Inclination of Orbit to Ecliptic (Deg)	7.0	3.39	0.0	1.85	1.31	2.49	0.77	1.77	17.15
Eccentricity (Degrees)	0.206	0.007	0.017	0.093	0.048	0.056	0.046	0.010	0.248
Equatorial Diameter Kilometers Miles	4,878 3,031	12,104 7,521	12,755 7,926	6,790 4,219	142,796 88,729	120,660 74,975	51,118 31,763	49,528 30,775	2,300 Appx. 1,429 Appx.
Atmosphere	Essentially None	Carbon Dioxide	Nitrogen, Oxygen	Carbon Dioxide	Hydrogen, Helium	Hydrogen, Helium	Hydrogen, Helium	Hydrogen, Helium	Methane
Satellites	None	None	1	2	16	18	15	8	1
Rings	None	None	None	None	1	Thousands	11	5	Probably None

The Solar System

Our automated spacecraft have traveled to the Moon and to all the planets beyond our world except Pluto; they have observed moons as large as small planets, flown by comets, and sampled the solar environment. The knowledge gained from our journeys through the solar system has redefined traditional Earth sciences like geology and meteorology and spawned an entirely new discipline called comparative planetology. By studying the geology of planets, moons, asteroids, and comets, and comparing differences and similarities, we are learning more about the origin and history of these bodies and the solar system as a whole. We are also gaining insight into Earth's complex weather systems. By seeing how weather is shaped on other worlds and by investigating the Sun's activity and its influence through the solar system, we can better understand climatic conditions and processes on Earth.

The Sun

Many spacecraft have explored the Sun's environment, but none have gotten any closer to its surface than approximately two-thirds of the distance from Earth to the Sun. Pioneers 5-11, the Pioneer Venus Orbiter, Voyagers 1 and 2, and other spacecraft have all sampled the solar environment. The Ulysses spacecraft, launched Oct 6, 1990, is a joint solar mission of NASA and the European Space Agency. After using Jupiter's gravity to change its trajectory, Ulysses will fly over the Sun's polar regions during 1994 and 1995 and will perform a wide range of studies using nine onboard scientific instruments.

The Sun dwarfs the other bodies in the solar system, representing approximately 99.86 percent of all the mass in the solar system. All of the planets, moons, asteroids, comets, dust, and gas add up to only about 0.14 percent. This 0.14 percent represents the material left over from the Sun's formation. One hundred and nine Earths would be required to fit across the Sun's disk, and its interior could hold over 1.3 million Earths.

As a star, the Sun generates energy by the process of fusion. The temperature at the Sun's core is 15 million degrees Celsius (27 million degrees Fahrenheit), and the pressure there is 340 billion times Earth's air pressure at sea level. The Sun's surface temperature of 5,500 degrees Celsius (10,000 degrees Fahrenheit) seems almost chilly compared to its core temperature. At the solar core, hydrogen can fuse into helium, producing energy. The Sun produces a strong magnetic field and streams of charged particles, extending far beyond the planets.

The Sun appears to have been active for 4.6 billion years and has enough fuel for another 5 billion years or so. At the end of its life, the Sun will start to fuse helium into heavier elements and begin to swell up, ultimately growing so large that it will swallow Earth. After a billion years as a "red giant," it will suddenly collapse into a "white dwarf" -- the final end product of a star like ours. It may take a trillion years to cool off completely.

Mercury

Obtaining the first close-up views of Mercury was the primary objective of the Mariner 10 spacecraft, launched Nov 3, 1973. After a journey of nearly 5 months, including a flyby of Venus, the spacecraft passed within 703 km (437 mi) of the solar system's innermost planet on Mar 29, 1974. Until Mariner 10, little was known about Mercury. Even the best telescopic views from Earth showed Mercury as an indistinct object lacking any surface detail. The planet is so close to the Sun that it is usually lost in solar glare. When the planet is visible on Earth's horizon just after sunset or before dawn, it is obscured by the haze and dust in our atmosphere. Only radar telescopes gave any hint of Mercury's surface conditions prior to the voyage of Mariner 10.

Mariner 10 photographs revealed an ancient, heavily cratered surface, closely resembling our Moon. The pictures also showed high cliffs crisscrossing the planet, apparently created when Mercury's interior cooled and shrank, buckling the planet's crust. The cliffs are as high as 3 km (2 mi) and as long as 500 km (310 mi).

Instruments on Mariner 10 discovered that Mercury has a weak magnetic field and a trace of atmosphere -- a trillionth the density of Earth's atmosphere and composed chiefly of argon, neon, and helium. When the planet's orbit takes it closest to the Sun, surface temperatures range from 467 degrees Celsius (872 degrees Fahrenheit) on Mercury's sunlit side to -183 degrees Celsius (-298 degrees Fahrenheit) on the dark side. This range in surface temperature is the largest for a single body in the solar system. Mercury literally bakes and freezes at the same time.

Days and nights are long on Mercury. The combination of a slow rotation relative to the stars (59 Earth days) and a rapid revolution around the Sun (88 Earth days) means that one Mercury solar day takes 176 Earth days or two Mercury years, the time it takes Mercury to complete two orbits around the Sun.

The Solar System

Mercury appears to have a crust of light silicate rock like that of Earth. Scientists believe Mercury has a heavy iron-rich core making up slightly less than half of its volume. That would make Mercury's core larger, proportionally, than the Moon's core or those of any of the planets.

After the initial Mercury encounter, Mariner 10 made two additional flybys -- on Sep 21, 1974, and Mar 16, 1975 -- before control gas used to orient the spacecraft was exhausted and the mission was concluded. Each flyby took place at the same local Mercury time when the identical half of the planet was illuminated; as a result, we still have not seen one-half of the planet's surface.

Venus

Veiled by dense cloud cover, Venus -- our nearest planetary neighbor -- was the first planet to be explored. The Mariner 2 spacecraft, launched Aug 27, 1962, was the first of more than a dozen successful American and Soviet missions to study the mysterious planet. On December 14, 1962, Mariner 2 passed within 34,839 kilometers (21,648 miles) of Venus and became the first spacecraft to scan another planet; onboard instruments measured Venus for 42 minutes. Mariner 5, launched in June 1967, flew much closer to the planet. Passing within 4,094 kilometers (2,544 miles) of Venus on the second American flyby, Mariner 5's instruments measured the planet's magnetic field, ionosphere, radiation belts, and temperatures. On its way to Mercury, Mariner 10 flew by Venus and transmitted ultraviolet pictures to Earth showing cloud circulation patterns in the Venusian atmosphere.

On Dec 4, 1978, the Pioneer Venus Orbiter became the first spacecraft to orbit the planet. Five days later, the five separate components making up a second spacecraft, the Pioneer Venus Multiprobe, entered the Venusian atmosphere at different locations above the planet. The four small probes and the main body radioed atmospheric data back to Earth during their descent toward the surface. Although designed to examine the atmosphere, one of the probes survived its impact with the surface and continued to transmit data for another hour.

Venus resembles Earth in size, physical composition, and density more closely than any other known planet. However, significant differences have been discovered. For example, Venus' rotation (west to east) is retrograde (backward) compared to the east-to-west spin of Earth and most of the other planets.

Approximately 96.5 percent of Venus' atmosphere (95 times as dense as Earth's) is carbon dioxide. The principal constituent of Earth's atmosphere is nitrogen. Venus' atmosphere acts like a greenhouse, permitting solar radiation to reach the surface but trapping the heat that would ordinarily be radiated back into space. As a result, the planet's average surface temperature is 482 degrees Celsius (900 degrees Fahrenheit), hot enough to melt lead.

A radio altimeter on the Pioneer Venus Orbiter provided the first means of seeing through the planet's dense cloud cover and determining surface features over almost the entire planet. NASA's Magellan spacecraft, launched on May 5, 1989, has orbited Venus since August 10, 1990. The spacecraft uses radar-mapping techniques to provide ultrahigh-resolution images of the surface.

Magellan has revealed a landscape dominated by volcanic features, faults, and impact craters. Huge areas of the surface show evidence of multiple periods of lava flooding with flows lying on top of previous ones. An elevated region named Ishtar Terra is a lava-filled basin as large as the United States. At one end of this plateau sits Maxwell Montes, a mountain the size of Mount Everest. Scarring the mountain's flank is a 100-km (62-mi) wide, 2.5-km (1.5 mi) deep impact crater named Cleopatra. (Almost all features on Venus are named for women: Maxwell Montes, Alpha Regio, and Beta Regio are the exceptions.) Craters survive on Venus for perhaps 400 million years because there is no water and very little wind erosion.

Extensive fault-line networks cover the planet, probably the result of the same crustal flexing that produces plate tectonics on Earth. But on Venus the surface temperature is sufficient to weaken the rock, which cracks just about everywhere, preventing the formation of major plates and large earthquake faults like the San Andreas Fault in California.

Venus' predominant weather pattern is a high-altitude, high-speed circulation of clouds that contain sulfuric acid. At speeds reaching as high as 360 km (225 mi) per hour, the clouds circle the planet in only 4 Earth days. The circulation is in the same direction -- west to east -- as Venus' slow rotation of 243 Earth days, whereas Earth's winds blow in both directions -- west to east and east to west -- in six alternating bands. Venus' atmosphere serves as a simplified laboratory for the study of our weather.

The Solar System

Earth

As viewed from space, Earth's distinguishing characteristics are its blue waters, brown and green land masses, and white clouds. We are enveloped by an ocean of air consisting of 78 percent nitrogen, 21 percent oxygen, and 1 percent other constituents. The only planet in the solar system known to harbor life, Earth orbits the Sun at an average distance of 150 million km (93 million mi). Earth is the third planet from the Sun and the fifth largest in the solar system, with a diameter a few hundred kilometers larger than that of Venus.

Our planet's rapid spin and molten nickel-iron core give rise to an extensive magnetic field, which, along with the atmosphere, shields us from nearly all of the harmful radiation coming from the Sun and other stars. Earth's atmosphere protects us from meteors as well, most of which burn up before they can strike the surface. Active geological processes have left no evidence of the pelting Earth almost certainly received soon after it formed -- about 4.6 billion years ago.

From our journeys into space, we have learned much about our home planet. The first American satellite -- Explorer 1 -- launched Jan 31, 1958, discovered an intense radiation zone, called the Van Allen radiation belts, surrounding Earth. Other research satellites revealed that our planet's magnetic field is distorted into a tear-drop shape by the solar wind. We've learned that the magnetic field does not fade off into space but has definite boundaries. And we now know that our wispy upper atmosphere, once believed calm and uneventful, seethes with activity -- swelling by day and contracting by night. Affected by changes in solar activity, the upper atmosphere contributes to weather and climate on Earth.

Besides affecting Earth's weather, solar activity gives rise to a dramatic visual phenomenon in our atmosphere. When charged particles from the solar wind become trapped in Earth's magnetic field, they collide with air molecules above our planet's magnetic poles. These air molecules then begin to glow and are known as the auroras or the northern and southern lights.

Satellites about 35,789 km (22,238 mi) out in space play a major role in daily local weather forecasting. These watchful electronic eyes warn us of dangerous storms. Continuous global monitoring provides a vast amount of useful data and contributes to a better understanding of Earth's complex weather systems.

From their unique vantage points, satellites can survey Earth's oceans, land use and resources, and monitor the planet's health. These eyes in space have saved countless lives, provided tremendous conveniences, and shown us that we may be altering our planet in dangerous ways.

The Moon

The Moon is Earth's single natural satellite. The first human footsteps on an alien world were made by American astronauts on the dusty surface of our airless, lifeless companion. In preparation for the Apollo expeditions, NASA dispatched the automated Ranger, Surveyor, and Lunar Orbiter spacecraft to study the Moon between 1964 and 1968.

NASA's Apollo program left a large legacy of lunar materials and data. Six 2-astronaut crews landed on and explored the lunar surface between 1969 and 1972, carrying back a collection of rocks and soil weighing a total of 382 km (842 lb) and consisting of more than 2,000 separate samples. From this material and other studies, scientists have constructed a history of the Moon that includes its infancy.

Rocks collected from the lunar highlands date to about 4.0-4.3 billion years old. The first few million years of the Moon's existence were so violent that few traces of this period remain. As a molten outer layer gradually cooled and solidified into different kinds of rock, the Moon was bombarded by huge asteroids and smaller objects. Some of the asteroids were as large as Rhode Island or Delaware, and their collisions with the Moon created basins hundreds of kilometers across.

This catastrophic bombardment tapered off approximately 4 billion years ago, leaving the lunar highlands covered with huge, overlapping craters and a deep layer of shattered and broken rock. Heat produced by the decay of radioactive elements began to melt the interior at depths of about 200 km (125 mi) below the surface. For the next 700 million years, lava rose from inside the Moon and gradually spread out over the surface, flooding the large impact basins to form the dark areas that Galileo Galilei, an astronomer of the Italian Renaissance, called maria, meaning seas. As far as we can tell, there has been no significant volcanic activity on the Moon for more than 3 billion years. Since then, the lunar surface has been altered only by micrometeorites, atomic particles from the Sun and stars, rare impacts of large meteorites, and spacecraft and astronauts.

The origin of the Moon is still a mystery. Four theories attempt an explanation. The Moon formed near Earth as a separate body; it was torn from Earth; it formed somewhere else and was captured by our planet's gravity, or it was the result of a collision between Earth and an asteroid about the size of Mars. The last theory has some good support but is far from certain.

Mars

Mars has long been considered the solar system's prime candidate for harboring extraterrestrial life. Astronomers studying the red planet through telescopes saw what appeared to be straight lines criss-crossing its surface. These observations, later determined to be optical illusions, led to the popular notion that intelligent beings had constructed a system of irrigation canals. Another reason for scientists to expect life on Mars was the apparent seasonal color changes on the planet's surface. This phenomenon led to speculation that conditions might support vegetation during the warmer months and cause plant life to become dormant during colder periods.

Six American missions to Mars have been carried out. Four Mariner spacecraft, three flying by the planet and one placed into martian orbit, surveyed the planet extensively before the Viking Orbiters and Landers arrived. Mariner 4, launched in late 1964, flew past Mars on Jul 14, 1965, within 9,846 km (6,118 mi) of the surface. Transmitting to Earth 22 close-up pictures of the planet, the spacecraft found many craters and naturally occurring channels but no evidence of artificial canals or flowing water. The Mariners 6 and 7 flybys, during the summer of 1969, returned 201 pictures. Mariners 4, 6, and 7 showed a diversity of surface conditions as well as a thin, cold, dry atmosphere of carbon dioxide.

On May 30, 1971, the Mariner 9 Orbiter was launched to make a year-long study of the martian surface. The spacecraft arrived 5-1/2 months after liftoff, only to find Mars in the midst of a planet-wide dust storm that made surface photography impossible for several weeks. After the storm cleared, Mariner 9 began returning the first of 7,329 pictures that revealed previously unknown martian features, including evidence that large amounts of water once flowed across the surface, etching river valleys and flood plains.

In Aug and Sep 1975, the Viking 1 and 2 spacecraft, each consisting of an orbiter and a lander, were launched. The mission was designed to answer several questions about the red planet, including, Is there life there? Nobody expected the spacecraft to spot martian cities, but it was hoped that the biology experiments would at least find evidence of primitive life, past or present.

Viking Lander 1 became the first spacecraft to successfully touch down on another planet when it landed on Jul 20, 1976. Photographs sent back from Chryse Planitia ("Plains of Gold") showed a bleak, rusty-red landscape. Panoramic images revealed a rolling plain, littered with rocks and marked by rippled sand dunes. Fine red dust from the martian soil gives the sky a salmon hue. When Viking Lander 2 touched down on Utopia Planitia on Sep 3, 1976, it viewed a more rolling landscape, one without visible dunes.

The results sent back by the laboratory on each Viking Lander were inconclusive. Small samples of the red martian soil were tested in three different experiments designed to detect biological processes. While some of the test results seemed to indicate biological activity, later analysis confirmed that this activity was inorganic in nature and related to the planet's soil chemistry. Is there life on Mars? No one knows for sure, but the Viking mission found no evidence that organic molecules exist there.

The Viking Landers became weather stations, recording wind velocity and direction as well as atmospheric temperature and pressure. Few weather changes were observed. The highest temperature recorded by either spacecraft was -14 degrees Celsius (7 degrees Fahrenheit) at the Viking Lander 1 site in midsummer. The lowest temperature, -120 degrees Celsius (-184 degrees Fahrenheit), was recorded in the more northerly Viking Lander 2 site during winter. Near-hurricane wind speeds were measured at the two martian weather stations during global dust storms, but because the atmosphere is so thin, wind force is minimal. Viking Lander 2 photographed light patches of frost, probably water-ice, during its second winter on the planet.

The martian atmosphere, like that of Venus, is primarily carbon dioxide. Nitrogen and oxygen are present only in small percentages. Martian air contains only about 1/1,000 as much water as our air, but this small amount can condense out, forming clouds that ride high in the atmosphere or swirl around the slopes of towering volcanoes. Patches of early morning fog can form in valleys. There is evidence that in the past a denser martian atmosphere may have allowed water to flow on the planet. Physical features closely resembling shorelines, gorges, riverbeds, and islands suggest that great rivers once marked the planet.

The Solar System

Mars has two moons, Phobos and Deimos. They are small and irregularly shaped and possess ancient, cratered surfaces. It is possible the moons were originally asteroids that ventured too close to Mars and were captured by its gravity.

The Viking Orbiters and Landers exceeded their design lifetimes of 120 and 90 days, respectively. The first to fail was Viking Orbiter 2, which stopped operating on Jul 24, 1978, when a leak depleted its attitude-control gas. Viking Lander 2 operated until Apr 12, 1980, when it was shut down due to battery degeneration. Viking Orbiter 1 quit on Aug 7, 1980, when the last of its attitude-control gas was used up. Viking Lander 1 ceased functioning on Nov 13, 1983. Despite the inconclusive results of the Viking biology experiments, we know more about Mars than any other planet except Earth.

Asteroids

The solar system has a large number of rocky and metallic objects in orbit around the Sun but are too small to be considered full-fledged planets. These objects are known as asteroids or minor planets. Most, but not all, are found in a band or belt between the orbits of Mars and Jupiter. Some have orbits that cross Earth's path, and there is evidence that Earth has been hit by asteroids in the past. One of the least eroded, best preserved examples is the Barringer Meteor Crater near Winslow, AZ.

Asteroids are material left over from the formation of the solar system. One theory suggests that they are the remains of a planet that was destroyed in a massive collision long ago. More likely, asteroids are material that never coalesced into a planet. In fact, if the estimated total mass of all asteroids was gathered into a single object, the object would be only about 1,500 km (932 mi) across, less than half the diameter of our Moon. Thousands of asteroids have been identified from Earth and 100,000 may be bright enough to be photographed through Earth-based telescopes.

Much of our understanding about asteroids comes from examining pieces of space debris that fall to the surface of Earth. Asteroids that are on a collision course with Earth are called meteoroids. When a meteoroid strikes our atmosphere at high velocity, friction causes this chunk of space matter to incinerate in a streak of light known as a meteor. If the meteoroid does not burn u completely, what's left strikes Earth's surface and is called a meteorite. One of the best places to look for meteorites is the ice cap of Antarctica.

Of all the meteorites examined, 92.8 percent are composed of silicate (stone), and 5.7 percent are composed of iron and nickel; the rest are a mixture of the three materials. Stony meteorites are the hardest to identify since they look very much like terrestrial rocks. Since asteroids are material from the very early solar system, scientists are interested in their composition. Spacecraft that have flown through the asteroid belt have found that the best is really quite empty and that asteroids are separated by very large distances.

Jupiter

Beyond Mars and the asteroid belt, in the outer regions of our solar system, lie the giant planets of Jupiter, Saturn, Uranus and Neptune. In 1972, NASA sent the first of four spacecraft to conduct the initial surveys of these colossal worlds of gas and their moons of ice and rock.

Pioneer 10, launched in March 1972, was the first spacecraft to penetrate the asteroid belt and travel to the outer regions of the solar system. In December 1973, it returned the first close-up images of Jupiter, flying within 132,252 km (82,178 mi) of the planet's banded cloud tops. Pioneer 11 followed a year later. Voyagers 1 and 2, launched in the summer of 1977, returned spectacular photographs of Jupiter and its family of satellites during flybys in 1979. These travelers found Jupiter to be a whirling ball of liquid hydrogen and helium, topped with a colorful atmosphere composed mostly of gaseous hydrogen and helium. Ammonia ice crystals form white Jovian clouds. Sulfur compounds (and perhaps phosphorus) may produce the brown and orange hues that characterize Jupiter's atmosphere.

It is likely that methane, ammonia, water and other gases react to form organic molecules in the regions between the planet's frigid cloud tops and the warmer hydrogen ocean lying below. Because of Jupiter's atmospheric dynamics, however, these organic compounds, if they exist, are probably short-lived.

The Great Red Spot has been observed for centuries through telescopes on Earth. This hurricane-like storm in Jupiter's atmosphere is more than twice the size of our planet. As a high-pressure region, the Great Red Spot spins in a direction opposite to that of low-pressure storms on Jupiter; it is surrounded by swirling currents that rotate around the spot and are sometimes consumed by it. The Great Red Spot might be a million years old.

Our spacecraft detected lightning in Jupiter's upper atmosphere and observed auroral emissions similar to Earth's northern lights at the Jovian polar regions. Voyager 1 returned the first images of a faint, narrow ring encircling Jupiter. Largest of the solar system's planets, Jupiter rotates at a dizzying pace, once every 9 hours 55 minutes 30 seconds. The massive planet takes almost 12 Earth years to complete a journey around the Sun. With 16 known moons, Jupiter is something of a miniature solar system.

A new mission to Jupiter, the Galileo Project, is underway. After a 6-year cruise that will take the Galileo Orbiter once past Venus, twice past Earth and the Moon, and once past two asteroids, the spacecraft will drop an atmospheric probe into Jupiter's cloud layers and relay data back to Earth. The Galileo Orbiter will spend 2 years circling the planet and flying close to Jupiter's large moons, exploring in detail what the two Pioneers and two Voyagers revealed.

Galilean Satellites

In 1610, Galileo Galilei aimed his telescope at Jupiter and Spotted four points of light orbiting the planet. For the first time, humans had seen the moons of another world. In honor of their discoverer, these four bodies would become known as the Galilean satellites or moons. But Galileo might have happily traded this honor for one look at the dazzling photographs returned by the Voyager spacecraft as they flew past these planet-sized satellites.

One of the most remarkable findings of the Voyager mission was the presence of active volcanoes on the Galilean moon Io. Volcanic eruptions had never before been observed on a world other than Earth. The Voyager cameras identified at least nine active volcanoes on Io, with plumes of ejected material extending as far as 280 km (175 mi) above the moon's surface. Io's pizza-colored terrain, marked by orange and yellow hues, is probably the result of sulfur-rich materials brought to the surface by volcanic activity. Volcanic activity on this satellite is the result of tidal flexing caused by the gravitational tug-of-war between Io, Jupiter, and the other three Galilean moons.

Europa, approximately the same size as our Moon, is the brightest Galilean satellite. The moon's surface displays an array of streaks, indicating the crust has been fractured. Caught in a gravitational tug-of-war like Io, Europa has been heated enough to cause its interior ice to melt, producing a liquid-water ocean. This ocean is covered by an ice crust that has formed where water is exposed to the cold of space. Europa's core is made of rock that sank to its center. Like Europa, the other two Galilean moons -- Ganymede and Callisto -- are worlds of ice and rock. Ganymede is the largest satellite in the solar system -- larger than the planets Mercury and Pluto. The satellite is composed of about 50 percent water or ice and the rest rock. Ganymede's surface has areas of different brightness, indicating that, in the past, material oozed out of the moon's interior and was deposited at various locations on the surface.

Callisto, only slightly smaller than Ganymede, has the lowest density of any Galilean satellite, suggesting that large amounts of water are part of its composition. Callisto is the most heavily cratered object in the solar system; no activity during its history has erased old craters except more impacts.

Detailed studies of all the Galilean satellites will be performed by the Galileo Orbiter.

Saturn

No planet in the solar system is adorned like Saturn. Its exquisite ring system is unrivaled. Like Jupiter, Saturn is composed mostly of hydrogen. But in contrast to the vivid colors and wild turbulence found in Jovian clouds, Saturn's atmosphere has a more subtle, butterscotch hue, and its markings are muted by high-altitude haze. Given Saturn's somewhat placid-looking appearance, scientists were surprised at the high-velocity equatorial jet stream that blows some 1,770 km (1,100 mi) per hour.

Three American spacecraft have visited Saturn. Pioneer 11 sped by the planet and its moon Titan in September 1979, returning the first close-up images. Voyager 1 followed in November 1980, sending back breathtaking photographs that revealed for the first time the complexities of Saturn's ring system and moons. Voyager 2 flew by the planet and its moons in August 1981.

The rings are composed of countless low-density particles orbiting individually around Saturn's equator at progressive distances from the cloud tops. Analysis of spacecraft radio waves passing through the rings showed that the particles vary widely in size, ranging from dust to house-sized boulders. The rings are bright because they are mostly ice and frosted rock.

The rings might have resulted when a moon or a passing body ventured too close to Saturn. The object would have been torn apart by great tidal forces on its surface and in its interior. Or the object may not have been fully formed and disintegrated under the influence of Saturn's gravity. A third possibility is that the object was shattered by collisions with larger objects orbiting the planet.

Unable either to form into a moon or to drift away from each other, individual ring particles appear to be held in place by the gravitational pull of Saturn and its satellites. These complex gravitational interactions form the thousands of ringlets that make up the major rings.

Radio emissions quite similar to the static heard on an AM car radio during an electrical storm were detected by the Voyager spacecraft. These emissions are typical of lightning but are believed to be coming from Saturn's ring system rather than its atmosphere, where no lightning was observed. As they had at Jupiter, the Voyagers saw a version of Earth's auroras near Saturn's poles.

The Voyagers discovered new moons and found several satellites that share the same orbit. We learned that some moons shepherd ring particles, maintaining Saturn's rings and the gaps in the rings. Saturn's 18th moon was discovered in 1990 from images taken by Voyager 2 in 1981.

Voyager 1 determined that Titan has a nitrogen-based atmosphere with methane and argon -- one more like Earth's in composition than the carbon dioxide atmosphere of Mars and Venus. Titan's surface temperature of -179 degrees Celsius (-290 degrees Fahrenheit) implies that there might be water-ice islands rising above oceans of ethane-methane liquid or sludge. Unfortunately, Voyager 1's cameras could not penetrate the moon's dense clouds.

Continuing photochemistry from solar radiation may be converting Titan's methane to ethane, acetylene and, in combination with nitrogen, hydrogen cyanide. These conditions may be similar to the atmospheric conditions of primeval Earth between 3 and 4 billion years ago. However, Titan's atmospheric temperature is believed to be too low to permit progress beyond this stage of organic chemistry.

Uranus

In January 1986, 4-1/2 years after visiting Saturn, Voyager 2 completed the first close-up survey of the Uranian system. The brief flyby revealed more information about Uranus and its moons than had been gleaned from ground observations since its discovery over 2 centuries ago by English astronomer William Herschel.

Uranus, third largest of the planets, is an oddball of the solar system. Unlike the other planets (with the exception of Pluto), this giant lies tipped on its side with its north and south poles alternately facing the Sun during an 84-year swing around the solar system. During Voyager 2's flyby, the south pole faced the Sun. Uranus might have been knocked over when an Earth-sized object collided with it early in the life of the solar system.

Voyager 2 discovered that Uranus' magnetic field does not follow the usual north-south axis found on the other planets. Instead, the field is tilted 60 degrees and offset from the planet's center, a phenomenon that on Earth would be like having one magnetic pole in New York City and the other in the city of Djakarta, on the island of Java in Indonesia.

Uranus' atmosphere consists mainly of hydrogen, with some 12 percent helium and small amounts of ammonia, methane, and water vapor. The planet's blue color occurs because methane in its atmosphere absorbs all other colors. Wind speeds range up to 580 km (360 mi) per hour, and temperatures near the cloud tops average -221 degrees Celsius (-366 degrees Fahrenheit).

Uranus' sunlit south pole is shrouded in a kind of photochemical "smog" believed to be a combination of acetylene, ethane, and other sunlight-generated chemicals. Surrounding the planet's atmosphere and extending thousands of kilometers into space is a mysterious ultraviolet sheen known as "electroglow." Approximately 8,000 km (5,000 mi) below Uranus' cloud tops, there is thought to be a scalding ocean of water and dissolved ammonia some 10,000 km (6,200 mi) deep. Beneath this ocean is an Earth-sized core of heavier materials.

Voyager 2 discovered 10 new moons, 16-169 km (10-105 mi) in diameter, orbiting Uranus. The five previously known -- Miranda, Ariel, Umbriel, Titania, and Oberon -- range in size from 520 to 1,610

km (323 to 1,000 mi) across. Representing a geological showcae, these five moons are half-ice, half-rock spheres that are cold and dark and show evidence of past activity, including faulting and ice flows.

The most remarkable of Uranus' moons is Miranda. Its surface features high cliffs as well as canyons, crater-pocked plains, and winding valleys. The sharp variations in terrain suggest that, after the moon formed, it was smashed apart by a collision with another body -- an event not unusual in our solar system, which contains many objects that have impact craters or are fragments from large impacts. What is extraordinary is that Miranda apparently reformed with some of the material that had been in its interior exposed on its surface.

Uranus was thought to have nine dark rings; Voyager 2 imaged 11. In contract to Saturn's rings, composed of bright particles, Uranus' rings are primarily made up of dark, boulder-sized chunks.

Neptune

Voyager 2 completed its 12-year tour of the solar system with an investigation of Neptune and the planet's moons. On Aug 25, 1989, the spacecraft swept to within 4,850 km (3,010 mi) of Neptune and then flew on to the moon Triton. During the Neptune encounter, it became clear that the planet's atmosphere was more active than Uranus'.

Voyager 2 observed the Great Dark Spot, a circular storm the size of Earth, in Neptune's atmosphere. Resembling Jupiter's Great Red Spot, the storm spins counter-clockwise and moves westward at almost 1,200 km (745 mi) per hour. Voyager 2 also noted a smaller dark spot and a fast-moving cloud dubbed the "Scooter," as well as high-altitude clouds over the main hydrogen and helium cloud deck. The highest wind speeds of any planet were observed, up to 2,400 km (1,500 mi) per hour.

Like the other giant planets, Neptune has a gaseous hydrogen and helium upper layer over a liquid interior. The planet's core contains a higher percentage of rock and metal than those of the other gas giants. Neptune's distinctive blue appearance, like Uranus' blue color, is due to atmospheric methane.

Neptune's magnetic field is tilted relative to the planet's spin axis and is not centered at the core. This phenomenon is similar to Uranus' magnetic field and suggests that the field of the two giants are being generated in an area above the cores, where the pressure is so great that liquid hydrogen assumes the electrical properties of a metal. Earth's magnetic field, on the other hand, is produced by its spinning metallic core and is only slightly tilted and offset relative to its center.

Voyager 2 also shed light on the mystery of Neptune's rings. Observations from Earth indicated that there were arcs of material in orbit around the giant planet. It was not clear how Neptune could have arcs and how these could be kept from spreading out into even, unclumped rings. Voyager 2 detected these arcs, but they were, in pact, part of thin, complete rings. A number of small moons could explain the arcs, but such bodies were not spotted.

Astronomers had identified the Neptunian moons Triton in 1846 and Nereid in 1949. Voyager 2 found six more. One of the new moons -- Proteus -- is actually larger than Nereid, but since Proteus orbits close to Neptune, it was lost in the planet's glare for observers on Earth.

Triton circles Neptune in a retrograde orbit in under 6 days. Tidal forces on Triton are causing it to spiral slowly toward the planet. In 10-100 million years (a short time in astronomical terms), the moon will be so close that Neptunian gravity will tear it apart, forming a spectacular ring to accompany the planet's modest current rings.

Triton's landscape is as strange and unexpected as those of Io and Miranda. The moon has more rock than its counterparts at Saturn and Uranus. Triton's mantle is probably composed of water-ice, but its crust is a thin verneer of nitrogen and methane. The moon shows two dramatically different types of terrain: the so-called "cantaloupe" terrain and a receding ice cap.

Dark streaks appear on the ice cap. These streaks are the fallout from geyser-like volcanic vents that shoot nitrogen gas and dark, fine-grained particles to heights of 1-8 km (1-5 mi). Triton's thin atmosphere, only 1/70,000th as thick as Earth's, has winds that carry the dark particles and deposit them as streaks on the ice cap -- the coldest surface yet discovered in the solar system (-235 degrees Celsius, -391 degrees Fahrenheit). Triton might be more like Pluto than any other object spacecraft have so far visited.

The Solar System

Pluto

Pluto is the most distant of the planets, yet the eccentricity of its orbit periodically carries it inside Neptune's orbit, where it has been since 1979 and where it will remain until March 1999. Pluto's orbit is also highly inclined -- tilted 17 degrees to the orbital plane of the other planets.

Discovered in 1930, Pluto appears to be little more than a celestial snowball. The planet's diameter is calculated to be approximately 2,300 km (1,430 mi), only 2/3 the size of our Moon.
Ground-based observations indicate that Pluto's surface is covered with methane ice and that there is a thin atmosphere that may freeze and fall to the surface as the planet moves away from the Sun. Observations also show that Pluto's spin axis is tipped by 122 degrees.

The planet has one known satellite, Charon, discovered in 1978. Charon's surface composition is different from Pluto's: the moon appears to be covered with water-ice rather than methane ice. Its orbit is gravitationally locked with Pluto, so both bodies always keep the same hemisphere facing ech other. Pluto's and Charon's rotational period and Charon's period of revolution are all 6.4 Earth days.

No spacecraft have ever visited Pluto.

Comets

The outermost members of the solar system occasionally pay a visit to the inner planets. As asteroids are the rocky and metallic remnants of the formation of the solar system, comets are the icy debris from that dim beginning and can survive only far from the Sun. Most comet nuclei reside in the Oort Cloud, a loose swarm of objects in a halo beyond the planets and reaching perhaps halfway to the nearest star.

Comet nuclei orbit in this frozen abyss until they are gravitationally perturbed into new orbits that carry them close to the Sun. As a nucleus falls inside the orbits of the outer planets, the volatile elements of which it is made gradually warm; by the time the nucleus enters the region of the inner planets, these volatile elements are boiling. The nucleus itself is irregular and only a few miles across, and is made principally of water-ice with methane and ammonia.

As these materials boil off of the nucleus, they form a coma or cloud-like "head" that can measure tens of thousands of kilometers across. The coma grows as the comet gets closer to the Sun. The stream of charged particles coming from the Sun pushes on this cloud, blowing it back and giving rise to the comet's "tails." Gases and ions are blown directly back from the nucleus, but dust particles are pushed more slowly. As the nucleus continues in its orbit, the dust particles are left behind in a curved arc.

Both the gas and dust tails point away from the Sun; in effect, the comet chases its tails as it recedes from the Sun. The tails can reach 150 million km (93 million mi) in length, but the total amount of material contained i this dramatic display would fit in an ordinary suitcase. Comets -- from the Latin cometa, meaning "long-haired" -- are essentially dramatic light shows.

Some comets pass through the solar system only once, but others have their orbits gravitationally modified by a close encounter with one of the giant outer planets. These latter visitors can enter closed elliptical orbits and repeatedly return to the inner solar system.

Halley's Comet is the most famous example of a relatively short period comet, returning on an average of once every 76 years and orbiting from beyond Neptune to within Venus' orbit. Confirmed sightings of the comet go back to 240 B.C. This regular visitor to our solar system is named for Sir Edmund Halley, because he plotted the comet's orbit and predicted its return, based on earlier sightings and Newtonian laws of motion. His name became part of astronomical lore when, in 1759, the comet returned on schedule. Unfortunately, Sir Edmund did not live to see it.

A comet can be very prominent in the sky if it passes comparatively close to Earth. Unfortunately, on its most recent appearance, Halley's Comet passed no closer than 62.4 million km (28.8 million mi) from our world. The comet was visible to the naked eye, especially for viewers in the southern hemisphere, but it was not spectacular. Comets have been so bright, on rare occasions, that they were visible during daytime. Historically, comet sightings have been interpreted as bad omens and have been artistically rendered as daggers in the sky.

Several spacecraft have flown by comets at high speed; the first was NASA's International Cometary Explorer in 1985. An armada of five spacecraft (two Japanese, two Soviet, and the Giotto spacecraft from the European Space Agency) flew by Halley's Comet in 1986.

USA Planetary Space Flights

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Mariner 1	Venus Flyby	Jul 22, 1962		Destroyed shortly after launch when vehicle veered off course.
Mariner 2	Venus Flyby	Aug 27, 1962	Dec 14, 1962	First successful planetary flyby. Provided instrument scanning data. Entered solar orbit.
Mariner 3	Mars Flyby	Nov 5, 1964		Shroud failed to jettison properly; Sun and Canpous not acquired; did not encounter Mars. Entered solar orbit.
Mariner 4	Mars Flyby	Nov 28, 1964	Jul 14, 1965	Provided first close-range pictures of Martian surface. Entered solar orbit.
Mariner 5	Venus Flyby	Jun 14, 1967	Oct 19, 1967	Advanced instruments returned data on Venus' surface temperature, atmosphere, and magnetic field environment. Entered solar orbit.
Mariner 6	Mars Flyby	Feb 24, 1969	Jul 31, 1969	Provided high-resolution photos of Martian surface, concentrating on equatorial region. Entered solar orbit.
Mariner 7	Mars Flyby	Mar 27, 1969	Aug 5, 1969	Provided high-resolution photos of Martian surface, concentrating on southern hemisphere. Entered solar orbit.
Mariner 8	Mars Orbiter	May 8, 1971		Centaur stage malfunctioned shortly after launch.
Mariner 9	Mars Orbiter	May 30, 1971	Nov 18, 1971	Mapped the whole planet; provided detailed photos of Phobos and Deimos. Craft inoperable in Mars orbit.
Pioneer 10	Jupiter Flyby	Mar 2, 1972	Dec 3, 1973	First spacecraft to penetrate the Asteroid Belt. Obtained first close-up images of Jupiter, investigated its magnetosphere, atmosphere and internal structure. Still operating in the outer Solar System.
Pioneer 11	Jupiter/Saturn Flyby	Apr 5, 1973	Dec 2, 1974 (Jupiter) Sep 1, 1979 (Saturn)	The successful encounter of Jupiter by Pioneer 10 permitted Pioneer 11 to be retargeted in flight to fly by Jupiter and encounter Saturn. Still operating in the outer Solar System.

