NASA Pocket Statistics

1997 Edition

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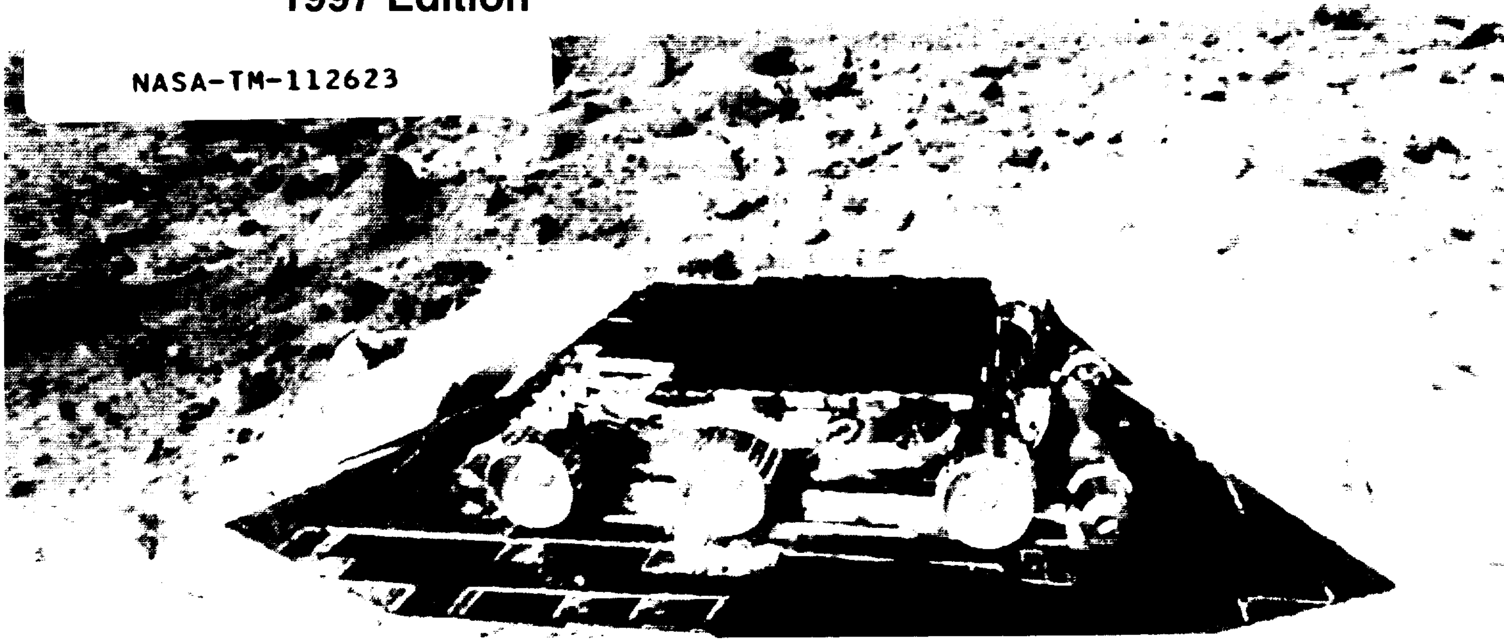

About the cover:

Mars Pathfinder on the Surface in Ares Vallis Region of Mars

In this first color panorama mosaic, the Sojourner rover sits on a solar panel of the *Sagan Memorial Station* (the lander) waiting for the command to roll off onto the Martian surface. Pathfinder landed July 4, 1997.

Foreword

POCKET STATISTICS is published by the NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA). Included in each edition is Administrative and Organizational information, summaries of Space Flight Activity including the NASA Major Launch Record, Aeronautics and Space Transportation and NASA Procurement, Financial and Workforce 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. All Satellites deployed from the cargo bay of the Shuttle and placed in a separate orbit or trajectory are counted as an additional payload. For a yearly breakdown of charts shown by decade, refer to the issues of POCKET STATISTICS published prior to 1995. Changes to this book may be made to Ron Hoffman at, (202) 358-1596, or E-mail; rhoffman@hq.nasa.gov

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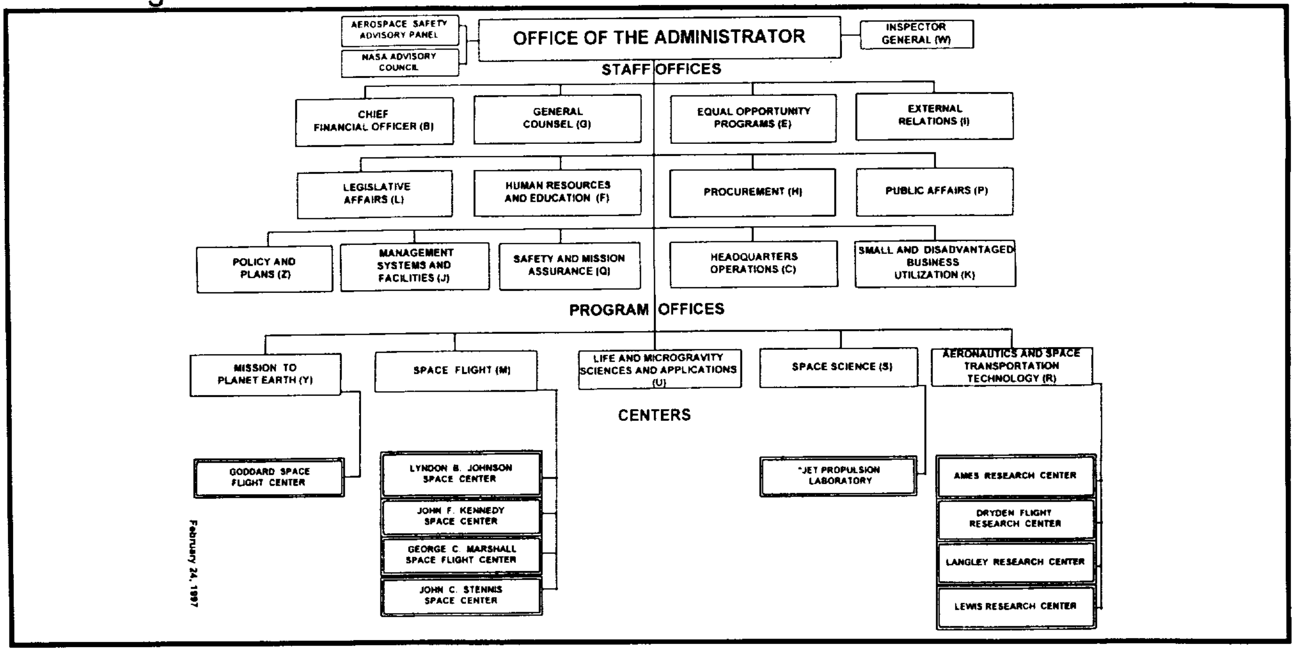
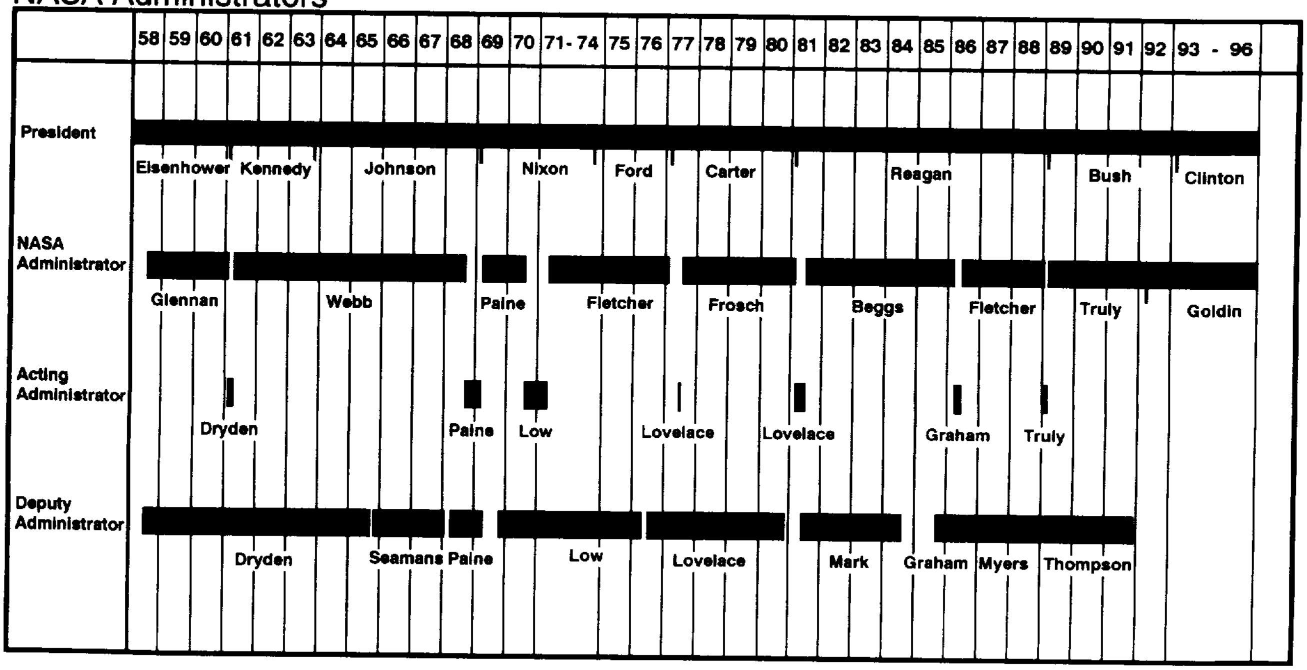
Section A

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 the Earth and 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;

Declaration Of Policy And Purpose (Continued)

(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

(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.

(h) It is the purpose of this Act to carry out and effectuate the policies declared in subsections (a), (b), (c), (d), (e), (f), and (g).

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;

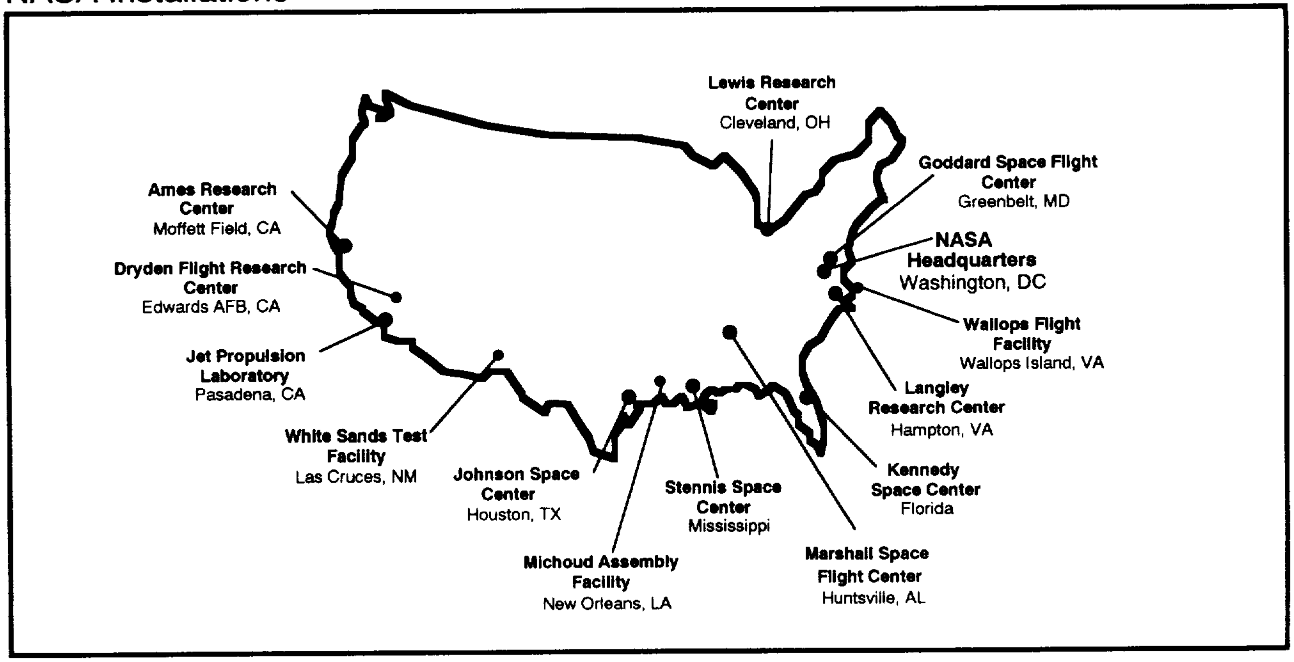
(2) arrange for participation by the scientific community in planning scientific measurements and observations to be made through use of aeronautical and space vehicles, and conduct or arrange for the conduct of such measurements and observations; and

(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 as are provided for in sections 4 through 10 of the Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976.

(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) as are provided for in sections 5, 6 and 9 of the Solar Heating and Cooling Demonstration Act of 1974.

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.

Management of NASA's research and development programs is the responsibility of program offices which report to and receive overall guidance and direction from an associate administrator.

AMES RESEARCH CENTER
Moffett Field, CA 94035

Ames Research Center's 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, solar systems exploration, airborne science and applications and infrared astronomy.

Ames is home to more than a dozen major wind tunnels, including the world's largest; several advanced flight simulators, a variety of supercomputers, including some of the world's fastest, and several unique aircraft -- both fixed-wing and rotocraft -- used for aeronautical flight research and for flying laboratories. It also includes a variety of unique facilities for life sciences research.

Through its research efforts, the center supports military programs, the Space Shuttle and various civil aviation projects. These projects and responsibilities will continue to evolve as NASA's needs change and Ames' capabilities develop.

HUGH L. DRYDEN FLIGHT RESEARCH CENTER
Edwards, CA 93523

The Dryden Flight Research Center was named after Hugh L. Dryden, an internationally known aeronautical scientist. In 1946, he was appointed NACA's Director of Aeronautical Research, and was responsible for making the center a permanent facility in 1947. His vision was "to separate the real from the imagined problems and to make known the overlooked and the unexpected problems."

Dryden acts as the flight arm of NASA's aeronautics enterprise. Dryden is the "Center of Excellence" for atmospheric flight operations and its primary mission is flight research. Dryden's charter is to research, develop, verify and transfer advanced aeronautics, space, and related technologies.

Dryden's primary research tools are research aircraft. The center operates approximately 20 flight research aircraft consisting of SR-71s, F-15s, F-16s, F-18s and a B-52. Experimental aircraft types vary greatly, ranging from the SR-71s that fly at speeds of Mach 3 to the Pathfinder solar powered Remotely Powered Aircraft(RPA) that flies at 25mph.

The center's ground-based facilities complement Dryden's flight research mission and include a highly-developed aircraft flight instrumentation capability; a data analysis facility for processing of flight research data; flight simulators and a test range communications and data transmission capability that links NASA's Western Aeronautical Test Range facilities.