USA Planetary Space Flights

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Mariner 10	Venus/Mercury Flyby	Nov 3, 1973	Feb 5, 1974 (Venus) Mar 29, 1974 (Mercury) Sep 21, 1974 (Mercury) Mar 16, 1975 (Mercury)	First dual-planet mission. Used gravity of Venus to attain Mercury encounter. Provided first ultraviolet photographs of Venus; returned close-up photographs and detailed data of Mercury. Transmitter was turned off March 24, 1975, when attitude control gas was depleted. Craft inoperable in solar orbit.
Viking 1	Mars Orbiter and Lander	Aug 20, 1975	Jul 19, 1976 (in orbit) Jul 20, 1976 (landed)	First U.S. attempt to soft land a spacecraft on another planet. Landed on the Plain of Chryse. Photographs showed an orange-red plain strewn with rocks and sand dunes. Orbiter 1 operated until August 7, 1980, when it used the last of its attitude control gas. Lander 1 ceased operating on November 13, 1983.
Viking 2	Mars Orbiter and Lander	Sep 9, 1975	Aug 7, 1976 (in orbit) Sep 3, 1976 (landed)	Landed on the Plain of Utopia. Discovered water frost on the surface at the end of the Martian winter. Orbiter 2 stopped operating on July 24, 1978, when its attitude control gas was depleted because of a leak. Lander 2 operated until April 12, 1980, when it was shut down due to battery degeneration.
Voyager 1	Tour of Jupiter and Saturn	Sep 5, 1977	Mar 5, 1979 (Jupiter) Nov 12, 1980 (Saturn)	Investigated the Jupiter and Saturn planetary systems. Returned spectacular photographs and provided evidence of a ring encircling Jupiter. Continues to return data enroute toward interstellar space.
Voyager 2	Tour of the Outer Planets	Aug 20, 1977	Jul 9, 1979 (Jupiter) Aug 25, 1981 (Saturn) Jan 24, 1986 (Uranus) Aug 25, 1989 (Neptune)	Investigated the Jupiter, Saturn and Uranus planetary systems. Provided first close-up photographs of Uranus and its moons. Used gravity-assist at Uranus to continue on to Neptune. Swept within 1280 km of Neptune on August 25, 1989. The spacecraft will continue into interstellar space.
Pioneer Venus 1	Venus Orbiter	May 20, 1978	Dec 4, 1978	Mapped Venus' surface by radar, imaged its cloud systems, explored its magnetic environment and observed interactions of the solar wind with a planet that has no intrinsic magnetic field. Provided radar altimetry maps for nearly all of the surface of Venus, resolving features down to about 50 miles across. Still operating in orbit around Venus.

USA Planetary Space Flights

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Pioneer Venus 2	Venus Probe	Aug 8, 1978	Dec 9, 1978	Dispatched heat-resisting probes to penetrate the atmosphere at widely separated locations and measured temperature, pressure, and density down to the planet's surface. Probes impacted on the surface.
Magellan	Venus Radar Mapping	May 4, 1989	Aug 1990	Returned radar images that showed geological features unlike anything seen on Earth. One area scientists called crater farms; another area was covered by a checkered pattern of closely spaced fault lines running at right angles. Most intriguing were indications that Venus still may be geologically active. Will continue to map the entire surface and observe evidence of volcanic eruption into 1991.
Galileo	Jupiter Orbiter and Probe	Oct 18, 1989	Dec 8, 1990 (Earth) Feb 1991 (Venus)	A sophisticated two-part spacecraft; an Orbiter will be inserted into orbit around Jupiter to remotely sense the planet, its satellites and the Jovian magnetosphere and a Probe will descent into the atmosphere of Jupiter to make in situ measurements of its nature. Galileo flew by Venus, conducting the first infrared imagery and spectroscopy below the planet's cloud deck and used the Earth's gravity to speed it on its way to Jupiter.

USSR Planetary Space Flights

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Venera 1	Venus Probe	Feb 12, 1961		First Soviet planetary flight; launched from Sputnik 8. Radio contact was lost during flight; spacecraft was not operating when it passed Venus.
Sputnik 19	Venus Probe	Aug 25, 1962		Unsuccessful Venus attempt.
Sputnik 20	Venus Probe	Sep 1, 1962		Unsuccessful Venus attempt.
Sputnik 21	Venus Probe	Sep 12, 1962		Unsuccessful Venus attempt.
Sputnik 22	Mars Probe	Oct 24, 1962		Spacecraft and final rocket stage blew up when accelerated to escape velocity.
Mars 1	Mars Probe	Nov 1, 1962		Contact was lost when the spacecraft antenna could no longer be pointed towards Earth.
Sputnik 24	Mars Probe	Nov 4, 1962		Disintegrated during an attempt at Mars trajectory from Earth parking orbit.
Zond 1	Venus Probe	Apr 2, 1964		Communications lost. Spacecraft went into solar orbit.
Zone 2	Mars Probe	Nov 30, 1964		Passed by Mars; failed to return data. Went into solar orbit.
Venera 2	Venus Probe	Nov 12, 1965	Feb 27, 1966	Passed by Venus, but failed to return data.
Venera 3	Venus Probe	Nov 16, 1965	Mar 1, 1966	Impacted on Venus, becoming the first spacecraft to reach another planet. Failed to return data.
Venera 4	Venus Probe	Jun 12, 1967	Oct 18, 1967	Descent capsule transmitted data during parachute descent. Sent measurements of pressure, density, and chemical composition of the atmosphere before transmissions ceased.
Venera 5	Venus Probe	Jan 5, 1969	Mar 16, 1969	Entry velocity reduced by atmospheric braking before main parachute was deployed. Capsule entered atmosphere on planet's dark side; transmitted data for 53 minutes while traveling into the atmosphere before being crushed.

USSR Planetary Space Flights

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Venera 6	Venus Probe	Jan 10, 1969	Mar 17, 1969	Descent capsule entered the atmosphere on the planet's dark side; transmitted data for 51 minutes while traveling into the atmosphere before being crushed.
Venera 7	Venus Lander	Aug 17, 1970	Dec 15, 1970	Entry velocity was reduced aerodynamically before parachute deployed. After fast descent through upper layers, the parachute canpoy opened fully, slowing descent to allow fuller study of lower layers. Gradually increasing temperatures were transmitted. Returned data for 23 minutes after landing.
Cosmos 359	Venus Lander	Aug 22, 1970		Unsuccessful Venus attempt; failed to achieve escape velocity.
Cosmos 419	Mars Probe	May 10, 1971		First use of Proton launcher for a planetary mission. Placed in Earth orbit but failed to separate from fourth stage.
Mars 2	Mars Orbiter and Lander	May 19, 1971	Nov 27, 1971	Landing capsule separated from orbiter and made first, unsuccessful attempt to soft land. Lander carried USSR pennant. Orbiter continued to transmit data.
Mars 3	Mars Orbiter and Lander	May 28, 1971	Dec 2, 1971	Lander separated from parent capsule and landed in the southern hemisphere. A TV camera transmitted small panoramic view. Orbiter transmitted for 3 months.
Venera 8	Venus Lander	Mar 27, 1972	Jul 22, 1972	As the spacecraft entered the upper atmosphere, the descent module separated while the service module burned up in the atmosphere. Entry speed was reduced by aerodynamic braking before parachute deployment. During descent, a refrigeration system was used to offset high temperatures. Returned data on temperature, pressure, light levels, and descent rates. Transmitted from surface for about 1 hour.
Cosmos 482	Venus Lander	Mar 31, 1972		Unsuccessful Venus probe; escape stage misfired leaving craft in Earth orbit.
Mars 4 & 5	Mars Orbiters and Landers	Jul 21, 1973 Jul 25, 1973	Feb 10, 1974 Feb 12, 1974	Pair of spacecraft launched to Mars. Mars 4 retro rockets failed to fire; as it passed the planet, it returned one swath of pictures and some radio occultation data. Mars 5 was successfully placed in orbit, but operated only a few days. Returned photographs showing small portion of southern hemisphere.

USSR Planetary Space Flights

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Mars 6 & 7	Mars Orbiters and Landers	Aug 5, 1973 Aug 9, 1973	Mar 12, 1974 Mar 9, 1974	Second pair of spacecraft launched to Mars. Mars 6 lander module transmitted measurements of the Martian atmosphere during descent. Telemetry ceased abruptly when the landing rockets were fired. Soviet report of Mars 7 said "the descent module was separated from the station because of a hitch in the operation of one of the onboard systems, and passed by the planet."
Venera 9	Venus Orbiter and Lander	Jun 8, 1975	Oct 22, 1975	First spacecraft to transmit a picture from the surface of another planet. The lander's signals were transmitted to Earth via the orbiter. Utilized a new parachute system, consisting of six chutes. Signals continued from the surface for nearly 2 hours 53 minutes.
Venera 10	Venus Orbiter and Lander	Jun 14, 1975	Oct 25, 1975	During descent, atmospheric measurements and details of physical and chemical contents were transmitted via the orbiter. Transmitted pictures from the surface of Venus.
Venera 11	Venus Orbiter and Lander	Sep 9, 1978	Dec 25, 1978	Arrived at Venus 4 days after Venera 12. The two landers took nine samples of the atmosphere at varying heights and confirmed the basic components. Imaging system failed; did not return photos. Operated for 95 minutes.
Venera 12	Venus Orbiter and Lander	Sep 14, 1978	Dec 21, 1978	A transit module was positioned to relay the lander's data from behind the planet. Returned data on atmospheric pressure and components. Did not return photos; imaging system failed. Operated for 110 minutes.
Venera 13	Venus Orbiter and Lander	Oct 31, 1981	Mar 1, 1982	Provided first soil analysis from Venusian surface. Transmitted eight color pictures via orbiter. Measured atmospheric chemical and isotopic composition, electric discharges, and cloud structure. Operated for 57 minutes.
Venera 14	Venus Orbiter and Lander	Nov 4, 1981	Mar 3, 1982	Transmitted details of the atmosphere and clouds during descent; soil sample taken. Operated for 57 minutes.
Venera 15	Venus Orbiter	Jun 2, 1983	Oct 10, 1983	Obtained first high-resolution pictures of polar area. Compiled thermal map of almost entire northern hemisphere.
Venera 16	Venus Orbiter	Jun 7, 1983	Oct 16, 1983	Provided computer mosaic images of a strip of the northern continent. Soviet and U.S. geologists cooperated in studying and interpreting these images.

USSR Planetary Space Flights

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Vega 1 & 2	Venus/Halley	Dec 15, 1984 Dec 21, 1984	Jun 11, 1985 (Venus) Mar 6, 1986 (Halley) Jun 15, 1985 (Venus) Mar 9, 1986 (Halley)	International two-spacecraft project using Venusian gravity to send them on to Halley's Comet after dropping the Venusian probes. The Venus landers studied the atmosphere and acquired a surface soil sample for analysis. Each lander released a helium-filled instrumented balloon to measure cloud properties. The other half of the Vega payloads, carrying cameras and instruments, continued on to encounter Comet Halley.
Phobos 1 & 2	Mars/Phobos	Jul 7, 1988 Jul 12, 1988	Jan 1989 (Mars) Jan 1989 (Mars)	International two-spacecraft project to study Mars and its moon Phobos. Phobos 1 was disabled by a ground controller error. Phobos 2 entered Mars orbit in January 1989 to study the Martian surface, atmosphere, and magnetic field. On March 27, 1989, communication with Phobos 2 was lost and efforts to contact the spacecraft were discontinued.

USA Lunar Space Flights

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Pioneer 1	Lunar Orbit	Oct 11, 1958		Did not achieve lunar trajectory; launch vehicle second and third stages did not separate evenly. Returned data on Van Allen Belt and other phenomena before reentering on October 12, 1958.
Pioneer 2	Lunar Orbit	Nov 8, 1958		Third stage of launch vehicle failed to ignite. Returned data that indicated the Earth's equatorial region has higher flux and energy levels than previously believed. Did not achieve orbit.
Pioneer 3	Lunar Probe	Dec 6, 1958		First stage of launch vehicle cut off prematurely; transmitted data on dual bands of radiation around Earth. Reentered December 7, 1958.
Pioneer 4	Lunar Probe	Mar 3, 1959	Mar 4, 1959	Passed within 37,300 miles from the Moon; returned excellent data on radiation. Entered solar orbit.
Pioneer P-3	Lunar Orbit	Nov 26, 1959		Payload shroud broke away 45 seconds after liftoff. Did not achieve orbit.
Ranger 1	Lunar Probe	Aug 23, 1961		Flight test of lunar spacecraft carrying experiments to collect data on solar plasma, particles, magnetic fields, and cosmic rays. Launch vehicle failed to restart resulting in low Earth Orbit. Reentered August 30, 1961.
Ranger 2	Lunar Probe	Nov 18, 1961		Flight test of spacecraft systems for future lunar and interplanetary missions. Launch vehicle altitude control system failed, resulting in low Earth orbit. Reentered November 20, 1961.
Ranger 3	Lunar Landing	Jan 26, 1962		Launch vehicle malfunction resulted in spacecraft missing the Moon by 22,862 miles. Spectrometer data on radiation were received. Entered solar orbit.
Ranger 4	Lunar Landing	Apr 23, 1962	Apr 26, 1962	Failure of central computer and sequencer system rendered experiments useless. No telemetry received. Impacted on far side of the Moon.
Ranger 5	Lunar Landing	Oct 18, 1962		Power failure rendered all systems and experiments useless; 4 hours of data received from gamma ray experiment before battery depletion. Passed within 450 miles of the Moon. Entered solar orbit.

USA Lunar Space Flights

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Ranger 6	Lunar Photo	Jan 30, 1964	Feb 2, 1964	TV cameras failed; no data returned. Impacted in the Sea of Tranquility area.
Ranger 7	Lunar Photo	Jul 28, 1964	Jul 31, 1964	Transmitted high quality photographs, man's first close-up lunar views, before impacting in the Sea of Clouds area.
Ranger 8	Lunar Photo	Feb 17, 1965	Feb 20, 1965	Transmitted high quality photographs before impacting in the Sea of Tranquility area.
Ranger 9	Lunar Photo	Mar 21, 1965	Mar 24, 1965	Transmitted high quality photographs before impacting in the Crater of Alphonsus. Almost 200 pictures were shown live via commercial television in the first TV spectacular from the Moon.
Surveyor 1	Lunar Lander	May 30, 1966	Jun 2, 1966	First U.S. spacecraft to make a fully controlled soft landing on the Moon; landed in the Ocean of Storms area. Returned high quality images, from horizon views of mountains to close-ups of its own mirrors, and selenological data.
Lunar Orbiter 1	Lunar Orbiter	Aug 10, 1966	Aug 14, 1966	Photographed over 2 million square miles of the Moon's surface. Took first photo of Earth from lunar distance. Impacted on the far side of the Moon on October 29, 1966.
Surveyor 2	Lunar Lander	Sep 20, 1966	Sep 22, 1966	Spacecraft crashed onto the lunar surface southeast of the crater Copernicus when one of its three vernier engines failed to ignite during a mid-course maneuver.
Lunar Orbiter 2	Lunar Orbiter	Nov 6, 1966	Nov 10, 1966	Photographed landing sites, including the Ranger 8 landing point, and surface debris tossed out at impact. Impacted the Moon on October 11, 1967.
Lunar Orbiter 3	Lunar Orbiter	Feb 4, 1967	Feb 8, 1967	Photographed lunar landing sites; provided gravitational field and lunar environment data. Impacted the Moon on October 9, 1967.

USA Lunar Space Flights

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Surveyor 3	Lunar Lander	Apr 17, 1967	Apr 19, 1967	Vernier engines failed to cut off as planned and the spacecraft bounced twice before landing in the Ocean of Storms. Returned images, including a picture of the Earth during lunar eclipse, and used a scoop to make the first excavation and bearing test on an extraterrestrial body. Returned data on a soil sample. Visual range of TV cameras was extended by using two flat mirrors.
Lunar Orbiter 4	Lunar Orbiter	May 4, 1967	May 8, 1967	Provided the first pictures of the lunar south pole. Impacted the Moon on October 6, 1967.
Surveyor 4	Lunar Lander	Jul 14, 1967	Jul 17, 1967	Radio contact was lost 2-1/2 minutes before touchdown when the signal was abruptly lost. Impacted in Sinus Medii.
Lunar Orbiter 5	Lunar Orbiter	Aug 1, 1967	Aug 5, 1967	Increased lunar photographic coverage to better than 99%. Used in orbit as a tracking target. Impacted the Moon on January 31, 1968.
Surveyor 5	Lunar Lander	Sep 8, 1967	Sep 10, 1967	Technical problems were successfully solved by tests and maneuvers during flight. Soft-landed in the Sea of Tranquility. Returned images and obtained data on lunar surface radar and thermal reflectivity. Performed first on-site chemical soil analysis.
Surveyor 6	Lunar Lander	Nov 7, 1967	Nov 9, 1967	Soft-landed in the Sinus Medii area. Returned images of the lunar surface, Earth, Jupiter, and several stars. Spacecraft engines were restarted, lifting the spacecraft about 10 feet from the surface and landing it 8 feet from the original site.
Surveyor 7	Lunar Lander	Jan 7, 1968	Jan 9, 1968	Landed near the crater Tycho. Returned some stereo pictures of the surface and of rocks that were of special interest. Provided first observation of artificial light from Earth.

USSR Lunar Space Flights

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Luna 11	Lunar Orbiter	Aug 24, 1966		Second lunar satellite. Data received during 277 orbits. Selenocentric orbit.
Luna 12	Lunar Orbiter	Oct 22, 1966		TV system transmitted large-scale pictures of Sea of Rains and Crater Aristarchus areas. Tested electric motor for Lunokhod's wheels. Selenocentric orbit.
Luna 13	Lunar Lander	Dec 21, 1966	Dec 24, 1966	Soft landed in Ocean of Storms and sent back panoramic views. Two arms were extended to measure soil density and surface radioactivity.
Luna 14	Lunar Orbiter	Apr 7, 1968		Studied gravitational field and "stability of radio signals sent to spacecraft at different locations in respect to the Moon." Made further tests of geared electric motor for Lunokhod's wheels. Selenocentric orbit.
Zond 5	Circumlunar	Sep 15, 1968		First spacecraft to circumnavigate the Moon and return to Earth. Took photographs of the Earth. Capsule was recovered from the Indian Ocean on September 21, 1968. Russia's first sea recovery.
Zond 6	Circumlunar	Nov 10, 1968		Second spacecraft to circumnavigate the Moon and return to Earth "to perfect the automatic functioning of a manned spaceship that will be sent to the Moon." Photographed lunar far side. Reentry made by skip-glide technique; capsule was recovered on land inside the Soviet Union on November 17, 1968.
Luna 15	Lunar Sample Return	Jul 13, 1969	Jul 21, 1969	First lunar sample return attempt. Began descent maneuvers on its 52nd revolution. Spacecraft crashed at the end of a 4 minute descent in the Sea of Crises.
Zone 7	Circumlunar	Aug 7, 1969		Third circumlunar flight. Far side of Moon photographed. Color pictures of Earth and Moon brought back. Reentry by skip-glide technique on August 14, 1969.
Cosmos 300	Lunar Probe	Sep 23, 1969		Unsuccessful lunar attempt. Reentered September 27, 1969.
Cosmos 305	Lunar Probe	Oct 22, 1969		Unsuccessful lunar attempt. Reentered October 24, 1969.

USSR Lunar Space Flights

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Luna 1	Lunar Impact	Jan 2, 1959		Intended to impact the Moon; carried instruments to measure radiation. Passed the Moon and went into solar orbit.
Luna 2	Lunar Impact	Sep 12, 1959	Sep 15, 1959	First spacecraft to reach another celestial body. Impacted east of the Sea of Serenity; carried USSR pennants.
Luna 3	Lunar Probe	Oct 4, 1959		First spacecraft to pass behind Moon and send back pictures of far side. Equipped with a TV processing and transmission system, returned pictures of far side including composite full view of far side. Reentered Apr 29, 1960.
Sputnik 25	Lunar Probe	Jan 4, 1963		Unsuccessful lunar attempt.
Luna 4	Lunar Orbiter	Apr 2, 1963		Attempt to solve problems of landing instrument containers. Contact lost as it passed the Moon. Barycentric orbit.
Luna 5	Lunar Lander	May 9, 1965	May 12, 1965	First soft landing attempt. Retrorocket malfunctioned; spacecraft impacted in the Sea of Clouds.
Luna 6	Lunar Lander	Jun 8, 1965		During midcourse correction maneuver, engine failed to switch off. Spacecraft missed Moon and entered solar orbit.
Zond 3	Lunar Probe	Jul 18, 1965		Photographed lunar far side and transmitted photos to Earth 9 days later. Entered solar orbit.
Luna 7	Lunar Lander	Oct 4, 1965	Oct 7, 1965	Retrorockets fired early; crashed in Ocean of Storms.
Luna 8	Lunar Lander	Dec 3, 1965	Dec 6, 1965	Retrorockets fired late; crashed in Ocean of Storms.
Luna 9	Lunar Lander	Jan 31, 1966	Feb 3, 1966	First successful soft landing; first TV transmission from lunar surface. Three panoramas of the lunar landscape were transmitted from the eastern edge of the Ocean of Storms.
Cosmos 111	Lunar Probe	Mar 11, 1966		Unsuccessful lunar attempt. Reentered March 16, 1966.
Luna 10	Lunar Orbiter	Mar 31, 1966		First lunar satellite. Studied lunar surface radiation and magnetic field intensity; monitored strength and variation of lunar gravitation. Selenocentric orbit.

USSR Lunar Space Flights

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Luna 16	Lunar Sample Return	Sep 12, 1970	Sep 20, 1970	First recovery of lunar soil by an automatic spacecraft. Controlled landing achieved in Sea of Fertility; automatic drilling rig deployed; samples collected from lunar surface and returned to Earth on September 24, 1970.
Zond 8	Circumlunar	Oct 20, 1970		Fourth circumlunar flight. Color pictures taken of Earth and Moon. Russia's second sea recovery occurred on October 27, 1970, in the Indian Ocean.
Luna 17	Lunar Rover	Nov 10, 1970	Nov 17, 1970	Carrying the first Moon robot, soft landed in Sea of Rains. Lunokhod 1, driven by 5-man team on Earth, traveled over the lunar surface for 11 days; transmitted photos and analyzed soil samples.
Luna 18	Lunar Lander	Sep 2, 1971		Attempted to land in Sea of Fertility on September 11, 1971. Communications ceased shortly after command was given to start descent engine.
Luna 19	Lunar Orbiter	Sep 28, 1971		From lunar orbit, studied Moon's gravitational field; transmitted TV pictures of the surface. Selenocentric orbit.
Luna 20	Lunar Sample Return	Feb 14, 1972		Soft landed in Sea of Crises. Used "photo-telemetric device" to relay pictures of surface. A rotary-percussion drill was used to drill into rock; samples were lifted into a capsule on ascent stage and returned to Earth on Feb 25, 1972.
Luna 21	Lunar Rover	Jan 8, 1973	Jan 15, 1973	Carried improved equipment and additional instruments; second Lunokhod rover soft landed near the Sea of Serenity. Lunar surface pictures were transmitted and experiments were performed. Ceased operating on the 5th lunar day.
Luna 22	Lunar Orbiter	May 29, 1974	Jun 2, 1974	Placed in circular lunar orbit then lowered to obtain TV panoramas of high quality and good resolution. Altimeter readings were taken and chemical rock composition was determined by gamma radiation. Selenocentric orbit.
Luna 23	Lunar Sample Return	Oct 28, 1974		Landed on the southern part of the Sea of Crises on November 6, 1974. Device for taking samples was damaged; no drilling or sample collection possible.
Luna 24	Lunar Sample Return	Aug 9, 1976	Aug 14, 1976	Landed in Sea of Crises on August 18, 1976. Carried larger soil carrier. Core samples were drilled and returned. U.S. and British scientists were given samples for analyses.

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
1958								**1958**
Pioneer I (U) Eta I	Thor-Able I 130 (U)	Oct 11		DOWN OCT 12, 1958			34.2	Measure magnetic fields around Earth or Moon. Error in burnout velocity and angle; did not reach Moon. Returned 43 hours of data on extent of radiation band, hydromagnetic oscillations of magnetic field, density of micrometeors in interplanetary space, and interplanetary magnetic field.
Beacon I (U)	Jupiter C (U)	Oct 23		DID NOT ACHIEVE ORBIT			4.2	Thin plastic sphere (12 feet in diameter after inflation) to study atmosphere density at various levels. Upper stages and payload separated prior to first-stage burnout.
Pioneer II (U)	Thor-Able I 129 (U)	Nov 8		DID NOT ACHIEVE ORBIT			39.1	Measurement of magnetic fields around Earth or Moon. Third stage failed to ignite. Its brief data provided evidence that equatorial region about Earth has higher flux and higher energy radiation than previously considered.
Pioneer III (U)	Juno II (U)	Dec 6		DOWN DEC 7, 1958			5.9	Measurement of radiation in space. Error in burnout velocity and angle; did not reach Moon. During its flight, discovered second radiation belt around Earth.
1959								**1959**
Vanguard II (U) Alpha 1	Vanguard (SLV-4) (U)	Feb 17	123.8	3140	558	32.9	9.4	Sphere (20 inches in diameter) to measure cloud cover. First Earth photo from satellite. Interpretation of data difficult because satellite developed precessing motion.
Pioneer IV (S) Nu 1	Juno II (S)	Mar 3		HELIOCENTRIC ORBIT			6.1	Measurement of radiation in space. Achieved Earth-Moon trajectory; returned excellent radiation data. Passed within 37,300 miles of the Moon on March 4, 1959.
Vanguard (U)	Vanguard (SLV-5) (U)	Apr 13		DID NOT ACHIEVE ORBIT			10.6	Payload consisted of two independent spheres: Sphere A contained a precise magnetometer to map Earth's magnetic field; Sphere B was a 30-inch inflatable sphere for optical tracking. Second stage failed because of damage at stage separation.
Vanguard (U)	Vanguard (SLV-6) (U)	Jun 22		DID NOT ACHIEVE ORBIT			9.8	Magnesium alloy sphere (20 inches in diameter), to measure solar-Earth heating process which generates weather. Faulty second-stage pressure valve caused failure.
Explorer (S-1) (U)	Juno II (U)	Jul 16		DID NOT ACHIEVE ORBIT			41.5	To measure Earth's radiation balance. Destroyed by Range Safety Officer 5-1/2 seconds after liftoff; failure of power supply to guidance system.

NASA Major Launch Record

1959

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
Explorer 6 (S-2) (S) Delta 1	Thor-Able III 134 (S)	Aug 7		DOWN PRIOR TO JULY 1961			64.4	Carried instruments to study particles and meteorology. Helped in the discovery of three radiation levels, a ring of electric current circling the Earth, and obtained crude cloud cover images.
Beacon II (U)	Juno II (U)	Aug 14		DID NOT ACHIEVE ORBIT			4.5	Thin plastic inflatable sphere (12-feet in diameter) to study atmosphere density at various levels. Premature fuel depletion in first stage caused upper stage malfunction.
Big Joe (Mercury) (S)	Atlas 10 (S)	Sep 9		SUBORBITAL FLIGHT				Suborbital test of the Mercury Capsule. Capsule recovered successfully after reentry test. (WFF)
Vanguard III (S) Eta 1	Vanguard (SLV-7) (S)	Sep 18	127.6	3521	514	33.4	45.4	Solar-powered magnesium sphere with magnetometer boom; provided a comprehensive survey of the Earth's magnetic field, surveyed location of lower edge of Van Allen radiation belts, and provided an accurate count of micrometeorite impacts. Last transmission December 8, 1959.
Little Joe 1 (S)	Little Joe (L/V #6) (S)	Oct 4		SUBORBITAL FLIGHT				Suborbital test of the Mercury Capsule to qualify the booster for use with the Mercury Test Program.
Explorer 7 (S-1a) (S) Iota 1	Juno II (S)	Oct 13		DOWN JULY 16, 1989			41.5	Provided data on energetic particles, radiation, and magnetic storms. Also recorded the first micrometeorite penetration of a sensor.
Little Joe 2 (S)	Little Joe (L/V #1A) (S)	Nov 4		SUBORBITAL FLIGHT				Suborbital test of Mercury Capsule to test the escape system. Vehicle functioned perfectly, but escape rocket ignited several seconds too late. (WFF)
Pioneer P-3 (U)	Atlas-Able 20 (U)	Nov 26		DID NOT ACHIEVE ORBIT			168.7	Lunar Orbiter Probe; payload shroud broke away after 45 seconds.
Little Joe 3 (S)	Little Joe (L/V #2)(S)	Dec 4		SUBORBITAL FLIGHT				Suborbital test of the Mercury Capsule, included escape system and biomedical tests with monkey (Sam) aboard, to demonstrate high altitude abort at max q. (WFF)
1960								**1960**
Little Joe 4 (S)	Little Joe (L/V #1B)(S)	Jan 21		SUBORBITAL FLIGHT				Suborbital test of Mercury Capsule included escape system and biomedical test with monkey (Miss Sam) aboard. (WFF)
Pioneer V (P-2) (S) Alpha 1	Thor-Able IV 219 (S)	Mar 11		HELIOCENTRIC ORBIT			43.0	Sphere, 26 inches in diameter, to investigate interplanetary space between orbits of Earth and Venus, test long-range communications; and determine strength of magnetic fields.

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
Explorer (S-46) (U)	Juno II (U)	Mar 23		DID NOT ACHIEVE ORBIT			18.0	Analyze electron and proton radiation energies in a highly elliptical orbit. Telemetry lost shortly after first stage burnout; one of the upper stages failed to fire.
Tiros I (S) Beta 2	Thor-Able II 148 (S)	Apr 1	98.7	717	673	48.4	122.5	First successful weather-study satellite. Demonstrated that satellites could be used to survey global weather conditions and study other surface features from space. Transmitted 22,952 good-quality cloud-cover photographs.
Scout X (U)	Scout X (U)	Apr 18		SUBORBITAL FLIGHT				Suborbital Launch Vehicle Development Test with live first and third stages. Vehicles broke up after first-stage burnout.
Echo A-10 (U)	Thor-Delta (1) (U)	May 13		DID NOT ACHIEVE ORBIT			75.3	100-foot passive reflector sphere to be used in a series of communications experiments. During coast period, attitude control jets on second stage failed.
Scout I (S)	Scout 1 (S)	Jul 1		SUBORBITAL FLIGHT				Launch Vehicle Development Test; first complete Scout vehicle. (WFF)
Mercury (MA-1) (U)	Atlas 50 (U)	Jul 29		DID NOT ACHIEVE ORBIT				Suborbital test of Mercury Capsule Reentry. The Atlas exploded 65 seconds after launch.
Echo I (A-11) (S) Iota 1	Thor-Delta (2) (S)	Aug 12		DOWN MAY 24, 1968			75.3	First passive communications satellite (100-foot sphere). Reflected a pre-taped message from President Eisenhower across the Nation, demonstrating feasibility of global radio communications via satellite.
Pioneer (P-30) (U)	Atlas-Able 60 (U)	Sep 25		DID NOT ACHIEVE ORBIT			175.5	Highly instrumented probe, in lunar orbit, to investigate the environment between the Earth and the Moon. Second stage failed due to malfunction in oxidizer system.
Scout II (S)	Scout 2 (S)	Oct 4		SUBORBITAL FLIGHT				Launch Vehicle Development Test; second complete Scout vehicle, reached an altitude of 3,500 mi. (WFF)
Explorer 8 (S-30) (S) Xi 1	Juno II (S)	Nov 3	106.1	1689	405	49.9	40.8	Contained instrumentation for detailed measurements of the ionosphere. Confirmed the existence of a helium layer in the upper atmosphere.
Little Joe 5 (U)	Little Joe (LJV #5)(S)	Nov 8		SUBORBITAL FLIGHT				Suborbital test of Mercury Capsule to quality capsule system. Capsule did not separate from booster. (WFF)
Tiros II (S) Pi 1	Thor-Delta (3) (S)	Nov 23	97.2	668	583	48.5	127.0	Test of experimental television techniques and infrared equipment for global meteorological information system.
Explorer (S-56) (U)	Scout 3 (U)	Dec 4		DID NOT ACHIEVE ORBIT			6.4	12-foot sphere to determine the density of the Earth's atmosphere. Second stage failed to ignite.

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Pioneer (P-31) (U)	Atlas-Able 91 (U)	Dec 15		DID NOT ACHIEVE ORBIT			175.9	Highly instrumented probe, in lunar orbit, to investigate the environment between the Earth and the Moon. Vehicle exploded about 70 seconds after launch due to malfunction in first stage.
Mercury (MR-1A) (S)	Redstone (S)	Dec 19		SUBORBITAL FLIGHT				Unmanned Mercury spacecraft, in suborbital trajectory, impacted 235 miles down range after reaching an altitude of 135 miles and a speed of near 4,200 mph. Capsule recovered about 50 minutes after launch.
1961								**1961**
Mercury (MR-2) (S)	Redstone (S)	Jan 31		SUBORBITAL FLIGHT			1315.0	Suborbital test of Mercury Capsule; 16-minute flight included biomedical test with chimpanzee (Ham) aboard.
Explorer 9 (S) Delta 1	Scout 4 (S)	Feb 16		DOWN APR 9, 1964			6.8	12-foot sphere to determine the density of the Earth's Atmosphere. First spacecraft orbited by an all-solid rocket. (WFF)
Mercury (MA-2) (S)	Atlas 67 (S)	Feb 21		SUBORBITAL FLIGHT			1315.0	Suborbital test of Mercury Capsule; upper part of Atlas strengthened by an 8-inch wide stainless steel band. Capsule recovered less than 1 hour after launch.
Explorer (S-45) (U)	Juno II (U)	Feb 24		DID NOT ACHIEVE ORBIT			33.6	Investigate the shape of the ionosphere. A malfunction following booster separation resulted in loss of payload telemetry; third and forth stages failed to ignite.
Little Joe 5A (U)	Little Joe (L/V #5A) (U)	Mar 18		SUBORBITAL FLIGHT			1315.0	Suborbital test of Mercury Capsule. Escape rocket motor fired prematurely and prior to capsule release. (WFF)
Mercury (MR-BD) (S)	Redstone (S)	Mar 24		SUBORBITAL FLIGHT			1315.0	Suborbital test of launch vehicle for Mercury flight to acquire further experience with booster before manned flight was attempted.
Explorer 10 (S) Kappa 1	Thor-Delta (4) (S)	Mar 25		DOWN JUN 1968			35.8	Injected into highly elliptical orbit. Provided information on solar winds, hydromagnetic shock waves, and reaction of the Earth's magnetic field to solar flares.
Mercury (MA-3) (U)	Atlas 100 (U)	Apr 25		DID NOT ACHIEVE ORBIT			907.2	Orbital flight test of Mercury capsule. Destroyed after 40 seconds by Range Safety Officer when the inertial guidance system failed to pitch the vehicle over toward the horizon.
Explorer 11 (S) Nu 1	Juno II (S) (4 stages)	Apr 27	105.8	1578	485	28.8	37.2	Placed in elliptical orbit to detect high energy gamma rays from cosmic sources and map their distribution in the sky.
Little Joe 5B (S)	Little Joe (L/V #5B)(S)	Apr 28		SUBORBITAL FLIGHT			1315.0	Suborbital flight test to demonstrate the ability of the escape and sequence systems to function properly at max q. (WFF)
Mercury (S) (Freedom 7)	Mercury-Redstone-3 (S)	May 5		SUBORBITAL FLIGHT LANDED MAY 5, 1961			1315.0	First manned suborbital flight with Alan B. Shepard, Jr. Pilot and spacecraft recovered after 15 minute 22 second flight.

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MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
Explorer (S-45a) (U)	Juno II (U)	May 24		DID NOT ACHIEVE ORBIT			33.6	Investigate the shape of the ionosphere. Second stage ignition system malfunctioned
Meteoroid Sat A Explorer (S-55) (U)	Scout 5 (U)	Jun 30		DID NOT ACHIEVE ORBIT			84.8	Evaluate launch vehicle; investigate micrometeoroid impact and penetration. Third stage failed to ignite. (WFF)
Tiros III (S) Rho 1	Thor-Delta (5) (S)	Jul 12	100.1	801	730	47.9	129.3	Development of meteorological satellite system. Provided excellent photos and infrared data. Photographed many tropical storms during 1961 hurricane season; credited with discovering Hurricane Esther.
Mercury (S) (Liberty Bell 7)	Mercury-Redstone-4 (S)	Jul 21		SUBORBITAL FLIGHT LANDED JUL 21, 1961			1470.0	Second manned suborbital flight with Virgil I. Grissom. After landing, spacecraft was lost but pilot was rescued from surface of water. Mission Duration 15 minutes 37 seconds.
Explorer 12 (S-3) (S) Upsilon 1	Thor-Delta (6) (S)	Aug 16		DOWN SEP 1963			37.6	First of a series to investigate solar winds, interplanetary magnetic fields, and energetic particles. Identified the Van Allen Belts as a magnetosphere.
Ranger I (U) Phi 1	Atlas-Agena B 111 (U)	Aug 23		DOWN AUG 30, 1961			306.2	Flight test of lunar spacecraft carrying experiments to investigate cosmic rays, magnetic fields, and energetic particles. Agena failed to restart, resulting in low Earth orbit.
Explorer 13 (U) Chi 1	Scout 6 (U)	Aug 25		DOWN AUG 28, 1961			84.8	Evaluate launch vehicle; investigate micrometeoroid impact and penetration. Third stage failed to ignite. (WFF)
Mercury (MA-4) (S) A-Alpha 1	Atlas 88 (S)	Sep 13		DOWN SEP 13, 1961			1224.7	Orbital test of Mercury capsule to test systems and ability to return capsule to predetermined recovery area after one orbit. All capsule, tracking, and recovery objectives met.
Probe A (P-21) (S)	Scout 7 (S)	Oct 19		SUBORBITAL FLIGHT				Vehicle test/scientific Geoprobe. Reached altitude of 4,261 miles; provided electron density measurements. (WFF)
Saturn Test (SA-1) (S)	Saturn I (S)	Oct 27		SUBORBITAL FLIGHT				Suborbital launch vehicle development test of the S-1 booster propulsion system; verification of aerodynamic and structural design of the entire vehicle.
Mercury (MS-1) (U)	AF 609A Blue Scout (U)	Nov 1		DID NOT ACHIEVE ORBIT			97.1	Orbital test of the Mercury Tracking Network. First Stage exploded 26 seconds after liftoff; other three stages destroyed by Range Safety Officer 44 seconds after launch.
Ranger II (U) A-Theta 1	Atlas-Agena B 117 (U)	Nov 18		DOWN NOV 20, 1961			306.2	Flight test of spacecraft systems designed for future lunar and interplanetary missions. Inoperative roll gyro prevented Agena restart resulting in a low Earth orbit.

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MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
Mercury (MA-5) (S) A-lota 1	Atlas 93 (S)	Nov 29		DOWN NOV 29, 1961			1315.4	Final flight test of all Mercury systems prior to manned orbital flight; chimpanzee Enos on board. Spacecraft and chimpanzee recovered after two orbits.
1962								**1962**
Echo (AVT-1) (S)	Thor 338 (S)	Jan 15		SUBORBITAL FLIGHT			256.0	Suborbital Communications Test. Canister ejection and opening successful, but 135-foot sphere ruptured.
Ranger III (U) Alpha 1	Atlas-Agena B 121 (U)	Jan 26		HELIOCENTRIC ORBIT			329.8	Rough land instrumented capsule on the Moon. Booster malfunction resulted in the spacecraft missing the Moon by 22,862 miles and going into solar orbit. TV pictures were unusable.
Tiros IV (S) Beta 1	Thor-Delta (7) (S)	Feb 8	100.1	824	700	48.3.3	129.3	Continued research and development of meteorological satellite system. U.S. Weather Bureau initiated international radio facsimile transmission of cloud maps based on data received.
Mercury (MA-6) (Friendship 7) (S) Gamma 1	Atlas 109 (S)	Feb 20		LANDED FEB 20, 1962			1354.9	First U.S. manned orbital flight. John H. Glenn, Jr. made three orbits of the Earth. Capsule and pilot recovered after 21 minutes in the water. Mission Duration 4 hours 55 minutes 23 seconds.
Reentry I (U)	Scout 8 (S)	Mar 1		SUBORBITAL FLIGHT				Launch vehicle development test/Reentry test. Desired speed was not achieved. (WFF)
OSO-I (S) Zeta 1	Thor-Delta (8) (S)	Mar 7		DOWN OCT 8, 1981			207.7	Carried 13 instruments to study Sun-Earth relationships. Transmitted almost 1,000 hours of information on solar phenomena, including measurements of 75 solar flares.
Probe B (P-21a) (S)	Scout 9 (S)	Mar 29		SUBORBITAL FLIGHT				Suborbital vehicle test/scientific geoprobe. Reached an altitude of 3,910 miles; provided electron density measurements. (WFF)
Ranger 4 (U) Mu 1	Atlas-Agena B (S)	Apr 23		IMPACTED MOON ON APR 26, 1962			331.1	Second attempt to rough land instrumented capsule on Moon. Failure of central computer and sequencer system rendered experiments useless. Impacted on far side of Moon after flight of 64 hours.
Saturn Test (SA-2) (S)	Saturn I (S)	Apr 25		SUBORBITAL FLIGHT			86167.0	Suborbital launch vehicle test; carried 95 tons of ballast water in upper stages which was released at an altitude of 65 miles to observe the effect on the upper region of the atmosphere (Project High Water).
Ariel I (S) Omicron 1	Thor-Delta (9) (S)	Apr 26		DOWN MAY 24, 1976			59.9	Carried six British experiments to study the ionosphere, solar radiation, and cosmic rays. First International Satellite. Cooperative with UK.
Centaur Test 1 (AC-1)(U)	Atlas-Centaur (F-1) (U)	May 8		SUBORBITAL FLIGHT				Launch vehicle development test. Centaur exploded before separation.

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Mercury (MA-7) (Aurora 7) (S) Tau 1	Atlas 107 (S)	May 24		LANDED MAY 24, 1962			1349.5	Second orbital Manned Flight with M. Scott Carpenter. Reentered under manual control after three orbits. Mission Duration 4 hours 56 minutes 5 seconds.
Tiros V (S) A-Alpha	Thor-Delta (S)	Jun 19	99.8	916	583	58.1	129.3	Continued research and development of meteorological satellite system. Extended observations to higher latitudes. Observed ice breakup in northern latitudes and storms originating in these areas.
Telstar 1 (S) A-Epsilon	Thor-Delta (10) (S)	Jul 10	157.8	5651	938	44.8	77.1	First privately built satellite to conduct communication experiments. First telephone and television experiments transmitted. Reimbursable (AT&T)
Echo (AVT-2) (S)	Thor-Delta (11) (S)	Jul 18		SUBORBITAL FLIGHT			256.0	Suborbital communications test. Inflation successful; radar indicated that the sphere surface was not as smooth as planned.
Mariner I (P-37) (U)	Atlas-Agena B 145 (U)	Jul 22		DID NOT ACHIEVE ORBIT			202.8	Venus Flyby. Vehicle destroyed by Range Safety Officer about 290 seconds after launch when it veered off course.
Mariner II (P-38) (S) A-Rho 1	Atlas-Agena B 179 (S)	Aug 27		HELIOCENTRIC ORBIT			202.8	Second Venus flyby. First successful interplanetary probe. Passed Venus on December 14, 1962, at 21,648 miles, 109 days after launch. Provided data on solar wind, cosmic dust density, and particle and magnetic field variations.
Reentry II (U)	Scout 13 (U)	Aug 31		SUBORBITAL FLIGHT				Reentry test at 28,000 fps: late third stage ignition, desired speed was not achieved. (WFF)
Tiros VI (S) A-Psi 1	Thor-Delta (12) (S)	Sep 18	98.1	679	653	58.3	127.5	Provide coverage of the 1962 hurricane season. Returned high quality cloud cover photographs.
Alouette I (S) B-Alpha 1	Thor-Agena B (S)	Sep 29	105.3	1025	989	80.5	145.2	Designed and built by Canada to measure variations in the ionosphere electron density distribution. Returned excellent data to 13 Canadian, British, and U.S. stations. Cooperative with Canada.
Explorer 14 (S-3a)(S) B-Gamma 1	Thor-Delta (13) (S)	Oct 2		DOWN JULY 1, 1966			40.4	Monitor trapped corpuscular radiation, solar particles, cosmic radiation, and solar winds. Placed into a highly elliptical orbit; excellent data received.
Mercury(MA-8) (Sigma 7) (S) B-Delta 1	Atlas 113 (S)	Oct 3		LANDED OCT 3, 1962			1360.8	Manned Orbital Flight with Walter M. Schirra, Jr. Made six orbits of the Earth. Mission Duration 9 hours 13 minutes 11 seconds.
Ranger V (U) B-Eta 1	Atlas-Agena B 215 (S)	Oct 18		HELIOCENTRIC ORBIT			342.5	Rough land instrumented capsule on the Moon. Malfunction caused power supply loss after 8 hours 44 minutes. Passed within 450 miles of the Moon.

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Explorer 15 (S-3b) (S) B-Lambda	Thor-Delta (14) (S)	Oct 27			DOWN OCT 5, 1967		44.5	Study location, composition, and decay rate of artificial radiation belt created by high altitude nuclear explosion over the Pacific Ocean. Despin device failed; considerable useful data transmitted.
Saturn (SA-3) (S)	Saturn I (S)	Nov 16			SUBORBITAL FLIGHT		86167.0	Suborbital launch vehicle development flight. Second "Project High Water" using 95 tons of water released at an altitude of 90 n mi.
Relay I (S) B-Upsilon 1	Thor-Delta (15) (S)	Dec 13	185.1	7440	1318	47.5	78.0	Test intercontinental microwave communication by low-altitude active repeater satellite. Initial power failure overcome. Over 500 communication tests and demonstrations conducted.
Explorer 16 (S-55b) (S) B-Chi 1	Scout 14 (S)	Dec 16	104.2	1166	74752.0	100.7		Measure micrometeoroid puncture hazard to structural skin samples. First statistical sample; flux level found to lie between estimated extremes. (WFF)
1963								**1963**
Syncom I (U) 1963 04A	Thor-Delta (16) (S)	Feb 14			CURRENT ELEMENTS NOT MAINTAINED		39.0	First test of communication satellite in geosynchronous orbit. Initial communication tests successful; all contact lost 20 seconds after command to fire apogee motor.
Saturn Test (SA-4) (S)	Saturn I (S)	Mar 28			SUBORBITAL FLIGHT			Suborbital launch vehicle development test. Programmed in-flight cutoff of one of eight engines; successfully demonstrated propellant utilization system function.
Explorer 17 (SA-4) (S) 1963 09A	Thor-Delta (17) (S)	Apr 3			DOWN NOV 24, 1966		183.7	Measure density, composition, pressure and temperature of the Earth's atmosphere. Discovered belt of neutral helium around Earth.
Telstar II (S) 1963 13A	Thor-Delta (18) (S)	May 7	225.3	10807	968	42.8	79.4	Conduct wideband communication experiments. Color and black and white television successfully transmitted to Great Britain and France. Reimbursable (AT&T).
Mercury (MA-9) (Faith 7) (S) 1963 15A	Atlas 130 (S)	May 15			LANDED MAY 16, 1963		1360.8	Fourth Orbital Manned flight with L. Gordon Cooper, Jr. Various tests and experiments performed. Capsule reentered after 22 orbits. Mission Duration 34 hours 19 minutes 49 seconds.
RFD-1 (S)	Scout 19 (S)	May 22			SUBORBITAL FLIGHT		217.6	Suborbital reentry flight test; carried AEC Reactor mockup. Reimbursable (AEC). (WFF)
Tiros VII (S) 1963 24A	Thor-Delta (19) (S)	Jun 19	95.8	560	557	58.2	134.7	Continued meteorological satellite development. Furnished over 30,000 useful cloud cover photographs, including pictures of Hurricane Ginny in its early stages in mid-October.

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CRL (USAF) (S) 1963 26A	Scout 21 (S)	Jun 28		DOWN DEC 14, 1983			99.8	Cambridge Research Lab geophysics experiment test. Reimbursable (DOD). (WFF)
Reentry III (U)	Scout 22 (U)	Jul 20		SUBORBITAL FLIGHT				Suborbital reentry flight demonstration test of an ablation material at reentry speeds. Vehicle failed. (WFF)
Syncom II (S) 1963 31A	Thor-Delta (20) (S)	Jul 26		CURRENT ELEMENTS NOT MAINTAINED			39.0	Geosynchronous communication satellite test. Voice, teletype, facsimile, and data transmission tests conducted.
Little Joe II Test (S)	Little Joe II #1 (S)	Aug 28		SUBORBITAL FLIGHT				Suborbital Apollo launch vehicle test. Booster qualification test with dummy payload. (White Sands)
Explorer 18 (S) (IMP-A) 1963 46A	Thor-Delta (21) (S)	Nov 27		DOWN DEC 30, 1965			62.6	First in a series of Interplanetary Monitoring Platforms to observe interplanetary space over an extended period of solar cycle. Discovered a region of high-energy radiation beyond the Van Allen belts; reported stationary shock wave created by the interaction of the solar wind and geomagnetic field.
Centaur Test II (S) 1963 47A	Atlas-Centaur (AC-2) (S)	Nov 27	105.8	1585	473	30.4	4620.8	Launch vehicle development test. Instrumented with 2,000 pounds of sensors, equipment, and telemetry; performance and structural integrity test.
Explorer 19 (AD-A) (S) 1963 53A	Scout 24 (S)	Dec 19		DOWN MAY 10, 1981			7.7	Sphere, 12 feet in diameter, was optically tracked after tracking beacon failed, to obtain long-term atmospheric density data and study density changes. (WSMC)
Tiros VIII (S) 1963 54A	Delta 22 (S)	Dec 21	98.9	719	687	58.5	120.2	Continued meteorological satellite development; initial flight test of Automatic Picture Transmission camera system which made it possible to obtain local cloud cover pictures using inexpensive ground stations.
1964								**1964**
Relay II (S) 1964 03A	Delta 23 (S)	Jan 21	194.7	7511	1990	46.4	85.3	Modified communication satellite with a capability of TV or 300 one-way voice transmissions or 12 two-way narrowband communication. Completed more than 230 demonstrations and tests; also obtained over 600 hours of radiation data.
Echo II (S) 1964 04A	Thor-Agena B (S)	Jan 25		DOWN JUN 7, 1969			348.4	Rigidized sphere, 135 feet in diameter, to conduct passive communication experiments (radio, teletype, facsimile tests). Good experiment results obtained, data exchanged with USSR. (WSMC)
Saturn I (SA-5) (S) 1964 05A	Saturn I (S)	Jan 29		DOWN APR 30, 1966			17,554.2	Launch vehicle development test. Fifth flight of Saturn, first Block II Saturn, first live flight of the LOX/LH_2 fueled second stage (S-IV). 11,146 measurements taken.

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Ranger VI (U) 1964 07A	Atlas-Agena B 199 (S)	Jan 30		IMPACTED MOON ON FEB 2, 1964			364.7	Photograph lunar surface before hard impact. No video signals received. Impacted on west side of Sea of Tranquility, within 20 miles of target, after 65.6 hour flight.
Beacon Explorer A (S-66) (U)	Delta 24 (U)	Mar 19		DID NOT ACHIEVE ORBIT			54.7	Provide data on ionosphere, conduct laser and Doppler shift geodetic tracking experiments. Vehicle third stage malfunctioned
Ariel II (UK) (S) 1964 15A	Scout 25 (S)	Mar 27		DOWN NOV 18, 1967			74.8	Carried three British experiments to measure galactic radio noise. Cooperative with UK. (WFF)
Gemini I (S) 1964 18A	Titan II 1 (S)	Apr 8	89.2	328.2	160.9	32.6	3175.2	Qualification of Gemini spacecraft configuration/Gemini launch vehicle combination in launch environment through orbital insertion phase
Fire I (S)	Atlas-Antares 263 (S)	Apr 14		SUBORBITAL FLIGHT			1995.8	Reentry Test to study the heating environment encountered by a body entering the Earth's atmosphere at high speed.
Apollo Abort A-001 (S)	Little Joe II (S)	May 13		SUBORBITAL FLIGHT				Vehicle development test to demonstrate Apollo spacecraft atmospheric abort system capabilities. (White Sands)
Saturn I (SA-6) (S) 1964 25A	Saturn I (SA-6) (S)	May 28	88.5	225.2	199.5	31.8	17644.9	Vehicle development test. First flight of unmanned model of the Apollo spacecraft. 106 measurements obtained.
Centaur Test III (S)	Atlas-Centaur (AC-3) (S)	Jun 30		SUBORBITAL FLIGHT				Launch vehicle development test, performance and guidance evaluation
SERT I (S)	Scout 28 (S)	Jul 20		SUBORBITAL FLIGHT				Test ion engine performance in space. Confirmed that high prevalence ion beams could be neutralized in space. (WFF)
Ranger VII (S) 1964 41A	Atlas-Agena B 250 (S)	Jul 28		IMPACTED MOON ON JUL 31, 1964			364.7	Photograph lunar surface before hard impact. Transmitted 4,316 high quality photographs showing amazing detail before impacting in Sea of Clouds, flight time 68 hours 35 minutes 55 seconds.
Reentry IV (S)	Scout 29 (S)	Aug 18		SUBORBITAL FLIGHT				Reentry Test. Demonstrated the ability of the Apollo spacecraft to withstand reentry conditions at 27,950 fps.
Syncom III (S) 1964 47A	Delta 25 (S)	Aug 19		CURRENT ELEMENTS NOT MAINTAINED			65.8	Experimental geosynchronous communications satellite. Provided live TV coverage of the Olympic games in Tokyo and conducted various communications tests.
Explorer 20 (S) 1964 51A	Scout 30 (S)	Aug 25	103.7	1007	858	79.9	44.5	Ionosphere Explorer to obtain radio soundings of upper ionosphere as part of the Topside Sounder program.
Nimbus I (S) 1964 52A	Thor-Agena B (S)	Aug 28		DOWN MAY 16, 1974			376.5	Improved meteorological satellite; Earth oriented to provide complete global cloud cover images. Returned more than 27,000 excellent photographs; APT system supplied daytime photos to low-cost ground stations.

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OGO I (U) 1964 54A	Atlas-Agena B 195 (S)	Sep 4 (S)		CURRENT ELEMENTS NOT MAINTAINED			487.2	Standardized spacecraft capable of conducting related experiments. Carried 20 instruments to investigate geophysical and solar phenomena. Boom deployment anomaly obscured horizon scanner's view of Earth. Varying quality data received from all experiments.
Saturn I (SA-7) (S) 1964 57A	Saturn I (S)	Sep 18		DOWN SEP 22, 1964				Demonstrate Launch Vehicle/spacecraft compatibility and test launch escape system. Telemetry obtained from 131 separate and continuous measurements.
Explorer 21 (U) 1964 60A	Delta 26 (U)	Oct 4		DOWN JAN 30, 1966				Interplanetary Monitoring Platform to obtain magnetic fields, radiation, and solar wind data. Failed to reach planned apogee, but provided good data.
RFD-2 (S)	Scout 31 (S)	Oct 9		SUBORBITAL FLIGHT			217.6	Reentry flight carried AEC Reactor Mockup. Reimbursable (AEC).
Explorer 22 (S) 1964 64A	Scout 32 (S)	Oct 10	104.5	1060	877	79.7	52.6	Beacon Explorer; to provide data on variations in the ionosphere's structure and relate ionospheric behavior to solar radiation. Low-cost ground stations throughout the world received uncoded radio signals. Laser tracking accomplished on October 11, 1964. (WSMC)
Mariner III (U) 1964 73A	Atlas-Agena D 289 (U)	Nov 5		HELIOCENTRIC ORBIT			260.8	Mars flyby. Fiberglass shroud failed to jettison properly, solar panels failed to extend, Sun and Canopus not acquired. Transmissions ceased 9 hours after launch.
Explorer 23 (S-55C) (S) 1964 74A	Scout 33 (S)	Nov 6		DOWN JUN 29, 1983			133.8	Provided data on meteoroid penetration and resistance of various materials to penetration.
Explorer 24 (S) 1964 76A	Scout 34 (S)	Nov 21		DOWN OCT 18, 1968			8.6	First dual payload (Air Density/Injun); two satellites provided detailed information on complex radiation-air density relationships in the upper atmosphere. (WSMC)
Explorer 25 (S) 1964 76B			115.2	2401	524	81.3	34.0	
Mariner IV (S) 1964 77A	Atlas-Agena D 288 (S)	Nov 28		HELIOCENTRIC ORBIT			260.8	Second of two 1964 Mars flyby launches. Encounter occurred on July 14, 1965, with closest approach at 6,118 miles of the planet. Transmitted 22 pictures.
Apollo Abort A-002 (S)	Little Joe II (S)	Dec 8		SUBORBITAL FLIGHT			42593.0	First test of Apollo emergency detection system at abort altitude. (White Sands)
Centaur 1964 82A	Atlas-Centaur (AC-4) (S)	Dec 11		DOWN DEC 12, 1964			2993.0	Vehicle development flight carried mass model of Surveyor spacecraft, propulsion and stage separation test.

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
San Marco 1 (S) 1964 84A	Scout 35 (S)	Dec 15		DOWN SEP 13, 1965			115.2	Flight test of satellite to furnish data on air density and ionosphere characteristics. Launch vehicle provided by NASA; launched by Italian launch crew. Cooperative with Italy. (WFF)
Explorer 26 (S) 1964 86A	Delta 27 (S)	Dec 21		CURRENT ELEMENTS NOT MAINTAINED			45.8	Energetic Particles Explorer; carried five experiments to provide data on high-energy particles.
1965								**1965**
Gemini II (S)	Titan II 2 (S)	Jan 19		SUBORBITAL FLIGHT			3133.9	Demonstrate structural integrity of reentry module heat protection during maximum heating rate reentry and demonstrate variable lift on reentry module.
Tiros IX (S) 1965 04A	Delta 28 (S)	Jan 22	119.0	2568	702	96.4	138.3	First "Cartwheel" configuration for Weather Bureau's Operational system. Provided increased coverage of global cloud cover with pictures of excellent quality.
OSO B-2 (S) 1965 07A	Delta 29 (S)	Feb 3		DOWN AUG 9, 1969			244.9	Second in a series to measure the frequency and energy of solar electromagnetic radiation in the ultraviolet, X-ray and gamma-ray regions of the spectrum.
Pegasus I (S) 1965 09A	Saturn I (SA-9) (S)	Feb 16		DOWN SEP 17, 1978			1451.5	Obtained scientific and engineering data on the magnitude and direction of meteoroids in near-Earth orbit.
Ranger VIII (S) 1965 10A	Atlas-Agena B 196 (S)	Feb 17		IMPACTED MOON ON FEB 20, 1965			364.7	Photograph lunar surface before hard impact. Transmitted 7,137 high quality photographs before impacting in the Sea of Tranquility; flight time 64.54 hours.
Centaur Test (U)	Atlas-Centaur (AC-5) (U)	Mar 2		SUBORBITAL FLIGHT			2548.0	Vehicle development test; Atlas stage failed 4 seconds after liftoff.
Ranger IX (S) 1965 23A	Atlas-Agena B 204 (S)	Mar 21		IMPACTED MOON ON MAR 24, 1965			364.7	Photograph lunar surface before hard impact. Transmitted 5,814 excellent quality pictures, about 200 pictures relayed live via commercial TV. Flight time 64.52 hours.
Gemini III (S) 1965 24A	Titan II 3 (S)	Mar 23		LANDED MAR 23, 1965			3236.9	First manned orbital flight of the Gemini program, with astronauts Virgil I. Grissom and John W. Young. Manually controlled reentry after three orbits. Mission Duration 4 hours 53 minutes.
Intelsat 1 (F-1) (S) 1965 28A	Delta 30 (S)	Apr 6		CURRENT ELEMENTS NOT MAINTAINED			38.5	First operational satellite for Comsat Corp., to provide commercial trans-Atlantic communications. Reimbursable (Comsat).
Explorer 27 (S) 1965 32A	Scout 36 (S)	Apr 29	107.8	1317	931	41.2	60.8	Beacon Explorer; obtained data on Earth's gravitational field. Also carried laser tracking experiments.

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
Apollo Abort A-003 (U)	Little Joe II (U)	May 19			SUBORBITAL FLIGHT			Demonstration of abort capability of Apollo spacecraft. Launch escape vehicle at high altitude not accomplished due to malfunction of Little Joe II Booster. (White Sands)
Fire II (S)	Atlas-Antares 264 (S)	May 22			SUBORBITAL FLIGHT		2005.8	Second Reentry Test to study heating environment encountered by a body entering the Earth's atmosphere at high speed.
Pegasus II (S) 1965 39A	Saturn I (SA-8) (S)	May 25			DOWN NOV 3, 1979		1451.5	Micrometeoroid detection experiment confirmed lower meteoroid density than expected.
Explorer 28 (S) 1965 42A	Delta 31 (S)	May 29			DOWN JUL 4, 1968		59.0	Third Interplanetary Monitoring Platform, carrying eight scientific instruments, to measure magnetic fields, cosmic rays, and solar wind beyond the Earth's magnetosphere.
Gemini IV (S) 1965 43A	Titan II 4 (S)	Jun 3			LANDED JUN 7, 1965		3537.6	Second manned Gemini flight with James A McDivitt and Edward H. White. During flight, White donned a pressure suit and performed an EVA using the ZIP (Zero-G Integral Propulsion) Unit. EVA duration: 22 minutes. Mission Duration: 97 hours 56 minutes 11 seconds.
Tiros X (S) 1965 51A	Delta 32 (S)	Jul 1	100.3	817	728	98.6	127.0	First U.S. Weather Bureau-funded Tiros; obtained maximum coverage of 1965 hurricane and typhoon season.
Pegasus III (S) 1965 60A	Saturn I (SA-10) (S)	Jul 30			DOWN AUG 4, 1969		1451.5	Final micrometeoroid detection experiment. Results of Pegasus program indicated that the flux of small particles was less than expected, the flux of large particles was more than expected, and the flux of medium-sized particles was about as predicted.
Scout Test (S) Secor (S) 1965 63A	Scout 37 (S)	Aug 10	122.2	2418	1136	69.2	20.0	Vehicle development test. Carried U.S. Army Secor geodetic satellite. Reimbursable (DOD).
Centaur Test (S) 1965 64A	Atlas-Centaur (AC-6) (S)	Aug 11			BARYCENTRIC ORBIT		952.6	Vehicle development test. Carried Surveyor dynamic model. Direct-ascent test for guidance evaluation.
Gemini V (S) 1965 68A REP 1965 68C	Titan II 5 (S)	Aug 21			LANDED AUG 29, 1965 DOWN AUG 27, 1965		3175.2	Third manned orbital flight with L. Gordon Cooper and Charles Conrad, Jr. Ejected Rendezvous Evaluation Pod (REP) for simulated rendezvous maneuvers experiment; participated in communications and other on-board experiments. Mission Duration 190 hours 56 minutes 14 seconds.
OSO-C (U)	Delta 33 (U)	Aug 25			DID NOT ACHIEVE ORBIT		281.2	Third in a series to maintain continuity of observations during solar activity cycle. Vehicle third stage ignited prematurely.

NASA Major Launch Record

1965

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
OGO II (U) 1965 81A	Thor-Agena D (S)	Oct 14			DOWN SEP 17, 1981		507.1	Carried 20 experiments to investigate near-Earth space phenomena on an interdisciplinary basis. Failure of primary launch vehicle guidance resulted in higher than planned orbit. 19 experiments returned useful data. (WSMC)
Gemini VI (U)	Atlas-Agena D 5301 (U)	Oct 25			DID NOT ACHIEVE ORBIT			Agena target vehicle. Simultaneous countdown of Gemini spacecraft and Atlas-Agena Target Vehicle. Telemetry lost 375 seconds after launch of target vehicle; Gemini launch terminated at T+42 minutes
Explorer 29 (S) 1965 89A	Delta 34 (S)	Nov 6	120.3	2273	1114	59.4	174.6	GEOS-A, part of U.S. Geodetic Satellite Program to provide new geodetic data about the Earth.
Explorer 30 (S) 1965 93A	Scout 38 (S)	Nov 18	100.4	881	676	59.7	56.7	Monitor solar X-rays and ultraviolet emissions during final portion of IQSY. Data acquired by NRL and foreign stations in 13 countries. Cooperative with NRL. (WFF)
Explorer 31 (S) 1965 98B	Thor-Agena B (S)	Nov 29	120.5	2905	502	79.8	98.9	Make related studies of ionospheric composition and temperature variations. Provided excellent data from regions of the ionosphere never before investigated. Cooperative with Canada. (WSMC)
Alouette II (S) 1965 98A			119.3	2801	500	79.8	146.5	
Gemini VII (S) 1965 100A	Titan II 6 (S)	Dec 4			LANDED DEC 18, 1965		3628.8	Fourth manned mission with Frank Borman and James A. Lovell, Jr. Astronauts flew part of the mission without wearing pressure suits. Mission Duration 330 hours 35 minutes 31 seconds.
French 1A (S) 1965 101A	Scout 39 (S)	Dec 6	99.2	728	716	75.9	71.7	Study VLF wave propagation in the ionosphere and magnetosphere and measure electron densities. Cooperative with France. (WSMC)
Gemini VI-A (S) 1965 104A	Titan II 7 (S)	Dec 15			LANDED DEC 16, 1965		3175.2	Fifth manned mission with Walter M. Schirra, Jr. and Thomas P. Stafford. First rendezvous in space accomplished with Gemini VII spacecraft. Mission Duration 25 hours 51 minutes 24 seconds.
Pioneer VI (S) 1965 105A	Delta 35 (S)	Dec 16			HELIOCENTRIC ORBIT		63.5	Operated in solar orbit to provide data on solar wind, interplanetary magnetic fields, solar physics, and high-energy charged particles and magnetic fields.
1966								**1966**
Apollo Abort A-004 (S)	Little Joe II (S)	Jan 20			SUBORBITAL FLIGHT		4989.0	Apollo development flight to demonstrate launch escape vehicle performance. Last unmanned ballistic flight. (White Sands)

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
ESSA I (S) 1966 08A	Delta 36 (S)	Feb 3	99.9	819	688	97.9	138.3	Sun-synchronous orbit permitted satellite to view weather in each area of the globe each day, photographing a given area at the same local time every day. First Advanced Vidicon Camera System provided valuable information about weather patterns and conditions. Reimbursable (NOAA). (WSMC)
Reentry V (S)	Scout 42 (S)	Feb 9			SUBORBITAL FLIGHT		95.0	Test to investigate the heating environment of a body reentering the Earth's atmosphere at 27,000 fps. (WFF)
Apollo Saturn (AS-201) (S)	Saturn IB (S)	Feb 26			SUBORBITAL FLIGHT		20820.1	Launch Vehicle development flight; carried unmanned Apollo spacecraft.
ESSA II (S) 1966 16A	Delta 37 (S)	Feb 28	113.4	1413	1352	101.0	131.5	Provided direct readout of cloud cover photos to local users. Along with ESSA I, completed the initial global weather satellite system. Reimbursable (NOAA). (WSMC)
Gemini VIII (U) 1966 20A	Titan II 8 (S)	Mar 16			LANDED MAR 17, 1966		3788.0	Agena Target Vehicle launched from Complex 14 and manned Gemini launched from Complex 19. Astronauts Neil A. Armstrong and David R. Scott accomplished rendezvous and docking. Attitude and maneuver thruster malfunction caused the docked spacecraft to tumble. Astronauts separated the vehicles and terminated the mission early; EVA was not accomplished. First Pacific Ocean landing. Mission Duration 10 hours 41 minutes 26 seconds.
GATV (S) 1966 19A	Atlas-Agena D 5302 (S)	Mar 16			DOWN SEP 15, 1967			
Centaur Test (U) 1966 30A	Atlas-Centaur (AC-8) (U)	Apr 8			DOWN MAY 5, 1966		784.7	Launch vehicle development flight; carried Surveyor model. Second Centaur Engine firing unsuccessful.
OAO I (U) 1966 31A	Atlas-Agena D 5002C (S)	Apr 8	100.8	799	788	35.0	1769.0	Carried four experiments to study UV, X-ray and gamma-ray regions. Primary battery malfunctioned.
Nimbus II (S) 1966 40A	Thor-Agena D D 5303 (S)	May 14	108.0	1175	1092	100.4	413.7	Provided global weather photography on 24-hour basis for meteorological research and operational use. (WSMC)
Gemini IX (U)	Atlas-Agena D 5303 (U)	May 17			DID NOT ACHIEVE ORBIT		3252.0	Target vehicle for Gemini IX; vehicle failure caused by a short in the servo control circuit.
Explorer 32 (S) 1966 44A	Delta 38 (S)	May 25			DOWN FEB 22, 1985		224.5	Atmosphere Explorer; carried 8 experiments to measure temperatures, composition, density and pressures in the upper atmosphere.
Surveyor I (S) 1966 45A	Atlas-Centaur (AC-10) (S)	May 30			LANDED ON MOON JUN 2, 1966		995.2	Achieved soft lunar landing in Ocean of Storms. Performed engineering tests and transmitted photography. Landing pads penetrated the lunar surface to a maximum depth of 1 inch.

NASA Major Launch Record

1966

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
Gemini IXA (U) 1966 47A	Titan II 9 (S)	Jun 3		LANDED JUN 6, 1966			3705.3	Seventh manned mission with Thomas P. Stafford and Eugene A. Cernan. Target vehicle shroud failed to separate; docking was not achieved. EVA was successful, but evaluation of AMU was not achieved. Mission Duration 72 hours 21 minutes.
GATV (U) 1966 46A	Atlas-Agena D 5304 (S)	Jun 1		DOWN JUN 11, 1966				
OGO III (S) 1966 49A	Atlas-Agena B 5601 (S)	Jun 7		CURRENT ELEMENTS NOT MAINTAINED			514.8	Carried 21 experiments to obtain correlated data on geophysical and solar phenomena in the Earth's atmosphere. First 3-axis stabilization in highly elliptical orbit.
OV-3 (S) 1966 52A	Scout 46 (S)	Jun 9	143.0	4711	647	40.8	173.0	Radiation research satellite for the USAF. Reimbursable (DOD). (WFF)
Pageos I (S) 1966 56A	Thor-Agena D (S)	Jun 23	177.6	5443	2735	84.4	56.7	Sphere, 100 feet in diameter, to determine the location of continents, land masses, and other geographic points using a world-wide triangulation network of stations. (WSMC)
Explorer 33 (S) 1966 58A	Delta 39 (S)	Jul 1		CURRENT ELEMENTS NOT MAINTAINED			93.4	Interplanetary Monitoring Platform to study, at lunar distance, the Earth's magnetosphere and magnetic tail. Planned anchored lunar orbit was not achieved; useful data obtained from Earth orbit.
Apollo Saturn AS-203 (S) 1966 59A	Saturn IB (S)	Jul 5		DOWN JUL 5, 1966			2635.4	Launch vehicle development flight to evaluate the S-IVB stage vent and restart capability.
Gemini X (S) 1966 66A	Titan II 10 (S)	Jul 18		LANDED JUL 21, 1966			3762.6	Eighth manned mission with John W. Young and Michael Collins. Performed first docked vehicle maneuvers; standup EVA of 87 minutes; umbilical EVA of 27 minutes. Mission duration 70 hours 46 minutes 39 seconds.
GATV (S) 1966 65A	Atlas-Agena D 5305 (S)	Jul 18		DOWN DEC 29, 1966				
Lunar Orbiter I (S) 1966 73A	Atlas-Agena D 5801 (S)	Aug 10		DOWN OCT 29, 1966			385.6	Photograph landing sites for Apollo and Surveyor missions from lunar orbit. Photographed over 2 million square miles of the Moon's surface; took the first two photos of the Earth from the distance of the Moon. Demonstrated maneuverability in lunar orbit.
Pioneer VII (S) 1966 75A	Delta 40 (S)	Aug 17		HELIOCENTRIC ORBIT			63.5	Second in a series of interplanetary probes to provide data on solar wind, magnetic fields, and cosmic rays.
Apollo Saturn AS-202 (S)	Saturn IB (S)	Aug 25		SUBORBITAL FLIGHT			25809.7	Apollo launch vehicle and spacecraft development flight to test the Command Module heat shield and obtain launch vehicle and spacecraft data.

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
Gemini XI (S) 1966 81A	Titan II 11 (S)	Sep 12		LANDED SEP 15, 1966			3798.4	Ninth manned mission with Charles Conrad, Jr. and Richard F. Gordon, Jr. Rendezvous and docking achieved. Umbilical and standup EVA performed and as well as tethered spacecraft experiment. Mission Duration 71 hours 17 minutes 8 seconds.
GATV (S) 1966 80A	Atlas-Agena D 5308 (S)	Sep 12		DOWN DEC 30, 1966				
Surveyor II (U) 1966 84A	Atlas-Centaur (AC-7 (S)	Sep 20		IMPACTED MOON ON SEP 23, 1966			1000.2	Second soft lunar landing planned. One vernier engine did not fire for midcourse correction, sending the spacecraft into a tumbling mode. Crashed southeast of crater Copernicus after 62.8 hour flight.
ESSA III (S) 1966 87A	Delta 41 (S)	Oct 2	114.5	1484	1383	101.1	147.4	Replaced ESSA I in Tiros Operational Satellite (TOS) system. Sophisticated cameras and sensors provided valuable information about the world's weather patterns and conditions. Reimbursable (NOAA). (WSMC)
Centaur Test (AC-9) (S) 1966 95A	Atlas-Centaur (AC-9) (S)	Oct 26		DOWN NOV 6, 1966			952.6	Launch vehicle development flight; Surveyor model injected into simulated lunar transfer orbit. Demonstrated two-burn parking orbit operational capability.
Intelsat II F-1 (U) 1966 96A	Delta 42 (S)	Oct 26	717.7	37023	3326	17.0	87.1	Comsat commercial communications satellite. Apogee monitor malfunction resulted in elliptical orbit. Reimbursable (Comsat).
Lunar Orbiter 2 (S) 1966 100A	Atlas-Agena D 5802 (S)	Nov 6		DOWN OCT 11, 1967			385.6	Photographed lunar landing sites from lunar orbit; provided new data on lunar gravitational field; photographed Ranger VIII landing point and surface debris tossed out at impact.
Gemini XII (S) 1966 104A	Titan II 12 (S)	Nov 11		LANDED NOV 15, 1966			3762.1	Tenth and last manned Gemini flight with James A. Lovell, Jr. and Edwin E. Aldrin, Jr. Rendezvous and docking achieved. Two EVA's performed. Mission duration 94 hours 35 minutes 31 seconds.
GATV (S) 1966 103A	Atlas-Agena D 5307 (S)	Nov 11		DOWN DEC 23, 1966				
ATS I (S) 1966 110A	Atlas-Agena D 5101 (S)	Dec 7	1250.5	35251	28888	14.0	703.1	Perform various communication, meteorology, and control technology experiments and carry out scientific measurements of orbital environment. Experiments results outstanding. Spin-scan cloud camera photographed changing weather patterns; air-to-ground and air-to-air communications demonstrated for the first time.
Biosatellite I (U) 1966 114A	Delta 43 (S)	Dec 14		DOWN FEB 15, 1967			426.4	Carried biological specimens to determine the effects of the space environment on life processes. Reentry vehicle separated but the rocket failed, leaving the capsule in orbit. No useful scientific data obtained.