Dryden continues to serve as the "back-up" landing site for the Space Shuttle Orbiters as well as processing the vehicles for ferry flights back to the Kennedy Space Center.

GODDARD SPACE FLIGHT CENTER
Greenbelt, MD 20771

This NASA field center, 10 miles northeast of Washington, DC, has one of the worlds leading groups of scientists, engineers and administrative managers. It has the largest scientific staff of all the NASA centers.

With its more than 12,000 civil service and contract employees, including its facility at Wallops Island, VA, the center's work includes research in the Earth and space sciences and the design, fabrication and testing of scientific satellites that survey the Earth and the universe. Goddard also has a leading role in tracking satellites and suborbital space vehicles.

Controllers in the Payload Operations Control Center maintain a 24-hour vigil every day of the year for more than a dozen orbiting spacecraft. Spacecraft being watched include Tracking and Data Relay Satellites which serve as vital communications links between orbiting spacecraft and Earth through a Goddard-managed ground terminal in White Sands, NM. One of those spacecraft is the world renowned Hubble Space Telescope which was launched in 1990. Other more recent payloads which remain under the watchful eyes of Goddard controllers include: Polar, Rossie X-ray Timing Explorer and the Solar and Heliospheric Observatory.

The Compton Gamma Ray Observatory, launched in April 1991, also is managed by Goddard. Compton's mission is to study gamma ray emitting objects in the Milky Way galaxy and beyond. Within its first three months of operation, the Energetic Gamma Ray Experiment Telescope, one of four instruments aboard Compton, detected one of the most luminous gamma-ray sources ever seen. The source of this radiation was identified with the variable Quasar 3C279 located in the constellation Virgo, approximately seven billion light years from Earth.

JET PROPULSION LABORATORY
Pasadena, CA 91109

The laboratory is engaged in exploring the Earth and the solar system with automated spacecraft. In addition to the Pasadena site, JPL manages the Deep Space Communications Complex, a station of the Worldwide Deep Space Network (DSN) located at Goldstone, CA, on 40,000 acres of land occupied under permit from the U.S. Army. The DSN allows for spacecraft communications, data aquisition and mission control, and for the study of space with radio science.

Current NASA flight projects under JPL management include Galileo, Mars Pathfinder and Mars Global Surveyor, New Millennium, Stardust, TOPEX/ Poseidon, Ulysses, Voyager and the planned Cassini mission. Major space science instruments include the second-generation Wide Field and Planetary Camera-2 for the Hubble Space Telescope, the NASA Scattometer and the Spaceborne Imaging Radar. The laboratory designs flight systems, including complete spacecraft and provides technical direction to contractor organizations.

The laboratory conducts research in a variety of fields, including microelectronics, biomedical and communications technologies, information and advanced computer systems.

LYNDON B. JOHNSON SPACE CENTER
Houston, TX 77058

JSC manages the selection and training of astronauts for Space Shuttle and future Space Station missions. All U.S. human space flights, from launch to landing, are controlled from the Mission Control Center at JSC, a new flight control Center at JSC. A new flight control facility came on line in 1995 and will replace the historic control rooms used since the Gemini program.

JSC manages a fleet of specialized aircraft at Ellington Field, located about seven miles north of the Center, used in training Shuttle pilot astronauts and for microgravity research. JSC also operates the White Sands Missile Range at Las Cruces, NM. WSTF tests Shuttle propulsion systems, powers systems and materials.

JSC is NASA's lead center for life science research, working with medical researchers around the country to study the effects of spaceflight on astronauts and to develop countermeasures that also have applications on Earth. JSC is teaming with researchers from academia and the private sector to form a Biomedical Science Institute, a world class life science research center for human space flight located in the Houston area.

Many of the facilities at JSC contain equipment unique to human space flight programs. Astronauts use the Mockup and Integration Laboratory to become familiar with the Shuttle and Space Station crew environments, to practice emergency procedures, and to rehearse on-orbit tasks. The Manipulator Development Facility employs a hydraulic robotic arm to allow astronauts to practice the precise on-orbit movements required of Shuttle's robotic arm during payload deployment and spacewalks.

Space Shuttle simulators provide realistic training for all phases of flight. The motion base simulator, a duplicate of the Orbiter flight deck, recreates the sights, sounds and feel of launch and entry. The fixed base simulator provides training for on-orbit activities.

The Weightless Environment Training Facility is a large water tank that uses neutral buoyancy to help astronauts practice for spacewalks. This facility will soon be augmented by a much larger Neutral Buoyancy Laboratory which will hold major Space Station components.

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

The Kennedy Space Center was established in the early 1960s as the launch site for the Apollo lunar landing missions. KSC pioneered the mobile launch technique in which space vehicles are built up inside protective structures and moved to their launch pads a short time before launch, reducing their exposure to the corrosive sea shore environment to a minimum.

After the Apollo program was concluded in 1972, KSC's Complex 39 was used for the launch of four Skylab missions and for the Apollo spacecraft used in the Apollo-Soyuz Test Project. The center's facilities were modified for the Space Shuttle program during the 1970s. The shuttle era began with the launch of the STS-1 mission on April 12, 1981. Since then, more than 75 Shuttle missions have been launched and the current forecast calls for the launch of approximately seven missions per year from KSC's twin pads.

KSC is NASA's prime center for the test, checkout and launch of payloads and space vehicles. This includes launch of manned vehicles at KSC and oversight of NASA missions launched on unmanned vehicles from Cape Canaveral Air Station, FL, and Vandenberg Air Force Base (VAFB) in California.

The Center is responsible for the assembly, checkout and launch of Space Shuttle vehicles and their payloads, landing operations and turn-around of Shuttle Orbiters between missions. KSC also is responsible for the operation of the KSC Vandenberg Launch Site Resident Office located at VAFB.

LANGLEY RESEARCH CENTER
Hampton, VA 23665-5225

Langley's primary 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 non-destructive evaluation.

Approximately 60 percent of Langley's efforts are in aeronautics, working to improve today's aircraft and to develop concepts and technology for future flight. Over 40 wind tunnels, other unique research facilities and testing techniques aid in the investigation of the full range-from general aviation and transport aircraft through hypersonic vehicles.

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.

Researchers are studying improved flight control systems to aid aircraft in operating more efficiently in all kinds of weather and in crowded terminal airways.

Langley is lead center for management of the agency's technology development program for the future High Speed Civil Transport progam. Langley will manage high-speed technology in areas of aerodynamic performance, airframe materials and structures, the flight deck and airframe systems integration. Improvements in supersonic (Mach 1-5) engine performance, fabrication of composite materials and laminar flow airfoil technology are spawning a new era in long-distance air travel. Passengers in the next century will benefit from current research programs at Langley.

LEWIS RESEARCH CENTER
Cleveland, OH 44135

In 1941 the National Advisory Committee for Aeronautics (NACA) established the NASA Lewis Research Center as a flight propulsion laboratory. The Center, which was named for George W. Lewis, NACA's Director of Research from 1924 to 1947, developed an international reputation for its research on jet propulsion systems.

Lewis mission involves aeropropulsion, space power, space communications, electric propulsion and microgravity science, including fluid physics, combustion and materials. In addition, Lewis is a supporting Center for chemical propulsion and expendable launch vehicles.

The Center conducts research for NASA's High-Speed Research Program in the areas of combustor design and enabling propulsion materials; for the Advanced Subsonic Technology Program and is advancing technologies to support advance short take-off and vertical landing aircraft; is managing the Advanced Communications Technology Satellite; and is playing a role in NASA's program to enable more effective access to Earth orbit and geosynchronous orbit.

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

Facilities at Lewis include a Space Experiments Lab, Zero-Gravity Drop Tower, Aero-Acoustic Propulsion Laboratory, an Icing Research Tunnel, four (4) unique wind tunnels, space tanks, chemical rocket thrust stands, and chambers for testing jet engine efficiency.

MARSHALL SPACE FLIGHT CENTER
Marshall Space Flight Center, AL 35812

Marshall is NASA's lead center for space transportation systems development and is the agency's center of excellence for space propulsion. Marshall is also NASA's lead center for microgravity, specializing in materials science and biotechnology research.

Marshall led the development of the main propulsion system for the Space Shuttle and for each flight provides the main engines, the external tank that carries liquid oxygen and liquid hydrogen for those engines, and the solid rocket boosters that, together with the engines, lift the Shuttle into orbit.

Additionally, Marshall is managing development of the super light-weight External Tank, planned to replace the current external tank in 1997. It is being fabricated of aluminum alloys and incorporates an orthogrid design for the panels that together make the tank 8,000 pounds lighter than the current configuration.

Marshall is NASA's host center for the Reusable Launch Vehicle (RLV) technology program, a partnership among NASA, the United States Air Force and private industry to conduct cutting-edge research needed to develop a new generation of single-stage-to-orbit launch vehicles. It includes the X-33 advanced technology demonstrator, the X-34 small technology vehicle, and the Delta Clipper-Experimental Advanced (DC-XA) single-stage rocket.

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Marshall is a manager of scientific payloads and experiments to be flown aboard the Shuttle. Many of these payloads to be flown in Spacelab, a reusable, modular research facility carried in the Shuttle's cargo bay. The center also operates NASA's Spacelab Mission Operations Control Center, from which all NASA Spacelab missions are controlled.

To prepare astronauts for Spacelab missions, the center also operates a Payload Crew Training Complex. Here, science astronauts train in Shuttle an Spacelab simulators to conduct the research they will perform in space.

A designated NASA center of excellence in space optical systems, Marshall is managing the Advanced X-ray Astrophysics Facility, a major astronomy observatory that will provide scientists with roughly a ten-fold improvements in resolving power over previous X-ray telescopes. The center previously managed development and initial checkout of the Hubble Space Telescope which is now relaying a wealth of new knowledge about the universe from distant galaxies to neighboring planets.

Other work assigned to Marshall includes the International Space Welding Experiment being jointly developed with Ukraine. Scheduled to fly aboard the Space Shuttle, the experiment will test a Ukranian Universal hand Tool electron beam welding system as a potential technology for contingency space repairs.

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

NASA's John C. Stennis Space Center (SSC), located near the Mississippi Gulf Coast, is NASA's primary center for testing and flight certifying large rocket propulsion systems for the Space Shuttle and future generations of space vehicles. Because of its important role in engine testing for more than three decades, Stennis Space Center has been designated NASA's Center of Excellence for rocket propulsion testing. SSC will be responsible for the Agency's rocket propulsion test programs. The center is a unique test facility and is available to support the national interest in propulsion systems development testing. Additionally, the center has developed into a scientific community actively engages in research and development programs involving space, oceans and Earth.

Since 1975, SSC's primary mission has been the testing of Space Shuttle Main Engines to include research and development testing and flight acceptance testing, Static testing is conducted on the same concrete and steel stands used from 1966 to 1970 to captive-fire all first and second stages of the Saturn V rocket used in the Apollo manned lunar landing and Skylab programs.

Stennis Space Center is working toward testing advances space propulsion hardware for future vehicles. Preparations are under way at Stennis for testing associated with the Reusable Launch Vehicle and Evolved Expendable Launch Vehicle programs. These two new programs are being designed by the aerospace industry, which is working with NASA and the Department of Defense to make space launch more accessible and affordable.

WALLOPS FLIGHT FACILITY
Wallops Island, VA 23337

Wallops Flight Facility, a part of the Goddard Space Flight Center, is one of the oldest launch sites in the world. Established in 1945, the facility covers 6,166 acres, including about 1,100 acres of marshland, in three separate areas of marshland, in three separate areas of Virginia's Eastern Shore.

Wallops manages and implements NASA's sounding rocket program which uses solid-fueled launch vehicles to accomplish approximately 30 scientific, suborbital missions each year. Launches are conducted at Wallops and other ranges worldwide.

Wallops manages and coordinates NASA's Scientific Balloon Program using thin-film, helium-filled balloons to provide approximately 30 scientific missions each year. Launches are conducted at Palestine, TX, Ft. Sumner, NM, and sites throughout the world.

Wallops supports NASA, the Department of Defense and other agencies in aeronautical research. Approximately 150-200 test operations, concentrating on aircraft/airport interface and aircraft operating problems research, are conducted each year at the research airport.

DISCOVERIES AND NEW CHALLENGES FOR NASA

A rock, a record, a rover and a new rocket were among the top NASA stories for 1996. Background material, video and still images are available to news media to illustrate these stories, with supporting material also available via the Internet and the World Wide Web.

LIFE ON MARS? TANTALIZING CLUES FROM AN ANCIENT ROCK

In an announcement that caused all humankind to take pause, NASA Administrator Daniel S. Goldin and a team of scientists revealed in August that a meteorite from Mars strongly suggested that primitive life may have existed on that planet more than 3 billion years ago. In a press conference at NASA Headquarters, a research team showed the world pictures of the first organic molecules thought to be of Martian origin; several features characteristic of biological activity, and possible microscopic fossils of primitive, bacteria-like organisms inside the ancient meteorite. In vowing to pursue the investigation of this historic discovery, Goldin said "The evidence is exciting , even compelling, but not conclusive. It is discovery that demands further scientific investigation. NASA is ready to assist the process of rigorous scientific investigation and lively scientific debate that will follow this discovery." Goldin invited governments from around the globe to participate in the continuing investigation of the meteorite.

LUCID SETS U.S. RECORD FOR STAY IN SPACE

Astronaut Dr. Shannon Lucid set a new record for an American living in space and broke the world's record for a woman living in space by spending 181 days aboard the Russian Mir Space Station. Lucid, who conducted microgravity and life sciences experiments aboard the Mir with two Russian cosmonauts, returned to Earth aboard Space Shuttle Atlantis in November. President Clinton presented Lucid with the Congressional Space Medal of Honor in an early December ceremony, citing Lucid "for her contributions to international cooperation in space ... Shannon Lucid is an explorer in the best tradition of those who dare to challenge the unknown." Lucid's stay on Mir was part of continuing U.S. - Russian space cooperation, which is setting the foundation for the International Space Station.

TWO PROBES LAUNCHED TO STUDY THE RED PLANET

In a continuing effort to learn more about Mars, the United States launched two new spacecraft to the Red Planet in 1996. The Mars Global Surveyor and the Mars Pathfinder missions were both successfully launched from NASA's Kennedy Space Center, FL. Mars Global Surveyor, due to rendezvous with Mars in September 1997, will spend four months dipping into Mars' atmosphere using a technique called "aerobraking." Starting in 1998, the Surveyor will begin compiling a systematic database as it surveys the Martian landscape and photographs unique features, such as polar caps and Mars' network of sinuous, interwining river channels. Mars Pathfinder, set to land on Mars July 4, 1997, is designed to test the feasibility of a new low-cost method of delivering a spacecraft, science payload and free-ranging rover to the surface of the Red Planet. Once deployed, the lander will transmit back to Earth science data collected during descent through Mars' atmosphere. The rover, named Sojourner, will then activate an onboard camera and send back images to Earth, signifying the start of its exploration.

GALILEO UNRAVELS MYSTERIES OF JUPITER AND ITS MOONS

Mars was not the only planet to reveal startling new secrets in 1996. NASA's Galileo spacecraft, in its flyby and probe deploy at Jupiter, revealed many previously unknown facts about our Solar System's largest planet. Galileo's Probe, which was successfully sent into Jupiter's violet atmosphere in December 1995, provided new discoveries for NASA scientists. New information on the extent of water, clouds, and the chemical composition of Jupiter's atmosphere was revealed. As Galileo sped by Jupiter's moons, new details of the satellites began to emerge. On Ganymede, Jupiter's largest moon, scientists were intrigued by three-dimensional pictures of giant, icy fissures and evidence of a magnetic field. Galileo also reported that "warm ice" or even liquid water may have existed, and perhaps still exists, beneath the cracked icy crust of the moon Europa. Galileo found that the volcanically-active moon Io had noticeably changed since it was last observed 17 years ago by the Voyager spacecraft. In November, Galileo flew by Jupiter's moon Callisto, investigating the strange, pockmarked fourth moon, so different from its other active siblings.

HUBBLE SPACE TELESCOPE CONTINUES TO AMAZE ASTRONOMERS

Living up to its role as one of the "Great Observatories," the Hubble Space Telescope showed images of galaxies colliding, the surface of Pluto, and the birth of stars during 1996. In April, Hubble sent back dramatic of gigantic tadpole-shaped objects surrounding a dying star. The "cometary knots" are probably the result of a dying star 's final outbursts, seen in the Helix nebula. The Space Telescope continues on track for measuring the expansion of the universe, sending back information that fine-tunes the Hubble Constant. Scientists are using the telescope to try and place the Hubble Constant to within a ten percent accuracy. Compiling a "cosmic Movie" of the Crab Nebula, Hubble found the Nebula even more dynamic than previously understood. Hubble measured the diameters of a special class of pulsating star called Mira variables, which rhythmically change size. At 11 billion light-years away, they existed during the epoch when it is commonly believed galaxies started to form. Hubble concluded the gigantic, old stars are not round but rather egg-shaped. That discovery may preview the fate of our Sun five billion years from now. Hubble also surveyed the "homes" of quasars, showing that they live in a remarkable variety of galaxies, many of which are violently colliding. The complicated image Hubble sent back suggests there may be a variety of mechanisms for "turning on " quasars, the universe's most energetic objects. Hubble introduced us to images of what may be galaxies under construction in the early universe, being made out of a long sought ancient population of "galactic building blocks." Those images show a grouping of 18 gigantic star clusters that appear to be the same distance from Earth, and close enough to each other that they will eventually merge into a few galaxy-sized objects. In October, Hubble followed the spectacular dance of Jupiter's aurora, allowing astronomers to map Jupiter's immense magnetic field and better understand how it generates such phenomena.

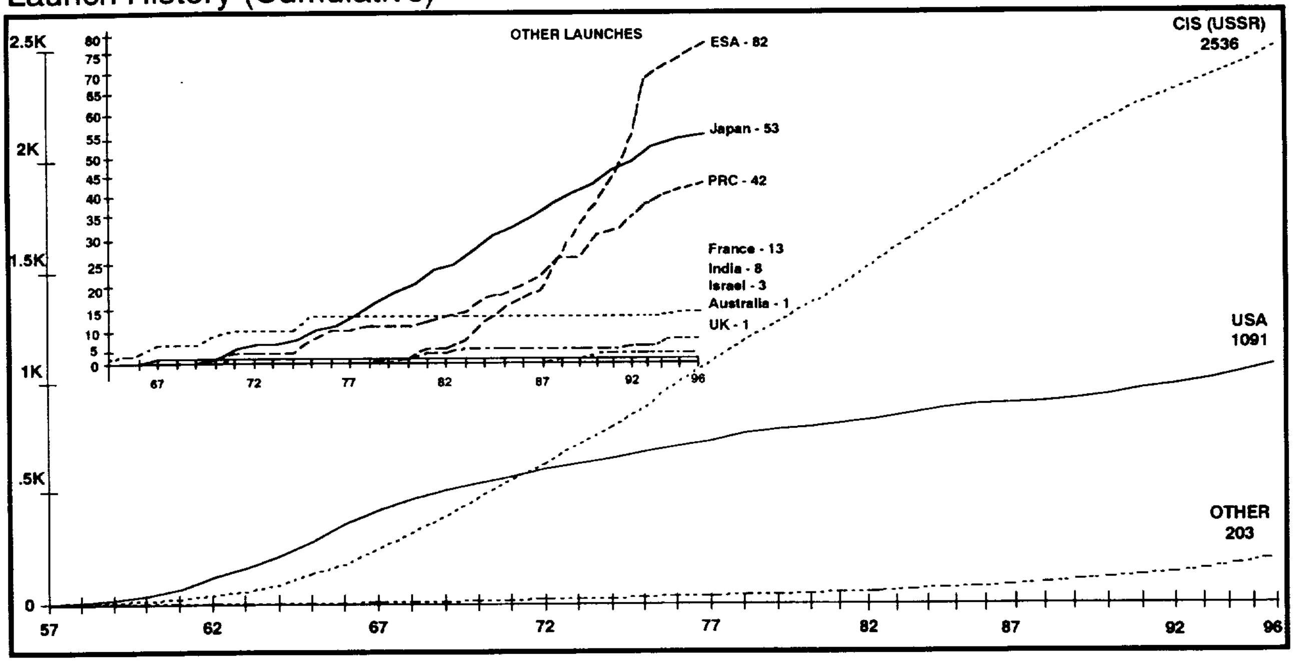
NEXT GENERATION LAUNCH VEHICLE CHOSEN FOR DEVELOPMENT

In a quest for a faster, better, cheaper access to space in the 21st Century, Vice President Al Gore and Administrator Goldin announced that Lockheed Martin was selected to build the X-33 technology demonstrate vehicle, a one-half scale prototype of the Reusable Launch Vehicle which will be used to demonstrate advanced technologies that will dramatically increase reliability and lower the costs of putting payloads into space. Lockheed Martin will design, build and conduct the first test flight of the X-33 test vehicle by March 1999, and conduct up to fifteen flights by December 1999. NASA has budgeted $941 million for the project through 1999, with Lockheed Martin contributing over $200 million. Called "VentureStar," the unpiloted vehicle will launch vertically like a rocket and land horizontally like an airplane.

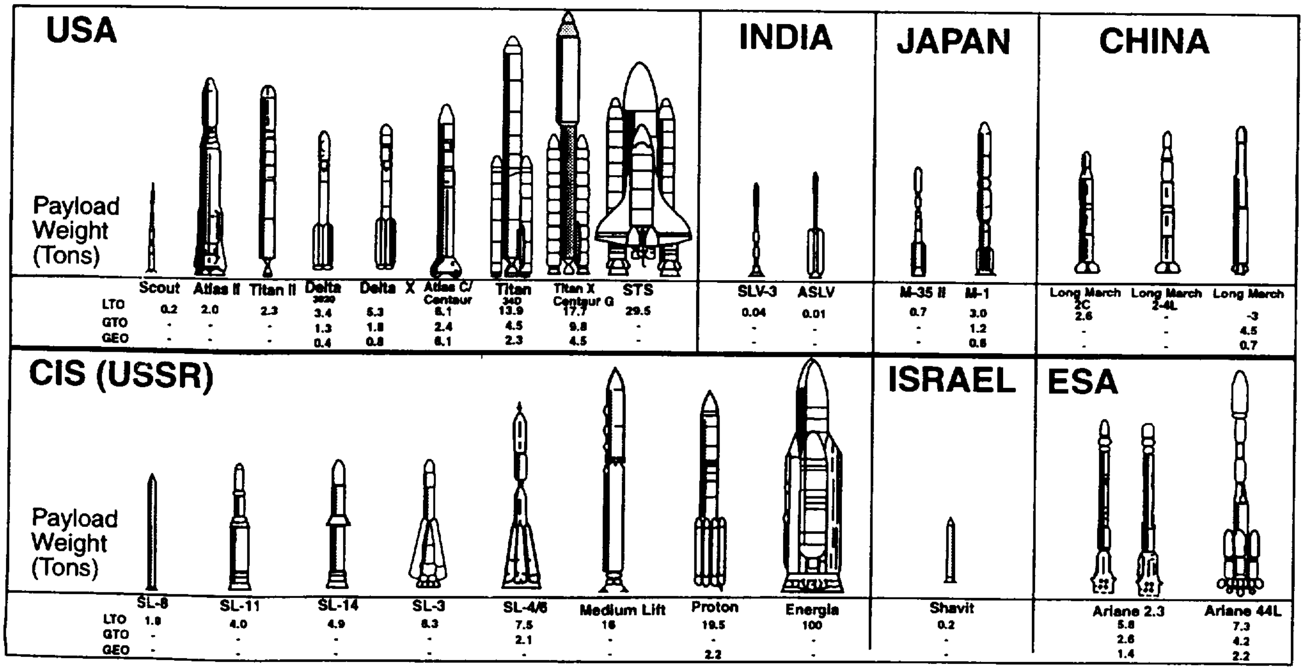
Section B

Space Flight Activity

Launch History (Cumulative)



Current Worldwide Launch Vehicles



Summary of Announced Launches

Worldwide Launches

	1957-1959	1960-1969	1970-1979	1980-1989	1990	1991	1992	1993	1994	1995	1996	TOTAL
Australia	--	1	0	0	0	0	0	0	0	0	0	1
CIS (USSR)	6	378	866	931	75	59	54	49	48	45	25	2536
DOD	11	284	114	54	10	8	10	8	12	10	10	524
ESA	--	--	1	29	5	7	9	9	5	5	10	80
France	--	4	6	0	0	0	0	0	0	0	0	10
India	--	--	--	3	0	0	1	0	2	1	1	8
Israel	--	--	--	1	1	0	0	0	0	1	0	3
Japan	--	--	15	23	3	2	3	1	2	3	1	53
NASA	7	187	151	96	8	8	13	12	11	8	12	501
PRC	--	--	8	15	5	1	3	1	5	1	2	41
United Kingdom	--	--	1	0	0	0	0	0	0	0	0	1
US Commercial	--	--	--	1	9	1	2	3	4	4	12	24
TOTAL	24	854	1162	1155	116	86	95	83	89	78	73	3816

NASA Launches

	1957-1959	1960-1969	1970-1979	1980-1989	1990	1991	1992	1993	1994	1995	1996	TOTAL
NASA	7	149	57	37	6	6	11	11	10	9	9	312
Cooperative	--	13	17	2	1	0	1	1	1	1	3	40
DOD	--	2	9	17	1	1	1	0	0	0	0	31
USA	--	20	37	35	0	1	0	0	0	0	0	92
Foreign	--	3	31	5	0	0	0	0	0	0	0	39
TOTAL	7	187	151	96	8	8	13	12	11	10	12	514

NASA Launches By Vehicle

	1957-1959	1960-1969	1970-1979	1980-1989	1990	1991	1992	1993	1994	1995	1996	TOTAL
Atlas	--	7	0	0	0	0	0	0	0	0	0	7
Atlas Agena	--	29	0	0	0	0	0	0	0	0	0	29
Atlas E/F	--	--	3	6	0	1	0	1	2	3	1	17
Atlas Centaur	--	17	27	16	1	0	0	1	0	0	0	61
Atlas II S/A	--	--	--	--	--	--	--	1	0	4	3	8
Delta	--	49	74	31	0	0	2	1	2	3	4	166
Juno II	3	2	0	0	0	0	0	0	0	0	0	5
Saturn I	--	6	0	0	0	0	0	0	0	0	0	6
Saturn IB	--	3	4	0	0	0	0	0	0	0	0	7
Saturn V	--	7	6	0	0	0	0	0	0	0	0	13
Scout	--	24	28	11	1	1	2	1	0	0	0	68
Shuttle	--	--	--	31	6	6	8	7	7	7	7	79
Thor Able	2	2	0	0	0	0	0	0	0	0	0	4
Thor Agena	--	10	2	0	0	0	0	0	0	0	0	12
Thor Delta	--	20	0	1	0	0	0	0	0	0	0	21
Titan II	--	11	0	0	0	0	0	0	0	0	0	11
Titan III	--	--	--	--	--	--	1	0	0	0	0	1
Titan Centaur	--	--	7	0	0	0	0	0	0	0	0	7
Vanguard	2	0	0	0	0	0	0	0	0	0	0	2
TOTAL	7	181	151	96	8	8	13	12	11	17	15	525

Summary of Announced Payloads

	1957-1959	1960-1969	1970-1979	1980-1989	1990	1991	1992	1993	1994	1995	1996	TOTAL
Argentina	--	--	--	--	1	0	0	0	0	0	0	1
AsiaSat	--	--	--	--	1	0	0	0	0	0	0	1
ASCO	--	--	--	2	0	0	0	0	0	0	0	2
Australia	--	1	1	3	0	0	2	0	1	0	0	8
Brazil	--	--	--	2	1	0	0	1	1	0	0	5
Canada	--	--	4	5	0	2	1	0	0	1	0	13
China	--	--	8	16	5	1	2	1	5	1	3	42
CIS(USSR)	6	399	1028	1132	96	101	77	59	64	45	25	3032
Cooperative *	--	14	23	4	3	5	3	1	1	1	0	55
Czechoslovakia	--	0	1	1	0	0	0	0	0	1	0	3
ESA	--	2	5	14	1	4	1	2	1	2	9	32
France	--	4	14	5	2	6	3	2	0	3	0	39
Germany	--	--	3	7	1	1	1	0	2	1	0	16
India	--	--	1	9	1	1	2	1	2	1	1	19
Indonesia	--	--	1	3	1	0	1	0	0	0	0	6
InMarSat	--	--	2	--	1	0	1	0	0	0	0	2
Israel	--	--	--	1	1	0	0	0	0	1	0	4
Italy	--	--	1	--	0	1	0	2	0	0	0	4
Japan	--	--	18	26	7	2	3	1	4	2	1	64
Korea	--	--	--	--	--	--	1	1	0	1	0	3
Luxembourg	--	--	--	--	--	--	--	1	0	1	0	2
Mexico	--	--	--	2	0	0	0	1	1	0	0	4
NATO	--	--	5	1	0	1	0	1	0	0	0	8
Pakistan	--	--	--	--	1	0	0	0	0	0	0	1
PanAmSat	--	--	--	1	0	0	0	0	0	0	0	1
Saudi Arabia	--	--	--	--	--	--	1	0	0	0	0	1
Spain	--	--	--	--	--	--	1	1	0	1	0	3
Sweden	--	--	--	2	0	0	1	0	0	1	0	4
United Kingdom	--	1	6	4	5	2	0	0	0	0	0	18
United States *	18	614	247	191	31	30	27	29	27	24	34	1272
TOTAL	24	1035	1366	1431	159	157	128	104	109	87	73	4673