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
1967								1967
Intelsat I F-2 (S) 1967 01A	Delta 44 (S)	Jan 11		CURRENT ELEMENTS NOT MAINTAINED			87.1	Comsat commercial communication satellite. Reached intended location on February 4, 1967. Reimbursable (Comsat).
ESSA IV (S) 1967 06A	Delta 45 (S)	Jan 26	113.4	1437	1324	102.0	131.5	Replaced ESSA II in TOS system. Provided daily coverage of local weather systems to APT receivers. Shutter malfunction rendered one camera inoperative. Reimbursable (NOAA). (WSMC)
Lunar Orbiter 3 (S) 1967 08A	Atlas-Agena D 5803 (S)	Feb 5		DOWN OCT 9, 1967			385.6	Photographed lunar landing sites from lunar orbit, also returned 600,000 sq. mi. of front and 250,000 sq. mi. of back side lunar photography; provided gravitational field and lunar environment data.
OSO III (S) 1967 20A	Delta 46 (S)	Mar 8		DOWN APR 4, 1982			284.4	Carried 9 experiments to study structure, dynamics and chemical composition of the outer solar atmosphere through X-ray, visible, and UV radiation measurements
Intelsat II F-3 (S) 1967 26A	Delta 47 (S)	Mar 22		CURRENT ELEMENTS NOT MAINTAINED			87.1	Comsat commercial communication satellite. Completed Intelsat II system. Reimbursable (Comsat).
ATS II (U) 1967 31A	Atlas-Agena D 5102 (U)	Apr 6		DOWN SEP 2, 1969			324.3	Test of the gravity gradient control system; carried microwave communications, meteorological cameras, and eight scientific experiments. Second stage failed to restart, resulting in an elliptical orbit. Limited data obtained
Surveyor III (S) 1967 35A	Atlas-Centaur (AC-12) (S)	Apr 17		LANDED ON MOON APR 20, 1967			1035.6	Vernier engines failed to cut off as planned; spacecraft bounced twice before landing. Surface sampler was used for pressing, digging, trenching, scooping, and depositing surface material in view of the camera. Returned over 6,300 photographs ,including pictures of the Earth during lunar eclipse
ESSA V (S) 1967 36A	Delta 48 (S)	Apr 20	13.5	1419	1352	101.8	147.4	Replaced ESSA III in TOS System. Furnished daily global coverage of weather systems. Reimbursable (NOAA). (WSMC)
San Marco II (S) 1967 38A	Scout 52 (S)	Apr 26		DOWN OCT 14, 1967			129.3	First satellite launch attempt from a mobile sea-based platform in the Indian Ocean; launched conducted by Italian crew. Spacecraft provided continuous equatorial air density measurements. Cooperative with Italy. (SM)
Lunar Orbiter IV (S) 1967 41A	Atlas-Agena D 5804 (S)	May 4		DOWN OCT 6, 1967			385.6	Lunar orbit achieved. Photographed 99% of the Moon's front side and additional back side areas.

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
Ariel III (S) 1967 42A	Scout 53 (S)	May 5		DOWN DEC 14, 1970			102.5	First UK-built satellite to extend atmospheric and ionospheric investigations. Cooperative with UK. (WSMC)
Explorer 34 (S) 1967 51A	Delta 49 (S)	May 24		DOWN MAY 3, 1969			73.9	Fifth in Interplanetary Monitoring Platform series to study Sun-Earth relationships. Elliptical orbit achieved. Useful data returned. (WSMC)
ESRO II-A (U)	Scout 55 (U)	May 29		DID NOT ACHIEVE ORBIT			89.1	Carried 7 experiments to study solar and cosmic radiation. Third stage vehicle failure. Cooperative with ESRO. (WSMC)
Mariner V (S) 1967 60A	Atlas-Agena D 5401 (S)	Jun 14		HELIOCENTRIC ORBIT			244.9	Venus flyby. Returned data on planet's atmosphere, radiation, and magnetic field environment.
Surveyor IV (U) 1967 68A	Atlas-Centaur (AC-11) (S)	Jul 14		IMPACTED MOON ON JUL 17, 1967			1037.4	Lunar soft landing mission. All systems were normal until 2 seconds before retro rocket burnout (2-1/2 minutes before touchdown) when the signal was abruptly lost.
Explorer 35 (S) 1967 70A	Delta 50 (S)	Jul 19		SELENOCENTRIC ORBIT			104.4	Interplanetary Monitoring Platform to study solar wind and interplanetary fields at lunar distances. Lunar orbit achieved. Results indicated no shock front precedes the Moon, no magnetic field, no radiation belts or evidence of lunar ionosphere.
OGO IV (S) 1967 73A	Thor-Agena D (S)	Jul 28		DOWN AUG 16, 1972			551.6	Study relationship between Sun and Earth's environment. Near-polar orbit achieved, 3-axis stabilized. (WSMC)
Lunar Orbiter V (S) 1967 75A	Atlas-Agena D 5805 (S)	Aug 1		DOWN JAN 31, 1968			385.6	Fifth and final mission to photograph potential landing sites from lunar orbit. Increased lunar photographic coverage to better than 99%.
Biosatellite II (S) 1967 83A	Delta 51 (S)	Sep 7		DOWN SEP 9, 1967			425.4	Carried 13 experiments to conduct biological experiments in low Earth orbit. Reentry initiated 17 orbits early because of communications difficulties and storm in recovery area. Air recovery successful.
Surveyor V (S) 1967 84A	Atlas-Centaur (AC-13) (S)	Sep 8		LANDED ON MOON SEP 11, 1967			1006.1	Lunar soft landing accomplished; returned TV photos of lunar surface and data on chemical characteristics of lunar soil.
Intelsat II (S) 1967 94A	Delta 52 (S)	Sep 28		CURRENT ELEMENTS NOT MAINTAINED			87.1	Comsat commercial communications satellite to provide 24-hour transoceanic service. Reimbursable (Comsat).
OSO-IV (S) 1967 100A	Delta 53 (S)	Oct 18		DOWN JAN 15, 1982			276.7	Continuation of OSO program to better understand the Sun's structure and determine the solar influence upon the Earth. Obtained the first pictures made of the Sun in extreme ultraviolet.
RAM C-1 (S)	Scout 57 (S)	Oct 19		SUBORBITAL FLIGHT			116.6	Reentry test to investigate communications problems experienced during reentry. (WFF)

NASA Major Launch Record

1967

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
ATS III (S) 1967 111A	Atlas-Agena D 5103 (S)	Nov 5	1436.1	35842	35733	12.1	714.0	Further development of experiments and concepts in useful applications of space technology to communications, meteorology, navigation, and Earth resources management.
Surveyor VI (S) 1967 112A	Atlas-Centaur (AC-14) (S)	Nov 7		LANDED ON MOON NOV 10, 1967			1008.3	Lunar soft landing achieved; pictures and soil analysis data transmitted. Vernier engines restarted, lifting spacecraft 10 feet from the surface and landing 8 feet from the original landing site, performing the first rocket-powered takeoff from the lunar surface.
Apollo 4 (S) 1967 113A	Saturn V AS-501 (S)	Nov 9		DOWN NOV 9, 1967			45506.0	Launch vehicle/spacecraft development flight. First launch of the Saturn V; carried unmanned Apollo Command/Service Module.
ESSA VI (S) 1967 114A	Delta 54 (S)	Nov 10	114.8	1483	1407	102.1	129.7	Replaced ESSA II and ESSA IV in the TOS system; used in central analysis of global weather. Reimbursable (NOAA). (WSMC)
Pioneer VIII (S) 1967 123A	Delta 55 (S)	Dec 13		HELIOCENTRIC ORBIT			65.8	Third in a series of interplanetary probes to provide data on the solar wind, magnetic fields, and cosmic rays. Carried TETR-1, the first NASA piggyback payload.
TETR-1 (S) 1967 123B				DOWN APR 28, 1968			20.0	
1968								**1968**
Surveyor VII (S) 1968 01A	Atlas-Centaur (AC-15) (S)	Jan 7		LANDED ON MOON JAN 9, 1968			1040.1	Lunar soft landing achieved; provided pictures of lunar terrain, portions of spacecraft, experiment operations, stars, planets, crescent Earth as it changed phases, and first observation of artificial light from the Earth.
Explorer 36 (S) 1968 02A	Delta 56 (S)	Jan 11	112.2	1572	1079	105.8	212.3	GEOS spacecraft to provide precise information about the size and shape of the Earth and strength of an variations in its gravitational field; part of the National Geodetic Program. (WSMC)
Apollo 5 (S) 1968 07A	Saturn IB AS-204 (S)	Jan 22		DOWN JAN 24, 1968			42,506.0	First flight test of the Lunar Module; verified the ascent and descent stages, propulsion systems, and restart operations.
OGO V (S) 1968 14A	Atlas-Agena D 5602A (S)	Mar 4		CURRENT ELEMENTS NOT MAINTAINED			611.0	Provided measurements of energy characteristics in the Earth's radiation belts; first evidence of electric fields in the bow shock.
Explorer 37 (S) 1968 17A	Scout 60 (S)	Mar 5		DOWN NOV 16, 1990			89.8	Solar Explorer to provided data on selected solar X-ray and ultraviolet emissions. Cooperative with NRL. (WFF)
Apollo 6 (U) 1968 25A	Saturn V AS-502 (U)	Apr 4		DOWN APR 4, 1968			42856.0	Launch vehicle and spacecraft development flight. Launch vehicle engines malfunctioned; spacecraft systems performed normally.
Reentry VI (S)	Scout 61 (S)	Apr 27		SUBORBITAL FLIGHT			272.0	Turbulent heating experiment to obtain heat transfer measurements at 20,000 fps. (WFF)

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
ESRO IIB (S) 1968 41A	Scout 62 (S)	May 17			DOWN MAY 8, 1971		89.1	Carried seven experiments to study solar and cosmic radiation in the lower Van Allen belt. Cooperative with ESRO. (WSMC)
Nimbus B (U) Secor 10 (U)	Thor-Agena D (U)	May 18			DID NOT ACHIEVE ORBIT		571.5 20.4	Experimental meteorological satellite; also carried Secor 10 (DOD) as a secondary payload. Booster malfunctioned; destruct signal sent by Range Safety Officer. (WSMC)
Explorer 38 (S) 1968 55A	Delta 57 (S)	Jul 4	224.2	5865	5828	120.8	275.4	Radio Astronomy Explorer to monitor low-frequency radio signals originating in our own solar system and the Earth's magnetosphere and radiation belts.
Explorer 39 (S) 1968 66A	Scout 63 (S)	Aug 8			DOWN JUN 22, 1981		9.3	Dual payload (Air Density/Injun Explorers) to continue the detailed scientific study of the density and radiation characteristics of the Earth's upper atmosphere. (WSMC)
Explorer 40 (S) 1968 66B			118.0	2506	678	80.7	69.4	
ATS IV (U) 1968 68A	Atlas-Centaur (AC-17) (U)	Aug 10			DOWN OCT 17, 1968		390.1	Evaluate gravity-gradient stabilization, simultaneous transmission of voice, TV, telegraph, and digital data. Centaur failed to reignite for second burn, spacecraft remained in parking orbit attached to Centaur.
ESSA VII (S) 1968 69A	Delta 58 (S)	Aug 16	114.9	1471	1429	101.5	147.4	Replaced ESSA V as the primary stored data satellite in the TOS system. Reimbursable (NOAA). (WSMC)
RAM CII (S)	Scout 64 (S)	Aug 22			SUBORBITAL FLIGHT		122.0	Measure electron and ion concentrations during reentry. (WFF)
Intelsat III F-1 (U)	Delta 59 (U)	Sep 18			DID NOT ACHIEVE ORBIT		286.7	Comsat commercial communications satellite. Vehicle failure. Reimbursable (Comsat).
ESROIA (S) 1968 84A	Scout 65 (S)	Oct 3			DOWN JUN 26, 1970		85.8	Carried eight experiments to measure energies and pitch angles of particles impinging on the polar ionosphere during magnetic storms and quiet periods. Cooperative with ESRO. (WSMC)
Apollo 7 (S) 1968 89A	Saturn IB AS-205 (S)	Oct 11			LANDED OCT 22, 1968		51,655.0	First manned flight of the Apollo spacecraft with Walter M. Schirra, Jr., Donn F. Eisele, and Walter Cunningham. Performed Earth orbit operations. Mission Duration 260 hours 9 minutes 3 seconds.
Pioneer IX (S) 1968 100A TETR 2 (S) 1968 100B	Delta 60 (S)	Nov 8			HELIOCENTRIC ORBIT DOWN SEP 19, 1979		66.7	Deep space probe to collect scientific data on the electromagnetic and plasma properties of interplanetary space. Carried TETR 2 as a secondary payload.
HEOS A (S) 1968 109A	Delta 61 (S)	Dec 5			DOWN OCT 28, 1975		108.8	Study interplanetary magnetic fields and solar cosmic ray particles. Reimbursable (ESA).

NASA Major Launch Record

1968

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
OAO II (S) 1968 110A	Atlas-Centaur (AC-16) (S)	Dec 7	100.1	768	759	35.0	2016.7	Perform astronomy investigations of celestial objects in the ultraviolet region of the electromagnetic spectrum.
ESSA VIII (S) 1968 114A	Delta 62 (S)	Dec 15	114.6	1461	1411	101.5	136.1	Meteorological satellite for ESSA. Reimbursable (NOAA). (WFF)
Intelsat III F-2 (S) 1968 116A	Delta 63 (S)	Dec 18		CURRENT ELEMENTS NOT MAINTAINED			286.7	Initial increment of first global commercial communications satellite system for Comsat. Reimbursable (Comsat).
Apollo 8 (S) 1968 118A	Saturn V AS-504 (S)	Dec 21		LANDED DEC 27, 1968			51655.0	First manned Saturn V flight with Frank Borman, James A. Lovell, Jr., and William A. Anders. First manned lunar orbit mission; provided a close-up look at the Moon during 10 lunar orbits. Mission Duration 147 hours 42 seconds.
1969								**1969**
OSO V (S) 1969 06A	Delta 64 (S)	Jan 22		DOWN APR 2, 1984			288.5	Continuation of OSO program to study Sun's X-rays, gamma rays, and radio emissions.
ISIS-A (S) 1969 09A	Delta 65 (S)	Jan 30	127.9	3489	574	88.4	235.9	Satellite built by Canada; carried 10 experiments to study the ionosphere. Cooperative with Canada. (WSMC)
Intelsat III F-3 (S) 1969 11A	Delta 66 (S)	Feb 5		CURRENT ELEMENTS NOT MAINTAINED			286.7	Second increment of Comsat's operational commercial communication satellite system. Reimbursable (Comsat).
Mariner VI (S) 1969 14A	Atlas-Centaur (AC-20) (S)	Feb 25		HELIOCENTRIC ORBIT			411.8	Mars flyby; provided high resolution photographs of the Martian surface. Closest approach was 2,120 miles on July 31, 1969.
ESSA IX (S) 1969 16A	Delta 67 (S)	Feb 26	115.2	1503	1423	101.6	157.4	Ninth and last in the TOS series of meteorological satellites. Reimbursable (NOAA).
Apollo 9 (S) 1969 18A	Saturn V SA-504 (S)	Mar 3		LANDED MAR 13, 1969			51655.0	Earth orbital flight with James A. McDivitt, David R. Scott, and Russell Schweickart. First flight of the lunar module. Performed rendezvous, docking, and EVA. Mission Duration 241 hours 1 minute 54 seconds.
Mariner VII (S) 1969 30A	Atlas-Centaur (AC-19) (S)	Mar 27		HELIOCENTRIC ORBIT			411.8	Mars flyby; provided high resolution photographs of the Martian surface. Closest approach was 2,190 miles on August 5, 1969.
Nimbus III (S) 1969 37A	Thor-Agena (S)	Apr 14	107.3	1130	1069	99.9	575.6	Provided night and day global meteorological measurements from space. Secor (DOD) provided geodetic position determination measurements. (WSMC)
Secor 13 (S) 1969 37B			107.2	1127	1067	99.9	20.4	
Apollo 10 (S) 1969 43A	Saturn V SA-505 (S)	May 18		LANDED MAY 26, 1969			51655.0	Manned lunar orbital flight with Thomas P. Stafford, John W. Young, and Eugene A. Cernan to test all aspects of an actual manned lunar landing except the landing. Mission Duration 192 hours 3 minutes.

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
Intelsat III F-4 (S) 1969 45A	Delta 68 (S)	May 21		CURRENT ELEMENTS NOT MAINTAINED			143.8	Third increment of Comsat's operational commercial communication satellite system. Reimbursable (Comsat).
OGO VI (S) 1969 51A	Thor-Agena (S)	Jun 5		DOWN OCT 12, 1979			631.8	Last in the OGO series to provide measurements of the energy characteristics in the Earth's radiation belts; provided the first evidence of electric fields in the bow shock. (WSMC)
Explorer 41 (S) 1969 53A	Delta 69 (S)	Jun 21		DOWN DEC 23, 1972			78.7	Seventh Interplanetary Monitoring Platform to continue study of the environment within and beyond Earth's magnetosphere. (WSMC)
Biosatellite III (U) 1969 56A	Delta 70 (S)	Jun 28		DOWN JUL 7, 1969			696.3	Conduct intensive experiments to evaluate effects of weightlessness with a pigtail monkey onboard. Spacecraft deorbited after 9 days because the monkey's metabolic condition was deteriorating rapidly. Monkey expired 8 hours after recovery, presumably from a massive heart attack brought on by dehydration.
Apollo 11 (S) 1969 59A	Saturn V SA-506 (S)	Jul 16		LANDED JUL 24, 1969			51655.0	First manned lunar landing and return to Earth with Neil A. Armstrong, Michael Collins, and Edwin A. Aldrin. Landed in the Sea of Tranquility on July 20, 1969; deployed TV camera and EASEP experiments, performed lunar surface EVA, returned lunar soil samples. Mission Duration 195 hours 18 minutes 35 seconds.
Intelsat III F-5 (U) 1969 64A	Delta 71 (S)	Jul 26		DOWN OCT 14, 1968			146.1	Fourth increment of Comsat's operational commercial communication satellite system. Third-stage malfunctioned; satellite did not achieve desired orbit. Reimbursable (Comsat).
OSO VI (S) 1969 68A	Delta 72 (S)	Aug 9		DOWN MAR 7, 1981			173.7	Continuing study of Sun's X-rays, gamma rays, and radio emissions. Carried PAC experiment to stabilize spent Delta stage.
PAC (S) 1969 68B				DOWN APR 28, 1977			117.9	
ATS V (U) 1969 69A	Atlas-Centaur (AC-18) (S)	Aug 12	1464.5	38298	34383	9.5	432.7	Evaluate gravity-gradient stabilization for geosynchronous satellites. Anomaly after apogee motor firing resulted in counterclockwise spin; gravity-gradient booms could not be deployed. Nine of 13 experiments returned useful data.
Pioneer E (U) (TETR C) (U)	Delta 73 (U)	Aug 27		DID NOT ACHIEVE ORBIT			67.1 18.1	Deep space probe to study magnetic disturbances in interplanetary space. Vehicle malfunctioned; destroyed 8 minutes 3 seconds into powered flight by Range Safety Officer.

NASA Major Launch Record

1969

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
ESRO 1B (S) 1969 83A	Scout 66 (S)	Oct 1		DOWN NOV 23, 1969			85.8	Fourth European-designed and built satellite to study ionospheric and auroral phenomena over the northern polar regions. Reimbursable (ESA) (WSMC)
GRS-A (S) 1969 97A	Scout 67 (S)	Nov 7	115.1	2538	379	102.8	72.1	Study the inner Van Allen belt and auroral zones of the Northern Hemisphere. Cooperative with Germany. (WSMC)
Apollo 12 (S) 1969 99A	Saturn V SA-507 (S)	Nov 14		LANDED NOV 24, 1969			51655.0	Second Manned lunar landing and return with Charles Conrad, Jr., Richard F. Gordon, and Alan F. Bean. Landed in the Ocean of Storms on November 19, 1969; deployed TV camera and ALSEP experiments; two EVA's performed; collected core sample and lunar materials; photographed and retrieved parts from Surveyor III spacecraft. Mission duration 244 hours 36 minutes 25 seconds
Skynet A (S) 1969 101A	Delta 74 (S)	Nov 21		ELEMENTS NOT AVAILABLE			242.7	Communication satellite for the United Kingdom. Reimbursable (UK).
1970								**1970**
Intelsat III F-6 (S) 1970 03A	Delta 75 (S)	Jan 14		CURRENT ELEMENTS NOT MAINTAINED			155.1	Part of Comsat's operational commercial communication satellite system. Reimbursable (Comsat)
ITOS I (S) 1970 08A	Delta 76 (S)	Jan 23	115.0	1477	1432	101.5	306.2	Second generation meteorological satellite to provide daytime and nighttime cloud cover observations in both direct and stored modes.
Oscar 5 (S) 1970 08B			115.0	1475	1432	101.5	9.1	Oscar (Australia), carried as a piggyback, was used by radio amateurs throughout the world. (WSMC)
SERT II (U) 1970 09A	Thor-Agena (S)	Feb 3	106.0	1046	1038	99.3	503.5	Ion engine test. Fell short of mission duration objective by less than 1 month. (WSMC)
NATOSAT I (S) 1970 21A	Delta 77 (S)	Mar 20	1436.2	36491	35086	9.4	242.7	Communications satellite for NATO. Reimbursable (NATO).
Nimbus D (S) 1970 25A	Thor-Agena (S)	Apr 8	107.1	1097	1086	99.7	619.6	Stabilized, Earth-oriented platform to test advanced systems for collecting meteorological and geological data. TOPO, carried as a piggyback, performed triangulation exercises. (WSMC)
TOPO 1 (S) 1970 25B			106.9	1085	1082	99.5	21.8	
Apollo 13 (U) 1970 29A	Saturn V SA-508 (S)	Apr 11		LANDED APR 17, 1970			51655.0	Third manned lunar landing attempt with James A. Lovell, Jr., John L. Swigert, Jr., and Fred W. Haise, Jr. Pressure lost in SM oxygen system; mission aborted; LM used for life support. Mission Duration 142 hours 54 minutes 41 seconds.

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
Intelsat III F-7 (S) 1970 32A	Delta 78 (S)	Apr 22		CURRENT ELEMENTS NOT MAINTAINED			290.3	Part of Comsat's operational commercial communication satellite system. Reimbursable (Comsat).
Intelsat III F-8 (U) 1970 55A	Delta 79 (S)	Jul 23	1408.2	36650	33823	12.2	290.3	Part of Comsat's operational commercial communication satellite system. Malfunction during apogee motor firing; failed to achieve desired orbit. Reimbursable (Comsat).
Skynet 2 (U) 1970 62A	Delta 80 (S)	Aug 19		CURRENT ELEMENTS NOT MAINTAINED			242.7	Communication satellite for the United Kingdom. Telemetry terminated following apogee motor failure. Reimbursable (UK).
RAM C-III (S)	Scout 69 (S)	Sep 30		SUBORBITAL FLIGHT			134.0	Reentry test of radio blackout.
OFO I (S) 1970 94A	Scout 70 (S)	Nov 9		DOWN MAY 9, 1971			132.9	Orbiting Frog Otolith (OFO) in which frogs were used to study the effects of weightlessness on the inner ear, which controls balance.
RMS (S) 1970 94B				DOWN FEB 7, 1971			21.0	Radiation Meteoroid Spacecraft (RMS) provided data on radiation belts. (WFF)
OAO B (U)	Atlas-Centaur (AC-21) (U)	Nov 30		DID NOT ACHIEVE ORBIT			2122.8	Perform stellar observations in the UV region. Centaur nose fairing failed to separate; orbit not achieved.
ITOS A (S) 1970 106A	Delta 81 (S)	Dec 11	114.8	1471	1421	101.5	306.2	To augment NOAA's satellite world wide weather observation capabilities. Reimbursable (NOAA). (WSMC)
Explorer 42 (S) 1970 107A	Scout 71 (S)	Dec 12		DOWN APR 5, 1979			142.0	Small Astronomy Satellite to catalog celestial X-ray sources within and outside the Milky Way. First X-ray satellite. (San Marco)
1971								**1971**
Intelsat IV F-2 (S) 1971 06A	Atlas-Centaur (AC-25) (S)	Jan 25		ELEMENTS NOT AVAILABLE			1387.1	Fourth generation satellite to provide increased capacity for Comsat's global commercial communications network. Reimbursable (Comsat).
Apollo 14 (S) 1971 08A	Saturn V SA-509 (S)	Jan 31		LANDED FEB 9, 1971			51655.0	Third Manned lunar landing with Alan B. Shepard, Jr., Stuart A. Roosa, and Edgar D.Mitchell. Landed in the Fra Mauro area on February 5, 1971; performed EVA, deployed lunar experiments, returned lunar samples. Mission duration 216 hours 1 minute 57 seconds.
NATOSAT 2 (S) 1971 09A	Delta 82 (S)	Feb 2	1435.8	41063	30496	8.7	242.7	Second communications satellite for NATO. Reimbursable (NATO)
Explorer 43 (S) 1971 19A	Delta 83 (S)	Mar 13		DOWN OCT 2, 1974			288.0	Second generation Interplanetary Monitoring Platform to extend man's knowledge of solar-lunar relationships.
ISIS B (S) 1971 24A	Delta 84 (S)	Mar 31	113.5	1423	1354	88.2	264.0	Study electron production and loss, and large scale transport of ionization in the ionosphere. Cooperative with Canada. (WSMC)

NASA Major Launch Record

1971

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
San Marco C (S) 1971 36A	Scout 72 (S)	Apr 24		DOWN NOV 29, 1971			163.3	Study atmosphere drag, density, neutral composition, and temperature. Cooperative with Italy. (SM)
Mariner H (U)	Atlas-Centaur (AC-24) (U)	May 8		DID NOT ACHIEVE ORBIT			997.9	Mariner Mars '71 Orbiter mission to map the Martian surface. Centaur stage malfunctioned shortly after launch.
Mariner I (S) 1971 051A	Atlas-Centaur (AC-23) (U)	May 30		AEROCENTRIC ORBIT			997.9	Second Mariner Mars '71 Orbiter mission to map the Martian surface. Achieved orbit around Mars on November 13, 1971. Transmitted 6,876 pictures.
PAET (S)	Scout 73 (S)	Jun 20		SUBORBITAL FLIGHT			62.1	Test to determine the structure and composition of an atmosphere from a probe entering at high speed.
Explorer 44 (S) 1971 58A	Scout 74 (S)	Jul 8		DOWN DEC 15, 1979			115.0	Solar radiation spacecraft to monitor the Sun's X-ray and ultraviolet emissions. Cooperative with NRL. (WFF)
Apollo 15 (S) 1971 63A	Saturn V SA-510 (S)	Jul 26		LANDED AUG 7, 1971			51655.0	Fourth manned lunar landing with David R. Scott, Alfred M. Worden, and James B. Irwin. Landed at Hadley Rille on July 30, 1971; performed EVA with Lunar Roving Vehicle; deployed experiments.
P&F Subsat (S) 1971 63D	SM	Aug 4		IMPACTED MOON JUL 30, 1971			36.3	P&F Subsatellite spring-launched from SM in lunar orbit. Mission Duration 295 hours 11 minutes 53 seconds.
CAS/EOLE (S) 1971 71A	Scout 75 (S)	Aug 16	100.2	870	662	50.1	85.0	Obtain data on winds, temperatures, and pressures using instrumented balloons launched from Argentina and a satellite. Cooperative with France. (WFF)
BIC (S)	Scout 76 (S)	Sep 20		SUBORBITAL FLIGHT			31.7	Barium Ion Cloud Project to study the Earth's magnetic field. Cooperative with Germany. (WFF)
OSO H (S) 1971 83A	Delta 85 (S)	Sep 29		DOWN JUL 9, 1974			635.0	Observe active physical processes on the Sun and how it influences the Earth and its space environment.
TETR4 (S) 1971 83B				DOWN SEP 21, 1978			20.4	
ITOS B (U) 1971 91A	Delta 86 (U)	Oct 21		DOWN JUL 21, 1972			31.7	To augment NOAA's satellite world-wide weather observation capabilities. Second stage failed. Reimbursable (NOAA). (WSMC)
Explorer 45 (S) 1971 96A	Scout 77 (S)	Nov 15	322.8	18149	272	3.2	50.0	Small Scientific Satellite to study magnetic storms and acceleration of charged particles within the inner magnetosphere. (San Marco)
UK-4 (S) 1971 109A	Scout 78 (S)	Dec 11		DOWN DEC 12, 1978			102.4	Study the interactions between plasma and charged particle streams in the atmosphere. Cooperative with UK. (WSMC)
Intelsat IV F-3 (S) 1971 116A	Atlas Centaur (AC-26) (S)	Dec 20	1454.6	36645	35649	3.9	1387.1	Fourth generation satellite to provide increased capacity for Comsat's global commercial communications network. Reimbursable (Comsat).

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
1972								**1972**
Intelsat IV F-4 (S) 1972 03A	Atlas-Centaur (AC-28) (S)	Jan 22	1438.0	35851	35797	5.3	1387.1	Fourth generation satellite to provide increased capacity for Comsat's global commercial communications network. Reimbursable (Comsat).
HEOS A-2 (S) 1972 05A	Delta 87 (S)	Jan 31		DOWN AUG 2, 1974			117.0	Carried seven experiments provided by various European organizations to investigate particles and micrometeorites in space. Reimbursable (ESA). (WSMC)
Pioneer 10 (S) 1972 12A	Atlas-Centaur (AC-27) (S)	Mar 2		SOLAR SYSTEM ESCAPE TRAJECTORY			258.0	Jupiter Flyby. First spacecraft to flyby Jupiter and return scientific data.
TD-1 (S) 1972 14A	Delta 88 (S)	Mar 11		DOWN JAN 9, 1980			470.8	Western European satellite to obtain data on high-energy emissions from stellar and galactic sources. Reimbursable (ESA). (WSMC)
Apollo 16 (S) 1972 31A	Saturn V SA-511 (S)	Apr 16		LANDED APR 27, 1972			5655.0	Fifth manned lunar landing mission with John W. Young, Ken Mattingly, and Charles M. Duke. Landed at Descartes on Apr 20, 1972. Deployed camera and experiments; performed EVA with lunar roving vehicle. Deployed P&F Subsatellite in lunar orbit. Mission Duration 265 hours 51 minutes 59 seconds.
P&F Subsat (S) 1972 31D	SM	Apr 16		IMPACTED MOON MAY 29, 1972			36.3	
Intelsat IV F-5 (S) 1972 41A	Atlas-Centaur (AC-29) (S)	Jun 13	1438.3	35852	35807	6.3	1387.1	Fourth generation satellite to provide increased capacity for Comsat's global commercial communications network. Reimbursable (Comsat).
ERTS-A (S) 1972 58A	Delta 89 (S)	Jul 23	103.1	909	899	9.1	941.0	Demonstrate remote sensing technology of the Earth's surface on a global scale and on a repetitive basis. (WSMC)
Explorer 46 (S) 1972 61A	Scout 79 (S)	Aug 13		DOWN NOV 2, 1979			206.4	Meteoroid Technology Satellite to measure meteoroid penetration rates and velocity. (WFF)
OAO 3 (S) 1972 65A	Atlas-Centaur (AC-22) (S)	Aug 21	99.4	735	726	35.0	2200.0	Study interstellar absorption of common elements in the interstellar gas, and investigate ultraviolet radiation emitted from young hot stars.
Transit (S) 1972 69A	Scout 80 (S)	Sep 2	100.2	816	721	90.0	94.0	Navigation Satellite for the U.S. Navy. Reimbursable (DOD). (WSMC)
Explorer 47 (S) 1972 73A	Delta 90 (S)	Sep 22		CURRENT ELEMENTS NOT MAINTAINED			375.9	Interplanetary Monitoring Platform, an automated space physics lab to study interplanetary radiation, solar wind, and energetic particles.
ITOS D (S) 1972 82A	Delta 91 (S)	Oct 15	114.9	1453	1447	101.7	34.5	To augment NOAA's satellite world-wide weather observation capabilities. Oscar, an amateur radio satellite, was carried as a piggyback. Reimbursable (ITOS/NOAA; Oscar/AMSAT)). (WSMC)
Oscar (S) 1972 82B		Oct 15	114.9	1453	1446	101.7	15.9	
Telesat A (ANIK) (S) 1972 90A	Delta 92 (S)	Nov 9	1457.5	36257	36150	4.6	544.3	First of a series of domestic communications satellites for Canada. Reimbursable (Canada). (WSMC)

NASA Major Launch Record

1972

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
Explorer 48 (S) 1972 91A	Scout 81 (S)	Nov 15		DOWN AUG 20, 1980			186.0	Small Astronomy Satellite; carried a gamma ray telescope in a bulbous dome to study gamma rays. Launched by an Italian crew from San Marco. (SM)
ESRO IV (S) 1972 92A	Scout 82 (S)	Nov 21		DOWN APR 15, 1974			114.0	Carried five experiments to investigate the ionosphere, the near magnetosphere, auroral, and solar particles. Reimbursable (ESA). (WSMC)
Apollo 17 (S) (AS-512/CSM-114/LM-12) 1972 96A	Saturn V SA-512 (S)	Dec 7		LANDED DEC 19, 1972			51655.0	Sixth and last manned lunar landing mission in the Apollo series with Eugene A. Cernan, Ronald E. Evans, and Harrison H. (Jack) Schmitt. Landed at Taurus-Littrow on Dec 11., 1972. Deployed camera and experiments; performed EVA with lunar roving vehicle. Returned lunar samples. Mission duration 301 hours 51 minutes 59 seconds.
Nimbus E (S) 1972 97A	Delta 93 (S)	Dec 11	107.1	1100	1087	99.6	716.8	Stabilized, Earth-oriented platform to test advanced systems for collecting meteorological and geological data. (WSMC)
AEROS (S) 1972 100A	Scout 83 (S)	Dec 16		DOWN AUG 22, 1973			125.7	Study the state and behavior of the upper atmosphere and ionosphere. Cooperative with Germany. (WSMC)
1973								**1973**
Pioneer G (S) 1973 19A	Atlas-Centaur (AC-30) (S)	Apr 5		SOLAR SYSTEM ESCAPE TRAJECTORY			259.0	Investigate the interplanetary medium beyond the orbit of Mars, the Asteroid Belt, and the near-Jupiter environment.
Telesat B (ANIK-2) (S) 1973 23A	Delta 94 (S)	Apr 20	1443.0	35973	35870	5.1	544.3	Second domestic communications satellite for Canada. Reimbursable (Canada).
Skylab Workshop (S) 1973 27A	Saturn V SA-513 (S)	May 14		DOWN JUL 11, 1979			71500.0	Unmanned launch of the first U.S. Space Station. Workshop incurred damage during launch. Repaired during follow-on manned missions.
Skylab 2 206/CSM-116 (S) 1973 32A	Saturn IB SA-206 (S)	May 25		LANDED JUN 22, 1973			29750.0	First manned visit to Skylab workshop with Charles (Pete) Conrad, Jr., Joseph P. Kerwin, and Paul J. Weitz. Deployed parasol-like thermal blanket to protect the hull and reduce temperatures within the workshop; freed solar wing that was jammed with debris. Mission duration 672 hours 49 minutes 49 seconds.
Explorer 49 (S) 1973 39A	Delta 95 (S)	Jun 10		SELENOCENTRIC ORBIT			328.0	Radio Astronomy Explorer to measure low frequency radio noise from galactic and extragalactic sources and from the Sun, Earth and Jupiter.
ITOS E (U)	Delta 96 (U)	Jul 16		DID NOT ACHIEVE ORBIT			333.8	To augment NOAA's satellite world-wide weather observation capabilities. Vehicle second stage malfunctioned. Reimbursable (NOAA). (WSMC)

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
Skylab 3 207/CSM-117 (S) 1973 50A	Saturn IB SA-207 (S)	Jul 28		LANDED SEP 25, 1973			29750.0	Second manned visit to Skylab Workshop with Alan L. Bean, Owen K. Garriott, and Jack R. Lousma. Performed systems and operational tests, conducted experiments, deployed thermal shield. Mission Duration 1427 hours 9 minutes 4 seconds.
Intelsat IV F-7 (S) 1973 58A	Atlas-Centaur (AC-31) (S)	Aug 23	1466.3	38057	34693	5.7	1387.1	Fourth generation satellite to provide increased capacity for Comsat's global commercial communications network. Reimbursable (Comsat).
Explorer 50 (S) 1973 78A	Delta 97 (S)	Oct 25		ELEMENTS NOT AVAILABLE			397.2	Last Interplanetary Monitoring Platform to investigate the Earth's radiation environment.
Transit (S) 1973 81A	Scout B4 (S)	Oct 30	105.3	1133	887	89.9	95.0	Navigation satellite for the U.S. Navy. Reimbursable (DOD). (WSMC)
Mariner 10 (Mariner/Venus/ Mercury) (S) 1973 85A	Atlas-Centaur (AC-34) (S)	Nov 3		HELIOCENTRIC ORBIT			504.0	Venus and Mercury flyby mission; first dual-planet mission. Photographed the Earth and the Moon on its flight to Venus; Venus encounter (at 5,800 km) on February 5, 1973; Mercury encounter (at 704 km) on March 29, 1974; second Mercury encounter (at 48,069 km) on September 21, 1974; third Mercury encounter (at 327 km) on March 16, 1975. Engineering tests conducted before attitude control gas was depleted and transmitter commanded off on March 24, 1975.
ITOS F (S) 1973 86A	Delta 98 (S)	Nov 6	116.1	1508	1499	101.9	345.0	To augment NOAA's satellite world-wide weather observation capabilities. Reimbursable (NOAA). (WSMC)
Skylab 4 (S) 1973 90A	Saturn IB SA-208 (S)	Nov 16		LANDED FEB 8, 1974			29,750.0	Third manned visit to Skylab Workshop with Gerald P. Carr, Edward G. Gibson, and William R. Pogue. Performed inflight experiments; obtained medical data on crew; performed four EVA's. Mission duration 2017 hours 15 minutes 32 seconds.
Explorer 51 (S) 1973 101A	Delta 99 (S)	Dec 16		DOWN DEC 12, 1978			663.0	Atmosphere Explorer; carried 14 instruments to study energy transfer, atomic and molecular processes, and chemical reactions in the atmosphere. (WSMC)
1974								**1974**
Skynet II-A (U) 1974 02A	Delta 100 (U)	Jan 18		DOWN JAN 25, 1974			435.5	Communication satellite for the United Kingdom. Short circuit in electronics package caused vehicle failure. Reimbursable (UK).
Centaur Proof Flight (U)	Titan IIIE Centaur (76) (U)	Feb 11		DID NOT ACHIEVE ORBIT				Launch vehicle development test of the Titan IIIE/Centaur (TC-1); carried simulated Viking spacecraft and Sphinx. Liquid oxygen boost pump failed to operate during Centaur starts. Destruct command sent 748 seconds after liftoff.