* Separate Breakdown Follows

Summary of USA Payloads

			U.S. Payloads									
	1957-1959	1960-1969	1970-1979	1980-1989	1990	1991	1992	1993	1994	1995	1996	TOTAL
AMSAT	--	--	3	0	2	0	0	0	0	0	0	5
AT&T	--	4	0	1	0	0	0	1	0	0	0	6
ASC	--	--	--	1	0	1	0	0	0	0	0	2
COMSAT	--	9	21	15	2	1	3	1	1	0	0	53
DOD	11	437	140	86	16	15	11	10	11	10	10	757
GTE	--	--	--	6	1	1	0	0	0	0	0	8
Hughes	--	--	--	7	1	0	2	1	0	0	0	13
NASA	7	155	67	49	7	11	11	11	11	10	12	351
NOAA	--	9	10	11	0	1	0	1	1	1	0	34
N. Utah Univ	--	--	--	1	0	0	0	0	0	0	0	1
RCA	--	--	3	7	1	0	0	0	0	0	0	11
SBS	--	--	--	4	1	0	0	0	0	0	0	5
WU	--	--	3	3	0	0	0	0	0	0	0	6
TOTAL	18	614	247	191	31	30	27	25	24	21	22	1252

			Cooperative Payloads									
	1957-1959	1960-1969	1970-1979	1980-1989	1990	1991	1992	1993	1994	1995	1996	TOTAL
NASA/Canada	--	3	2	0	0	0	0	0	0	0	0	5
NASA/DOD	--	--	--	--	2	2	0	0	1	0	0	5
NASA/ESA	--	2	4	0	0	1	0	2	0	1	1	11
NASA/France	--	1	3	2	0	0	1	0	0	0	0	7
France/Germany	--	--	2	0	0	0	0	0	0	0	0	2
NASA/Germany	--	1	3	0	1	0	0	0	1	0	0	6
NASA/Italy	--	2	2	1	0	0	1	0	0	0	1	7
NASA/Japan	--	--	--	--	--	--	1	0	0	1	1	3
NASA/Netherlands	--	--	1	1	0	0	0	0	0	0	0	2
NASA/NOAA	--	--	2	0	0	1	0	1	1	1	0	6
NASA/NRL	--	2	1	0	0	0	0	0	0	0	0	3
NASA/SKorea	--	--	--	--	--	--	--	--	--	1	1	1
NASA/Spain	--	--	1	0	0	0	0	0	0	0	0	1
NASA/UK	--	3	2	0	0	1	0	1	0	0	0	6
TOTAL	--	14	24	4	3	5	3	4	3	3	4	66

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.

CIS (USSR) Spacecraft Designations

The Union of Soviet Socialist Republics (USSR) became the Confederation of Independent States (CIS) on December 25, 1991.

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.
ELECTRO: Geosynchronous meteorological satellite
ELEKTRON: Dual satellites to study the radiation belts.
FOTON: Scientific satellite to continue space materials studies.
GALS: Geosynchronous Direct Broadcast TV satellite.
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.
KORONAS: Earth orbiting satellite for scientific study of the sun.
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.
PION: Scientific satellite for research of the upper atmosphere.
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: 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.

NASA Astronauts

Name	Service	Mission	Position	Flight Time (hr:min:sec)	EVA (hr:min)	Total Flighttime (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	121:00:08		334:22:35
		STS-43	MS	213:22:27		
Akers, Thomas D. Maj	USAF	STS-41	MS	98:10:03		914:44:42
		STS-49	MS	213:17:38	16:14	
		STS-61	MS	259:58:35	13:25	
		STS-79	MS	243:18:26		
Aldrin, Edwin E., Jr., Col.	USAF Ret	Gemini 12	Plt	94:34:31	05:37	289:53:06
		Apollo 11	LMP	195:18:35	*02:15	
Allen, Andrew M., Maj.	USAF	STS-46	Plt	191:16:07		904:13:09
		STS-62	Plt	335:16:41		
		STS-75	CDR	377:40:21		
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	143:32:45	10:49	848:11:34
		STS-47	MS	190:30:23		
		STS-59	MS	269:49:30		
		STS-79	MS	243:18:46		
Armstrong, Neil	Civ	Gemini 8	Cdr	10:41:26		206:00:01
		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	119:39:20		664:32:33
		STS-50	MS	331:30:04		
		STS-71	MS	235:23:09		
Baker, Michael A. Capt	USN	STS-43	Plt	213:22:27		720:04:48
		STS-52	Plt	236:56:13		
		STS-68	Cdr	269:46:08		
Barry, Daniel T., PhD	Civ	STS-72	MS	214:01:47		214:01:47
Bartoe, John-David F., PhD	Civ	STS-51F	PS	190:45:26		190:45:26

*Lunar Surface EVA

Name	Service	Mission	Position	Flight Time (hr:min:sec)	EVA (hr:min)	Total Flighttime (hr:min:sec)
Baudry, Patrick, Lt. Col.	FAF	STS-51G	PS	169:38:52		169:38:52
Bean, Alan F., Capt	USN Ret	Apollo 12	LMP	244:36:24	*07:45	1666:47:33
		Skylab 3	Cdr	1416:11:09	02:45	
Blaha, John E., Col	USAF	STS-29	Plt	119:38:52		789:20:37
		STS-33	Plt	120:06:46		
		STS-43	Cdr	213:22:27		
		STS-58	Cdr	336:12:32		
Bluford, Guion S., Col	USAF	STS-8	MS	145:08:43		688:36:38
		STS-61A	MS	168:44:51		
		STS-39	MS	199:23:17		
		STS-53	MS	175:19:47		
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		680:39:23
		STS-31	Plt	121:16:06		
		STS-45	Cdr	214:10:24		
		STS-60	Cdr	199:09:02		
Bondar, Roberta L., PhD	Civ	STS-42	PS	193:15:43		193:15:43
Borman, Frank, Col.	USAF Ret	Gemini 7	Cdr	330:35:01		477:36:13
		Apollo 8	Cdr	147:00:42		
Bowersox, Kenneth D., Lt. Cdr.	USN	STS-50	Plt	331:30:04		973:21:56
		STS-61	Plt	259:58:35		
		STS-73	CDR	381:53:17		
Brady, Charles E. Jr., MD	USN	STS-78	MS	405:47:45		405:47:45
Brand, Vance D.	Civ	Apollo Soyuz	CMP	217:28:23		746:03:51
		STS-5	Cdr	122:14:26		
		STS-41B	Cdr	191:15:55		
		STS-35	Cdr	215:05:07		
Brandenstein, Daniel C., Capt	USN	STS-8	Plt	145:08:43		789:05:50
		STS-51G	Cdr	169:38:52		
		STS-32	Cdr	261:00:37		
		STS-49	Cdr	213:17:38		

** Suborbital Flight

NASA Astronauts

Name	Service	Mission	Position	Flight Time (hr:min:sec)	EVA (hr:min)	Total Flighttime (hr:min:sec)
Bridges, Roy D., Col	USAF	STS-51-F	Plt	190:45:26		190:45:26
Brown, Curtis L.		STS-47	Plt	190:30:23		693:41:43
		STS-66	Plt	262:32:02		
		STS-77	Plt	240:39:18		
Brown, Mark F., Lt. Col	USAF	STS-28	MS	121:00:08		249:27:51
		STS-48	MS	128:27:51		
Buchli, James F., Col	USMC	STS-51C	MS	73:33:23		490:24:57
		STS-61A	MS	168:44:51		
		STS-29	MS	119:38:52		
		STS-48	MS	128:27:51		
Budarin,Nikolai M.	CS	STS-71	FE	235:23:09		235:23:09
Bursch, Daniel W. Cdr	USN	STS-51	MS	236:11:11		746:00:37
		STS-68	MS	269:46:08		
		STS-77	MS	240:39:18		
Cabana, Robert D., Lt. Col.	USMC	STS-41	Plt	98:10:03		626:57:14
		STS-53	Plt	175:19:47		
		STS-65	Cdr	353:55:00		
Cameron, Kenneth D. Col.	USMC	STS-37	Plt	143:32:45		562:12:43
		STS-56	Cdr	222:08:16		
		STS-74	Cdr	196:31:42		
Carpenter, M. Scott, Cdr.	USN Ret	Aurora 7	Cdr	4:56:05		4:56:05
Carr, Gerald P., Col	USMC Ret	Skylab 4	Cdr	2016:01:16	15:48	2016:01:16
Carter, Manley, Cdr.	USN	STS-33	MS	120:06:46		120:06:46
Casper, John H., Col	USAF	STS-36	Plt	106:18:22		825:52:40
		STS-54	Cdr	143:38:19		
		STS-62	Cdr	335:16:41		
		STS-77	Cdr	240:39:18		
Cenker, Robert J.	Civ	STS-61C	PS	146:03:51		146:03:51
Cernan, Eugene A., Capt.	USN Ret	Gemini 9A	Plt	72:20:50	2:08	566:16:12
		Apollo 10	LMP	192:03:23		
		Apollo 17	Cdr	301:51:59	*22:04	

*Lunar Surface EVA

Name	Service	Mission	Position	Flight Time (hr:min:sec)	EVA (hr:min)	Total Flighttime (hr:min:sec)
Chang-Diaz, Franklin R., PhD.	Civ	STS-61C	MS	146:03:51		1033:49:01
		STS-34	MS	119:39:20		
		STS-46	MS	191:16:07		
		STS-60	MS	199:09:22		
		STS-75	MS	377:40:21		
Cheli, Maurizio., Lt Col	IAF	STS-75	MS	377:40:21		377:40:21
Chiao, Leroy, PhD	Civ	STS-65	MS	353:55:00		571:55:41
		STS-72	MS	218:00:41		
Chilton, Kevin P., Lt. Col.	USAF	STS-49	Plt	213:17:38		703:50:01
		STS-59	Plt	269:49:30		
		STS-76	Cdr	221:15:53		
Cleave, Mary L., PhD	Civ	STS-61B	MS	165:04:49		262:00:52
		STS-30	MS	96:56:28		
Clervoy, Jean Francois, MD	Civ	STS-66	MS	262:32:02		262:32:02
Clifford, M. Richard Lt. Col.	USA	STS-53	MS	175:19:47		666:25:10
		STS-59	MS	269:49:30		
		STS-76	MS	221:15:53		
Coats, Michael L., Capt.	USN	STS-41D	Plt	144:56:04		463:58:13
		STS-29	Cdr	119:38:52		
		STS-39	Cdr	199:23:17		
Cockrell, Kenneth	Civ	STS-56	MS	222:08:16		646:0134
		STS-80	Cdr	423:53:18		
Coleman, Catherine,CaptPhD	USAF	STS-73	MS	381:53:17		381:53:17
Collins, Michael, M. Gen	USAF	Gemini 10	Plt	70:46:39	01:30	266:05:14
		Apollo 11	CMP	195:18:35		
Collins, Eileen M., Lt Col	USAF	STS-63	Plt	196:29:36		196:29:36
Conrad, Charles (Pete), Capt	USN Ret	Gemini 5	Plt	190:55:14		1179:38:35
		Gemini 11	Cdr	71:17:08		
		Apollo 12	Cdr	244:36:24	*07:45	
		Skylab 2	Cdr	672:49:49	05:51	
Cooper, L. Gordon, Jr., Col.	USAF Ret	Faith 7	Plt	34:19:49		225:15:03
		Gemini 5	Cdr	190:55:14		

** Suborbital Flight

NASA Astronauts

Name	Service	Mission	Position	Flight Time (Hr:min:sec)	EVA (hr:min)	Total Flight Time (hr:min:sec)
Covey, Richard O., Col	USAF	STS-51I	Plt	170:17:42		645:10:05
		STS-26	Plt	97:00:11		
		STS-38	Cdr	117:54:27		
		STS-61	Cdr	259:58:35		
Creighton, John O., Capt	USN	STS-51G	Plt	169:38:52		404:24:05
		STS-36	Cdr	106:18:22		
		STS-48	Cdr	128:27:51		
Crippen, Robert L, Capt	USN	STS-1	Plt	54:20:53		565:48:32
		STS-7	Cdr	146:23:59		
		STS-41C	Cdr	167:40:07		
		STS-41G	Cdr	197:23:33		
Culbertson, Frank L., Capt.	USN	STS-38	Plt	117:54:27		354:05:38
		STS-51	Cdr	236:11:11		
Cunningham, Walter	Civ	Apollo 7	LMP	260:09:03		260:09:03
Currie, Nancy J. Maf	USA	STS-70	MS	214:21:09		214:21:09
Davis, N. Jan, PhD	Civ	STS-47	MS	190:30:23		389:39:45
		STS-60	MS	199:09:22		
Delucas, Lawrence J., PhD	Civ	STS-50	PS	331:30:04		331:30:04
Duffy, Brian K., Lt. Col.	USAF	STS-45	Plt	214:10:24		671:55:59
		STS-57	Plt	239:44:54		
		STS-72	Cdr	218:00:41		
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		976:40:04
		STS-32	MS	261:00:37		
		STS-50	MS	331:30:04		
		STS-271	MS	235:23:09		
Durrance, Samuel T., PhD	Civ	STS-35	PS	215:05:07		614:14:54
		STS-67	PS	399:09:47		
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	54:13:12		244:30:54
		STS-51I	Cdr	170:17:42		
Evans, Ronald R., Capt	USN Ret	Apollo 17	CMP	301:51:59	01:06	301:51:59

*Lunar Surface EVA

Name	Service	Mission	Position	Flight Time (Hr:min:sec)	EVA (hr:min)	Total Flight Time (hr:min:sec)
Fabian, John M. Col.	USAF	STS-7	MS	146:23:59		316:02:51
		STS-51G	MS	169:38:52		
Favier, Jean-Jacques, PhD	Civ	STS-78	PS	405:47:45		405:47:45
Fettman, Martin J., Dr.	Civ	STS-58	PS	336:12:32		336:12:32
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
Foale, C. Michael, PhD	Civ	STS-45	MS	214:10:24		632:48:16
		STS-56	MS	222:08:16		
		STS-63	MS	196:29:36		
Frimout, Dirk D., PhD	Civ	STS-45	PS	214:10:24		214:10:24
Fullerton, C. Gordon, Col.	USAF	STS-3	Plt	192:04:46		382:50:12
		STS-51F	Cdr	190:45:26		
Furrer, Reinhard, PhD	Civ	STS-61A	PS	168:44:51		168:44:51
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., Col.	USAF	STS-27	Plt	105:05:37		320:10:44
		STS-35	Plt	215::05:07		
Garn, E. J. "Jake"	Civ	STS-51D	PS	167:55:23		167:55:23
Garneau, Marc, PhD	Civ	STS-41G	PS	197:23:33		438:02:51
		STS-77	MS	240:39:18		
Garriott, Owen K., PhD	Civ	Skylab 3	Plt	1416:11:09	13:44	1663:58:33
		STS-9	MS	247:47:24		
Gemar, Charles D., Lt. Col	USA	STS-38	MS	117:54:27		781:38:59
		STS-48	MS	128:27:51		
		STS-62	MS	335:16:41		
Gernhardt, Michael L, PhD	Civ	STS-69	MS	260:29:56		260:29:56
Gibson, Edward G., PhD	Civ	Skylab 4	Plt	2016:01:16	15:20	2016:01:16
Gibson, Robert L., Cdr.	USN	STS-41B	Plt	191:15:55		868:18:65
		STS-61C	Cdr	146:03:51		
		STS-27	Cdr	105:05:37		
		STS-47	Cdr	190:30:23		
		STS-71	Cdr	235:23:09		

** Suborbital Flight

NASA Astronauts

Name	Service	Mission	Position	Flight Time (hr:min:sec)	EVA (hr:min)	Total Flighttime (hr:min:sec)
Glenn, John H., Jr., Col	USMCRet	Friendship 7	Cdr	4:55:23		4:55:23
Godwin, Linda M. PhD	Civ	STS-37	MS	143:32:45		634:38:08
		STS-59	PC	269:49:30		
		STS-76	MS	221:15:53		
Gordon, Richard F., Jr., Capt.	USNRet	Gemini 11	Plt	71:17:08	01:57	315:53:32
		Apollo 12	CMP	244:36:24		
Grabe, Ronald J., Col	USAF	STS-51J	Plt	97:44:38		627:41:40
		STS-30	Plt	96:56:28		
		STS-42	Cdr	193:15:43		
		STS-57	Cdr	239:44:54		
Gregory, Frederick D., Col	USAF	STS-51B	Plt	168:08:46		455:07:59
		STS-33	Cdr	120:06:46		
		STS-44	Cdr	166:52:27		
Gregory, William G. Lt Col	USAF	STS-67	Plt	399:09:47		399:09:47
Griggs, S. David	Civ	STS-51D	MS	167:55:23		167:55:23
Grissom, Virgil I., Lt Col.	*USAF	*Liberty Bell	Plt	15:37		5:08:08
		Gemini 3	Cdr	4:52:31		
Grunsfeld, John M. PhD	Civ	STS-67	MS	399:09:47		399:09:47
Guidoni, Umberto, PhD	Civ	STS-75	PS	377:40:21		370:40:21
Gutierrez, Sidney M. Lt. Col.	USAF	STS-40	Plt	218:15:14		488:04:44
		STS-59	Cdr	269:49:30		
Hadfield, Chris, Maj.	CAF	STS-74	MS	196:31:42		196:31:42
Halsell, James D, Jr., Lt Co.	USAF	STS-65	Plt	353:55:00		549:26:4
		STS-74	Plt	196:31:42		
Haise, Fred W.	Civ	Apollo 13	LMP	142:54:41		142:54:41
Hammond, L. Blaine, Jr. Col	USAF	STS-39	Plt	199:26:17		462:16:14
		STS-64	Plt	262:49:57		

*Lunar Surface EVA

Name	Service	Mission	Position	Flight Time (hr:min:sec)	EVA (hr:min)	Total Flighttime (hr:min:sec)
Harbaugh, Gregory J.	Civ	STS-39	MS	199:26:17	04:27	578:27:45
		STS-54	MS	143:38:19		
		STS-71	MS	235:23:09		
Harris, Bernard, Jr., Dr.	Civ	STS-55	MS	239:39:59		439:09:35
		STS-63	MS	196:29:36		
Hart, Terry J	Civ	STS-41C	MS	167:40:07		167:40:07
Hartsfield, Henry W.	USAFRet	STS-4	Plt	169:09:31		482:50:26
		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., Ph	Civ	STS-41D	MS	144:56:04		412:16:01
		STS-61C	MS	146:03:51		
		STS-31	MS	121:16:06		
Helms, Susan, Maj.	USAF	STS-54	MS	143:38:19		812:16:01
		STS-64	MS	262:49:57		
		STS-78	MS	405:47:45		
Henize, Karl G., PhD	Civ	STS-51F	MS	190:45:26		190:45:26
Hennen, Thomas J.	USA	STS-44	PS	166:52:27		166:52:27
Henricks, Terence T. Col.	USAF	STS-44	Plt	166:52:27		812:20:11
		STS-55	Plt	239:39:59		
		STS-78	Cdr	405:47:45		
Hieb, Richard J	Civ	STS-39	MS	199:26:17		766:38:55
		STS-49	MS	213:17:38	17:42	
		STS-65	MS	353:55:00		
Hilmers, David C., Lt. Col.	USMC	STS-51J	MS	97:44:38		494:18:54
		STS-26	MS	97:00:11		
		STS-36	MS	106:18:22		
		STS-42	MS	193:15:43		

** Suborbital Flight

NASA Astronauts

Name	Service	Mission	Position	Flight Time (hr:min:sec)	EVA (hr:min)	Total Flighttime (hr:min:sec)
Hoffman, Jeffery A., PhD	Civ	STS-51D	MS	167:55:23	03:10	1211:55:33
		STS-35	MS	215:05:07		
		STS-46	MS	91:16:07		
		STS-61	MS	259:58:35	22:03	
		STS-75	MS	377:40:21		
Horowitz, Scott J. Lt Col	USAF	STS-75	Plt	377:40:21		377:40:21
Hughes-Fulford, Millie Dr.	Civ	STS-40	PS	218:15:14		218:15:14
Irwin, James B., Col	USAFRet	Apollo 15	LMP	295:11:53	*18:35	295:11:53
Ivins, Marsha S.	Civ	STS-32	MS	261:00:37		787:33:25
		STS-46	MS	191:16:07		
		STS-62	MS	335:16:41		
Jarvis, Gregory B	Civ	STS-51L	PS	N/A		N/A
Jemison, Mae C., MD	Civ	STS-47	MS	190:30:23		190:30:23
Jernigan, Tamara E. PhD	Civ	STS-40	MS	218:15:14		879:04:45
		STS-52	MS	236:56:13		
		STS-80	MS	423:53:18		
Jett, Brent W. Cdr	USN	STS-72	Plt	214:01:47		214:01:47
Jones. Thomas D. PhD	Civ	STS-59	MS	269:49:30		963:33:56
		STS-68	PC	269:46:08		
		STS-80	MS	423:58:18		
Kerwin, Joseph P., Capt	USN Ret	Skylab 2	Plt	672:49:49	03:30	672:49:49
Kregel, Kevin R.		STS-70	Plt	214:21:09		887:08:54
		STS-78	Plt	405:47:45		
Krikalev, Sergei	CIS	STS-60	MS	199:09:22		199:09:22
Lawrence, Wendy, Cdr	USN	STS-67	MS	399:09:47		399:09:47
Lee, Mark C. Maj	USAF	STS-30	MS	96:56:28		550:16:48
		STS-47	MS	190:30:23		
		STS-64	MS	262:49:57		
Leetsma, David C. Cdr	USN	STS-41G	MS	197:23:33	03:29	532:34:05
		STS-28	MS	121:00:08		
		STS-45	MS	214:10:24		

*Lunar Surface EVA

Name	Service	Mission	Position	Flight Time (hr:min:sec)	EVA (hr:min)	Total Flighttime (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		461:57:48
		STS-45	PS	214:10:24		
Lind, Don Leslie, PhD	CIV	STS-51B	MS	168:08:46		168:08:46
Linenger, Jerry, MD, PhD	USN	STS-64	MS	262:49:57		
Lounge, John M.	Civ	STS-51I	MS	170:17:42		482:23:00
		STS-26	MS	97:00:11		
		STS-35	MS	215:05:07		
Lousma, Jack R., Col	USMC	Skylab 3	Plt	1416:11:09	10:59	1608:15:55
		STS-3	Cdr	192:04:46		
Lovell, James A., Jr., Capt	USN Ret	Gemini 7	Plt	330:35:01		715:04:55
		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		714:07:58
		STS-43	MS	213:22:27		
		STS-57	PC	239:44:54	05:50	
Lucid, Shannon W., PhD	Civ	STS-51G	MS	169:38:52		838:53:11
		STS-34	MS	119:39:20		
		STS-43	MS	213:22:27		
		STS-58	MS	336:12:32		
Malerba, Franco, PhD	Civ	STS-46	PS	191:16:07		191:16:07
Mattingly, Thomas K., Capt	USN	Apollo 16	CMP	265:51:05	01:24	508:33:59
		STS-4	Cdr	169:09:31		
		STS-51C	Cdr	73:33:23		
McArthur, William, Jr., Lt Col	USA	STS-58	MS	336:12:32		336:12:32
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	STS41-B	MS	191:15:55	11:37	191:15:55
McCulley, Michael, Cdr	USN	STS-34	Plt	119:39:20		119:39:20
McDivitt, James A., B. Gen	USAF Ret	Gemini 4	Cdr	97:56:12		338:57:06
		Apollo 9	Cdr	241:00:54		

** Suborbital Flight

NASA Astronauts

Name	Service	Mission	Position	Flight Time (hr:min:sec)	EVA (hr:min)	Total Flighttime (hr:min:sec)
McMonagle, Donald R. Lt.Col.USAF		STS-39	MS	199:23:17		605:36:38
		STS-54	Plt	143:38:19		
		STS-66	Cdr	262:32:02		
McNair,Ronald E., PhD	Civ	STS-41B	MS	191:15:55		191:15:55
		STS-51L	MS	N/A		
Meade, Carl J., Col.	USAF	STS-38	MS	117:54:27		712:13:28
		STS-50	MS	331:30:04		
		STS-64	MS	262:49:57		
Melnick, Bruce E., Cdr	USCG	STS-41	MS	98:10:03		311:27:41
		STS-49	MS	213:17:38		
Merbold, Ulf, PhD	Civ	STS-9	PS	247:47:24		441:03:07
		STS-42	PS	193:15:43		
Messerschmid, Ernest, PhD	Civ	STS-61A	PS	168:44:51		168:44:51
Mitchell, Edger D., Capt	USN Ret	Apollo 14	LMP	216:01:58	09:2	216:01:58
Mohri, Mamoru, PhD	Civ	STS-47	PS	190:30:23		190:30:23
Mullane, Richard M., Col	USAF	STS-41D	MS	144:56:04		571:25:10
		STS-27	MS	105:05:37		
		STS-36	MS	106:18:22		
Mukai, Chiaki, MD, PhD		STS-65	PS	353:55:00		353:55:00
Musgrave, F. Story, MD, PhD	Civ	STS-6	MS	120:23:42	03:54	1281:00:14
		STS-51F	MS	190:45:26		
		STS-33	MS	120:06:46		
		STS-44	MS	166:52:27		
		STS-61	MS	259:58:35	22:03	
		STS-80	MS	423:53:18		
Nagel, Steven R., Col.	USAF	STS-51G	MS	169:38:52		721:36:27
		STS-61A	Plt	168:44:51		
		STS-37	Cdr	143:32:45		
		STS-55	Cdr	239:39:59		
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		

Name	Service	Mission	Position	Flight Time (hr:min:sec)	EVA (hr:min)	Total Flighttime (hr:min:sec)
Neri Vela, Rodolpho, PhD	Civ	STS-61B	PS	165:04:09		165:04:09
Newman, James H., Dr.	Civ	STS-51	MS	236:11:11	07:05	236:11:11
Nicollier, Claude, PhD	Civ	STS-46	MS	191:16:07		828:55:03
		STS-61	ESA	259:58:35		
		STS-75	MS	377:40:21		
Ochoa, Ellen, Dr.	Civ	STS-56	MS	222:08:16		484:40:18
		STS-66	MS	262:32:02		
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		
Onizuka, Ellison S., Lt. Col	USAF	STS-51C	MS	73:33:23		73:33:23
		STS-51L	MS	N/A		
Oswald, Steven S.	Civ	STS-42	Plt	193:15:43		415:23:59
		STS-56	Plt	222:08:16		
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
Parazynski, Scott, MD	Civ	STS-66	MS	262:32:02		262:32:02
Parise, Ronald A., PhD	Civ	STS-35	PS	215:05:07		215:05:07
Parker, Robert A., PhD	Civ	STS-9	MS	247:47:24		462:52:31
		STS-35	MS	215:05:07		
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	2016:01:16	13:34	2016:01:16
Precourt, Charles, Lt Col.	USAF	STS-55	MS	239:39:59		239:39:59
Readdy, William F.	Civ	STS-42	MS	193:15:43		672:45:20
		STS-51	Plt	236:11:11		
		STS-79	Cdr	243:18:26		
Reightler, Kenneth S., Jr.	CdrUSN	STS-48	Plt	128:27:51		327:36:53
		STS-60	Plt	199:09:02		

** Suborbital Flight

NASA Astronauts

Name	Service	Mission	Position	Flight Time (hr:min:sec)	EVA (hr:min)	Total Flighttime (hr:min:sec)
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	121:00:08		813:30:12
		STS-41	Cdr	98:10:03		
		STS-50	Cdr	331:30:04		
		STS-64	Cdr	262:49:57		
Ride, Sally K.,PhD	Civ	STS-7	MS	146:23:59		343:47:32
		STS-41G	MS	197:23:33		
Rominger, Kent, Cdr	USN	STS-73	Plt	381:53:17		805:47:35
		STS-80	Plt	423:53:18		
Roosa, Stuart A., Col	USAFRet	Apollo14	CMP	216:01:58		216:01:58
Ross, Jerry L., Lt Col	USAF	STS-61B	MS	165:04:49	12:20	413:43:11
		STS-27	MS	105:05:37		
		STS-37	MS	143:32:45	10:49	
Runco, Mario Jr., Lt Cdr	USN	STS-44	MS	166:52:27		551:10:04
		STS-54	MS	143:38:19	04:27	
		STS-77	MS	240:39:18		
Sacco, Albert, Lt Cdr	USN	STS-73	PS	381:53:17		381:53:17
Schirra, Walter M., Jr., Capt	USN Ret	Sigma 7	Plt	9:13:11		295.13.11
		Gemini 6A	Cdr	25:51:24		
		Apollo 7	Cdr	260:09:03		
Schlegel, Hans (German)	Civ	STS-55	PS	239:39:59		239:39:59
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	
Scott, Winston, Cpt	USN	STS-72	MS	214:01:47		214:01:47
Scully-Power, Paul D	Civ	STS-41G	PS	197:23:33		197:33:23
Searfoss, Richard, Maj	USAF	STS-58	Plt	336:12:32		557:28:25
		STS-76	Plt	221:15:53		