NASA Major Launch Record

1974

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
San Marco C-2 (S) 1974 09A	Scout 85 (S)	Feb 18			DOWN MAY 4, 1976		170.0	Measure variations of equatorial neutral atmosphere density, composition, and temperature. Cooperative with Italy. (San Marco)
UK-X4 (S) 1974 13A	Scout 86 (S)	Mar 8	100.6	890	688	97.9	91.6	Three-axis stabilized spacecraft to demonstrate the technology involved in the design and manufacture of this type platform for use on small spacecraft. Reimbursable (UK). (WSMC)
Westar A (S) 1974 13A	Delta 101 (S)	Apr 13	1441.6	35942	4.1		571.5	Domestic communications satellite for Western Union. Reimbursable (WU).
SMS A (S) 1974 33A	Delta 102 (S)	May 17			ELEMENTS NOT AVAILABLE		628.0	Geostationary environmental satellite to provide Earth imaging in visible and IR spectrum. First weather observer to operate in a fixed geosynchronous orbit about the Equator. Cooperative with NOAA.
ATS F (S) 1974 39A	Titan III C Centaur 79 (S)	May 30	1412.0	35433	35195	8.8	1403.0	Applications Technology Satellite capable of providing good quality TV signals to small, inexpensive ground receivers. Carried over 20 technology and science experiments.
Explorer 52 (S) 1974 40A	Scout 87 (S)	Jun 3			DOWN APR 28, 1978		26.6	"Hawkeye" spacecraft to investigate the interaction of the solar wind with the Earth's magnetic field. (WSMC)
AEROS B (S) 1974 55A	Scout 88 (S)	Jul 16			DOWN SEP 25, 1975		125.7	German-built satellite to study the state and behavior of the upper atmosphere and ionosphere. Reimbursable (Germany). (WSMC)
ANS A (S) 1974 70A	Scout 89 (S)	Aug 30			DOWN JUN 14, 1977		129.8	Study the sky in ultraviolet and X-ray from above the atmosphere. Cooperative with the Netherlands. (WSMC)
Westar B (S) 1974 75A	Delta 103 (S)	Oct 10	1442.0	35917	35886	4.4	571.5	Domestic communications satellite for Western Union. Reimbursable (WU).
UK-5 (S) 1974 77A	Scout 90 (S)	Oct 15			DOWN MAR 14, 1980		130.3	Measure the spectrum, polarization and pulsar features of non-solar X-ray sources. Cooperative with UK. (San Marco)
ITOS-G (S) 1974 89A	Delta 104 (S)	Nov 15	114.9	1456	1443	101.6	345.0	ITOS-G - To augment NOAA's satellite world-wide weather observation capabilities. Reimbursable (NOAA)
Intasat (S) 1974 89B			114.8	1457	1439	101.6	20.4	Intasat - Conduct worldwide observations of ionospheric total electron counts. Cooperative with Spain.
Oscar (S) 1974 89C			114.8	1457	1438	101.6	28.6	Oscar - provide communications capability for amateur radio enthusiasts around the world. Reimbursable (AMSAT). (WSMC)
Intelsat IV F-8 (S) 1974 93A	Atlas-Centaur (AC-32) (S)	Nov 21	1443.1	35946	35901	3.6	1387.1	Fourth generation satellite to provide increased capacity for Comsat's global commercial communications network. Reimbursable (Comsat).
Skynet II-B (S) 1974 94A	Delta 105 (S)	Nov 22	1434.5	35773	35736	7.7	435.0	Communication satellite for the United Kingdom. Reimbursable (UK).

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
Helios A (S) 1974 97A	Titan IIIE Centaur 83 (S)	Dec 10		HELIOCENTRIC ORBIT			370.0	Study the Sun from an orbit near the center of the solar system. Cooperative with West Germany
Symphonie A (S) 1974 101A	Delta 106 (S)	Dec 18	1435.0	36658	34871	3.6	402.0	Joint French-German communications satellite to serve North and South America, Europe, Africa and the Middle East. Reimbursable (France/Germany)
1975								**1975**
Landsat 2 (S) 1975 04A	Delta 107 (S)	Jan 22	103.1	913	901	98.8	953.0	Second Earth Resources Technology Satellite to locate, map, and measure Earth resources parameters from space and demonstrate the applicability of this approach to the management of the worlds resources. (WSMC)
SMS-B (S) 1975 11A	Delta 108 (S)	Feb 6		ELEMENTS NOT AVAILABLE			628.0	Together with SMS-A, provide cloud-cover pictures every 30 minutes to weathermen at NOAA. Cooperative with NOAA
Intelsat IV F-8 (U)	Atlas-Centaur (AC-33) (U)	Feb 20		DID NOT ACHIEVE ORBIT			1387.1	Fourth generation satellite to provide increased capacity for Comsat's global commercial communications network. Launch vehicle malfunctioned. Reimbursable (Comsat)
GEOS C (S) 1975 27A	Delta 109 (S)	Apr 9	101.7	857	816	115.0	340.0	Oceanographic and geodetic satellite to measure ocean topography, sea state, and other features. (WSMC)
Explorer 53 (S) 1975 37A	Scout 91 (S)	May 7		DOWN APR 9, 1979			196.7	Small Astronomy Satellite to study X-ray sources within and beyond the Milky Way galaxy. (San Marco)
Telesat C (S) 1975 38A	Delta 110 (S)	May 7	1439.6	35867	35842	3.8	544.3	Third domestic communications satellite for Canada. Reimbursable (Canada)
Intelsat IV F-1 (S) 1975 42A	Atlas-Centaur (AC-35) (S)	May 22	1450.8	36120	36028	3.6	1387.1	Fourth generation satellite to provide increased capacity for Comsat's commercial communications network. Last of the IV series. Reimbursable (Comsat)
Nimbus F (S) 1975 52A	Delta 111 (S)	Jun 12	107.4	1111	1100	99.6	827.0	Stabilized, Earth-oriented platform to test advanced systems for collecting meteorological and geological data. (WSMC)
OSO I (S) 1975 57A	Delta 112 (S)	Jun 21		DOWN JUL 9, 1986			1088.4	Observe active physical processes on the Sun and how it influences the Earth and its space environment
Apollo Soyuz Test Project (S) 1975 66A	Saturn IB SA-210 (S)	Jul 15		DOWN JUL 24, 1975			14,856.0	Manned Apollo spacecraft with Thomas P. Stafford, Vance D. Brand and Donald K. Slayton. Rendezvoused and docked with Soyuz 19 spacecraft (also launched July 15, 1975) with Aleksey Leonov and Valeriy Kubasov on July 17, 1975. Mission Duration 217 hours 28 minutes 23 seconds.

NASA Major Launch Record

1975

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
COS B (S) 1975 72A	Delta 113 (S)	Aug 8		CURRENT ELEMENTS NOT MAINTAINED			277.5	Cosmic ray satellite to study extraterrestrial gamma radiation. Reimbursable (ESA) (WSMC)
Viking A Orbiter(S) 1975 75A	Titan IIIE Centaur 88 (S)	Aug 20		AEROCENTRIC ORBIT			2324.7	Mars Orbiter and Lander mission to conduct systematic investigation of Mars. U.S. first attempt to soft land a spacecraft on another planet achieved on July 20, 1976. First analysis of surface material on another planet.
Viking A Lander (S) 1975 75C				LANDED ON MARS JUL 20, 1976			571.5	
Symphonie B (S) 1975 77A	Delta 114 (S)	Aug 29	1440.5	35879	35864	8.1	402.0	Second joint French-German communications satellite to serve North and South America, Europe, Africa and the Middle East. Reimbursable (France/Germany).
Viking B Orbiter(S) 1975 83A	Titan IIIE Centaur 89 (S)	Sep 9		AEROCENTRIC ORBIT			2324.7	Second Mars Orbiter and Lander mission to conduct systematic investigation of Mars. Soft landed on Mars on September 3, 1976. Returned excellent scientific data.
Viking B Lander 1975 83C				LANDED ON MARS SEP 3, 1976			571.5	
Intelsat IVA F-1 (S) 1975 91A	Atlas-Centaur (AC-36) (S)	Sept 25	1441.1	35896	35870	3.6	1515.0	Improved satellite with double the capacity of previous Intelsats for Comsat's global commercial communications network. Reimbursable (Comsat).
Explorer 54 (S) 1975 96A	Delta 115 (S)	Oct 6		DOWN MAR 12, 1976			675.0	Atmosphere Explorer to investigate chemical processes and energy transfer mechanisms which control the Earth's atmosphere. (WSMC)
Transit (S) 1975 99A	Scout 92 (S)	Oct 12	96.8	677	529	90.4	161.9	Second in a series of improved navigation satellite for the U.S. Navy. Reimbursable. (WSMC)
SMS-C/GOES A (S) 1975 100A	Delta 116 (S)	Oct 16	1435.6	35780	35771	7.6	628.0	First operational satellite in NOAA's geosynchronous weather satellite system. Reimbursable (NOAA).
Explorer 55 (S) 1975 107A	Delta 117 (S)	Nov 20		DOWN JUN 10, 1981			719.6	Atmosphere Explorer to investigate the chemical processes and energy transfer mechanisms which control Earth's atmosphere.
Dual Air Density Explorer (U)	Scout 93 (U)	Dec 5		DID NOT ACHIEVE ORBIT			35.3	Measure global density of upper atmosphere and lower exosphere. Malfunction during third stage burn resulted in loss of vehicle control; destroyed by Range Safety Officer at 341 seconds. (WSMC)
RCA A (S) 1975 117A	Delta 118 (S)	Dec 13	1445.9	36074	35880	3.7	867.7	First RCA domestic communications satellite. Reimbursable (RCA).
1976								**1976**
Helios B (S) 1976 03A	Titan IIIE Centaur 93 (S)	Jan 15		HELIOCENTRIC ORBIT			374.7	Carried 11 scientific instruments to study the Sun. Cooperative with Germany.

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
CTS (S) 1976 04A	Delta 119 (S)	Jan 17	1436.3	35859	35732	8.2	347.0	Experimental high-powered communication satellite to provide communications in remote areas. Cooperative with Canada
Intelsat IVA F-2 (S) 1976 10A	Atlas-Centaur (AC-37) (S)	Jan 29	1444.6	35965	35941	3.8	1515.0	Second improved satellite with double the capacity of previous Intelsats for Comsat's global commercial communications network. Reimbursable (Comsat)
Marisat A (S) 1976 17A	Delta 120 (S)	Feb 19	1436.2	35800	35776	6.5	655.4	Comsat Maritime Satellite to provide rapid, high-quality communications between ships at sea and home offices. Reimbursable (Comsat)
RCA B (S) 1976 29A	Delta 121 (S)	Mar 26	1406.1	36536	35973	3.2	867.7	Second RCA domestic communications Satellite. Reimbursable (RCA)
NATO IIIA (S) 1976 35A	Delta 122 (S)	Apr 22	1436.0	35788	35783	6.1	670.0	Third-generation communications satellite for NATO. Reimbursable (NATO)
LAGEOS (S) 1976 39A	Delta 123 (S)	May 4	225.4	5945	5837	109.9	411.0	Solid, spherical passive satellite to provide a reference point for laser ranging experiments. (WSMC)
Comstar 1A (S) 1976 42A	Atlas-Centaur (AC-38) (S)	May 13	1442.6	35925	35902	3.6	1490.1	First domestic communications satellite for Comsat. Reimbursable (Comsat)
Air Force P76-5 (S) 1976 47A	Scout 94 (S)	May 22	105.5	1049	985	99.6	72.6	Evaluate propagation effects of disturbed plasmas on radar and communications systems. Reimbursable (DOD) (WSMC)
Marisat B (S) 1976 53A	Delta 124 (S)	Jun 9	1436.1	35799	35776	5.4	655.4	Second Comsat Maritime Satellite to provide rapid, high-quality communications between ships at sea and home offices. Reimbursable (Comsat)
Gravity Probe A (S)	Scout 95 (S)	Jun 18		SUBORBITAL FLIGHT			102.5	Scientific probe to test Einstein's Theory of Relativity (WFF)
Palapa A (S) 1976 66A	Delta 125 (S)	Jul 8	1435.9	36028	35537	2.3	573.8	Communication Satellite for Indonesia. Reimbursable (Indonesia).
Comstar B (S) 1976 73A	Atlas-Centaur (AC-40) (S)	Jul 22		GEOSYNCHRONOUS ORBIT			1490.1	Second domestic communications satellite for Comsat. Reimbursable (Comsat)
ITOS H (S) 1976 77A	Delta 126 (S)	Jul 29	116.2	1519	1503	101.8	345.0	Second generation satellite for NOAA's world-wide weather observation. Reimbursable (NOAA) (WSMC)
TIP III (S) 1976 89A	Scout 96 (S)	Sep 1		DOWN MAY 30, 1981			166.0	Improved Transit Navigation Satellite for the U.S. Navy. Reimbursable (DOD). (WSMC)

NASA Major Launch Record

1976

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
Marisat C (S) 1976 101A	Delta 127 (S)	Oct 14	1436.0	35797	35780	6.9	655.4	Third Comsat Maritime Satellite to provide rapid, high-quality communications between ships at sea and home offices. Reimbursable (Comsat).
1977								**1977**
NATO IIIB (S) 1977 05A	Delta 128 (S)	Jan 27	1436.0	35790	35779	5.7	670.0	Third-generation communications satellite for NATO. Reimbursable (NATO).
Palapa B (S) 1977 18A	Delta 129 (S)	Mar 10		GEOSYNCHRONOUS ORBIT			573.8	Second Communication Satellite for Indonesia. Reimbursable (Indonesia).
GEOS/ESA (U) 1977 29A	Delta 130 (U)	Apr 20	734.1	38475	2682	26.6	571.5	ESA scientific satellite; carried seven experiments to investigate the Earth's magnetosphere. Malfunction during second stage/third stage spinup placed GEOS in unusable orbit. Reimbursable (ESA).
Intelsat IVA F-4 (S) 1977 29A	Atlas-Centaur (AC-39) (S)	May 26	1436.2	35802	35774	2.5	1515.0	Improved satellite with double the capacity of previous Intelsats for Comsat's global commercial communications network. Reimbursable (Comsat).
GOES/NOAA (S) 1977 48A	Delta 131 (S)	Jun 16	1436.3	35824	35754	5.8	635.0	Visible/infrared spin-scan radiometer provided day and night global weather pictures for NOAA. Reimbursable (NOAA).
GMS (S) 1977 65A	Delta 132 (S)	Jul 14	1436.2	35796	35779	6.0	669.5	Operational weather satellite; Japan's contribution to the Global Atmosphere Research Program (GARP). Reimbursable (Japan).
HEAO A (S) 1977 75A	Atlas-Centaur (AC-45) (S)	Aug 12		DOWN MAR 15, 1979			2551.9	High Energy Astronomy Observatory to study and map X-rays and gamma rays.
Voyager 2 (S) 1977 76A	TITAN III E Centaur 106 (S)	Aug 20		SOLAR SYSTEM ESCAPE TRAJECTORY			2086.5	Investigate the Jupiter and Saturn planetary systems and the interplanetary medium between the Earth and Saturn. Jupiter flyby occurred on July 9, 1979; Saturn flyby occurred on August 25, 1981; Uranus flyby occurred on January 24, 1986; and Neptune flyby occurred on August 25, 1989. Will continue into interstellar space.
SIRIO (S) 1977 80A	Delta 133 (S)	Aug 25	1435.6	35793	35759	1.9	398.0	Italian scientific satellite to study the propagation characteristics of radio waves transmitted at super high frequencies during adverse weather. Reimbursable (Italy).

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
Voyager 1 (S) 1977 84A	TITAN III E Centaur 107 (S)	Sep 5		HELIOCENTRIC ORBIT			2086.5	Investigate the Jupiter and Saturn planetary systems and the interplanetary medium between the Earth and Saturn. Jupiter flyby occurred on March 5, 1979; Saturn flyby occurred on November 12, 1980; departed Saturn at a high angle to the ecliptic plane to observe the large cloud-covered moon Titan. Will not be involved in any more planetary encounters.
ESA/OTS (U)	Delta 134 (U)	Sep 13		DID NOT ACHIEVE ORBIT			865.0	ESA experimental communications satellite. Vehicle exploded at 54 seconds after liftoff. Reimbursable (ESA).
Intelsat IVA F-5 (U)	Atlas-Centaur (AC-43) (U)	Sep 29		DID NOT ACHIEVE ORBIT			1515.0	Improved satellite with double the capacity of previous Intelsats for Comsat's global commercial communications network. Launch vehicle failed. Reimbursable (Comsat).
ISEE A/B 1977 102A (S) 1977 102B (S)	Delta 135 (S)	Oct 22		DOWN SEP 26, 1987 DOWN SEP 26, 1987			329.0 157.7	Dual payload International Sun Earth Explorer to the study interaction of the interplanetary medium with the Earth's immediate environment. Cooperative with ESA.
Transit (S) 1977 106A	Scout 97 (S)	Oct 27	106.9	1101	1060	89.9	93.9	Improved Transit navigation satellite for the U.S. Navy. Reimbursable (DOD). (WSMC)
Meteosat (S) 1977 108A	Delta 136 (S)	Nov 22	1437.2	35875	35741	7.0	695.3	ESA Meteorological satellite; Europe's contribution to the Global Atmospheric Research Program (GARP). Reimbursable (ESA).
CS/Japan (S) 1977 118A	Delta 137 (S)	Dec 14	1455.9	36185	36159	5.3	677.0	Experimental communication satellite for Japan. Reimbursable (Japan).
1978								**1978**
Intelsat IVA F-3 (S) 1978 02A	Atlas-Centaur (AC-46) (S)	Jan 6	1436.2	35792	35783	1.9	1515.0	Provide increased telecommunications capacity for Intelsat's global network. Reimbursable (Comsat).
IUE-A (S) 1978 12A	Delta 138 (S)	Jan 26	1436.1	43036	28536	30.9	698.5	International Ultraviolet Explorer to obtain high resolution data of stars and planets in the UV region of the spectrum. Cooperative with ESA.
Fltsatcom-A (S) 1978 16A	Atlas-Centaur (AC-44) (S)	Feb 9	1436.5	35807	35774	6.1	1863.3	Provide communications capability for the USAF and the USN for fleet relay and fleet broadcast. Reimbursable (DOD).
Landsat-C (S) 1978 26A	Delta 139 (S)	Mar 5	103.1	917	897	98.8	900.0	Third Earth Resources Technology Satellite to study the Earth's natural resources; measure water, agricultural fields, and mineral deposits. Carried Lewis Research Center Plasma Interaction Experiment (PIX-I) and AMSAT Oscar Amateur Radio communications relay satellite. Reimbursable (Oscar/AMSAT).
Oscar-8 (S) 1978 26B			103.0	908	896	98.9	27.3	
PIX-I (S) 1978 26C				CURRENT ELEMENTS NOT MAINTAINED			34.0	

NASA Major Launch Record

1978

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
Intelsat IVA F-6 (S) 1978 35A	Atlas-Centaur (AC-46) (S)	Mar 31	1437.6	35860	35769	1.7	1515.0	Provide increased telecommunications capacity for Intelsat's global network. Reimbursable (Comsat).
BSE/Japan (S) 1978 39A	Delta 140	Apr 7	1433.6	37702	33775	4.5	665.0	Japan's Broadcasting Satellite/Experimental for conducting TV broadcast experiments. Reimbursable (Japan).
HCMM/AEM-A (S) 1978 41A	Scout 98 (S)	Apr 26		DOWN DEC 22, 1961			134.3	Heat Capacity Mapping Mission to test the feasibility of measuring variations in the Earth's temperatures. (WSMC)
OTS-B (S) 1978 44A	Delta 141	May 11	1436.1	35802	35722	4.1	865.0	Orbital Test Satellite to conduct communications experiments for ESA. Reimbursable (ESA).
Pioneer Venus-A (Orbiter) (S) 1978 51A	Atlas-Centaur (AC-50) (S)	May 20		ELEMENTS NOT AVAILABLE			582.0	One of two Pioneer flights to Venus in 1978; was placed in orbit around Venus for remote sensing and direct measurements of the planet and its surrounding environment.
GOES-C/NOAA (S) 1978 62A	Delta 142 (S)	Jun 16	1436.0	35795	35775	4.7	635.0	Part of NOAA's global network of geostationary environmental satellites to provide Earth imaging, monitor the space environment, and relay meteorological data to users. Reimbursable (NOAA).
Seasat-A (S) 1978 64A	Atlas-F (S)	Jun 26	100.4	779	775	108.0	2300.0	Demonstrate techniques for global monitoring of oceanographic phenomena and features. After 106 days of returning data, contact was lost when a short circuit drained all power from batteries. (WSMC)
Comstar C (S) 1978 68A	Atlas-Centaur (AC-41) (S)	Jun 29	1451.7	36168	36012	1.7	1516.0	Third domestic communications satellite for Comsat. Reimbursable (Comsat).
GEOS-B/ESA (S) 1978 71A	Delta 143 (S)	Jul 14	1449.1	36066	36016	6.9	575.0	Positioned on magnetic field lines to study the magnetosphere and correlate data with ground station, balloon, and sounding rocket measurements. Reimbursable (ESA).
Pioneer/Venus-B (Multiprobe) 1978 78A	Atlas-Centaur (AC-51) (S)	Aug 8		PROBES LANDED DEC 9, 1978			904.0	Second Pioneer flight to Venus in 1978 to determine the nature and composition of the atmosphere of Venus. All four probes and the bus transmitted scientific data. The large probe, north probe, and night probe went dead upon impact; the day probe continued to transmit for 68 minutes after impact.
ISEE-C (S) 1978 79A ICE (S)	Delta 144 (S)	Aug 12		HELIOCENTRIC ORBIT			479.0	Monitored the characteristics of solar phenomena about 1 hour before ISEE-A and B to gain knowledge of how the Sun controls the Earth's near space environment. The spacecraft was renamed ICE in 1985 and its orbit was changed to encounter the Comet Giacobini-Zinner on September 11, 1985. Cooperative with ESA.

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
Tiros-N (S) 1978 96A	Atlas-F (S)	Oct 13	101.8	851	836	99.0	1405.0	Third generation polar orbiting environmental spacecraft to provide improved meteorological and environmental data. Operated by NOAA. (WSMC)
Nimbus-G (S) 1978 98A	Delta 145 (S)	Oct 24	104.0	970	925	99.4	987.0	Carried advanced sensors and technology to conduct experiments in pollution monitoring, oceanography, and meteorology. ESA received and processed data direct. After separation from Nimbus-G, the Delta vehicle released lithium over Northern Scandinavia and barium over Northern Alaska as part of Project CAMEO (Chemically Active Material Ejected in Orbit).
Cameo 1978 98B			104.0	970	925	99.4		
HEAO-B (S) 1978 103A	Atlas-Centaur (AC-52) (S)	Nov 13			DOWN MAR 25, 1982		3152.0	Second High Energy Astronomical Observatory; carried a large X-ray telescope to study the high energy universe, pulsars, neutron stars, black holes, quasars, radio galaxies, and supernovas.
NATO IIIC (S) 1978 106A	Delta 146 (S)	Nov 18	1436.1	35792	35782	3.2	706.0	Third-generation communications satellite for NATO. Reimbursable (NATO)
Telesat D (S) 1978 116A	Delta 147 (S)	Dec 15	1442.9	36022	35818	1.3	887.2	Fourth domestic communications satellite for Canada. Reimbursable (Canada).
1979								**1979**
SCATHA (S) 1979 07A	Delta 148 (S)	Jan 30	1415.7	42425	28348	5.5	658.6	Spacecraft Charging at High Altitudes (SCATHA) carried 12 experiments to investigate electrical static discharges that affect satellites. Reimbursable (DOD).
SAGE/AEM-2 (S) 1979 13A	Scout 99 (S)	Feb 18			DOWN APR 11, 1989		127.0	Stratospheric Aerosol and Gas Experiment Applications Explorer Mission, to map vertical profiles of ozone, aerosol, nitrogen dioxide, and Rayleight molecular extinction around the globe. (WFF)
Fltsatcom B (S) 1979 38A	Atlas-Centaur (AC-47) (S)	May 4	1436.1	35837	35736	4.7	1876.1	Provide communications capability for the USAF and the USN for fleet relay and fleet broadcast. Reimbursable (DOD). (WFF)
UK-6 (S) 1979 47A	Scout 100 (S)				DOWN SEP 23, 1990		154.5	Measure ultra-heavy cosmic ray particles and study low-energy cosmic X-rays. Reimbursable (UK). (WSMC)
NOAA-6 (S) 1979 57A	Atlas-F (S)	Jun 27	101.0	813	797	98.5	1405.0	To provide continuous coverage of the Earth and high-accuracy world-wide meteorological data. Reimbursable (NOAA). (WSMC)
Westar C (S) 1979 72A	Delta 149 (S)	Aug 9	1436.2	35793	35782	0.0	571.5	Domestic communications satellite for Western Union. Reimbursable (WU).

NASA Major Launch Record

1979

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
HEAO 3 (S) 1979 82A	Atlas-Centaur (AC-53) (S)	Sep 20			DOWN DEC 7, 1981		2898.5	High Energy Astronomy Observatory carried two cosmic ray experiments and one gamma ray spectrometer to obtain data on cosmic rays observed across the far reaches of space
MAGSAT/AEM-3 (S) 1979 94A	Scout 101 (S)	Oct 30			DOWN JUN 11, 1980		183.0	Magnetic Field Satellite, Applications Explorer Mission to map the magnetic field of the Earth. (WSMC)
RCA-C (U) 1979 101A	Delta 150 (S)	Dec 6	789.0	35495	8314	10.5	895.4	Third RCA domestic communications satellite. Contact was lost shortly after apogee motor firing. Reimbursable (RCA).
1980								**1980**
Fltsatcom C (S) 1980 04A	Atlas-Centaur (AC-49) (S)	Jan 17	1436.1	35804	35767	4.3	1864.7	Provide communications capability for the USAF and the USN for fleet relay and fleet broadcast. Reimbursable (DOD)
SMM-A (S) 1980 14A	Delta 151 (S)	Feb 14			DOWN DEC 2, 1989		2315.0	Solar Maximum Mission; first solar satellite designed to study specific solar phenomena using a coordinated set of instruments; performed a detailed study of solar flares, active regions, sunspots, and other solar activity. Also measured the total output of radiation from the Sun.
NOAA-7 (U) 1980 43A	Atlas 19F (U)	May 29			DOWN MAY 3, 1981		1405.0	A companion to TIROS N to provide continuous coverage of the Earth and provide high-accuracy worldwide meteorological data. Launch vehicle malfunctioned; failed to place satellite into proper orbit. Reimbursable (NOAA). (WSMC)
GOES D (S) 1980 74A	Delta 152 (S)	Sep 9	1436.2	35795	35780	4.1	832.0	Part of NOAA's global network of geostationary environmental satellites to provide Earth imaging, monitor the space environment, and relay meteorological data. Reimbursable (NOAA).
Fltsatcom D (S) 1980 87A	Atlas-Centaur (AC-57) (S)	Oct 30	1436.2	35811	35765	4.0	1863.8	Provide communications capability for the USAF and the USN for fleet relay and fleet broadcast. Reimbursable (DOD).
SBS-A (S) 1980 91A	Delta 153 (S)	Nov 15	1436.1	35797	35777	0.7	1057.0	Satellite Business Systems (SBS) to provide fully switched private networks to businesses, government agencies, and other organizations with large, varied communications requirements. Reimbursable (SBS).
Intelsat V-A F-2 (S) 1980 98A	Atlas-Centaur (AC-54) (S)	Dec 6	1436.2	35810	35765	0.0	1928.2	Advanced series of spacecraft to provide increased telecommunications capacity for Intelsat's global network. Reimbursable (Comsat).
1981								**1981**
Comstar D (S) 1981 18A	Atlas-Centaur (AC-42) (S)	Feb 21	1436.2	35810	35765	0.0	1484.0	Fourth domestic communications satellite for Comsat. Reimbursable (Comsat).

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
STS-1 (S) 1981 34A	Shuttle (S) (Columbia)	Apr 12		LANDED AT DFRF APR 14, 1981				First Manned orbital test flight of the Space Transportation System with John W. Young and Robert L. Crippen to verify the combined performance of the Space Shuttle Vehicle. Mission duration 54 hours 20 minutes 32 seconds.
NOVA-1 (S) 1981 44A	Scout 102 (S)	May 15		ELEMENTS NOT AVAILABLE			166.9	Improved Transit satellite for the Navy's operational navigation system. Reimbursable (DOD)
GOES E (S) 1981 49A	Delta 154 (S)	May 22	1436.1	35792	35782	1.2	837.0	Part of NOAA's Geostationary Operational Environmental Satellite system to provide near continual, high resolution visual and infrared imaging over large areas. Reimbursable (NOAA)
Intelsat V-8 F-1 (S) 1981 50A	Atlas-Centaur (AC-56) (S)	May 23	1436.2	35809	35768	0.0	1928.2	Advanced series of spacecraft to provide increased telecommunications capacity for Intelsat's global network. Reimbursable (Comsat)
NOAA-C (S) 1981 59A	Atlas 87F (S)	Jun 23	101.8	855	835	99.1	1405.0	To provide continuous coverage of the Earth and provide high-accuracy worldwide meteorological data. Reimbursable (NOAA) (WSMC)
DE A & B(S) 1981 70A (S) 1981 70B (S)	Delta 155	Aug 3	410.4	23339	495 DOWN FEB 19, 1983	89.4	424.0 420.0	Dynamic Explorer (DE A & B); dual spacecraft to study the Earth's electromagnetic fields. (WSMC)
Fltsatcom E (U) 1981 73A	Atlas-Centaur (AC-59) (S)	Aug 6	1460.0	36284	36222	4.6	1863.8	Provide communications capability for the USAF and the USN for fleet relay and fleet broadcast. Reimbursable (DOD)
SBS-B 1981 96A	Delta 156 (S)	Sep 24	1436.1	35789	35785	0.0	1057.0	Satellite Business Systems (SBS) to provide fully switched private networks to businesses, government agencies, and other organizations with large, varied communications requirements. Reimbursable (SBS)
SME (S) 1981 100A UoSAT 1 (S) 1981 100B	Delta 157 (S)	Oct 6	94.7	504	502 DOWN OCT 13, 1989	97.7	437.0 52.0	Solar Mesosphere Explorer, an atmospheric research satellite to study reactions between sunlight, ozone and other chemicals in the atmosphere. Carried UoSat-Oscar 9 (UK) Amateur Radio Satellite as secondary payload. Reimbursable (UoSat-Oscar 9)
STS 2 (S) 1981 111A	Shuttle (S) (Columbia)	Nov 12		LANDED AT DFRF NOV 14, 1981				Second Manned orbital test flight of the Space Transportation System with Joe E. Engle and Richard H. Truly to verify the combined performance of the Space Shuttle vehicle. OSTA-1 payload demonstrated capability to conduct scientific research in the attached mode. Mission duration 54 hours 13 minutes 13 seconds.

NASA Major Launch Record

1981

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
RCA-D (S) 1981 114A	Delta 158 (S)	Nov 19	1436.2	35791	35785	0.1	1081.8	Fourth RCA domestic communications satellite Reimbursable (RCA).
Intelsat V F-3 (S) 1981 119A	Atlas-Centaur (AC-55) (S)	Dec 15	1436.2	35809	35771	0.0	1928.2	Advanced series of spacecraft to provide increased telecommunications capacity for Intelsat's global network. Reimbursable (Comsat).
1982								1982
RCA C (S) 1982 04A	Delta 159 (S)	Jan 16	1436.3	35795	35784	0.1	1081.8	RCA domestic communications satellite. Reimbursable (RCA).
Westar IV (S) 1982 14A	Delta 160 (S)	Feb 25	1436.2	35796	35778	0.1	1072.0	Second generation domestic communications satellite for Western Union. Reimbursable (WU).
Intelsat V-D F-4 (S) 1982 17A	Atlas-Centaur (AC-58) (S)	Mar 4	1436.2	35808	35767	0.0	1928.2	Advanced series of spacecraft to provide increased telecommunications capacity for Intelsat's global network. Reimbursable (Comsat).
STS 3 (S) 1982 22A	Shuttle (S) (Columbia)	Mar 22		LANDED AT WHITE SANDS MAR 30, 1982				Third Manned orbital test flight of the Space Transportation System with Jack R. Lousma and C. Gordon Fullerton to verify the combined performance of the Space Shuttle vehicle. OSS-1 scientific experiments conducted from the cargo bay. Mission duration 192 hours 4 minutes 45 seconds.
Insat 1-A (U) 1982 31A	Delta 161 (S)	Apr 10	1434.2	35936	35562	0.1	1152.1	Multipurpose telecommunications/meteorology spacecraft for India. Reimbursable (India).
Westar V (S) 1982 58A	Delta 162 (S)	Jun 8	1436.2	35796	35778	0.1	1105.0	Western Union domestic communications satellite. Reimbursable (WU).
STS 4 (S) 1982 65A	Shuttle (S) (Columbia)	Jun 27		LANDED AT DFRF JUL 4, 1982				Fourth and last manned orbital test flight of the Space Transportation System with Thomas K. (Ken) Mattingly II and Henry W. Hartsfield to verify the combined performance of the Space Shuttle vehicle. Carried first operational Getaway Special canister for Utah State University and payload DOD 82-1. Mission duration 169 hours 4 minutes 40 seconds.
Landsat D (S) 1982 72A	Delta 163 (S)	Jul 16	98.8	702	698	98.3	1942.0	Earth Resources Technology Satellite to provide a continuing Earth remote sensing data. Instruments included a multispectral scanner and thematic mapper. (WSMC)
Telesat G (S) 1982 82A	Delta 164 (S)	Aug 25	1436.0	35796	35776	0.0	1238.3	Commercial communications satellite for Canada. Reimbursable (Canada).