*Lunar Surface EVA

Name	Service	Mission	Position	Flight Time (hr:min:sec)	EVA (hr:min)	Total Flighttime (hr:min:sec)
Seddon, M. Rhea, MD	Civ	STS-51D	MS	167:55:23		722:23:09
		STS-40	MS	218:15:14		
		STS-58	PC	336:12:32		
Sega, Ronald M,	Civ	STS-60	MS	199:09:22		420:25:15
		STS-76	MS	221:15:53		
Shaw, Brewster H., Col	USAF	STS-9	Plt	247:47:24		533:52:21
		STS-61B	Cdr	165:04:49		
		STS-28	Cdr	121:00:08		
Shepard, Alan B., Jr., R. Adm.	USN Ret	**Freedom 7	Plt	15:22		216:17:20
		Apollo 14	Cdr	216:01:5	*09:23	
Shepherd, William M., Capt	USN	STS-27	MS	105:05:37		440:11:53
		STS-41	MS	98:10:03		
		STS-52	MS	236:56:13		
Sherlock, Nancy J., Capt.	USA	STS-57	MS	239:44:54		239:44:54
Shriver, Loren J., Col	USAF	STS-51C	Plt	73:33:23		386:05:36
		STS-31	Cdr	121:16:06		
		STS-46	Cdr	191:16:07		
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
Smith, Steven L	Civ	STS-68	MS	269:46:08		269:46:08
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		237:33:19
		STS-38	MS	117:54:27		
Stafford, Thomas P., Lt. Gen	USAF Ret	Gemini 6A	Plt	25:51:24		507:44:00
		Gemini 9A	Cdr	72:20:50		
		Apollo 10	Cdr	192:03:23		
		Apollo Soyuz	Cdr	217:28:23		
Stewart, Robert L., Col	USA	STS-41B	MS	191:15:55	11:37	289:00:33
		STS-51J	MS	97:44:38		
Strekalov, Gennady, FE	RUS	STS-71	FE	235:23:09		235:23:09
Swigert, John L., Jr.	Civ	Apollo 13	CMP	142:54:41		152:54:41

** Suborbital Flight

NASA Astronauts

Name	Service	Mission	Position	Flight Time (hr:min:sec)	EVA (hr:min)	Total Flighttime (hr:min:sec)
Tanner, Joseph, R.	USN	STS-66	MS	262:32:02		262:32:02
Thagard, Norman E., MD	Civ	STS-7	MS	168:08:46		672:42:06
		STS-30	MS	96:56:28		
		STS-42	MS	193:15:43		
		STS-71	MS	214:21:09		
Thirsk, Robert B., MD	Civ	STS-78	PS	405:47:45		405:47:45
Thomas, Andrew S.W., PhD	Civ	STS-77	MS	240:39:18		240:39:18
Thomas. Donald A, PhD	Civ	STS-65	MS	353:55:00		568:16:09
		STS-70	MS	214:21:09		
Thornton, Kathryn	Civ	STS-33	MS	120:06:46		975:16:17
		STS-49	MS	213:17:38	7:45	.
		STS-61	MS	259:58:35	13:25	
		STS-73	MS	381:53:17		
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	106:18:22		654:52:41
		STS-49	MS	213:17:38	17:42	
		STS-62	MS	335:16:41		
Titov,Vladimir Georgievich	RUS	STS-63	MS	196:29:36		196:29:36
Trinh, Eugene H. , PhD.	Civ	STS-50	PS	331:30:04		331:30:04
Truly, Richard H., Capt	USN	STS-2	Plt	54:13:12		199:21:55
		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	337:57:49
		STS-51I	MS	170:17:41	1:51	
Veach, Charles Lacy	USAF	STS-39	MS	199:23:17		436:19:30
		STS-52	MS	236:56:13		
Voss, James S. Lt.Col.	USA	STS-44	MS	166:52:27		602:42:10
		STS-53	MS	175:19:47		
		STS-69	MS	260:29:56		
Voss, Janice E., Dr.	Civ	STS-57	MS	239:44:54		436:14:30
		STS-63	MS	196:29:36		
Wakata, Koichi	Civ	STS-72	MS	214:01:47		214:01:47
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		724:31:07
		STS-30	Cdr	96:56:28		
		STS-53	Cdr	175:19:47		
		STS-69	Cdr	260:29:56		
Walter, Ulrich (Germany)	Civ	STS-55	PS	239:39:59		239:39:59
Walz, Carl E., Maj	USAF	STS-51	MS	236:11:11	07:05	864:01:57
		STS-65	MS	353:55:00		
		STS-79	MS	243:18:46		
Wang, Taylor G., PhD	Civ	STS-51B	PS	168:08:46		168:08:46
Weber, Mary, PhD	Civ	STS-70	MS	214:01:46		214:01:46
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		694:36:36
		STS-52	Cdr	236:56:13		
		STS-63	Cdr	196:29:36		
White, Edward H., Lt. Col	USAF	Gemini 4	Plt	97:56:12	00:23	97:56:12
Wilcutt, Terrence, Maj	USMC	STS-68	Plt	269:46:08		513:06:54
		STS-79	Plt	243:18:46		
Williams, Donald E., Capt	USN	STS-51D	Plt	167:55:23		287:34:43
		STS-34	Cdr	119:39:20		
Wisoff, Peter J. K., Dr.	Civ	STS-57	MS	239:44:54	05:50	509:31:02
		STS-68	MS	269:46:08		
Wolf, David A.., Dr	Civ	STS-58	MS	336:12:32		336:12:32
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	4:52:31		835:41:55
		Gemini 10	Cdr	70:46:39		
		Apollo 10	CMP	192:03:23		
		Apollo 16	Cdr	265:51:05	*20:14	
		STS-1	Cdr	54:20:53		
		STS-9	Cdr	247:47:24		

Lunar Surface EVA

Suborbital Flight

Summary of United States Human 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
Liberty Bell 7	Grissom	15:37	15:37
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	9:13:11
Faith 7	Cooper	34:19:49	34:19:49
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	4:52:30	9:45:02
Gemini 4	McDivitt, White	97:56:12	195:52:24
Gemini 5	Cooper, Conrad	190:55:14	381:50:28
Gemini 6A	Schirra, Stafford	25:51:24	51:42:48
Gemini 7	Borman, Lovell	330:35:01	661:10:02
Gemini 8	Armstrong, Scott	10:41:26	21:22:52
Gemini 9A	Stafford, Cernan	72:20:50	144:41:40
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		969:50:56	1939:41:52
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	244:36:24	733:49:12
Apollo 13	Lovell, Swigert, Haise	142:54:41	428:44:03
Apollo 14	Shepard, Roosa, Mitchell	216:01:58	648:05:54
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	6725:34:42
TOTAL APOLLO FLIGHTS - 11		2502:00:37	7506:01:51
SKYLAB SATURN IB			
Skylab 2	Conrad, Kerwin, Weitz	672:49:49	2018:29:27
Skylab 3	Bean, Garriott, Lousma	1416:11:09	4248:33:27
Skylab 4	Carr, E. Gibson, Pogue	2016:10:16	6048:03:48
TOTAL SKYLAB FLIGHTS - 3		4105:02:14	12315:06:42
APOLLO SATURN IB			
ASTP	Stafford, Brand, Slayton	217:28:23	652:25:09

Summary of United States Human Space Flight

Mission	Crew Members	Mission Duration (hr:min:sec)	Crew Hours (hr:min:sec)
STS-1 - Columbia	Young, Crippen	54:20:53	108:41:46
STS-2 - Columbia	Engle, Truly	54:13:12	108:26:24
STS-3 - Columbia	Lousma, Fullerton	192:04:46	384:09:32
STS-4 - Columbia	Mattingly, Hartsfield	169:09:31	338:19:02
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	958:49:40
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	488:43:10
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, Buchi, Springer	119:38:52	598:14:20
STS-30 - Atlantis	Walker, Grabe, Thagard, Cleave, Lee	96:56:28	484:42:20
STS-28 - Columbia	Shaw, Richards, Leetsma, Adamson, Brown	121:00:08	605:00:40
STS-34 - Atlantis	Williams, McCully, Baker, Chang-Diaz, Lucid	119:39:20	598:16:40
STS-33 - Discovery	Gregory, Blaha, Musgrave, K. Thornton, Carter	120:06:46	600:33:50
STS-32 - Columbia	Brandenstein, Wetherbee, Dunbar, Ivins, Low	261:00:37	1305:03:05
STS-36 - Atlantis	Creighton, Casper, Hilmers, Mullane, Thuot	106:18:22	531:31:50
STS-31 - Discovery	Shriver, Bolden, McCandless, Hawley, Sullivan	121:16:06	606:20:30
STS-41- Discovery	Richards, Cabana, Melnick, Shepard, Akers	98:10:03	490:50:15
STS-38 - Atlantis	Covey, Springer, Meade, Culbertson, Gemar	117:54:27	589:35:15
STS-35 - Columbia	Brand, Lounge, Hoffman, Parker, G. Gardner, Parise, Durrance	215:05:07	1505:35:49
STS-37 - Atlantis	Nagel, Cameron, Ross, Apt, Godwin	143:32:45	717:43:45
STS-39 - Discovery	Coats, Hammond, Harbaugh, Hieb, McMonagle, Bluford, Veach	199:23:17	1395:42:59

Summary of United States Human Space Flight

Mission	Crew Members	Mission Duration (hr:min:sec)	Crew Hours (hr:min:sec)
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	213:22:27	1066:52:15
STS-48 - Discovery	Creighton, Reightler, Buchli, Brown, Gemar	128:27:51	642:19:15
STS-44 - Atlantis	Gregory, Henricks, Musgrave, Runco, Voss, Hennen	166:52:27	1001:14:42
STS-42 - Discovery	Grabe, Oswald, Thagard, Readdy, Hilmers Bondar, Merbold	193:15:43	1352:50:01
STS-45 - Atlantis	Bolden, Duffy, Sullivan, Leestma, Foale, Frimout, Lichtenburg	214:10:24	1499:12:48
STS-49 - Endeavour	Brandenstein, Chilton, Hieb, Melnick, Thout, Thornton, Akers	213:30:04	1493:03:26
STS-50 - Columbia	Richards, Bowersox, Dunbar, Meade, Baker Delucas	331:30:04	1989:00:24
STS-46 - Atlantis	Shriver, Allen, Hoffman, Chang-Diaz, Nicollier, Ivins, Malerba	191:16.07	1338:52:49
STS-47 - Endeavour	Gibson, Brown, Lee, Davis, Jemison, Apt, Mohri	190:30:23	1333:32:41
STS-52 - Columbia	Weatherbee, Baker, Shepherd, Jernigan, Veach, MacLean	236:56:13	1421:37:18
STS-53 - Discovery	Walker, Cabana, Bluford, Voss, Clifford	175:19:47	876:38:55
STS-54 - Endeavour	Casper, McMonagle, Runco, Harbaugh Helms	143:38:19	718:11:35
STS-56 - Discovery	Cameron, Oswald, Foale, Cockrell, Ochoa	222:08:24	1110:42:00
STS-55 - Columbia	Nagel, Henricks, Precourt, Harris, Walter, Schlegel	239:39:59	1437:59:54
STS-57 - Endeavour	Grabe, Duffy, Low, Sherlock, Wisoff,Voss	239:44:54	1438:16:36
STS-51 - Discovery	Culbertson, Readdy, Newman, Bursch, Walz	236:11:11	1186:41:50
STS-58 - Columbia	Blaha, Searfoss, Seddon, Lucid, Wolf, McArthur, Fettman	336:12:32	2023:27:42
STS-61 - Endeavour	Covey, Bowersox, Musgrave, Akers, Hoffman, Thornton, Nicollier	259:58:35	1971:57:05
STS-60 - Discovery	Bolden, Reightler, Chang-Diaz, Davis, Seqa, Krikalev	199:09:22	1195:56:12
STS-62 - Columbia	Casper, Allen, Thout, Gemar, Ivins	335:16:41	1686:12:25
STS-59 - Endeavour	Gutierrez,Chilton, Godwin, Apt,Clifford,Jones	269:49:30	1618:57:00
STS-65 - Columbia	Cabana, Halsell, Hieb, Walz, Chiao, Thomas, Naito-Mukai	353:55:00	2477:25:00
STS-68 - Endeavour	Baker, Wilcutt, Jones, Smith, Bursch, Wisoff	269:46:08	1618:36:48
STS-64 - Discovery	Richards, Hammond, Linenger, Helms, Meade, Lee	262:49:57	1576:59:42
STS-66 - Atlantis	McMonagle, Brown, Ochoa, Tanner, Clervoy, Parazynski	262:32:02	1575:12:12
STS-63 - Discovery	Wetherbee, Collins, Harris, Foale, Voss, Titov	196:29:36	1179:03:36
STS-67 - Endeavour	Oswald, Gregory, Grunsfeld, Lawrence, Parise Jerrigan, Durrance	399:09:47	2794:06:29
STS-71 - Atlantis	Gibson, Precourt, Baker, Harbaugh, Dunbar, Sofovyev, Budarin, Dezhurow, Strekakov, Thagard	235:23:09	2353:51:30
STS-70 - Discovery	Herricks, Kregel, Thomas, Currie, Webber	214:21:09	1071:45:45
STS-69 - Endeavour	Walker, Cockrell, Voss, Newman, Gernhardt	260:29:56	1302:29:40
STS-73 - Columbia	Bowersox, Rorringer, Coleman, Thornton, Lopez-Alegria, Leslie, Sacco	381:53:17	2673:12:59
STS-74 - Atlantis	Cameron, Halsel, Hadfield, Ross, McArthur	196:31:42	982:38:30
STS-72 - Endeavour	Duffy, Jett, Chiao, Scott, Barry, Wakata	218:00:41	1308:04:06
STS-75 - Columbia	Allen, Horowitz, Hoffman, Cheli, Nicollier, Chang-Diaz, Guidoni	377:40:21	2643:42:27
STS-76 - Atlantis	Chilton, Searfoss, Sega, Clifford, Godwin, Lucid	221:15:53	1106:17:25
STS-77 - Endeavour	Casper, Brown, Thomas, Bursch, Runco, Garneau	240:39:18	1441:55:48
STS-78 - Columbia	Henricks, Kregel, Linnehan, Helms, Brady, Favler, Thirsk	405:47:45	2840:34:15
STS-79 - Atlantis	Readdy,Wilcutt,Apt,Akers,Walz, Blaha, Lucid	243:18:26	1216:32:10
STS-80 - Coumbia	Cockrell, Rominger,Jerrigan,Jones, Musgrave	423:53:18	2119:25:30
TOTAL SHUTTLE FLIGHTS - 79		15825:54:08	92302:34:67

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-1 Columbia Mission Duration: 54 hrs 20 mins 53 secs	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)	**GAS (Getaway Special): None** **Crew Compartment Payloads: None** **Special Payload Mission Kits: None**
STS-2 Columbia Mission Duration: 54 hrs 13 mins 12 secs	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 Instrument) 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 mins 46 secs	Mar 22, 1982 KSC	Mar 30, 1982 White Sands	Cdr: Jack R. Lousma Plt: Charles G. Fullerton	**Deployable Payloads: None** 1. Plasma Diagnostic Package **Attached PLB Payloads:** 1. OSS (Office of Space Science)-1 Pallet a. Plant Lignification Experiment b. Plasma Diagnostic Package * c. Vehicle Charging and Potential d. Space Shuttle Induced Atmosphere e. Thermal Canister f. Solar Flare X-ray Polarimeter g. Solar Ultraviolet and Spectral Irradiance Monitor h. Contamination Monitor Package i. Foil Microabrasion Package *RMS deployed/berthed	2. DFI (Development Flight Instrument) Pallet 3. ACIP (Aerodynamic Coefficient Identification Package) **GAS (Getaway Special):** 1. Verification Canister **Crew Compartment Payloads:** 1. MLR (Monodisperse Latex Reactor) 2. HBT (Heflex Bioengineering Test) **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 Mission Duration: 169 hrs 9 mins 31 secs	Jun 27, 1982 KSC	Jul 4, 1982 DFRF	Cdr: Thomas K. Mattingly, II Plt: Henry W. Hartsfield, Jr.	**Deployable Payloads: None** 1. IECM (Induced Environment Contamination Monitor) deployed/reberthed by RMS **Attached PLB Payloads** 1. DFI (Development Flight Instrument) Pallet **Department of Defense** 1. DOD 82-1 **GAS (Getaway Special):** 1. Utah State University a. Drosophila Melanogaster (fruit fly) Growth Experiment b. Antemia (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. Algai 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 Mission Duration: 122 hrs 14 mins 26 secs	Nov 11, 1982 KSC	Nov 16, 1982 DFRF	Cdr: Vance DeVoe Brand Plt: Robert F. Overmyer MS: Joseph P. Allen MS: William B. Lenoir	**Deployable Payloads: None** 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 Instrument) Pallet 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)
STS-6 Challenger Mission Duration: 120 hrs 23 mins 42 secs	Apr 4, 1983 KSC	Apr 9, 1983 DFRF	Cdr: Paul J. Weitz Plt: Karol J. Bobko MS: Donald H. Peterson MS: Story Musgrave	**Deployable Payloads: None** 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)

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-7 Columbia Mission Duration: 146 hrs 23 mins 59 secs	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	**Deployable Payloads: None** 1. ANIK-C/PAM-D (Telesat Canada Satellite) 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)
STS-8 Challenger Mission Duration: 145 hrs 8 mins 43 secs	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	**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 PhotoFilm 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)

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-9 Columbia Mission Duration: 247 hrs 47 mins 24 secs	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	**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
STS-41B Challenger Mission Duration: 191 hrs 15 mins 55 secs	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	**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 Rendezvous 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 SE81-10 - 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 Mission Duration: 167 hrs 40 mins 7 secs	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	**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 Mission Duration: 144 hrs 56 mins 4 secs	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	**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 Mission Duration: 197 hrs 23 mins 33 secs	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 **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) e. SASSE (Space Adaptation Syndrome Stidoes Exp) 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 Lab - Low 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 University - 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)

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-51A Discovery Mission Duration: 191 hrs 44 mins 56 secs	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	**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 Mission Duration: 73 hrs 33 mins 23 secs	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	**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
STS-51D Discovery Mission Duration: 167 hrs 55 mins 23 secs	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)

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-51B Challenger Mission Duration: 168 hrs 8 mins 46 secs	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 Processing in 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 Utah 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.

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-51G Discovery Mission Duration: 169 hrs 38 mins 52 secs	Jun 17, 1985 KSC	Jun 24, 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	**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 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 - Slipcasting in micro-g. 4. G028: DFVLR of West Germany - Manganese - Bismuth production in micro-g. 5. G034: Dickshire Coors, Texas High School Students a. 12 Biological/physical science experiments b. 1 Microprocessor controller 6. 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 2. Galley

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-51F Challenger Mission Duration: 190 hrs 45 mins 26 secs	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. Plasma 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

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-51I Discovery Mission Duration: 170 hrs 17 mins 42 secs	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	**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 Mission Duration: 97 hrs 44 mins 38 secs	Oct 3, 1985 KSC	Oct 7, 1985 EDW	Cdr: Karol Bobko Plt: Ronald J. Grabe MS: Robert C. Stewart MS: David C. Hilmers PS: William A. Pailes	**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-61B Atlantis Mission Duration: 165 hrs 4 mins 49 secs	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, inoculation 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)

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments
STS-61C Columbia Mission Duration: 146 hrs 3 mins 51 secs	Jan 12, 1986 KSC	Jan 18, 1986 KSC	Cdr: Robert L. Gibson 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	**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 an 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 US 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 Mission Duration: N/A	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

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-26 Discovery Mission Duration: 97 hrs 0 mins 11 secs	Sep 29, 1988 KSC	Oct 3, 1988 EAFB	Cdr: Frederick H. Hauck Plt: Richard O. Covey MS: John M. Lounge MS: David C. Hilmers MS: George D. Nelson	**Deployable Payloads:** 1. TDRS-C/IUS: Tracking and Data Relay Satellite/ Inertial Upper Stage. **Attached PLB Payloads:** 1. OASIS-1: Orbiter Experiment Autonomous Supporting Instrumentation System measures and records payload bay environmental data. **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
STS-27 Atlantis Mission Duration: 105 hrs 5 mins 37 secs	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.

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-29 Discovery Mission Duration: 119 hrs 38 mins 52 secs	Mar 13, 1989 KSC	Mar 17, 1989 EAFB	Cdr: Michael L. Coats Plt: John E. Blaha MS: James P. Bagian 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): None** **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) 5. Chicken Embryo Development (CHIX) in space. 6. Effects of Weightlessness of Bones (SSIP 82-08) **Special Payload Mission Kits: None**
STS-30 Atlantis Mission Duration: 96 hrs 56 mins 28 secs	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 mins 8 secs	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.
STS-34 Atlantis Mission Duration: 119 hrs 39 mins 20 secs	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	**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**

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-33 Discovery Mission Duration: 120 hrs 6 mins 46 secs	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	**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 Mission Duration: 261 hrs 0 mins 37 secs	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	**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
STS-36 Atlantis Mission Duration: 106 hrs 18 mins 22 secs	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	**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 Mission Duration: 121 hrs 16 mins 6 secs	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	**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

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-41 Discovery Mission Duration: 98 hrs 10 mins 3 secs	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	**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** **Crew Compartment Payloads:** 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
STS-38 Atlantis Mission Duration: 117 hrs 54 mins 27 secs	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 5 mins 7 secs	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. Hopkins 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) **Special Payload Mission Kits:** 1. Galley 2. Aerodynamic Coefficient Identification Package (ACIP)
STS-37 Atlantis Mission Duration: 143 hrs 22 mins 45 secs	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 Mission Duration: 199 hrs 23 mins 17 secs	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	**Deployable Payloads:** 1. Shuttle Payload Autonomous Satellite (SPAS)-II/ 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
STS-40 Columbia Mission Duration: 218 hrs 15 mins 14 secs	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	**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 (GBA) - 12 GAS experiments mounted on a truss structure 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 Mission Duration: 213 hrs 22 mins 27 secs	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	**Deployable Payloads:** 1. TDRS-E/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 Mission Duration: 128 hrs 27 mins 51 secs	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	**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**
STS-44 Atlantis Mission Duration: 166 hrs 52 mins 27 secs	Nov 14, 1991 KSC	Dec 1, 1991 EAFB	Cdr: Frederick D. Gregory Plt: Terence T. Henricks MS: F. Story Musgrave MS: Mario Runco, Jr. MS: James S. Voss PS: Thomas J. Hennen	**Deployable Payloads:** 1. Defense Support Program/Inertial Upper Stage satellite (DSP/IUS) **Attached PLB Payloads:** 1. Interim Operational Contamination Monitor (IOCM) Experiments 1. Gas Bridge Assembly (GBA) **Crew Compartment Payloads:** 1. Terra Scout 2. Military Man in Space (M88-1)	3. Air Force Maui Optical Site (AMOS) 4. Cosmic Radiation Effects and Activation Monitor (CREAM) 5. Shuttle Activation Monitor (SAM) 6. Radiation Monitoring Experiment (RME-III) 7. Visual Function Monitor (VFT-1) 8. Ultraviolet Plume Instrument (UVPI) **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-42 Discovery Mission Duration: 193 hrs 15 mins 43 sec	Jan 22, 1992 KSC	Jan 30, 1992 EAFB	Cdr: Ronald J. Grabe Plt: Steven S. Oswald MS: Norman E. Thagard MS: William F. Readdy MS: David C. Hilmers PS: Roberta L. Bondar PS: Ulf D. Merbold	**Deployable Payloads: None** **Attached PLB Payloads:** International Microgravity Laboratory-1 (Spacelab Long Module) Objective: Conduct 9 Materials Science and 7 Life Sciences experiments in microgravity: 1. Fluid Experiment System - Crystal growth and fluid behavior 2. Vapor Crystal Growth System - Reflight from Spacelab 3 3. Mercury Iodide Crystal Growth - Reflight from Spacelab 3 4. Protein Crystal Growth - Reflight from STS 26, 29, 32, 37 (Middeck) 5. Organic Crystal Growth Facility - Crystal growth 6. Cryostat- Crystal growth 7. Space Acceleration Monitoring System - Measure on-orbit shuttle acceleration to support other microgravity experiments 8. Critical Point Facility - Measure material properties at the critical point 9. Gravitational Plant Physiology Facility - Biological investigation of plants during spaceflight 10. Biorack - Biological investigation of various life forms during spaceflight 11. Space Physiology Experiments - Investigate human space adaptation and motion sickness 12. Microgravity Vestibular Investigations - Study space motion sickness 13. Biostack - Investigate space radiation effects on biological materials 14. Mental Workload and Performance Evaluation - Test human performance of computer tasks in Zero-G 15. Radiation Monitoring Container/Dosimeter - Measure effect of space radiation on biological material	**GAS (Getaway Special) Bridge consisting of 12 canisters:** 1. G-086 - Effects of microgravity on cysts hatched in space; thermal conductivity and bubble velocity of air in water 2. G-140 - Marangoni convection in a floating zone 3. G-143 - Glass bubbles in glass melts 4. G-329 - Solidification of phenomena in metal alloys 5. G-336 - Measurement of diffuse zodiacal and galactic emissions at B, R, and V standard 6. G-337 - Performance of thermoacoustic refrigerator under microgravity 7. G-457 - Gas-liquid separation under microgravity 8. G-609, G-610 - Ultraviolet observations of deep space 9. G-614 - Motion of debris under microgravity conditions: low melting point materials processing 10. Middeck 0-Gravity Dynamics Experiment (MODE) 11. GAS ballast payload no. 1 (GPB #1) 12. GAS ballast payload no. 2 (GPB #2) **Crew Compartment Payload:** 1. Gelation of Sols: Applied Microgravity Research (GOSAMR) - Objective: Investigate processing of gelled sols in microgravity 2. Student Experiment SE 93-2 - Objective: Study zero gravity capillary rise of liquid through granular porous media 3. Student Experiment SE 81-9 - Objective: Study convection in zero gravity 4. Investigation into Polymer Membrane Processing (IPMP) Objective: Manufacture polymers in space 5. Radiation Monitoring Experiment (RME-III) - Objective: Measure radiation environment on-orbit **Special Payload Mission Kits: None**

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments
STS-45 Atlantis Mission Duration: 214 hrs 10 mins 24 secs	Mar 24, 1992 KSC	Apr 2, 1992 KSC	Cdr: Charles F. Bolden Plt: Brian K. Duffy MS: Kathryn D. Sullivan MS: David C. Leestma MS: C. Michael Foale PS: Dirk D. Frimout PS: Bryon K. Lichtenburg	**Deployable Payloads: None** **Attached PLB Payloads:** ATLAS-1 (2 Spacelab Pallet and Igloo) - Objective: Study the composition of the middle atmosphere and its variations over an 11 year solar cycle. This is the first of 10 planned ATLAS missions over the next 11 years. Atmosphere Physics: 1. Atmosphere Trace Molecule Spectroscopy (ATMOS) - Previously flown on Spacelab 1, Reflight from Spacelab 3 2. Millimeter Wave Atmospheric Sounder (MAS) - First flight 3. Atmospheric Lyman Alpha Emissions (ALAE) - Previously flown on Spacelab 1 4. Grille Spectrometer (GRILLE) - Previously flown on Spacelab 1 5. Imaging Spectrometric Observatory (ISO) - Previously flown on Spacelab 1 Solar Science: 1. Active Cavity Radiometer Irradiance Monitor (ACRIM) - ACRIM 1 flown on the solar maximum satellite 2. Measurement of the Solar Constant (SOLCON) - Previously flown on Spacelab 1 3. Solar Spectrum Measurement from 180 to 3200 Nanometers (SOLSPEC) - Previously flown on Spacelab 1 4. Solar Ultraviolet Spectral Irradiance Monitor (SUSIM) - Previously flown on Spacelab 2 and on the Upper Atmosphere Research Satellite (UARS) Space Plasma Physics: 1. Atmospheric Emissions Photometric Imaging (AEPI) - Previously flown on Spacelab 1 2. Space Experiments with Particle Accelerators (SEPAC) - Previously flown on Spacelab 1 3. Energetic Neutral Atom Precipitation Ultraviolet Astronomy: 1. Far Ultraviolet Space Telescope (FAUST) - Previously flown on Spacelab 1 2. Shuttle Solar Backscatter Ultraviolet/A (SSBUV/A) - Objective: To provide more accurate and reliable readings of global ozone to aid in the calibration of backscatter ultraviolet instruments being flown on free-flying satellites **GAS (Getaway Special):** 1. Getaway Special 229 (GAS-229) - Objective: To melt and regrow gallium arsenide crystals with convective effects absent **Crew Compartment Payload:** 1. Investigation into Polymer Membranes Processing (IPMP)- Objective: To flash evaporate mixed solvent systems in the absence of convection to control the porosity of the polymer membrane in microgravity 2. Space Tissue Loss-01 (STL-01) - Objective: To monitor the activities of tissue samples at the cellular level under the influence of microgravity 3. Radiation Monitoring Equipment-III (RME-III) - Objective: To measure ionizing radiation over repeated time intervals and digitally store the resulting data 4. Visual Function Tester-2 (VFT-2) - Objective: To measure basic vision performance parameters in an orbital space flight environment 5. Cloud Logic to Optimize Use of Defense System - Objective: To obtain photographic sequences of cloud fields of interest as targets of opportunity 6. Shuttle Amateur Radio Experiment (SAREX II) - Objective: To demonstrate voice, slow-scan television (SSTV), and pocket radio. All transmitted on 2 meter capabilities and fast scan television (FSTV) transmitted on 70 cm capability.