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
Intelsat V-E F-5 (S) 1982 97A	Atlas-Centaur (AC-60) (S)	Sep 28	1436.1	35805	35769	0.1	1928.2	Advanced series of spacecraft to provide increased telecommunications capacity for Intelsat's global network. Carried Maritime Communications Services (MCS) package for INMARSAT. Reimbursable (Comsat).
RCA-E (S) 1982 105A	Delta 165 (S)	Oct 27	1436.2	35791	0.0		1116.3	RCA domestic communications satellite. Reimbursable (RCA).
STS 5 (S) 1982 110A	Shuttle (S) (Columbia)	Nov 11		LANDED AT DFRF NOV 16, 1982				First operational flight of STS with Vance Brand, Robert Overmeyer, Joseph Allen and William Lenoir. Two satellites deployed:
SBS-C (S) 1982 110B		Nov 11	1436.1	35788	35786	0.0	3344.8	SBS-C (Reimbursable - SBS) and Telesat-C (Reimbursable - Canada). Demonstrated ability to conduct routine space operations. Mission duration 122 hours 14 minutes 26 seconds.
Telesat-E (S) 1982 110C		Nov 12	1436.1	35794	35779	0.0	4443.4	
1983								**1983**
IRAS (S) 1983 04A	Delta 166 (S)	Jan 25	102.9	905	887	99.1	1075.9	Infrared Astronomical Satellite to make the first all-sky survey for objects that emit infrared radiation and to provide a catalog of infrared sky maps. Cooperative with the Netherlands.
PIX II (S) 1983 04B			102.4	886	855	100.1		Lewis Research Center Plasma Interaction Experiment (PIX), to investigate interactions between high voltage systems and space environment, activated by Delta after IRAS separation.
NOAA-8 (S) 1983 22A	Atlas 73E (S)	Mar 28	101.2	825.5	805	98.6	1712.0	Advanced Tiros-spacecraft to provide continuous coverage of the Earth and provide high-accuracy worldwide meteorological data. Reimbursable (NOAA). (WSMC)
STS 6 (S) 1983 26A	Shuttle (S) (Challenger)	Apr 4		LANDED AT DFRF APR 9, 1983				Second operational flight of the STS with Paul Weitz, Karol Bobko, Donald Peterson, Story Musgrave. Deployed Tracking and Data Relay Satellite (TDRS) to provide improved tracking and data acquisition services to spacecraft in low Earth orbit; performed EVA. Mission duration 120 hours 23 minutes 42 seconds.
TDRS-A (S) 1983 26B		Apr 4	1436.3	35804	35776	2.3	17014.0	
RCA F (S) 1983 30A	Delta 167 (S)	Apr 11	1436.1	35790	35781	0.1	1116.3	RCA domestic communications satellite. Reimbursable (RCA).
GOES 6 (S) 1983 41A	Delta 168 (S)	Apr 28	1436.4	35891	35776	0.1	838.0	Part of NOAA's Geostationary Operational Environmental Satellite system to provide near continual, high resolution visual and infrared imaging over large areas. Reimbursable (NOAA).

NASA Major Launch Record

1983

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
Intelsat V-F F-6 (S) 1983 47A	Atlas-Centaur (AC-61) (S)	May 19	1436.2	35810	35765	0.0	1928.2	Advanced series of spacecraft to provide increased telecommunications capacity for Intelsat's global network. Carried Maritime Communications Services (MCS) package for INMARSAT. Reimbursable (Comsat).
EXOSAT (S) 1983 51A	Delta 169 (S)	May 26		DOWN MAY 6, 1986			500.0	X-ray satellite to provide continuous observations of X-ray sources. Reimbursable (ESA).
STS 7 (S) 1983 59A	Shuttle (S) (Challenger)	Jun 18		LANDED AT DFRF JUN 24, 1983				Third operational flight of STS with Robert L. Crippen, Frederick H. Hauck, John M. Fabian, Sally K. Ride (first woman astronaut), and Norman E. Thagard. Deployed two communications satellites. Telesat (Reimbursable - Canada) and Palapa (Reimbursable - Indonesia). Carried out experiments including launching and recovering SPAS 01 (Reimbursable - Germany). Mission duration 146 hours 23 minutes 59 seconds.
Telesat-F (S) 1983 59B		Jun 18	1436.0	35791	35782	0.0	4443.4	
Palapa-B-1 (S) 1983 59C		Jun 18	1436.1	35788	35783	0.0	4521.5	
SPAS-01 (S) 1983 59F		Jun 18		RETRIEVED JUN 24, 1983				
AF P83-1 (S) 1983 63A	Scout 103 (S)	Jun 27	100.9	834	765	82.0	112.6	Air Force HILAT satellite to evaluate propagation effects of disturbed plasmas on radar and communication systems. Reimbursable (DOD). (WSMC)
Galaxy 1 (S) 1983 65A	Delta 170 (S)	Jun 28	1436.2	35797	35782	0.0	519.0	Hughes Communications, Inc. communications satellite. Reimbursable (Hughes).
Telsat 3A (S) 1983 77A	Delta 171 (S)	Jul 28	1436.1	35796	35778	0.0	635.0	AT&T communications satellite. Reimbursable (AT&T).
STS 8 (S) 1983 89A	Shuttle (S) (Challenger)	Aug 30		LANDED AT DFRF SEP 5, 1983				Fourth operational flight of STS with Richard H. Truly, Daniel C. Brandenstein, Dale A. Gardner, Guion S. Bluford (first black astronaut), and William E. Thornton. First night launch and landing. Deployed satellite, INSAT (Reimbursable - India), performed tests and experiments. Mission duration 145 hours 8 minutes 43 seconds.
INSAT-B (S) 1983 89B		Aug 31	1436.2	35819	35755	0.1	3391.0	
RCA G (S) 1983 94A	Delta 172 (S)	Sep 8	1436.2	35797	35778	0.0	1121.3	RCA domestic communications Satellite. Reimbursable (RCA).
Galaxy 2 (S) 1983 98A	Delta 173 (S)	Sep 22	1436.2	35799	35782	0.0	579.0	Hughes Communications satellite. Reimbursable (Hughes).

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
STS-9 (S) Spacelab-1 1983 116A	Shuttle (S) (Columbia)	Nov 28		LANDED AT DFRF DEC 8, 1983				Fifth operational flight of STS with John W. Young, Brewster W. Shaw, Jr., Owen K. Garriott, Robert A. R. Parker, Byron K. Lichtenberg, and Ulf Merbold (ESA). Spacelab-1, a multi-discipline science payload, carried in Shuttle Cargo Bay. Cooperative with ESA. Mission Duration 247 hours 47 minutes 24 seconds.
1984								**1984**
STS 41-B (S) 1984 11A	Shuttle (S) (Challenger)	Feb 3		LANDED AT KSC FEB 11, 1984				Fourth Challenger flight with Vance D. Brand, Robert L. Gibson, Bruce McCandless, Ronald E. McNair and Robert L. Stewart. Deployed
Westar 6 (U) 1984 11B		Feb 3		RETRIEVED NOV 16, 1984 (51-A)			3309.0	Westar (Reimbursable - WU), and Palapa B-2 (Reimbursable - Indonesia). Both PAM's failed; both satellites retrieved on STS 51-A
IRT (S) 1984 11C		Feb 3		DOWN FEB 11, 1984			234.0	mission. Rendezvous tests performed with IRT, using deflated target. Evaluated Manned Maneuvering Unit (MMU) and Manipulator Foot
Palapa B-2 (U) 1984 11D		Feb 6		RETRIEVED NOV 16, 1984 (51-A)			3419.0	Restraint (MFR). First STS landing at KSC. Mission duration 191 hours 15 minutes 55 seconds.
Landsat 5 (S) 1984 21A	Delta 174 (S)	Mar 1	98.8	702	697	98.2	1947.0	Earth resources technology satellite to provide continuing Earth remote sensing data. Instruments included a multispectral scanner and
UoSAT (S) 1984 21B			98.4	691	674	98.1	52.0	thematic mapper. Reimbursable (NOAA). UoSAT sponsored by AMSAT (Reimbursable - AMSAT). (WSMC)
STS 41-C (S) 1984 34A	Shuttle (S) (Challenger)	Apr 6		LANDED AT DFRF APR 13, 1984				Fifth Challenger flight with Robert L. Crippen, Frances R. Scobee, Terry J. Hart, George D. Nelson and James D. Van Hoften. Deployed
LDEF (S) 1984 34B		Apr 6		RETRIEVED JAN 20, 1990 (STS-32)			9670.0	LDEF; SMM retrieved and repaired in Cargo Bay; redeployed April 12. Mission duration 167 hours 40 minutes 7 seconds.
Intelsat V-G F-9 (U) 1984 57A	Atlas-Centaur (AC-62) (U)	Jun 9		DOWN OCT 24, 1984			1928.2	Advanced series of spacecraft to provide increased telecommunications capacity for Intelsat's global network. Carried Maritime Communications Services (MCS) package for INMARSAT. Vehicle failed to place satellite in useful orbit. Reimbursable (Comsat).
AMPTE CCE (S) 1984 88A	Delta 175 (S)	Aug 16	939.4	49817	974	3.8	242.0	Three active magnetospheric particle tracer explorers: Charge Composition Explorer (CCE) provided by the U.S.; Ion Release Module
IRM (S) 1984 88B			2653.4	113818	402	27.0	605.0	(IRM) provided by the Federal Republic of Germany; and the United Kingdom Subsatellite (UKS) provided by the UK; to study the transfer of mass from the solar wind to the magnetosphere. International
UKS (S) 1984 88C			2659.6	113417	1002	26.9	77.0	Cooperative.

NASA Major Launch Record

1984

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
STS 41-D (S) 1984 93A	Shuttle (S) (Discovery)	Aug 30		LANDED AT EAFB SEP 5, 1984				First Discovery flight with Henry W. Hartsfield, Michael L. Coats, Richard M. Mullane, Steven Hawley, Judith A. Resnik, and Charles D. Walker. Deployed SBS (Reimbursable - SBS), Leasat (Reimbursable - Hughes), and Telstar (Reimbursable - AT&T), carried out experiments including OAST-1 solar array structural testing. Mission duration 144 hours 56 minutes 4 seconds.
SBS-4 (S) 1984 93B		Aug 31	1436.1	35793	35781	0.0	3344.0	
Syncom IV-2 (S) 1984 93C		Aug 31	1463.0	35788	35782	0.7	6889.0	
Telstar 3-C (S) 1984 93D		Sep 1	1436.1	35791	35782	0.0	3402.0	
Galaxy C (S) 1984 101A	Delta 176 (S)	Sep 21	1436.2	35792	35783	0.0	519.0	Hughes Communications Satellite. Reimbursable (Hughes).
STS 41-G (S) 1984 108A	Shuttle (S) (Challenger)	Oct 5		LANDED AT KSC OCT 13, 1984				Sixth Challenger flight with Robert L. Crippen, Jon A. McBride, Kathryn D. Sullivan, Sally K. Ride, David C. Leestma, Paul D. Scully-Power, and Marc Garneau (Canada). Deployed ERBS to provide global measurements of the Sun's radiation reflected and absorbed by the Earth; performed scientific experiments using OSTA-3 and other instruments. Mission duration 197 hours 23 minutes 33 seconds.
ERBS (S) 1984 108B		Oct 5	96.8	607	599	57.0	2449.0	
NOVA III (S) 1984 110A	Scout 104 (S)	Oct 11	108.9	1200	1149	90.0	173.7	Improved Transit Navigation Satellite for the U.S. Navy. Reimbursable (DOD). (WSMC)
STS 51-A (S) 1984 113A	Shuttle (S) (Discovery)	Nov 8		LANDED AT KSC NOV 16, 1984				Second Discovery flight with Frederick H. Hauck, David M. Walker, Joseph P. Allen, Anna L. Fisher, Dale A. Gardner. Deployed Telesat (Reimbursable - Canada) and Syncom IV-1 (Reimbursable - Hughes). Retrieved and returned Palapa B-2 and Westar 6 (Launched on 41-B). Mission duration 191 hours 44 minutes 56 seconds.
Telesat-H (S) 1984 113B		Nov 9	1436.1	35795	35788	0.0	3420.0	
Syncom IV-1 (S) 1984 113C		Nov 10	1436.0	35890	35679	0.9	6889.0	
NATO III-D (S) 1984 115A	Delta 177 (S)	Nov 13	1436.1	35788	3.2		761.0	Fourth in a series of communication satellites for NATO. Reimbursable (NATO).
NOAA-9 (S) 1984 123A	Atlas 39E (S)	Dec 12	102.2	863	839	99.1	1712.0	Advanced TIROS-N spacecraft to provide continuous coverage of the Earth and provide high-accuracy worldwide meteorological data. Reimbursable (NOAA). (WSMC)

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
1985								1985
STS 51-C (S) 1985 10A	Shuttle (S) (Discovery)	Jan 24		LANDED AT KSC JAN 27, 1984				Third Discovery flight with Thomas K. Mattingly, Loren J. Shriver, Ellison S. Onizuka, James F. Buchli, and Gary E. Payton.
DOD (S) 1985 10B				ELEMENTS NOT AVAILABLE				Deployed unannounced payload for DOD. (Reimbursable - (DOD)) Mission duration 73 hours 33 minutes 23 seconds.
Intelsat V-A F-10 (S) 1985 25A	Atlas-Centaur (AC-63) (S)	Mar 22	1436.1	35807	35768	0.0	1996.7	First in a series of improved Commercial Communication satellites for Intelsat. Reimbursable (Comsat).
STS 51-D (S) 1985 28A	Shuttle (S) (Discovery)	Apr 12		LANDED AT KSC APR 19, 1985				Fourth Discovery flight with Karol K. Bobko, Donald F. Williams, M. Rhea Seddon, S. David Griggs, Jeffrey A. Hoffman, Charles D. Walker, and E. J. "Jake" Garn (U.S. Senator). Deployed Syncom (Reimbursable - Hughes) and Telesat (Reimbursable - Canada).
Telesat-I (S) 1985 28B		Apr 13	1436.0	35796	35777	0.3	3550.0	
Syncom IV-3 (S) 1985 28C		Apr 12	1436.2	35809	35768	1.4	8889.0	Syncom Sequencer failed to start, despite attempts by crew, remained inoperable until restarted by crew of 51-I (August 1985). Mission duration 167 hours 54 minutes.
STS 51-B (S) Spacelab-3 1985 34A	Shuttle (S) (Challenger)	Apr 29		LANDED AT DFRF MAY 6, 1985				Sixth Challenger flight with Robert F. Overmeyer, Frederick D. Gregory, Don Lind, Norman E. Thagard, William E. Thornton, Lodewijk Vanderberg, and Taylor Wang. Spacelab-3 (Cooperative with ESA) mission to conduct applications, science and technology experiments. Deployed Northern Utah Satellite (NUSAT) (Reimbursable - Northern Utah University). Global Low Orbiting Message Relay Satellite (GLOMR) (Reimbursable - DOD) failed to deploy and was returned. Mission duration 167 hours 55 minutes 23 seconds.
				DOWN DEC 15, 1986			47.6	
STS 51-G (S) 1985 48A	Shuttle (S) (Discovery)	Jun 17		LANDED AT EAFB JUN 24, 1985				Fifth Discovery flight with Daniel C. Brandenstein, John O. Creighton, Shannon W. Lucid, John M. Fabian, Steven R. Nagel, Patrick Baudry (France), and Prince Sultan Salman Al-Saud (Saudi Arabia). Deployed Morelos (Reimbursable - Mexico), Arabsat (Reimbursable - ASCO) and Telstar (Reimbursable - AT&T). Deployed and retrieved Spartan1. Mission duration 168 hours 8 minutes 46 seconds.
Morelos-A (S) 1985 48B		Jun 17	1436.2	35793	35782	0.0	3443.0	
ARABSAT-A (S) 1985 48C		Jun 18	1436.2	35807	35768	0.0	3499.0	
TELSTAR 3-D (S) 1985 48D		Jun 19	1436.1	35804	35770	0.0	3437.0	
SPARTAN 1 (S) 1985 48E		Jun 20		RETRIEVED JUN 24, 1985			2051.0	

NASA Major Launch Record

1985

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
Intelsat VA F-11 (S) 1985 55A	Atlas-Centaur (AC-64) (S)	Jun 29	1436.1	35802	35772	0.0	1996.7	Second in a series of improved Commercial Communications Satellites for Intelsat. Reimbursable (Comsat)
STS 51-F (S) Spacelab-2 1985 63A POP (S) 1985 63B	Shuttle (S) (Challenger)	Jul 29		LANDED AT EAFB AUG 6, 1985 RETRIEVED JUL 29, 1985				Seventh Challenger flight with Charles G. Fullerton, Roy D. Bridges, Jr., Karl G. Heinze, Anthony W. England, F. Story Musgrave, Loren W. Acton, and John-David F. Bartow/. Conducted experiments in Spacelab-2 (Cooperative with ESA). Deployed Plasma Diagnostic Package (PDP) which was retrieved 6 hours later. Mission duration 190 hours 45 minutes 26 seconds.
Navy SOOS-I 1985 66A (S) 1985 66B (S)	Scout 105 (S)	Aug 2	107.9 107.9	1257 1257	1002 1002	89.9 89.9	64.2 64.2	Two Navigation Satellites for the U.S. Navy. Reimbursable (DOD) (WSMC)
STS 51-I (S) 1985 76A Aussat-1 (S) 1985 76B ASC (S) 1985 76C Syncom IV-4 (U) 1985 76D	Shuttle (S) (Discovery)	Aug 27 Aug 27 Aug 27 Aug 29	1436.2 1436.1 1436.1	LANDED AT EAFB SEP 3, 1985 35794 35796 36493	35781 35777 35079	0.0 0.1 1.4	3445.5 3406.1 6894.7	Sixth Discovery flight with Joe H. Engle, Richard O. Covey, James D. VanHoften, William F. Fisher, John M. Lounge. Deployed Aussat (Reimbursable - Australia), ASC (Reimbursable - American Satellite Co.), and Syncom IV-4 (Reimbursable - Hughes -). After reaching Geosynchronous Orbit, Syncom IV-4 ceased functioning. Repaired Syncom IV-3 (launched by 51-D, April 1985). Mission duration 170 hours 17 minutes 42 seconds.
Intelsat VA F-12 (S) 1985 87A	Atlas-Centaur (AC-65) (S)	Sep 28	1436.1	35802	35772	0.0	1996.7	Third in a series of improved commercial Communications Satellites for Intelsat. Reimbursable (Comsat).
STS 51-J (S) (DOD) 1985 92A	Shuttle (S) (Atlantis)	Oct 3		LANDED AT EAFB OCT 7, 1985				First Atlantis flight with Karol J. Bobko, Ronald J. Grabe, Robert A. Stewart, David C. Hilmers, and William A. Pailes. DOD mission. Mission duration 97 hours 14 minutes 38 seconds.

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
STS 61-A (S) Spacelab D-1 1985 104A GLOMR (S) 1985 104B	Shuttle (S) (Challenger)	Oct 30		LANDED AT EAFB NOV 6, 1985 DOWN DEC 26, 1986			267.6	Eighth Challenger flight with Henry W. Hartsfield, Steven R. Nagel, Bonnie J. Dunbar, James F. Buchli, Guion S. Bluford, Ernst Messerschmid (Germany), Reinhard Furrer (Germany), and Wubbo Ockels (Dutch). Spacelab D-1 mission (Cooperative with ESA) to conduct scientific experiments. Deployed GLOMR (Reimbursable - DOD). Carried Materials Experiment Assembly (MEA) for on-orbit processing of materials science experiment specimens. Mission duration 168 hours 44 minutes 51 seconds.
STS 61-B (S) 1985 109A Morelos-B (S) 1985 109B Aussat-2 (S) 1985 109C Satcom (S) 1985 109D OEX Target 1985 109E	Shuttle (S) (Atlantis)	Nov 26 Nov 27 Nov 27 Nov 28	 1436.1 1436.2 1436.2	LANDED AT EAFB DEC 3, 1985 35794 35794 35796 DOWN MAR 2, 1987	 35780 35780 35781	 1.1 0.0 0.0	 4539.6 4569.1 7225.3	Second Atlantis Flight with Brewster H. Shaw, Bryan D. O'Conner, Mary L. Cleave, Sherwood C. Spring, Jerry L. Ross, Rudolfo Neri Vela (Morelos), Charles D. Walker (MDAC). Deployed Morelos (Reimbursable - Mexico), Aussat (Reimbursable - Australia), and Satcom (Reimbursable - RCA). Demonstrated construction in space by manually assembling EASE and ACCESS Experiments. Deployed Station Keeping Target (OEX) to conduct advanced Station Keeping Tests. Mission duration 165 hours 4 minutes 49 seconds.
AF-16 1985 114A (S) 1985 114B (S)	Scout 106 (S)	Dec 12	94.6	691 DOWN AUG 9, 1987	311	37.1		Air Force instrumented test vehicle. (Dual Payload) Reimbursable (DOD). (WFF)
1986								**1986**
STS 61-C (S) 1986 03A SATCOM (S) 1986 03B	Shuttle (S) (Columbia)	Jan 12 Jan 12	 1436.2	LANDED AT EAFB JAN 18, 1986 35795	 35780	 0.0	 7225.3	Seventh Columbia flight with Robert L. Gibson, Charles F. Bolden, Jr., Franklin R. Chang-Diaz, George D. Nelson, Steven A Hawley, Robert J. Cenker (RCA), and C. William Nelson (Congressman). Deployed Satcom (Reimbursable - RCA). Evaluated material science lab payload carrier and processing facilities. Carried HHG-1 to accommodate GAS payloads. Mission duration 146 hours 3 minutes 51 seconds.
STS 51-L (U) TDRS-B (U)	Shuttle (U) (Challenger)	Jan 28		DID NOT ACHIEVE ORBIT			2103.3	Ninth Challenger flight with Francis R. Scobee, Michael J. Smith, Judith A. Resnik, Ellison S. Onizuka, Ronald E. McNair, Gregory Jarvis (Hughes), S. Christie McAuliffe (Teacher). Approximately 73 seconds into flight, the Shuttle exploded.

NASA Major Launch Record

1986

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
GOES-G (U)	Delta 178 (U)	May 5		DID NOT ACHIEVE ORBIT			840.0	Provide systematic world-wide weather coverage for NOAA. Vehicle failed. Reimbursable NOAA)
DOD (U) 1986 69A	Delta 180 (U)	Sep 5		DOWN SEP 28, 1986				Carried DOD experiment. Reimbursable (DOD).
NOAA-G (S)	Atlas 52E	Sep 17	823	804	98.7		1712.0	Operational environmental satellite for NOAA. Included ERBE instrument to complement data being acquired by ERBS, launched in 1984. Carried search and rescue instruments provided by Canada and France. Reimbursable (NOAA). (WSMC)
AF P87-11 (S) Polar Bear 1986 88A	Scout 107 (S)	Nov 13	104.9	1018	957	89.5		Scientific satellite to study the atmospheric effect on electromagnetic propagation. Reimbursable (DOD). (WSMC)
Flisatcom (F-7) (S) 1986 96A	Atlas-Centaur (AC-66) (S)	Dec 4	1436.2	35875	35703	4.3	1128.5	Provide communication between aircraft, ships, and ground stations for DOD. Reimbursable (DOD).
1987								**1987**
GOES-H (S) 1987 22A	Delta 179 (S)	Feb 26	1436.3	35796	35783	0.1	840.0	Operational environmental satellite to provide systematic worldwide weather coverage. Reimbursable (NOAA).
Palapa B2-P 1987 29A	Delta 182	Mar 20	1436.2	35788	35788	0.0	652.0	Provide communication coverage over Indonesia and the Asian countries. Reimbursable (Indonesia).
Flisatcom (F-6) (U)	Atlas-Centaur (AC-67) (U)	Mar 26		DID NOT ACHIEVE ORBIT			1038.7	Part of the worldwide communications system between aircraft, ships, and ground stations for the DOD. Telemetry lost shortly after launch; destruct signal sent at 70.7 seconds into flight. An electrical transient, caused by a lighting strike on the launch vehicle, most probable cause of loss. Reimbursable (DOD).
SOOS-2 1987 80A (S) 1987 80B (S)	Scout 108 (S)	Sep 16	107.2 107.2	1175 1181	1017 1014	90.3 90.3	64.5 64.5	Two Transit navigation satellites in a stacked configuration for the U.S. Navy. Reimbursable (DOD). (WSMC)
1988								**1988**
DOD (SDI) (S) 1988 08A	Delta 181 (S)	Feb 8	90.1	333	223	28.6		Strategic Defense Initiative Organization (SDIO) Payload. Reimbursable (DOD).
San Marco D/L (S) 1988 26A	Scout 109 (S)	Mar 25		DOWN DEC 6, 1988			273	Explore the relationship between solar activity and meteorological phenomena. Cooperative with Italy. (San Marco)

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
SOOS-3 1988 33A (S) 1988 33B (S)	Scout 110 (S)	Apr 25					129.6	Two Transit navigation satellites in a stacked configuration for the U.S. Navy. Reimbursable (DOD). (WSMC)
Nova II 1988 52A	Scout 111 (S)	Jun 16					170.5	Improved Transit Navigation Satellite for the U.S. Navy. Reimbursable (DOD). (WSMC)
SOOS-4 1988 74A (S) 1988 74B (S)	Scout 112 (S)	Aug 25					128.2	Two Transit navigation satellites in a stacked configuration for the U.S. Navy. Reimbursable (DOD). (WSMC)
NOAA-H (S) 1988 89A	Atlas 63E (S)	Sep 24					1712.0	Operational environmental satellite for NOAA. Carried Search and Rescue instruments provided by Canada and France. Reimbursable (NOAA). (WSMC)
STS-26 (S) 1988 91A TDRS-3 (S) 1988 91B	Shuttle (S) (Discovery)	Sep 29		LANDED AT EAFB OCT 3, 1988				Sixth Discovery flight with Frederick H. Hauck, Richard O. Covey, John M. Lounge, David C. Hilmers, and George D. Nelson. Deployed TDRS-3. Performed experiment activities for commercial and scientific middeck experiments. Mission Duration 97 hours 0 minutes 11 seconds.
		Sep 29	1434.8	35803	35719	0.1	2224.9	
STS-27 1988 106A DOD 1988 106B	Shuttle (S) (Atlantis)	Sep 29		LANDED AT EAFB DEC 6, 1988				Third Atlantis flight with Robert L. Gibson, Guy S. Gardner, Richard M. Mullane, Jerry L. Ross and William M. Shepherd. DOD Mission. Mission Duration 105 hours 05 minutes 37 seconds.
1989								**1989**
STS-29 1989 21A TDRS-D 1989 21B	Shuttle (S) (Discovery)	Mar 13		LANDED AT EAFB MAR 18, 1989				Eighth Discovery flight with Michael L. Coats, John E. Blaha, James Bagian, James F. Buchli, Robert Springer. Deployed a new Tracking and Data Relay Satellite. Performed commercial and scientific experiments. Mission Duration 119 hours 38 minutes 52 seconds.
			1436.1	35808	35766	0.0	2224	
STS-30 1989 33A Magellan 1989 33B	Shuttle (S) (Atlantis)	May 4		LANDED AT EAFB MAY 8, 1989 TRANS-VENUS TRAJECTORY				Fourth Atlantis flight with David M. Walker, Ronald J. Grabe, Mary L. Cleave, Mark C. Lee, Norman E. Thagard. Deployed the Magellan spacecraft on a mission toward Venus. Performed commercial and scientific middeck experiments. Mission Duration: 96 hours 56 minutes 25 seconds.
STS-28 1989 61A	Shuttle (S) (Columbia)	Aug 8		LANDED AT EAFB AUG 13, 1989				Ninth Columbia flight with Brewster H. Shaw, Richard N. Richards, David C. Leetsma, James C. Adamson, and Mark N. Brown. DOD Mission. Mission Duration: 121 hours 00 minutes 09 seconds.

NASA Major Launch Record

1989

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
Fltsatcom 1989 77A	Atlas-Centaur (AC-68) (S)	Sep 25	1436.2	35898	35677	4.1	1863	Navy Communications satellite to provide communications between aircraft, ships and ground stations for DOD. Reimbursable (DOD).
STS-34 1989 84A Galileo 1989 84B	Shuttle (S) (Atlantis)	Oct 18		LANDED AT EAFB OCT 23, 1989 ELEMENTS NOT AVAILABLE				Fifth Atlantis flight with Donald E. Williams, Michael J. McCulley, Ellen Baker, Shannon N. Lucid, and Franklin Chang-Diaz. Deployed the Galileo spacecraft on a mission toward Jupiter. Performed experiment activities for commercial and scientific middeck experiments. Mission Duration: 119 hours 39 minutes 24 seconds.
COBE 1989 89A	Delta 2 (S)	Nov 18	102.6	889	877	99.0	2206	Cosmic Background Explorer spacecraft to provide the most comprehensive observations to date of the radiative content of the universe.
STS-33 1989 90A DOD 1989 90B	Shuttle (S) (Discovery)	Nov 23		LANDED AT EAFB NOV 28, 1989 ELEMENTS NOT AVAILABLE				Ninth Discovery flight with Frederick Gregory, John E. Blaha, Manly L. Carter, Franklin S. Musgrave and Kathryn C. Thornton. DOD Mission. Mission Duration: 120 hours 6 minutes 49 seconds.
1990								**1990**
STS-32 1990 2A Syncom IV-5 1990 2B	Shuttle (S) (Columbia)	Jan 9	1436.1	LANDED AT EAFB JAN 20, 1990 35799	35744	3.0	6953.4	Tenth Columbia flight with Daniel C. Brandenstein, James D. Wetherbee, Bonnie J. Dunbar, Marsha S. Ivins and G. David Low. Deployed Syncom IV-5 (Reimbursable - DOD), a geostationary communications satellite also known as Leasat, for the U.S. Navy. Also retrieved the Long Duration Exposures Facility (LDEF) deployed on STS-41C on April 6, 1984. Mission Duration: 261 hours 0 minutes 37 seconds.
STS-36 1990 19A DOD 1990 19B	Shuttle (S) (Atlantis)	Feb 28		LANDED AT EAFB MAR 4, 1990 ELEMENTS NOT AVAILABLE				Sixth Atlantis flight with John D. Creighton John H. Casper, David C. Hilmers, Richard M. Mullane and Pierre J. Thuot. DOD Mission. Mission Duration: 106 hours 18 minutes 23 seconds.
Pegsat 1990 28A	Pegasus (S) (Orb Sci)	Apr 5	95.6	645	453	94.1		A 50-foot rocket (Pegasus), dropped from the wing of a B-52 aircraft flying over the Pacific Ocean, launched the Pegsat satellite in the first demonstration flight of the Pegasus launch vehicle. The Pegsat science investigations are part of the Combined Release and Radiation Effects Satellite (CRRES), a joint NASA/DOD program.

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
STS-31 1990 37A HST 1990 37B	Shuttle (S) (Discovery)	Apr 24	97.0	LANDED AT EAFB APR 29, 1990 619	610	28.5	11355.4	Tenth Discovery flight with Loren J. Shriver, Charles F. Bolden, Bruce McCandless, Steven A. Hawley, and Kathryn D. Sullivan. Deployed the Edwin P. Hubble Space Telescope (HST) astronomical observatory. Designed to operate above the Earth's turbulent and obscuring atmosphere to observe celestial objects at ultraviolet, visible and near-infrared wavelengths. Joint NASA/ESA mission. Mission Duration: 121 hours 16 minutes 5 seconds
Macsat 1990 43A/B	Scout 113 (S)	May 9	98.5	765	605	3.0	89.9	Two Multiple Access Communications Satellites (MACSATs) to provide global store-and-forward message relay capability for DOD Users. Reimbursable (DOD) (VAFB)
ROSAT 1990 49A	Delta 2 (S)	Jun 1	96.1	578	560	53.0	2421.1	Roentgen Satellite (ROSAT), an Explorer class scientific satellite configured to accommodate a large X-ray telescope, to study X-ray emissions from non-solar celestial objects. International cooperative program with NASA, Germany, and the UK.
CRRES 1990 65A	Atlas-Centaur (AC-69) (S)	Jul 25	591.0	33575	323	18.2		Combined Release and Radiation Effects Satellite (CRRES) which uses chemical releases to study the Earth's magnetic fields and the plasmas, or ionized gases, that travel through them. Joint NASA/DOD program
STS-41 1990 90A Ulysses 1990 90B	Shuttle (S) (Discovery)	Oct 6		LANDED AT EAFB OCT 10, 1990 HELIOCENTRIC ORBIT			20079.5	Eleventh Discovery flight with Richard N. Richards, Robert D. Cabana, Bruce E. Melnick, William M. Shepherd, and Thomas D. Akers. Deployed the Ulysses spacecraft, a joint NASA/ESA mission to study the poles of the Sun and the interplanetary space above and below the poles. Mission Duration: 98 hours 11 minutes 0 seconds.
STS-38 1990 97A DOD 1990 97B	Shuttle (S) (Atlantis)	Nov 15		LANDED AT KSC NOV 20, 1990 ELEMENTS NOT AVAILABLE				Seventh Atlantis flight with Richard O. Covey, Robert C. Springer, Carl J. Meade, Frank L. Culbertson and Charles D. Gemar. DOD Mission. Mission Duration: 117 hours 55 minutes 0 seconds.
STS-35 1990 106A	Shuttle (S) (Columbia)	Dec 2		LANDED AT EAFB DEC 11, 1990				Eleventh Columbia flight with Vance D. Brand, John M. Lounge, Jeffrey A. Hoffman, Robert A. Parker, Guy S. Gardner, Ronald A. Parise, and Samuel T. Durrance. Carried Astro-1, a Space Shuttle attached payload to acquire high priority astrophysical data on a variety of celestial objects. Mission Duration: 215 hours 6 minutes 0 seconds

NASA Major Launch Record

1991

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
1991								1991
STS-37 1991 27A GRO 1991 27B	Shuttle (S) (Atlantis)	Apr 5	93.1	LANDED AT EAFB APR 11, 1991 432	416	28.5	15900	Eighth Atlantis flight with Steven R. Nagel, Kenneth D. Cameron, Linda M. Godwin, Jerome Apt, and Jerry L. Ross. An unplanned EVA took place to help with the deployment of GRO's high gain antenna. Also demonstrated were mobility aids which will be used on Space Station Freedom. Mission Duration: 143 hrs 33 min 40 sec.
STS-39 (S) 1991 31A IBSS 1991 31B	Shuttle (S) (Discovery)	Apr 28		LANDED AT KSC MAY 6, 1991				Twelfth Discovery flight with Michael L. Coats, Blaine L. Hammond, Jr., Guion S. Bluford, Gregory J. Harbaugh, Richard J. Hieb, Donald R. McMonagle, and Charles L. Veach. Discovery performed dozens of maneuvers, deploying canisters from the cargo bay, releasing and retrieving a payload with the RMS, allowing the Department of Defense to gather important plume observation data and information for the SOIO. Mission Duration: 199 hrs 26 min 16 sec.
NOAA-12 1991 32A	Atlas-E (S)	May 14	101.2	825	807	98.7	1418	Third-generation operational spacecraft to provide systematic global weather observations. Will replace NOAA-10 as the morning satellite in NOAA's two polar satellite system. Joint NASA/NOAA effort.
STS-40 (S) Spacelab (SLS-1) 1991 40A	Shuttle (S) (Columbia)	Jun 5		LANDED AT EAFB JUN 14, 1991				Twelfth Columbia flight with Bryan D. O'Connor, Sidney M. Gutierrez, M. Rhea Seddon, James P. Bagian, Tamara E. Jernigan, F. Drew Gaffney, and Millie Hughes-Fulford. The first mission since Skylab to do intensive investigations into the effects of weightlessness on humans. Data learned from this flight will be used in NASA's planning for longer Shuttle missions set for 1992, and in the planning of Space Station Freedom. Mission Duration: 218 hrs 15 min 14 sec.
REX (S) 1991 45A	Scout (S)	Jun 29	101.3	870	767	89.6	96.7	Radiation Experiment to do further research to overcome and understand the physics of the electron density irregularities that cause disruptive scintillation effects on transionospheric radio signals. Reimbursable - DOD.
STS-43 (S) 1991 54A TDRS-E 1991 54B	Shuttle (S) (Atlantis)	Aug 2	1436.3	LANDED AT KSC AUG 11, 1991 35808	35774	0	2226.9	Ninth Atlantis flight with John E. Blaha, Michael A. Baker, James C. Adamson, G. David Low, and Shannon E. Lucid. A TDRS satellite was deployed, keeping the network which supports Shuttle missions and other spacecraft at full operational capability. Mission Duration: 213 hrs 22 min 26 sec.

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS Apogee (km)	Perigee (km)	Incl (deg)	WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
STS-48 (S) 1991 63A UARS 1991 63B	Shuttle (S) (Discovery)	Sep 12		LANDED AT EAFB SEP 18, 1991			6532.2	Thirteenth Discovery flight with John O. Creighton, Kenneth S. Reightler, Mark F. Brown, James F. Buchli, and Charles D. Gemar. The Upper Atmosphere Research Satellite (UARS) will study physical processes acting within and upon the stratosphere, mesosphere, and lower thermosphere. Mission Duration: 128 hrs 28 min 17 sec.
STS-44 (S) 1991 80A DSP 1991 80B	Shuttle (S) (Atlantis)	Nov 24 Nov 25		LANDED AT EAFB DEC 1, 1991 ELEMENTS NOT AVAILABLE				Tenth Atlantis flightwith Frederick D. Gregory, Terence T. Henricks, F. Story Musgrave, Mario Runco, Jr., James S. Voss, and Thomas J. Hennen. A dedicated mission for the Department of Defense to gather data for their programs. Deployed Defense Support Program satellite (DSP). The mission was shortened when an inertial measurement unit failed on the sixth day of the mission. Mission Duration: 170 hrs 52 min 36 sec.

Section C

Procurement, Funding and Manpower

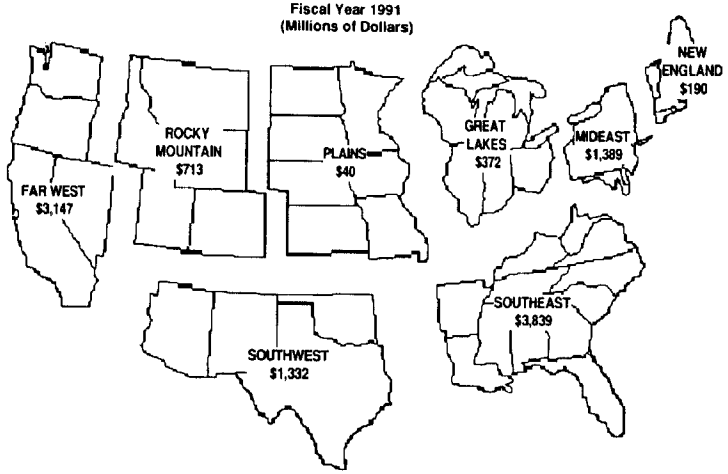
NASA Contract Awards By State

(FY 1991) STATE	TOTAL (THOUSANDS)	BUSINESS (THOUSANDS)	EDUCATIONAL & NONPROFIT (THOUSANDS)
Alabama	1,132,872	1,108,351	24,521
Alaska	6,725	--	6,725
Arizona	32,393	13,829	18,564
Arkansas	343	15	328
California	3,100,916	2,933,315	167,601
Colorado	265,907	243,986	21,921
Connecticut	60,323	57,740	2,583
Delaware	3,128	1,057	2,071
District of Columbia	95,436	68,367	27,069
Florida	1,487,017	1,475,556	11,461
Georgia	17,756	8,756	9,000
Hawaii	7,434	260	7,174
Idaho	1,733	40	1,693
Illinois	17,417	5,963	11,454
Indiana	18,399	12,998	5,401
Iowa	10,303	366	9,937
Kansas	3,754	1,553	2,201
Kentucky	2,926	2,085	841
Louisiana	394,068	391,977	2,091
Maine	951	119	832
Maryland	895,979	804,012	91,967
Massachusetts	112,796	27,526	85,270
Michigan	30,904	5,293	25,611
Minnesota	6,983	3,302	3,681
Mississippi	318,588	315,161	3,427
Missouri	16,620	12,486	4,134
Montana	663	--	663
Nebraska	836	116	720
Nevada	1,186	653	533
New Hampshire	12,594	3,161	9,433
New Jersey	144,548	138,453	6,095
New Mexico	57,120	50,156	6,964
New York	61,196	33,269	27,927
North Carolina	10,663	2,012	8,651
North Dakota	181	--	181
Ohio	256,745	226,374	30,371
Oklahoma	5,934	193	5,741
Oregon	5,986	2,684	3,302
Pennsylvania	188,386	171,745	16,641
Rhode Island	2,893	527	2,366
South Carolina	1,790	369	1,421
South Dakota	694	92	602
Tennessee	36,728	20,128	16,600
Texas	1,236,002	1,151,901	84,101
Utah	444,878	442,744	2,134
Vermont	793	679	114
Virginia	432,317	398,081	34,236
Washington	39,219	31,240	7,979
West Virginia	4,213	189	4,024
Wisconsin	48,566	35,350	13,216
Wyoming	186	--	186
Total	$11,035,988	$10,204,229	$831,759

Note: Excludes smaller procurements, generally those of $25,000 or less; also excludes awards placed through other Government agencies, awards outside the U.S., and actions on the JPL contracts.

U.S. Geographical Distribution of NASA Prime Contract Awards *

Fiscal Year 1991
(Millions of Dollars)



* Excludes smaller procurements, generally those of $25,000 or less; also excludes awards placed through other Government agencies, awards outside the U.S., and awards on the JPL contracts.

Procurement Activity

TOTAL PROCUREMENT BY INSTALLATION

(FY 1991)

INSTALLATION	AWARDS (MILLIONS)	PERCENT
TOTAL	$13,159.0	100.0
Marshall Space Flight Center	3,124.8	23.7
Johnson Space Center	2,641.9	20.1
Goddard Space Flight Center	2,003.8	15.2
Kennedy Space Center	1,409.7	10.7
NASA Resident Office/JPL	1,173.8	8.9
Headquarters	954.8	7.3
Lewis Research Center	812.4	6.2
Ames Research Center	520.2	3.9
Langley Research Center	404.6	3.1
Stennis Space Center	113.0	.9

AWARDS TO BUSINESS FIRMS BY TYPE OF EFFORT
(FY 1991)

CATEGORY	NUMBER OF CONTRACTS	TOTAL (MILLIONS)
TOTAL	5,690	$10,204.6*
Research and Development	2,247	3,222.9
Aeronautics & Space Technology	1,001	1,005.3
Space Science & Applications	521	413.2
Space Flight	141	548.1
Space Operations	72	353.3
Commercial Programs	40	95.5
Space Station	27	500.2
Other Space R&D	398	290.5
Other R&D	47	16.8
Services	1,546	3,883.7
ADP & Telecommunication	173	334.9
Maint., Repair & Rebldg. of Equip.	194	1,096.4
Operation of Gov't-owned Facilities	58	414.2
Professional, Admin. & Mgmt Support	214	1,116.8
Utilities & Housekeeping	97	216.6
Constr. of Structures & Facilities	157	308.4
Maint., Repair, Alter. of Real Prop.	286	142.3
Other Services	369	254.1
Supplies & Equipment	1,895	3,098.0
Ammunition & Explosives	10	283.8
Space Vehicles	57	1,626.4
Engines, Turbines & Components	17	866.2
Communication, Detection & Coherent Radiation Equipment	122	25.6
Electrical & Electronic Equipment Components	60	10.5
Instruments & Laboratory Equipment	370	29.7
ADP Equipment, Software, Supplies & Support Equipment	769	168.2
Fuels, Lubricants, Oils & Waxes	23	29.3
Other Supplies & Equipment	467	58.3

* Excludes smaller procurements, generally those of $25,000 or less.

Distribution of NASA Procurements

(In Millions of Dollars)

Fiscal Years 1961 - 1991

	FY 61	FY 62	FY 63	FY 64	FY 65	FY 66	FY 67	FY 68	FY 69	FY 70	FY 71	FY 72
Total Business	423.3	1,030.1	2,261.7	3,521.1	4,141.4	4,087.7	3,864.1	3,446.7	3,022.3	2,759.2	2,279.5	2,143.3
(Small Business)	(63.5)	(123.6)	(191.3)	(240.3)	(286.3)	(255.9)	(216.9)	(189.6)	(162.8)	(161.2)	(178.1)	(160.9)
Educational	24.5	50.2	86.9	112.9	139.5	150.0	132.9	131.5	131.3	134.3	133.9	118.8
Nonprofit			15.3	29.1	25.3	27.7	39.6	33.6	32.3	33.0	29.3	28.0
JPL	86.0	148.5	230.2	226.2	247.2	230.3	222.2	207.2	156.3	179.8	173.3	210.8
Government	221.7	321.8	628.5	692.6	622.8	512.5	366.9	287.0	279.0	265.8	212.5	207.8
Outside U.S.	(*)	(*)	7.9	12.0	11.2	23.4	25.2	26.7	30.8	33.5	29.7	29.1
Total	755.5	1,550.6	3,230.5	4,593.9	5,187.4	5,031.6	4,650.9	4,132.7	3,652.0	3,405.6	2,858.2	2,737.8

	FY 73	FY 74	FY 75	FY 76	FY 77T	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83
Total Business	2,063.8	2,118.6	2,255.0	2,536.1	663.2	2,838.1	2,953.8	3,416.4	3,868.3	4,272.8	4,805.6	5,586.0
(Small Business)	(155.3)	(181.2)	(216.0)	(218.3)	(68.4)	(255.0)	(281.5)	(325.4)	(384.6)	(409.4)	(430.1)	(482.3)
Educational	111.7	97.8	111.4	123.0	27.7	125.5	137.2	147.2	177.0	192.5	187.0	211.3
Nonprofit	26.4	39.3	33.0	32.0	7.6	32.0	42.8	50.8	82.2	155.1	108.8	102.5
JPL	202.3	215.2	234.5	263.7	63.6	289.0	283.8	338.6	397.2	410.8	426.3	454.9
Government	235.2	208.6	198.3	222.4	63.9	223.2	216.0	221.4	271.8	321.9	308.1	394.2
Outside U.S.	34.0	34.1	34.2	27.4	3.8	24.5	26.0	37.4	46.1	55.2	47.9	47.9
Total	2,673.4	2,713.6	2,866.4	3,204.6	829.8	3,532.3	3,659.6	4,211.8	4,842.6	5,408.3	5,883.7	6,796.8

	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
Total Business	5,967.4	6,652.9	6,356.0	6,540.5	7,274.9	8,567.6	10,071.5	10,417.3
(Small Business)	(556.2)	(644.7)	(671.3)	(786.3)	(801.4)	(857.3)	(924.3)	(968.3)
Educational	22.6	256.9	276.6	315.4	370.3	464.2	513.6	592.0
Nonprofit	98.6	103.1	119.0	119.1	129.5	180.0	200.6	244.0
JPL	533.1	724.6	891.3	1,005.6	979.9	1,058.1	1,106.8	1,139.6
Government	494.3	535.1	489.7	594.9	734.6	543.2	610.4	693.4
Outside U.S.	38.1	35.4	47.1	34.3	55.9	63.3	62.3	72.7
Total	7,154.1	8,308.0	8,179.7	8,609.8	9,545.1	10,876.4	12,565.2	13,159.0

*Included in Government

Principal Contractors (Business Firms)

One Hundred Contractors (Business Firms) Listed According To Total Awards Received (FY1991)

	Contractor and Principle Place of Contract Performance	Awards (Thousands)	Percent
	Total Awards To Business Firms	$10,417,332	100.00
1.	Rockwell International Corp Canoga Park, CA	1,559,634	14.97
2.	McDonnell Douglas Corp Huntington Beach, CA	1,089,205	10.45
3.	Lockheed Space Operations Co Kennedy Space Center, FL	591,449	5.68
4.	Martin Marietta Corp New Orleans, LA	571,732	5.49
5.	Boeing Co Marshall Space Flight, AL	468,308	4.50
6.	Lockheed Missiles & Space Co Iuka, MS	458,981	4.41
7.	Thiokol Corp Brigham City, UT	437,966	4.20
8.	Rockwell Space Operations Inc Houston, TX	343,157	3.29
9.	General Electric Co King of Prussia, PA	308,042	2.96
10.	Lockheed Engrg & Science Co Houston, TX	258,742	2.48
11.	E G & G Florida Inc Kennedy Space Center, FL	227,406	2.18
12.	Computer Sciences Corp Greenbelt, MD	207,005	1.99
13.	U S B I Booster Production Co Huntsville, AL	197,660	1.90
14.	T R W Inc Redondo Beach, CA	192,015	1.84
15.	Loral Aerospace Corp Houston, TX	185,968	1.79
16.	Bendix Field Engineering Corp Greenbelt, MD	175,972	1.69
17.	Boeing Computer Support Services Marshall Space Flight, AL	158,857	1.52
18.	United Technologies Corp West Palm Beach, FL	133,380	1.28
19.	Grumman Aerospace Corp Reston, VA	99,769	.96
20.	Sverdrup Technology Inc Middleburgh Heights, OH	97,403	.93
21.	Johnson Controls World Services Inc Stennis Space Center, MS	70,232	.67
22.	International Business Machines Houston, TX	67,951	.65
23.	Teledyne Industries Inc Marshall Space Flight, AL	65,343	.63
24.	BAMSI Inc Marshall Space Flight, AL	51,801	.50
25.	Contel Corp Gaithersburg, MD	49,794	.48

Principal Contractors (Business Firms)

One Hundred Contractors (Business Firms) Listed According To Total Awards Received (FY1991)

Contractor and Principle Place of Contract Performance		Awards (Thousands)	Percent
26. Cray Research Inc Chippewa Falls, WI		46,800	.45
27. Fairchild Industries Inc Germantown, MD		46,377	.45
28. Cae Link Corp Houston, TX		45,488	.44
29. Harris Space Systems Corp Rockledge, FL		45,163	.43
30. Bionetics Corp Marshall Space Flight, AL		41,069	.39
31. S T Systems Corp Greenbelt, MD		40,748	.39
32. N S I Technology Sevices Corp Greenbelt, MD		36,941	.35
33. P R C Inc Washington, DC		36,749	.35
34. Orbital Sciences Corp Denver, Co	(S)	36,406	.35
35. Raytheon Service Co Greenbelt, MD		34,856	.33
36. Sterling Federal Systems Inc Moffett Field, CA		34,391	.33
37. Unisys Corp Greenbelt, MD		31,076	.30
38. Cortez III Service Corp Cleveland, OH		29,076	.28
39. Aerojet General Corp Azusa, CA		26,222	.25
40. Krug International Corp Houston, TX		25,305	.24
41. Air Products & Chemicals Inc Allentown, PA		25,183	.24
42. Grumman Data Systems Corp Marshall Space Flight, AL		24,629	.24
43. Calspan Corp Moffett Field, CA		23,563	.23
44. Ball Corp Boulder, CO		21,950	.21
45. Analex Corp Fairview Park, OH		21,570	.21
46. General Dynamics Corp San Diego, CA		19,206	.18
47. Silicon Graphics Inc Mountain View, CA	(S)	19,182	.18
48. Ogden Logistics Services Greenbelt, MD		17,319	.17
49. Lockheed Corp Burbank, CA		17,263	.17
50. Engineering & Economics Res Beltsville, MD	(S) (D)	17,189	.16
51. Science Application Intl Corp San Diego, CA		16,994	.16

Principal Contractors (Business Firms)

One Hundred Contractors (Business Firms) Listed According To Total Awards Received (FY1991)

Contractor and Principle Place of Contract Performance		Awards (Thousands)	Percent
52. Northrop Worldwide Aircraft Houston, TX		16,840	.16
53. Sterling Zero One Inc Moffett Field, CA	(S)	16,752	.16
54. Korte Construction Co Marshall Space Flight, AL		15,339	.15
55. Pioneer Contract Services Inc Houston, TX	(S)	14,724	.14
56. C B I Services Inc Moffett Field, CA		14,409	.14
57. Micro Craft Inc Tullahoma, TN	(S)	14,252	.14
58. Hughes Danbury Optical Sys Danbury, CT		14,052	.13
59. Quad S Co Moffett Field, CA	(S)	13,665	.13
60. Cleveland Electroic Illuminating Cleveland, OH		13,472	.13
61. Wyle Laboratories Hampton, VA		13,346	.13
62. Digital Equipment Corp Kennedy Space Center, FL		13,226	.13
63. Santa Barbara Research Center Goleta, CA		12,983	.12
64. Johnson Engineering Corp Houston, TX	(S)	12,918	.12
65. Jackson & Tull Inc Greenbelt, MD	(S) (D)	12,868	.12
66. Virginia Electric & Power Co Hampton, VA		12,830	.12
67. Swales & Associates Inc Greenbelt, MD	(S)	12,433	.12
68. Metric Constructors Inc Kennedy Space Center, FL		12,200	.12
69. Mason & Hanger Services Inc Hampton, VA		12,060	.12
70. Vitro Corp Washington, DC		11,849	.11
71. B D M International Inc Columbia, MD		11,523	.11
72. Hernandez Engineering Inc Houston, TX	(S) (D)	11,453	.11
73. Coleyon Mechanical Corp Cleveland, OH	(S) (D)	11,424	.11
74. Warner R E & Associates Lorain, OH	(S)	11,193	.11
75. Pepper Lawson Construction Inc Houston, TX		10,900	.10
76. Engineering Design Group Inc Cleveland, OH	(S)	10,835	.10
77. Perkin Elmer Corp Pomona, CA		10,590	.10

Principal Contractors (Business Firms)

One Hundred Contractors (Business Firms) Listed According To Total Awards Received (FY1991)

	Contractor and Principle Place of Contract Performance		Awards (Thousands)	Awards Percent
78.	F D Services Inc Houston, TX		10,042	.10
79.	Science Systems Applications Lanham, Md	(S) (D)	9,934	.10
80.	Pacificorp Capital Inc Houston, TX		9,619	.09
81.	Hughes Aircraft Co El Segundo, CA		9,043	.09
82.	Computer Sciences Pan Am Services Slidell, LA		8,911	.09
83.	R M S Associates Inc JV Linthicum, MD		8,735	.08
84.	Booz Allen & Hamilton Inc Bethesda, MD		8,679	.08
85.	Stellacom Inc Houston, TX	(S)	8,266	.08
86.	Kelsey Seybold Clinic Houston, TX		8,261	.08
87.	Boeing Aerospace Operations Inc Moffett Field, CA		8,179	.08
88.	Haskell Co Kennedy Space Center, FL		8,157	.08
89.	Convex Computer Corp Richardson, TX		8,064	.08
90.	Advanced Computer Systems Inc. Greenbelt, MD	(S) (D)	7,984	.08
91.	Allied Signal Inc Phoenix, AZ		7,977	.08
92.	Spacehab Corp Washington, DC	(S)	7,959	.08
93.	Osterland G R Co Cleveland, OH	(S)	7,882	.08
94.	Hamm E L & Associates Inc Greenbelt, MD	(S) (D)	7,690	.07
95.	Gassman Corp Greenbelt, MD		7,568	.07
96.	S Y R E JV Moffett Field, CA		7,442	.07
97.	North Bay Construction Inc Cleveland, OH	(S)	7,320	.07
98.	Electronic Data Systems Corp Bethesda, MD		7,184	.07
99.	H F S Inc Kennedy Space Center, FL		7,110	.07
100.	Iveys Construction Inc. Kennedy Space Center, FL		7,099	.07
	Other *		1,041,604	10.01

(S=Small Business/D=Disadvantaged Business)
*Includes other Awards over $25,000 and smaller procurements of $25,000 or less.

Educational and Nonprofit Institutions

One Hundred Educational And Nonprofit Institutions
Listed According To Total Awards Received *
(FY1991)

	Institution and Principle Place of Performance		Awards (Thousands)	Percent
	Total Awards to Educational and Nonprofit Institutions		$835,970	100.00
1.	Stanford Univ Stanford, CA		$55,016	6.59
2.	Assn Univ Research & Astron Baltimore, MD	(N)	$47,355	5.67
3.	Smithsonian Institution Cambridge, MA	(N)	$31,395	3.76
4.	Universities Space Research Greenbelt, MD	(N)	$28,261	3.38
5.	Mass Institute Technology Cambridge, MA		$25,535	3.06
6.	Mitre Corp Houston, TX	(N)	$23,453	2.81
7.	Univ Maryland College Park College Park, MD		$22,333	2.67
8.	New Mexico State Univ Las Cru Palestine, TX		$21,177	2.54
9.	Univ Calif Berkeley Berkeley, CA		$20,306	2.43
10.	Univ Alabama Huntsville Huntsville, AL		$17,371	2.08
11.	Univ Colorado Boulder Boulder, CO		$16,520	1.98
12.	Charles Stark Draper Lab Inc Cambridge, MA	(N)	$15,973	1.91
13.	Univ Calif San Diego La Jolla, CA		$15,950	1.91
14.	Univ Arizona Tucson, AZ		$15,300	1.83
15.	National Academy Sciences Washington, DC	(N)	13,423	1.61
16.	Univ Michigan Ann Arbor Ann Arbor, MI		12,573	1.51
17.	Univ Wisconsin Madison Madison, WI		11,987	1.44
18.	Calif Institute Technology Pasadena, CA		11,701	1.40
19.	Southwest Research Institute San Antonio, TX	(N)	11,906	1.33
20.	U T Calspan Center Aerospace Res Tullahoma, TN	(N)	10,745	1.29
21.	Pennsylvania State Univ UP University Park, PA		10,646	1.27
22.	Saginaw Valley State Univ University Center, MI		10,100	1.21
23.	Univ Iowa Iowa City, IA		8,624	1.03
24.	Univ New Hampshire Durham, NH		8,354	1.00

Educational and Nonprofit Institutions

One Hundred Educational And Nonprofit Institutions Listed According To Total Awards Received *
(FY1991)

	Institution and Principle Place of Performance		Awards (Thousands)	Awards Percent
25.	Univ Calif Los Angeles Los Angeles, CA		7,801	.93
26.	Univ Washington Seattle, WA		7,680	.92
27.	Case Western Reserve Univ Cleveland, OH		7,627	.91
28.	Harvard Univ Cambridge, MA		7,451	.89
29.	Univ Hawaii Honolulu, HI		7,113	.85
30.	Univ Texas Austin Austin, TX		7,031	.84
31.	S E T I Institute Moffett Field, CA	(N)	6,833	.82
32.	Univ Houston Houston, TX		6,755	.81
33.	Univ Alaska Fairbanks Fairbanks, AK		6,725	.81
34.	Univ Houston Clear Lake Houston, TX		6,723	.80
35.	Columbia Univ New York, NY		6,480	.78
36.	Cornell Univ Ithaca, NY		5,995	.72
37.	Johns Hopkins Univ Baltimore, MD		5,958	.71
38.	Univ Chicago Chicago, IL		5,939	.71
39.	Ohio State Univ Columbus, OH		5,593	.67
40.	Univ Alabama Birmingham Birmingham, AL		5,369	.64
41.	Battelle Memorial Institute Columbus, OH	(N)	5,284	.63
42.	Texas A & M Univ El Paso, TX		5,235	.63
43.	Georgia Institute Technology Atlanta, GA		5,170	.62
44.	Oklahoma State Univ Stillwater, OH		5,024	.60
45.	Univ Virginia Charlottesville, VA		4,969	.59
46.	San Jose State Univ Moffett Field, CA		4,851	.58
47.	Virginia Polytechnic Institute Blacksburg, VA		4,822	.58
48.	Old Dominion Univ Norfolk, VA		4,297	.51
49.	Princeton Univ Princeton, NJ		4,132	.49
50.	Univ Calif Santa Barbara Santa Barbara, CA		3,908	.47

Educational and Nonprofit Institutions

One Hundred Educational And Nonprofit Institutions Listed According To Total Awards Received *
(FY1991)

	Institution and Principle Place of Performance		Awards (Thousands)	Percent
51	American Instit Aero & Astro New York, NY	(N)	3,779	.45
52	North Carolina State Univ Raleigh, NC		3,669	.44
53	George Washington Univ Washington, DC		3,634	.44
54	Univ Minnesota Minnpl St Paul Minneapolis, MN		3,581	.43
55	Eloret Institute Moffett Field, CA	(N)	3,416	.41
56	Washington Univ St Louis St. Louis, MO		3,408	.41
57	Univ Southern Calif Los Angeles, CA		3,257	.39
58	Auburn Univ Auburn Auburn, AL		3,254	.39
59	Purdue Univ West Lafayette, IN		3,250	.39
60.	Carnegie Mellon Univ Pittsburgh, PA		3,194	.38
61.	Rensselaer Poly Inst N Y Troy, NY		3,155	.38
62.	Hampton City Hampton, VA	(N)	3,154	.38
63.	Cleveland State Univ Cleveland, OH		3,139	.38
64.	Wheeling Jesuit College Wheeling, WV		3,119	.37
65.	S R I International Corp Menlo Park, CA	(N)	3,102	.37
66.	Univ Illinois Urbana Urbana, IL		3,018	.36
67.	Research Traingle Institute Hampton, VA	(N)	2,957	.35
68.	Vanderbilt Univ Nashville, TN		2,911	.35
69.	Ohio Aerospace Institute Brook Park, OH	(N)	2,774	.33
70.	Oregon State Univ Corvallis, OR		2,769	.33
71.	Univ Florida Gainesville, FL		2,689	.32
72.	Univ Corp Atmospheric Research Boulder, CO	(N)	2,664	.32
73.	Arizona State Univ Tempe, AZ		2,608	.31
74.	North Carolina A & T State Univ Greensboro, NC		2,498	.30
75.	Univ Texas Dallas Dallas, TX		2,471	.30
76.	Univ Mass Amherst Amherst, MA		2,201	.26

Educational and Nonprofit Institutions

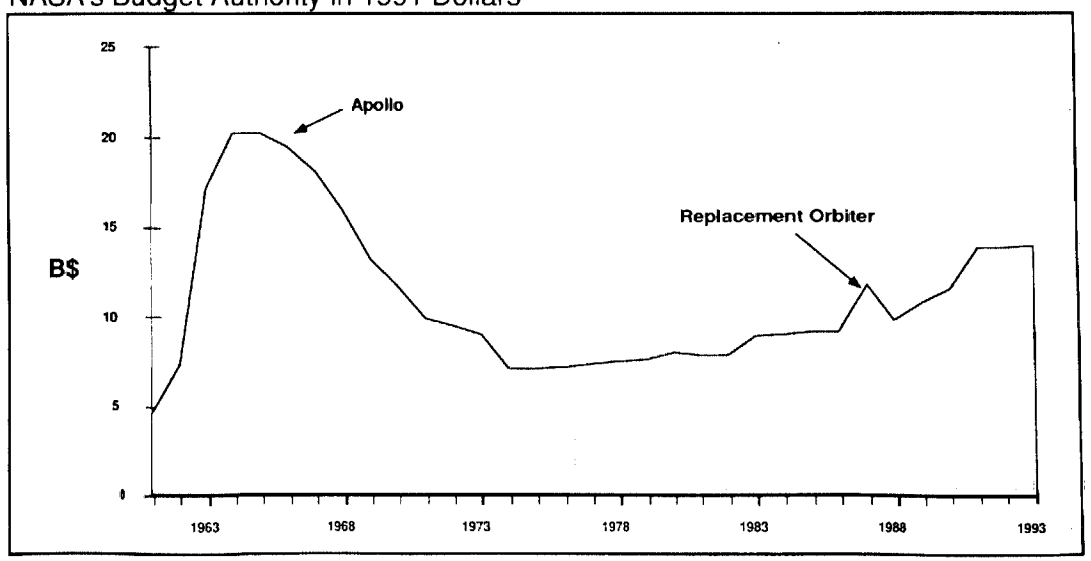
One Hundred Educational And Nonprofit Institutions
Listed According To Total Awards Received *
(FY1991)

	Institution and Principle Place of Performance		Awards (Thousands)	Percent
77.	Univ Miami Miami, FL		2,198	.26
78.	MCAT Institute Moffett Field, CA	(N)	2,158	.26
79.	Hampton Univ Hampton, VA		2,146	.26
80.	Colorado State Univ Fort Collins, CO		2,075	.25
81.	Univ Calif Davis Davis, CA		2,023	.24
82.	Rice Univ Houston, TX		2,021	.24
83.	Florida State Univ Tallahassee, FL		1,862	.22
84.	Environmental Res Instit Mich Ann Arbor, MI	(N)	1,812	.22
85.	Aerospace Corp El Segundo, CA	(N)	1,754	.21
86.	Howard Univ Washington, DC		1,746	.21
87.	Northwestern Univ Evanston Evanston, IL		1,715	.21
88.	Univ Idaho Moscow, ID		1,704	.20
89.	Univ Cincinnati Cincinnati, OH		1,691	.20
90.	Clarkson Univ Potsdam, NY		1,667	.20
91.	Morehouse College Atlanta, GA		1,654	.20
92.	Univ Calif Irvine Irvine, CA		1,578	.19
93.	Boston Univ Boston, MA		1,570	.19
94.	Univ Central Florida Orlando, FL		1,530	.18
95.	Univ Pittsburgh Pittsburgh, PA		1,513	.18
96.	Univ Rochester Rochester, NY		1,504	.18
97.	Univ New Mexico Albuquerque, NM		1,500	.18
98.	Univ Toledo Toledo, OH		1,457	.17
99.	Yale Univ Moffet Field, CA		1,456	.17
100.	State Univ New York Stony Brook Stony Brook, NY		1,455	.17
	Other**		94,551	11.31

* Excludes JPL

** Includes other Awards over $25,000 and smaller procurements of $25,000 or less.

NASA's Budget Authority in 1991 Dollars



Financial Summary

(In Millions Of Dollars)

FISCAL YEAR	TOTAL APPROPRIATIONS	TOTAL DIRECT OBLIGATIONS	OUTLAYS TOTAL	RESEARCH & DEVELOPMENT	SPACE FLIGHT, CONTROL & DATA COMMUNICATIONS	CONSTRUCTION OF FACILITIES	RESEARCH & PROGRAM MANAGEMENT	AS OF 30 SEP 91 TRUST FUNDS	OFFICE OF INSPECTOR GENERAL
1959	330.90	298.70	145.50	34.00	--	24.80	86.70	--	--
1960	523.60	486.90	401.00	255.70	--	54.30	91.00	--	--
1961	966.70	908.30	744.30	487.00	--	98.20	159.10	--	--
1962	1,825.30	1,691.70	1,257.00	935.60	--	114.30	207.10	--	--
1963	3,674.10	3,448.40	2,552.40	2,308.40	--	225.30	18.70	--	--
1964	5,100.00	4,864.80	4,171.00	3,317.40	--	437.70	415.90	--	--
1965	5,250.00	5,500.70	5,092.90	3,984.50	--	530.90	577.50	--	--
1966	5,175.00	5,350.50	5,933.00	4,741.10	--	572.50	619.40	--	--
1967	4,968.00	5,011.70	5,425.70	4,487.20	--	288.60	649.90	--	--
1968	4,588.90	4,520.40	4,723.70	3,946.10	--	126.10	651.50	--	--
1969	3,995.30	4,045.20	4,251.70	3,530.20	--	65.30	656.20	--	--
1970	3,749.20	3,858.90	3,753.10	2,991.60	--	54.30	707.20	--	--
1971	3,312.60	3,324.00	3,381.90	2,630.40	--	43.70	707.80	--	--
1972	3,310.10	3,228.60	3,422.90	2,623.20	--	50.30	749.40	--	--
1973	3,407.60	3,154.00	3,315.20	2,541.40	--	44.70	729.10	--	--
1974	3,039.70	3,122.40	3,256.20	2,421.60	--	75.10	759.50	--	--
1975	3,231.20	3,265.90	3,266.50	2,420.40	--	85.30	760.80	--	--
1976	3,551.80	3,604.80	3,669.00	2,748.80	--	120.90	799.30	--	--
TQ	932.20	918.80	951.40	730.70	--	25.80	194.90	--	--
1977	3,819.10	3,858.10	3,945.30	2,980.70	--	105.00	859.60	--	--
1978	4,063.70	4,000.30	3,983.10	2,988.70	--	124.20	870.20	--	--
1979	4,561.20	4,557.50	4,196.50	3,138.80	--	132.70	925.00	--	--
1980	5,243.40	5,098.10	4,851.60	3,701.40	--	140.30	1,009.90	--	--
1981	5,522.70	5,606.20	5,421.20	4,223.00	--	146.80	1,051.40	--	--
1982	6,020.00	5,946.70	6,035.40	4,796.40	--	109.00	1,130.00	--	--
1983	6,837.70	6,723.90	6,663.90	5,316.20	--	108.10	1,239.60	--	--
1984	7,228.10	7,135.20	7,047.60	2,791.80	2,914.60	108.80	1,232.40	--	--
1985	7,548.70	7,638.40	7,317.70	2,118.20	3,707.00	170.00	1,322.50	--	--
1986	7,764.20	7,463.00	7,403.50	2,614.80	3,267.40	188.90	1,332.40	--	--
1987	10,796.00	8,603.70	7,591.40	2,436.20	3,597.30	149.00	1,408.90	--	--
1988	9,116.60	9,914.70	9,091.60	2,915.80	4,362.20	165.90	1,647.70	--	--
1989	11,008.90	11,315.80	11,051.50	3,922.40	5,030.20	190.10	1,908.30	0.50	--
1990	12,397.67	13 068 93	12 428 83	5,094 30	5,116.52	218.42	1,991.09	1.00	7.50
1991	14,015.93	13,973.54	13,877.64	5,765 48	5,590.28	326.31	2,185.06	1.02	9.49

Research and Development Funding By Program

(In Millions of Dollars)

	FY 1991	FY 1990	FY 1989	FY 1988	FY 1987	FY 1986	FY 1985	FY 1984	FY 1983	FY 1982	FY 1981	FY 1980	FY 1979	FY 1978	FY 1977 & Prior
											As of September 30, 1991				
Space Station	1,875.39	1,723.7	884.6	387.4	414.5	197.8	153.6	--	--	--	--	--	--	--	
Space Flight															
Space Shuttle	--	--	--	--	--	--	--	--	1,696.2	2,098.1	1,994.7	1,870.3	1,637.6	1,348.8	4,599.9
Space Transp Cap Dev	588.79	546.02	660.4	585.8	522.3	390.0	387.8	446.1	1,771.5	902.2	676.2	446.6	299.7	263.8	3,946.3
STS Oper Capability Dev	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(278.8)	(201.5)	(223.5)	(112.9)	(89.9)	(64.4)	(65.4)
Spacelab	(129.30)	(118.58)	(87.6)	(66.5)	(72.0)	(77.3)	(55.6)	(111.0)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)
Upper Stages	(76.47)	(79.70)	(131.6)	(142.2)	152.0	(113.6)	(135.8)	(157.7)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)
Payload Oper & Support Eqt	(93.52)	(58.54)	(53.1)	(74.1)	(34.1)	(54.2)	(54.5)	(59.6)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)
Eng & Tech Base (ETB)/DTMS	(208.50)	(181.60)	(160.6)	(133.9)	133.4	(105.5)	(105.6)	(93.1)	(70.2)	(182.9)	(183.5)	(172.6)	(177.2)	(171.9)	(1,050.8)
Advanced Programs	(35.20)	(29.70)	(47.7)	(46.4)	(37.7)	(19.4)	(20.5)	(21.4)	(12.6)	(9.7)	(8.8)	(13.0)	(7.0)	(10.0)	(188.8)
Advanced Launch Systems	(- -)	(- -)	(80.4)	(64.3)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)
Advanced Transportation Tech.	(23.90)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)
Tethered Satellite Program	(21.90)	(27.30)	(26.4)	(12.1)	(10.6)	(15.0)	(15.8)	(3.3)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)
Orbital Maneuvering Veh (OMV)	(- -)	(50.60)	(73.0)	(46.3)	(82.5)	(5.0)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)
STS Operations	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(1,409.9)	(508.1)	(260.4)	(148.1)	(25.6)	(16.5)	(- -)
Skylab	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(2,427.1)
Apollo Soyuz Test Project	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(214.2)
Expendable Launch Vehicles	--	--	--	--	--	--	--	--	82.9	31.1	54.4	67.4	73.6	136.5	2,276.8
Completed Programs	--	--	--	--	--	--	--	--	--	--	--	--	--	--	22,020.5
Apollo	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(20,444.0)
Gemini	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(1,280.7)
Others	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(- -)	(295.8)
Total OSF	588.79	546.02	660.4	585.8	522.3	390.0	387.8	446.1	3,550.6	3,031.4	2,725.3	2,384.3	2,010.9	1,749.1	32,843.5
Commercial Programs															
Technology Utilization	23.85	23.40	16.3	18.8	15.5	10.4	9.4	9.0	9.0	8.0	8.8	12.0	9.1	9.1	75.3
Commercial Use of Space	62.79	32.41	27.8	29.3	23.6	16.0	--		--	--	--	--	--	--	--
Total OCP	86.64	55.81	44.1	48.1	39.1	26.4	9.4	9.0	9.0	8.0	8.8	12.0	9.1	9.1	75.3

Research and Development Funding By Program

(In Millions of Dollars)	FY 1991	FY 1990	FY 1989	FY 1988	FY 1987	FY 1986	FY 1985	FY 1984	FY 1983	FY 1982	FY 1981	FY 1980	FY 1979	FY 1978	FY 1977 & Prior
											As of September 30, 1991				
Aeronautics and Space Technology															
Current Programs															
Space Research & Technology	280.42	273.77	273.7	217.1	164.5	148.1	141.0	130.3	121.2	106.9	107.8	111.8	98.3	88.7	431.6
Aeronautical Research & Tech	495.20	433.36	384.6	320.2	360.5	324.3	328.3	296.7	274.5	261.1	268.8	308.3	264.1	228.0	1,022.0
Transatmospheric Res & Tech	93.76	58.29	68.5	51.9	44.4	--	--	--	--	--	--	--	--	--	--
Energy Tech. Applications	--	--	--	--	--	--	--	--	--	--	1.9	3.0	5.0	7.5	20.8
Prior Programs															
Apollo Applications Expr	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.0
Chemical & Solar Power	--	--	--	--	--	--	--	--	--	--	--	--	--	--	62.3
Basic Research	--	--	--	--	--	--	--	--	--	--	--	--	--	--	193.6
Space Vehicle Systems	--	--	--	--	--	--	--	--	--	--	--	--	--	--	332.3
Electronic Systems	--	--	--	--	--	--	--	--	--	--	--	--	--	--	272.0
Human Factor Systems	--	--	--	--	--	--	--	--	--	--	--	--	--	--	151.3
Space Power & Elec Prop Sys	--	--	--	--	--	--	--	--	--	--	--	--	--	--	385.4
Nuclear Rockets	--	--	--	--	--	--	--	--	--	--	--	--	--	--	512.9
Chemical Propulsion	--	--	--	--	--	--	--	--	--	--	--	--	--	--	365.4
Aeronautical Vehicles	--	--	--	--	--	--	--	--	--	--	--	--	--	--	451.2
Nuclear Power & Propulsion	--	--	--	--	--	--	--	--	--	--	--	--	--	--	44.1
Mission Analysis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	16.0
Total OAST	869.38	765.42	726.8	589.2	569.4	472.4	469.3	427.0	395.7	368.0	378.5	423.1	367.4	324.2	4,261.9
Space Tracking & Data Systems															
Tracking and Data Acquisition	19.75	19.08	18.6	17.7	16.9	15.3	14.7	14.1	496.3	401.3	339.8	332.1	299.9	276.3	3,852.9
Safety, Reliability, Maintainability & Quality Assurance															
Standards & Practices	32.59	22.35	22.1	13.9	11.9	7.5	4.8	4.6	3.0	3.0	2.1	3.8	9.0	9.0	24.2
University Space Science & Technology Academic Program															
Academic Programs	37.43	23.00	--	--	--	--	--	--	--	--	--	--	--	--	--
Minority University Res. Prog	16.98	14.03	--	--	--	--	--	--	--	--	--	--	--	--	--
Total U.S.S.&T.A. P.	54.41	37.03	--	--	--	--	--	--	--	--	--	--	--	--	--

Research and Development Funding By Program

(In Millions of Dollars)	FY 1991	FY 1990	FY 1989	FY 1988	FY 1987	FY 1986	FY 1985	FY 1984	FY 1983	FY 1982	As of September 30, 1991 FY 1981	FY 1980	FY 1979	FY 1978	FY 1977 & Prior
Space Science and Applications															
Current Programs															
Physics & Astronomy	954.14	847.11	712.1	596.2	526.5	554.6	654.7	558.6	480.8	318.2	320.0	335.6	281.8	223.1	2,191.2
Planetary Exploration	469.91	380.85	405.9	323.5	362.2	349.1	286.5	216.1	180.0	205.0	174.1	219.4	181.9	146.7	3,550.9
Life Sciences	135.60	104.70	78.1	72.1	70.2	65.0	61.9	57.6	55.6	39.5	42.2	43.8	40.1	33.3	145.8
Space Applications	835.07	632.05	578.3	557.4	550.6	478.4	367.6	309.5	311.4	325.0	325.7	328.5	271.9	232.1	2,093.2
Prior Programs															
Manned Space Science	--	--	--	--	--	--	--	--	--	--	--	--	--	--	46.4
Launch Vehicle Development	--	--	--	--	--	--	--	--	--	--	--	--	--	--	614.4
Bioscience	--	--	--	--	--	--	--	--	--	--	--	--	--	--	257.8
Space Flight Operations	--	--	--	--	--	--	--	--	--	--	--	--	--	4.0	58.3
Payload, Plan & Prog Integ	(--)	(--)	(--)	(--)	(--)	(--)	(--)	(--)	(--)	(--)	(--)	(--)	(--)	(4.0)	(58.3)
Total OSSA	2,394.72	1,964.71	1,774.4	1,549.2	1,551.5	1,447.1	1,370.7	1,141.8	1,027.8	887.7	862.0	927.3	775.7	639.2	8,958.0
University Affairs	--	--	--	--	--	--	--	--	--	--	--	--	--	--	229.2
Operating Account	88.94	93.56	103.5	63.6	68.1	59.6	55.0	23.6	33.1	23.6	17.8	5.5	5.2	4.7	229.2
Total Program	6,010.61	5,227.69	4,234.5	3,254.8	3,153.7	2,616.1	2,465.3	2,066.2	5,515.5	4,723.0	4,334.3	4,088.1	3,477.2	3,011.6	50,474.2
Approp Trans & Adjustment	0.00	54.20	-45.9	19.3	-26.0	19.0	-2.7	54.3	27.3	17.9	2.0	3.0	0.0	1.4	301.0
Appropriation	6,010.61	5,281.89	4,188.6	3,274.1	3,127.7	2,635.1	2,462.6	2,011.9	5,542.8	4,740.9	4,336.3	4,091.1	3,477.2	3,013.0	50,775.2
Lapse Unoblig Bal Incl	--	(1.68)	(.5)	(1.1)	(4.4)	(.3)	(.2)	(.3)	(.2)	(.3)	(.6)	(.1)	(.3)	(.3)	

Note: Unobligated Balances Lapsed at the end of the second year of accountability.

Research and Development Funding By Location

(In Millions of Dollars)	FY 1991	FY 1990	FY 1989	FY 1988	FY 1987	FY 1986	FY 1985	FY 1984	FY 1983	FY 1982	As of September 30, 1991 FY 1981	FY 1980	FY 1979	FY 1978	FY 1977 & Prior
Headquarters	643.75	471.79	403.5	332.8	258.2	175.8	150.3	141.8	218.4	152.6	136.0	132.5	115.3	95.0	2,254.5
Ames Research Center	349.96	314.20	295.1	261.7	291.1	241.5	223.5	196.8	180.6	162.9	141.0	147.5	140.4	115.5	1,183.3
Dryden Flight Research Facility	--	--	--	--	--	--	--	--	--	11.9	18.4	16.6	13.1	18.6	242.0
Electronics Research Center	--	--	--	--	--	--	--	--	--	--	--	--	--	--	82.5
Goddard Space Flight Center	1,130.01	930.64	743.7	510.9	488.8	522.6	447.1	361.6	816.3	744.0	567.6	552.0	516.8	492.9	6,400.3
Jet Propulsion Laboratory	649.97	575.29	581.6	490.3	466.8	451.9	347.8	253.7	308.2	316.4	262.8	320.5	236.8	201.4	3,018.4
Johnson Space Center	1,153.72	1,049.33	572.6	334.8	331.0	249.5	235.2	174.9	1,593.0	1,557.2	1,524.5	1,398.3	1,161.8	970.7	15,424.0
Kennedy Space Center	207.83	150.68	116.2	90.5	57.3	71.1	49.0	55.7	529.3	420.5	365.4	300.8	234.9	170.0	2,503.5
Langley Research Center	285.20	260.81	245.9	199.0	221.1	175.2	177.7	140.4	131.9	130.5	143.3	168.2	138.2	157.1	2,323.5
Lewis Research Center	548.10	500.26	393.7	257.3	266.8	257.1	325.1	292.8	269.9	178.4	163.3	170.4	148.5	133.6	2,868.3
Marshall Space Flight Center	950.18	959.89	870.0	760.9	730.1	465.3	503.2	443.5	1,702.1	1,238.5	1,005.9	868.2	785.2	630.9	13,292.2
NASA Pasadena Office	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4.4
Stennis Space Cneter	16.89	14.80	17.3	16.7	22.5	10.2	11.1	9.7	8.6	10.1	8.9	9.3	9.2	10.0	21.5
Pacific Launch Operations	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.3
Space Nuclear Systems Office	--	--	-5.1	--	--	--	--	--	--	--	--	--	--	--	436.5
Station 17	--	--	--	--	--	-3.8	-4.7	-4.7	-242.8	-200.0	-14.0	-31.7	-38.8	--	--
Wallops Flight Facility	--	--	--	--	--	--	--	--	--	11.2	15.7	15.8	15.9	156.3	--
Western Support Office	--	--	--	--	--	--	--	--	--	--	--	--	--	--	119.7
Undistributed	75.00	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Program	6,010.61	5,227.69	4,234.5	3,254.9	3,153.7	2,616.4	2,465.3	2,066.2	5,515.5	4,734.2	4,338.8	4,088.2	3,477.3	3,152.0	50,174.9
Approp Trans & Adjustment	0.00	54.20	-45.9	19.3	-26.0	19.0	-2.7	-54.3	27.3	17.9	2.0	3.0	0.0	1.4	301.0
Appropriation	6,010.61	5,281.89	4,188.6	3,274.2	3,127.7	2,635.4	2,462.6	2,011.9	5,542.8	4,752.1	4,340.8	4,091.2	3,477.3	3,153.4	50,475.9
Lapse Unoblig Bal Incl	--	(1.68)	(0.5)	(1.1)	(4.4)	(.3)	(.2)	(.3)	(.2)	(.3)	(.6)	(.1)	(.3)	(.3)	

Note: Unobligated Balances Lapsed at the end of the second year of accountability

Space Flight, Control and Data Communications By Program

(In Millions of Dollars)

As of September 30, 1991

		FY 1990	FY 1989	FY 1988	FY 1987	FY 1986	FY 1985	FY 1984
Space Flight								
Shuttle Prod & Oper Cap	1,310.07	1,189.84	1,116.55	1,092.40	3,326.38	1,354.7	1,478.1	1,637.2
Space Transportation Ops	2,976.73	2,628.41	2,604.26	1,825.50	1,737.06	1,633.2	1,308.6	1,431.7
Total OSF	4,286.80	3,818.25	3,720.81	2,917.90	5,063.44	2,987.9	2,786.7	3,068.9
Space Tracking & Data Systems	963.77	897.97	813.45	969.30	764.70	658.2	792.2	673.9
Operating Account	10.13	9.39	13.79	8.70	17.36	15.6	15.3	9.0
Total Program	5,260.70	4,725.61	4,548.05	3,895.90	5,845.50	3,661.7	3,594.2	3,751.8
Approp Trans & Adjustment	1,063.29	-182.50	-190.40	12.40	-180.50	19.1	7.6	39.8
Appropriation	6,323.99	4,543.11	4,357.65	3,908.30	5,665.00	3,680.8	3,601.8	3,791.6
Lapse Unoblig Bal Incl	--	(0.82)	(0.90)	(0.40)	(0.30)	(.3)	(.2)	(.5)

Note: Unobligated Balances Lapsed at the end of the second year of accountability.

Space Flight, Control and Data Communications By Location

(In Millions of Dollars)

As of September 30, 1991

	FY 1991	FY 1990	FY 1989	FY 1988	FY 1987	FY 1986	FY 1985	FY 1984
Headquarters	220.34	160.73	159.30	364.40	336.95	204.5	259.5	227.6
Ames Research Center	18.61	18.70	16.70	15.40	16.30	18.0	15.6	10.3
Goddard Space Flight Center	617.79	635.73	549.92	467.10	415.90	330.0	432.2	431.0
Jet Propulsion Laboratory	150.22	154.72	124.97	132.10	128.00	117.4	111.9	97.3
Johnson Space Center	1,161.43	1,130.53	1,054.62	909.70	2,475.65	1,083.7	1,308.0	1,360.5
Kennedy Space Center	921.63	857.80	828.37	720.20	660.62	511.5	493.4	490.5
Langley Research Center	0.36	2.05	14.30	0.10	0.25	0.4	0.6	0.2
Lewis Research Center	101.16	54.63	10.90	3.70	5.00	3.3	4.3	2.0
Marshall Space Flight Center	1,922.98	1,683.63	1,779.81	1,263.90	1,734.05	1,655.4	1,437.0	1,379.0
Stennis Space Center	24.81	27.09	21.56	19.30	16.09	15.1	12.3	1.1
Station 17	--	--	-12.40	--	--	-277.6	-480.6	-247.7
Undistributed	121.37	--	--	--	56.69	--	--	--
Total Program	5,260.70	4,725.61	4,548.05	3,895.90	5,845.50	3,661.7	3,594.2	3,751.8
Approp Trans & Adjustment	1,063.29	-182.50	-190.40	12.40	-180.50	19.1	7.6	39.8
Appropriation	6,323.99	4,543.11	4,357.65	3,908.30	5,665.00	3,680.8	3,601.8	3,791.6
Lapse Unoblig Bal Incl	--	(0.82)	(0.90)	(0.40)	(0.30)	(.3)	(.2)	(.5)

Note: Unobligated Balances Lapsed at the end of the second year of accountability.

Construction of Facilities Funding

(In Millions of Dollars)	FY 91	FY 90	FY 89	FY 88	FY 87	FY 86	FY 85	FY 84	FY 83	FY 82	FY 81	FY 80	FY 79	FY 78	FY 77	76/TQ	FY 75	FY 74	FY 73
Ames Research Center	--	12.7	--	16.0	18.9	7.8	14.2	14.7	--	--	13.6	2.9	9.1	--	4.4	2.6	3.7	--	3.2
Dryden Flight Research Fac.	12.8	--	--	12.7	--	--	--	--	3.5	--	--	--	--	0.4	0.8	--	--	--	--
Goddard Space Flight Center	16.6	15.7	6.2	8.6	8.0	3.6	2.1	--	2.6	--	--	--	5.6	4.5	--	--	1.9	1.3	0.6
Jet Propulsion Laboratory	28.3	5.3	--	--	11.7	9.2	13.7	5.5	--	1.8	2.8	--	4.6	3.1	--	--	9.2	1.3	0.5
Kennedy Space Center	--	11.2	--	--	--	--	--	--	--	1.1	0.6	4.8	--	1.7	2.6	--	--	--	9.7
Langley Research Center	4.6	6.8	7.4	--	11.3	4.7	13.8	10.5	13.5	2.9	22.0	7.1	5.3	1.6	6.1	1.6	3.2	4.0	4.3
Lewis Research Center	16.0	--	--	17.0	--	--	--	12.9	4.8	1.2	8.7	5.7	5.8	0.8	2.7	--	3.7	--	10.0
Johnson Space Center	11.0	2.8	7.8	--	7.6	--	--	--	--	3.0	--	--	--	2.0	2.2	--	0.7	--	0.6
Marshall Space Flight Ctr.	--	--	12.6	--	--	--	1.6	--	--	--	4.0	6.3	--	--	--	--	3.8	--	--
Stennis Space Center	3.8	--	--	--	--	--	--	--	--	--	--	--	--	0.6	--	--	--	--	--
Wallops Flight Facility	5.2	--	--	--	--	--	--	--	2.1	--	--	1.1	--	--	--	--	1.1	0.9	0.6
Various Locations	17.6	2.6	--	6.4	16.9	17.4	14.0	--	--	9.8	32.0	1.7	--	1.1	--	--	7.7	3.7	--
Facility Planning & Design	28.0	26.3	22.0	16.0	17.0	11.8	12.0	9.1	8.2	10.0	9.7	13.9	10.6	11.7	12.6	12.5	10.8	13.5	7.9
Large Aero Fac	--	--	--	--	--	--	--	--	--	--	--	45.7	56.1	37.0	31.0	--	--	--	--
Minor Construction	11.0	10.0	9.0	7.4	6.8	5.9	4.9	4.7	3.7	2.3	3.9	3.5	4.2	6.0	2.9	6.2	4.6	4.6	1.7
Repair	30.0	27.2	22.5	22.9	22.1	19.5	17.9	17.2	13.8	12.8	14.8	12.0	--	--	--	--	--	--	--
Envir Compl & Rest. Program	32.0	30.0	26.0	23.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Rehab & Mods *	32.9	35.0	31.2	31.5	29.8	24.3	21.5	21.4	18.9	17.6	17.3	19.7	14.1	18.9	17.8	23.0	14.8	14.8	11.6
Space Station Facilities	12.0	49.1	--	--	12.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Shuttle Facilities	165.5	121.2	66.1	17.2	6.9	36.1	37.6	49.2	28.1	32.8	9.9	27.9	30.9	64.7	30.3	46.6	76.5	56.5	27.8
Shuttle Payload Facility	--	--	--	--	--	3.8	6.7	13.2	1.7	--	1.5	4.3	--	7.3	4.4	--	--	--	--
Unallocated Plans & Design	--	--	--	--	--	--	--	--	0.5	--	--	--	--	--	--	--	--	--	--
Aero. Facils Revitalization	32.6	55.5	46.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Advanced Launch System Fac.	--	--	15.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Trust Fund	--	--	15.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Water Shield Facility	3.0	2.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Future Software Program	4.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Earth Science Info Network	1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
JSC Visitor Center	10.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Deferred Rehab & Major Maint.	20.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL PROGRAM	497.9	413.6	286.8	179.6	169.5	144.1	160.0	158.4	101.4	95.3	140.8	156.6	146.3	161.4	117.8	92.5	141.7	100.6	78.5
Approp Trans & Adjust	0.0	187.7	3.3	-1.3	299.8	-10.8	-10.0	-2.9	-3.9	0.5	-25.8	-0.5	1.2	-0.5	0.3	0.4	-1.5	0.5	-1.2
Approp & Availability	497.9	601.3	290.1	178.3	469.3	133.3	150.0	155.5	97.5	95.8	115.0	156.1	147.5	160.9	118.1	92.9	140.2	101.1	77.3

*Included in Various Locations Prior to FY 1972.

Construction of Facilities Funding

(In Millions of Dollars)

As of 30 Sep 91

	FY 72	FY 71	FY 70	FY 69	FY 68	FY 67	FY 66	FY 65	FY 64	FY 63	FY 62	FY 61	FY 60	FY 59
Ames Research Center	6.5	1.1	0.3	0.4	4.2	--	2.8	5.8	11.3	14.3	6.3	0.6	6.1	3.8
Dryden Flight Research Facility	--	--	0.9	--	--	--	--	--	2.5	1.8	--	--	1.8	--
Electronics Research Center	--	--	--	--	--	7.4	5.2	10.4	1.6	--	--	--	--	--
Goddard Space Flight Center	0.7	1.4	0.7	--	0.6	0.7	2.4	2.3	17.7	21.3	11.5	9.4	14.0	3.9
Jet Propulsion Laboratory	--	1.9	--	--	3.1	0.3	0.9	3.6	3.0	11.4	3.6	8.6	7.7	--
Johnson Space Center	--	1.1	--	0.9	0.6	11.8	4.0	17.3	33.9	24.5	--	--	--	--
Kennedy Space Center	15.6	0.3	10.5	7.4	20.4	34.6	7.2	87.8	273.4	332.8	115.6	27.8	4.0	--
Langley Research Center	--	0.6	5.6	--	--	6.4	8.4	3.3	9.7	9.8	6.9	12.3	4.5	10.8
Lewis Research Center	0.8	0.7	0.3	--	2.1	16.2	0.9	0.8	20.4	45.5	1.1	9.6	6.6	8.0
Marshall Space Flight Center	--	1.3	--	--	0.9	--	1.8	12.0	28.2	40.5	30.7	26.1	--	--
Michoud Assembly Facility	--	--	--	0.4	0.5	0.5	0.3	6.2	7.3	28.5	--	--	--	--
Stennis Space Center	--	--	1.4	--	--	--	--	58.4	102.9	77.1	--	--	--	--
Nuclear Rocket Dev Station	--	--	--	--	--	--	--	--	4.1	11.5	--	--	--	--
Pacific Launch Operations	--	--	--	--	--	--	--	0.3	--	--	0.6	0.4	1.1	--
Wallops Flight Facility	--	--	0.5	0.5	0.7	0.2	1.0	1.7	0.5	4.1	11.3	2.0	--	16.1
Various Locations	0.7	22.5	26.4	20.8	3.5	6.5	15.1	28.3	211.5	129.9	159.0	28.0	52.4	5.1
Facility Planning & Design	3.5	5.4	3.5	1.0	5.4	5.4	5.0	8.8	10.4	12.9	9.8	--	--	--
Rehab & Mods *	7.9	(17.5)	--	--	--	--	--	--	--	--	--	--	--	--
Shuttle Facilities	18.3	--	--	--	--	--	--	--	--	--	--	--	--	--
Other	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL PROGRAM	54.0	36.3	50.1	31.4	42.0	90.0	55.0	247.0	738.4	765.9	356.4	124.8	98.2	47.7
Approp Trans & Adjust	-1.3	-11.3	3.1	-9.6	-6.1	-7.1	5.0	15.9	-58.4	10.3	-40.4	-2.0	-13.6	0.3
Appropr & Availability	52.7	25.0	53.2	21.8	35.9	82.9	60.0	262.9	680.0	776.2	316.0	122.8	84.6	48.0

*Included in Various Locations Prior to FY 1972

Research and Program Management Funding

(In Millions of Dollars)

1/	FY 91	FY 90	FY 89	FY 88	FY 87	FY 86	FY 85	FY 84	FY 83	FY 82	FY 81	FY 80	FY 79	FY 78	FY 77	76/TQ	FY 75	FY 74	FY 73
Headquarters	283.00	259.00	255.20	205.60	142.50	124.00	122.20	114.00	111.90	115.90	96.40	88.70	84.60	83.40	78.40	93.50	68.90	63.00	61.20
Ames Research Center	211.50	187.90	178.30	165.30	134.00	123.50	122.30	114.90	107.20	76.60	72.20	67.40	62.80	57.70	53.10	63.90	48.60	46.40	42.40
Dryden Flight Research Fac.			--	--	--	--	--	--	--	24.40	22.60	20.20	18.90	18.20	17.20	19.70	13.20	12.20	11.70
Goddard Space Flight Center	304.90	266.50	255.90	244.00	216.10	200.50	198.30	191.40	183.90	169.10	142.50	133.70	127.80	123.50	114.30	136.60	104.80	97.30	95.70
Kennedy Space Center	299.60	277.90	269.90	243.40	200.00	192.20	185.10	176.40	164.90	156.00	150.20	135.50	126.40	116.30	110.10	128.00	95.90	94.40	92.40
Langley Research Center	214.60	198.70	188.70	178.50	153.70	145.00	147.60	139.20	132.70	126.60	120.80	113.80	106.60	100.70	94.70	115.70	88.60	83.30	78.60
Lewis Research Center	230.30	206.30	196.40	181.90	151.70	143.10	137.40	128.50	118.80	106.40	99.90	94.80	87.50	84.70	83.30	102.40	80.30	79.60	81.20
Johnson Space Center	346.00	325.20	302.70	283.30	228.00	206.90	216.10	201.90	195.20	230.50	176.30	164.70	153.00	146.20	139.10	165.20	121.30	117.60	110.60
Marshall Space Flight Center	293.70	276.80	256.00	239.90	213.10	195.00	199.70	190.90	184.30	172.10	165.30	156.60	149.00	143.60	140.20	170.00	129.10	137.50	137.20
Stennis Space Center	28.30	25.10	23.50	20.60	12.40	11.20	10.70	6.30	6.60	5.50	4.90	2.80	1.30	0.10	0.70	0.50	1.60	--	--
Station 17			--	--	--	-0.10	-7.60	-7.60	-8.10	--	--	--	--	--	--	--	--	--	--
Space Nuclear Sys Office			--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.10	--
Wallops Flight Facility			--	--	--	--	--	--	--	--	20.00	17.80	15.90	15.10	13.30	17.00	12.40	11.60	10.80
TOTAL PROGRAM	2,211.90	2,023.40	1,926.50	1,763.00	1,451.50	1,341.30	1,331.80	1,255.90	1,197.40	1,183.10	1,071.10	996.00	933.80	889.50	844.40	1,012.50	764.70	744.00	
Lapsed Unoblig Bal	0.30		--	--	1.00	0.20	0.50	0.20	--	0.20	0.30	0.20	0.30	0.30	0.30	0.60	0.20	0.60	7.60
Approp Trans & Adjust	-0.30	-41.20	-71.60	-266.90	-27.50	20.50	--	--	--	--	--	--	--	--	--	--	-4.90	--	--
Appropriation	2,211.90	1,982.20	1,996.20	1,495.70	1,425.00	1,362.00	1,332.30	1,256.10	1,197.40	1,183.30	1,071.40	996.20	934.10	889.80	844.60	1,013.10	760.00	744.60	729.40

1/ Includes NASA Pasadena Office

Research and Program Management Funding

(In Millions of Dollars)

	FY 72	FY 71	FY 70	FY 69	FY 68	FY 67	FY 66	FY 65	FY 64	FY 63	FY 62	FY 61	FY 60	FY 59
Headquarters (1)	61.60	64.90	63.20	60.80	57.10	57.40	54.40	69.30	56.10	51.30	26.00	13.90	8.50	5.70
Ames Research Center	42.20	40.60	37.60	34.00	33.80	33.80	33.20	31.80	26.90	25.60	22.90	19.90	17.80	16.30
Electronics Research Center (2)	–	–	19.10	17.20	15.40	12.20	8.40	3.20	0.50	–	–	–	–	–
Dryden Flight Research Center	11.70	11.10	10.30	9.70	9.50	9.50	9.40	10.50	9.40	7.50	7.20	5.10	4.30	3.30
Goddard Space Flight	96.50	93.10	86.40	73.20	68.30	71.10	64.40	93.30	61.90	52.80	39.10	20.40	15.50	1.80
Kennedy Space Center	92.80	98.30	97.50	95.80	93.10	92.70	82.00	40.80	26.80	18.80	6.40	–	–	–
Langley Research Center	80.20	75.30	69.80	63.00	62.20	64.30	63.50	59.00	52.10	51.80	46.60	39.10	33.00	31.40
Lewis Research Center	82.50	78.00	73.90	67.90	66.20	66.30	66.40	69.30	58.50	53.40	45.20	35.80	31.20	27.90
Johnson Space Center	113.00	111.10	106.60	96.90	95.70	95.70	86.50	88.70	64.70	51.00	34.10	9.20	–	–
Marshall Space Flight Center	138.90	145.10	125.70	116.30	126.20	128.70	128.40	138.70	124.30	112.60	89.20	68.60	5.10	–
Pacific Launch Operations	–	–	–	–	–	–	0.60	0.90	0.90	0.60	0.10	–	–	–
Space Nuclear Systems Office	2.20	2.40	2.30	2.10	2.00	2.00	1.80	1.70	1.50	1.00	0.30	–	–	–
Western Support Office	–	–	–	–	1.00	3.20	4.90	5.00	4.40	3.40	1.40	5.70	0.50	–
Wallops Flight Facility	10.90	10.30	9.70	9.10	8.80	9.70	9.30	11.10	8.80	8.90	7.10	5.00	2.70	1.30
TOTAL PROGRAM	732.30	730.20 (3)	702.20	648.00	638.30	646.60	611.20	623.30	486.80	438.70	315.60	222.70	118.60	87.60
	0.30	0.20	0.40	0.10	0.10	0.90	0.60	–	–	–	–	–	–	–
Approp Trans & Adjust	2.10	-7.70	-12.60	-44.90	-11.40	-7.50	-27.80	0.20	-2.80	–	–	–	–	–
Appropriation	734.70	722.70	690.00	603.20	628.00	640.00	584.00	623.50	484.00	438.70	315.60	222.70	118.60	87.60

1/Includes NASA Pasadena Office
2/ERC was closed on June 30, 1970
3/Includes $10 million for basic institutional and other requirements for agencies resident at MTF/Slidell
Pacific Launch Operations (PLO)
Space Nuclear Systems Office (SNSO)
Western Support Office (WSO)

Personnel Summary

Onboard At End Of Fiscal Year*	FY59	FY60	FY61	FY62	FY63	FY64	FY65	FY66	FY67	FY68	FY69	FY70	FY71	FY72
Headquarters	429	587	735	1,477	2,001	2,158	2,135	2,336	2,373	2,310	2,293	2,187	1,895	1,755
Ames Research Center	1,464	1,421	1,471	1,658	2,116	2,204	2,270	2,310	2,264	2,197	2,117	2,033	1,968	1,844
Dryden Flight Research Facility (1)	340	408	447	538	616	619	669	662	642	622	601	583	579	539
Electronics Research Center	--	--	--	--	25 (a)	33 (a)	250	555	791	950	951	592	--	--
Goddard Space Flight Center	398	1,255	1,599	2,755	3,487	3,675	3,774	3,958	3,997	4,073	4,295	4,487	4,459	4,178
Kennedy Space Center	--	--	--	399	1,181	1,625	2,464	2,669	2,867	3,044	3,058	2,895	2,704	2,568
Langley Research Center	3,624	3,203	3,338	3,894	4,220	4,330	4,371	4,485	4,405	4,219	4,067	3,970	3,830	3,592
Lewis Research Center	2,809	2,722	2,773	3,800	4,697	4,859	4,897	5,047	4,956	4,583	4,399	4,240	4,083	3,866
Johnson Space Center	--	in GSFC	794	1,786	3,345	4,277	4,413	4,889	5,064	4,956	4,751	4,539	4,298	3,935
Marshall Space Flight Center	--	370	5,948	6,843	7,332	7,679	7,719	7,740	7,602	6,935	6,639	6,325	6,060	5,555
NASA Pasadena Office	--	--	--	--	--	-- (b)	19	85	91	79	80	72	44	40
Pacific Launch Operations Office	--	--	--	--	17	22	21	-- (c)	--	--	--	--	--	--
Space Nuclear Systems Office	--	--	4	39	96	112	116	115	113	108	104	103	89	45
Stennis Space Center	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Wallops Flight Facility (2)	171	229	302	421	493	530	554	563	576	565	554	522	497	465
Western Support Office	--	37	60	136	308	376	377	294	119	-- (d)	--	--	--	--
Total	9,235	10,232	17,471	23,696	29,934	32,499	34,049	35,708	35,860	34,641	33,929	32,548	30,506	28,382

	FY73	FY74	FY75	FY76	FY77	FY78	FY79	FY80	FY81
Headquarters	1,747	1,734	1,673	1,708	1,619	1,606	1,534	1,658	1,638
Ames Research Center	1,740	1,776	1,754	1,724	1,645	1,691	1,713	1,713	1,652
Dryden Flight Research Facility	509	531	544	566	546	514	498	499	491
Electronics Research Center	--	--	--	--	--	--	--	--	--
Goddard Space Flight Center	3,852	3,936	3,871	3,808	3,666	3,641	3,562	3,535	3,431
Kennedy Space Center	2,516	2,408	2,377	2,404	2,270	2,234	2,264	2,291	2,224
Langley Research Center	3,389	3,504	3,472	3,407	3,207	3,167	3,125	3,094	3,028
Lewis Research Center	3,368	3,172	3,181	3,168	3,061	2,964	2,907	2,901	2,782
Johnson Space Center	3,896	3,886	3,877	3,796	3,640	3,617	3,563	3,616	3,498
Marshall Space Flight Center	5,287	4,574	4,337	4,336	4,014	3,808	3,677	3,646	3,479
NASA Pasadena Office	39	39	35	--	--	--	--	--	--
Pacific Launch Operations Office	--	--	--	--	--	--	--	--	--
Space Nuclear Systems Office	--	--	--	--	--	--	--	--	--
Stennis Space Center	--	--	76	72	94	108	108	111	113
Wallops Flight Facility	434	447	441	437	426	429	409	406	400
Western Support Office	--	--	--	--	--	--	--	--	--
Total	26,777	26,007	25,638	25,426	24,188	23,779	23,360	23,470	22,736

NOTES:

* Includes Other Than Permanent

(1) Included in ARC After FY 1981
(2) Included in GSFC After FY 1981

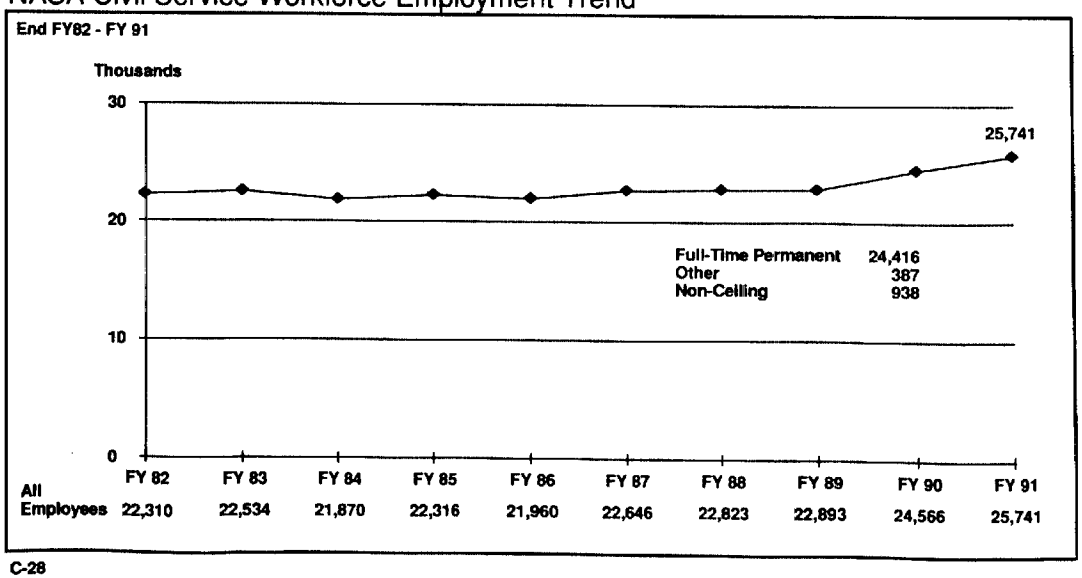
(a) Figures for North Eastern Office
(b) Prior Years Figures Included in WSO
(c) Effective in 1966, PLOO Activity Was Merged Under KSC
(d) Effective in 1968, WSO Was Disestablished and Elements Merged With NaPO

Personnel Summary

Year-End Strength

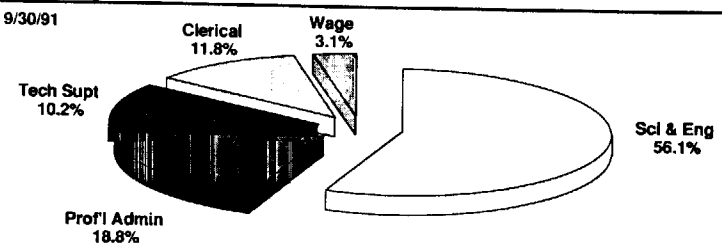
	FY82	FY83	FY84	FY85	FY86	FY87	FY88	FY89	FY90	FY91
Headquarters	1,431	1,492	1,396	1,383	1,362	1,532	1,653	1,727	1,966	2,092
Ames Research Center	2,041	2,033	2,043	2,052	2,072	2,079	2,101	2,151	2,205	2,263
Langley Research Center	2,485	2,632	2,624	2,715	2,598	2,663	2,649	2,749	2,728	2,835
Lewis Research Center	2,801	2,904	2,821	2,827	2,814	2,851	2,840	2,864	2,961	2,969
Total OAST	7,327	7,569	7,488	7,594	7,484	7,593	7,590	7,764	7,894	8,067
Goddard Space Flight Center/OSSA	3,621	3,668	3,541	3,629	3,679	3,648	3,626	3,735	3,873	3,999
Marshall Space Flight Center	3,332	3,351	3,223	3,284	3,260	3,384	3,340	3,609	3,619	3,788
Stennis Space Center	103	106	108	122	123	137	147	183	192	222
Johnson Space Center	3,268	3,235	3,227	3,330	3,269	3,349	3,399	3,578	3,615	3,677
Kennedy Space Center	2,104	2,084	2,067	2,081	2,051	2,188	2,236	2,423	2,466	2,571
Total OSF	8,807	8,776	8,625	8,817	8,703	9,058	9,122	9,793	9,892	10,258
NASA Permanent	**21,186**	**21,505**	**21,050**	**21,423**	**21,228**	**21,831**	**21,991**	**23,019**	**23,625**	**24,416**
Other Than Permanent	1,124	1,029	820	893	732	815	832	874	941	1,325
NASA Total	**22,310**	**22,534**	**21,870**	**22,316**	**21,960**	**22,646**	**22,823**	**23,893**	**24,566**	**25,741**

NASA Civil Service Workforce Employment Trend



Occupational Summary

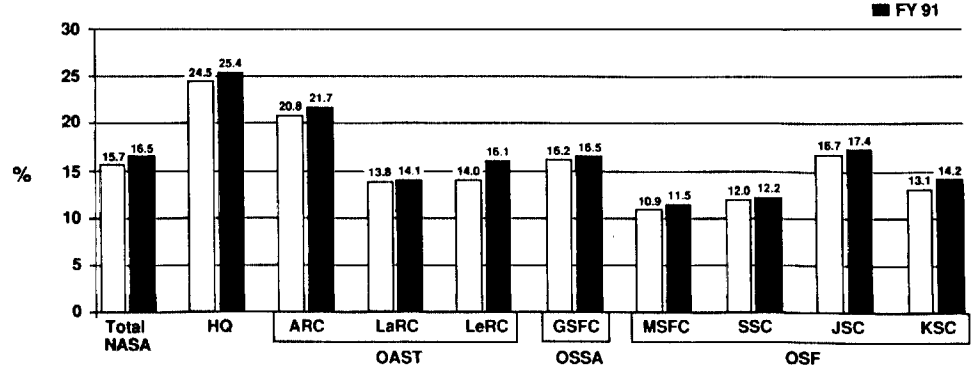
Permanent Personnel - 9/30/91



Occupation	Total NASA	HQ	OAST ARC	OAST LaRC	OAST LeRC	OSSA GSFC	OSF MSFC	OSF SSC	OSF JSC	OSF KSC	JPL
S&E	13,694	590	1,212	1,443	1,612	2,240	2,514	128	2,402	1,553	3,834
Prof'l Admin	4,579	1,047	364	308	301	819	620	55	649	416	909
Clerical	2,881	447	221	275	237	439	476	37	430	319	624
Tech. Support	2,494	6	150	933	327	433	178	2	188	277	435
Wage System	768	2	316	10	358	68	0	0	8	6	399
Total	24,416	2,092	2,263	2,969	2,835	3,999	3,788	222	3,677	2,571	6,201

Minorities as Percent of Permanent Employees

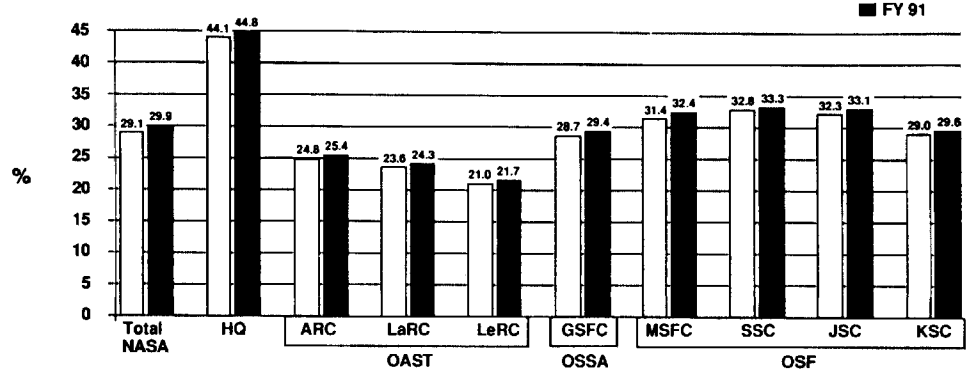
By Installation



Total Minorities	Total NASA	HQ	ARC	LaRC	LeRC	GSFC	MSFC	SSC	JSC	KSC
FY 91	4,025	532	491	418	456	661	435	27	641	364
FY 90	3,706	482	459	410	381	629	396	23	604	322
FY 82	2,433	301	327	305	213	455	183	7	420	177

Women as Percent of Permanent Employees

By Installation



Total Women	Total NASA	HQ	ARC	LaRC	LeRC	GSFC	MSFC	SSC	JSC	KSC
FY 91	7,301	938	574	721	615	1,176	1,226	74	1,216	761
FY 90	6,881	867	547	699	572	1,112	1,138	63	1,167	716
FY 82	4,620	568	402	515	384	834	695	31	705	486