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-49 Endeavour Mission Duration: 213 hrs 17 mins 38 secs	May 2, 1992 KSC	May 16, 1992 EAFB	Cdr: Daniel C. Brandenstein Plt: Kevin P. Chilton MS: Richard J. Hieb MS: Bruce E. Melnick MS: Pierre J. Thout MS: Kathryn C. Thornton MS: Thomas D. Akers	**Deployable Payloads:** 1. Intelsat VI F3 (International Telecommunications Satellite)/perigee kick motor (PKM) **Attached PLB Payloads:** 1. Assembly of station by EVA methods **GAS (Getaway Special): None**	**Crew Compartment Payloads:** 1. Commercial protein crystal growth (CPGC) 2. Air Force Maui Optical Site Calibration (AMOS) 3. Ultraviolet Plume Instrument (UVPI) **Special Payload Mission Kits: None**
STS-50 Columbia Mission Duration: 331 hrs 30 mins 04 secs	Jun 25, 1992 KSC	Jul 9, 1992 KSC	Cdr: Richard N. Richards Plt: Keneth D. Bowersox MS: Bonnie J. Dunbar MS: Carl J. Meade MS: Ellen S. Baker PS: Lawrence J. DeLucas	**Deployable Payloads: None** **Attached PLB Payloads:** 1. U.S. Microgravity Laboratory (USML-1) 2. Investigation into Polymer Membrane Processing (IPMP) 3. Shuttle Amateur Radio Experiment-II (SAREX-II) 4. Ultraviolet Plume Instrument (UVPI) 5. Orbital Acceleration Research Experiment (OARE) 6. Zeolite Crystal Growth (ZCG) 7. Astroculture 8. Generic Bioprocessing Apparatus (GBA) 9. Protein Crystal Growth (PCG) Block 1	**GAS (Getaway Special): None** **Crew Compartment Payloads:** 1. Zeolite Crystal Growth 2. Generic Bioprocessing Apparatus with 1 Refrigerator/Incubator Module (R/IM) 3. Astroculture (ASC) 4. Protein Crystal Growth (PCG) Block 1 with 3 R/IMs 5. Investigation into Polymer Membrane Processing (IPMP) 6. Shuttle Amateur Radio Experiment-II (SAREX-II) 7. Ultraviolet Plume Instrument (UVPI) **Special Payload Mission Kits: None**
STS-46 Atlantis Mission Duration: 191 hrs 16 mins 07 secs	Jul 31, 1992 KSC	Aug 8, 1992 KSC	Cdr: Loren J. Shriver Plt: Andrew M. Allen MS: Jeffrey A. Hoffman MS: Franklin R. Chang-Diaz MS: Claude Nicollier MS: Martha S. Ivins PS: Franco Malerba	**Deployable Payloads:** 1. EURECA **Attached PLB Payloads** 1. Tethered Satellite System (TSS-1) 2. Evaluation of Oxygen Interation with Materials-III/Thermal Energy Management Processes 2A-3 (EOIM-III/Temp 2A) 3. IMAX Cargo Bay Camera (ICBC) 4. Consortium for Material Development in Space Complex Autonomous Payload-II (CONCAP-II) 5. CONCAP-III 6. Limited Duration Space Environment Candidate Materials Exposure (LDCE)	**GAS (Getaway Special): None** **Crew Compartment Payloads:** 1. Gas Autonomous Payload Controller (GAPC) for Use in ICBC Operations 2. Pituitary Growth Hormone Cell Function (PHCF) 3. Air Force Maui Optical Site Calibration (AMOS) (Passive Requirements Only) 4.. Ultraviolet Plume Instrument (UVPI) **Special Payload Mission Kits: None**

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-47 Endeavour Mission Duration: 190 hrs 30 mins 23 secs	Sep 12, 1992 KSC	Sep 20, 1992 KSC	Cdr: Robert L. Gibson Plt: Curtis L. Brown MS: Mark C. Lee MS: N. Jan Davis MS: Mae C. Jemison MS: Jerome Apt PS: Mamoru Mohri	**Deployable Payloads: None** **Attached PLB Payloads:** 1. Japanese Spacelab (Spacelab-J) Long Module Gas Bridge Assembly (GBA) with 12 Gas Canisters **GAS (Getaway Special): None**	**Crew Compartment Payloads:** 1. Israeli Space Agency Investigation about Hornets (ISAIAH) 2. Shuttle Amateur Radio Experiment (SAREX) 3. Solid Surface Combustion Experiment (SSCE) 4.. Ultraviolet Plume Instrument (UVPI) - Payload of Opportunity **Special Payload Mission Kits: None**
STS-52 Columbia Mission Duration: 236 hrs 56 mins 13 secs	Oct 22, 1992 KSC	Nov 1, 1992 KSC	Cdr: James D. Wetherbee Plt: Michael A. Baker MS: William M. Sheperd MS: Tamara E. Jernigan MS: Charles L. Veach	**Deployable Payloads: None** 1. Laser Geodynamics Satellite (LAGEOS) **Attached PLB Payloads** 1. United Stated Microgravity Payload (USMP-1) **GAS (Getaway Special): None** **Crew Compartment Payloads:** 1. Queens University Experiment in Liquid Metal Diffusion (QUELD) 2. Phase Partition in Liquid (PARLIQ) 3. Sun Photo Spectrometer Earth Atmosphere 3. Sun Photo Spectrometer Earth Atmosphere Measurement-2 (SPEAM)	4. Orbiter Glow-2 5. Commercial Materials Dispersion Apparatus Instrumentation Technology Associates Experiments (CMIX) 6. Crystal by Vapor Transport Experiment (CVTE) 7. Heat Pipe Performance (HPP) (CMIX) 8. Commercial Protein Crystal Growth (CPCG) 9. Shuttle Plume Impingement Experiment (SPIE) 10. Physiological System Experiment (PSE) **Special Payload Mission Kits: None**
STS-53 Discovery Mission Duration: 175 hrs 19 mins 47 secs	Jul 31, 1992 KSC	Aug 8, 1992 EAFB	Cdr: Loren J. Shriver Plt: Andrew M. Allen MS: Jeffrey A. Hoffman MS: Franklin R. Chang-Diaz MS: Claude Nicollier	**Deployable Payloads:** **Attached PLB Payloads**	**GAS (Getaway Special): None** **Crew Compartment Payloads:** **Special Payload Mission Kits: None**

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-54 Endeavour Mission Duration: 143 hrs 38 mins 19 secs	Jan 13, 1993 KSC	Jan 19, 1993 KSC	Cdr: John H. Casper Plt: Donald R McMonagle MS: Mario Runco, Jr MS: Gregory Harbaugh MS Susan Helms	**Deployable Payloads: None** 1. Tracking and Data Relay Satellite/Inertial Upper Stage(TDRS/IUS) **Attached PLB Payload:** 1. Diffuse X-Ray Spectrometer(DXS) **GAS(Getaway Special):** None **Crew Compartment Payloads:** 1. Chromosome and Plant Cell Division in Space(CHROMEX)	2. Commercial Generic Bioprocessing Apparataus(CGBA) 3. Physiological and Anatomical Rodent Experiment(PARE) 4. Solid Surface Combustioin Experiment(SSCE) **Special Payload Mission Kits:** None
STS-56 Discovery Mission Duration: 222 hrs 08 mins 24 secs	Apr 8, 1993 KSC	Apr 17, 1993 KSC	Cdr: Kenneth Cameron Plt: Steven S. Oswald MS: C. Michael Foale MS: Kenneth Cockrell MS: Ellen Ochoa	**Deployable Payloads:** 1. Shuttle Point Autonomous Research Tool for Astronomy - 201(SPARTAN-201) **Attached PILB Payloads:** 1. Atmospheric Laboratory for Applications and Science (ATLAS-2) **GAS (Getaway Special):** None **Crew Compartment Payloads:** 1. Solar Ultraviolet Spectrometer(SUVE) 2. Hand-Held, Earth-Oriented, RealTime, Cooperative, User-Friendly, Location Targeting, and Environmental System(HERCULES) 3. Radiation Monitoring Equipment II(RME-III)	4. Cosmic Radiatiion Effects and Activation Monitor(CREAM) 5. Shuttle Amateur Radio Experiment II(SAREX II) 6. Commercial Materials Dispersion Apparatus ITA Experiments(CMIX) 7. Space Tissue Loss Experiment(STL) 8. Physiological and Anatomical Rodent Experiment(PARE) **Special Payload Mission Kits** 1. Remote Manipulator System
STS-55 Columbia Missioin Duration: 239 hrs 39 mins 59 secs	Apr 26, 1993 KSC	May 6, 1993 EAFB	Cdr. Steven R. Nagel Plt. Terence T. Hendricks MS. Charles Precourt MS. Bernard Harris, Jr. PS. Ulrich Walter PS Hans Schlegel	**Deployable Payload:** None **Attached PLB Payload:** 1. D2 payload user support structure: German(SPACELAB) 2. Material Science Autonomous Payload(MAUS) 3. Atomic Oxygen Exposure Tray(AOET) 4. Galactic Ultrawide Angle Schmidt System Camera(GAUSS) 5. Modular Opto-Electronic Multispectral Stereo Scanner (MOMS)	**GAS (Gateway Special):** 1. Reaction Kinetics in Glass Melts(RKGM) **Crew Compartment Payload:** 1. Crew Telesupport Experiment 2. Shuttle Amateur Radio Experiment(SARAX) **Special Payload Mission Kits:** None

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-57 Endeavour Mission Duration: 239 hrs 44 mins 54 secs	Jun 21, 1993 KSC	Jul 1, 1993 KSC	Cdr: Ronald J. Grabe Plt: Brian J. Duffy PC: G. David Low MS: Nancy J. Sherlock MS: Peter J. K. Wisoff MS: Janice E. Voss	**Deployable Payloads:** 1. EURECA **Attached PLB Paylaods** 1. Spacehab-1 a. Experiments(22) **GAS (Getaway Special):** 1. G-022: Pedriodic Volume Stimulus 2 G-324: Earth Photographs 3. G-399: Insulin/Artemia/Ion Expts 4. G-450: Crystal Growth/Fluid Transfer 5. G-452: Crystal Growth 6. G-453: Semiconductor/Boiling Expts	7. G-454: Crystal Growth 8. G-535: Pool Boiling 9. G-601: High Frequency Variations 10. G-647: Liquid Phase Electroepitaxy **Crew Compartment Payloads:** 1. SAREX-II (Shuttle Amateur Radio Experiment -II) 2. FARE (Fluid Acquisition and Resupply Experiment) 3. AMOS (Air Force Maui Optical Site Calibration Test) **Special Payload Mission Kits:** 1. SHOOT: (Superfluid Helium On-Orbit Transfer) 2. CONCAP-IV: (Consortium for Materials Development in Space Complex Autonomous Payload IV)
STS-51 Discovery Mission Duration: 236 hrs 11 mins 11 secs	Sept 12, 1993 KSC	Sept 22, 1993 KSC	Cdr: Frank Culbertson, Jr. Plt: William F. Readdy MS: James H. Newman MS: Daniel W. Bursch MS Carl E. Walz	**Deployable Payloads:** 1. ACTS: (Advanced Communication Technology Satellite) 2. TOS: (Transfer Orbit Stage) 3. ORFEUS/SPAS: (Orbiting Retrievable Far and Extreme Ultraviolet Spectrometer-Shuttle Pallet Satellite) 4. LDCE: (Limited Duration Space Environment Candidate Materials Exposure) **Attached PLB Payloads:** 1. IMAX: Camera 2. CPCG: (Commercial Protein Crystal Growth) 3. CHROMEX:(Chromosome and Plant Cell Division in Space) 4. HRSGS-A: (High Resolution Shuttle Glow Spectroscopy) 5. APE-B: (Auiroral Photography Experiment) 6. RME-III: (Radiation Monitoring Experiment-III) 7. IPMP: (Investigations into Polymer Membrane Processing) 8. AMOS: (Air Force Maui Optical Site Calibration Test) **GAS (Getaway Special): None**	**Crew Compartment Payloads:** **Special Payload Mission Kits:**

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-58 Columbia	Oct 18, 1993 KSC	Nov 1, 1993 EAFB	Cdr: John E. Blaha Plt: Richard Searfoss PC: Margaret Rhea Seddon MS: Shannon W. Lucid MS: David A. Wolf MS: William McArthur, Jr. PS: Martin J. Fettman	**Deployable Payloads: None** **Attached PLB Payloads:** 1. Spacelab Life Sciences-2(SLS-2) a. Spacelab Long Module b. Spacelab Pallet c. Tunnel d. Tunnel Extension **GAS (Getaway Special): None**	**Crew Compartment Payloads:** 1. Urine Monitoring System (UMS 2. Shuttle Amateur Radio Experiment (SAREX **Special Payload Mission Kits:**
Mission Duration: 336 hrs 12 mins 32 secs					
STS-61 Endeavour	Dec 2, 1993 KSC	Dec 13, 1993 KSC	Cdr: Richard O. Covey Plt: Kenneth D. Bowersox MS: F. Story Musgrave MS: Thomas D. Akers MS: Jeffery A. Hoffman MS: Kathryn C. Thornton MS: Claude Nicollier	**Deployable Payloads:** 1. Hubble Space Telescope (HST) Service Mission - 01 a. Solar Array (SA) b. Wide Field/Planetary Camera (WFPC) c. Corrective Optics Space Telescope Axial Replacement (COSTAR) **Attached PLB Payloads:** 1. MFR (Manipulator Foot Restraint) 2. SESA (Special Equipment Stowage Assembly) 3. IMAX Cargo Bay Camera (ICBC-04) 4. Air Force Maui Opitical Site Calibration Test (AMOS) **GAS (Getaway Special): None**	**Crew Compartment Payloads** 1. Hubble Space Telescope Special Tools 2. Shuttle Orbiter Repackaged Galley (SORG) 3. Electronic Still Camera Photography Test 4. Global Positioning System (GYS) **Special Payload Mission Kits: None**
Mission Duration: 259 hrs 58 mins 35 secs					

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-60 Discovery Mission Duration: 199 hrs 09 mins 22 secs	Feb 3, 1994 KSC	Feb 11, 1994 KSC	Cdr: Charles Bolden Plt: Ken Reightler MS: Franklin Chang-Diaz MS: Jan Davis MS: Ronald Sega MS: Sergei Krikalev	**Deployable Payloads:** 1. Wake Shield Facility-1 (WSF-1) **Attached PLB Payloads:** 1. SPACEHAB-2 a. Experiments-12 2. Capillary Pump Loop (CAPL) **GAS (Getaway Special):** 1. Oribtal Debris Radar Calibration Spheres (ODERACS) 2. BREMAN Satellite (BREMSAT) 3. G-071 (Ball Bearing Experiment) 4. G-514 (Orbiter Stability Exper.& Medicines in Microgravity) 5. G-536 (Heat Flux) 6. G-557 (Capillary Pumped Loop Experiment)	**Crew Compartment Payloads:** 1. Shuttle Amateur Radio Experiment-II (SAREX-2) 2. Aurora Photography Experiment-B (APE-B) **Special Payload Mission Kits: None**
STS-62 Columbia Mission Duration: 335 hrs 16 mins 41 ses	Mar 9, 1994 KSC	Mar 18, 1994 KSC	Cdr: John Casper Plt: Andrew Allen MS: Pierre Thuot MS Charles Gemar MS Marsha Ivins	**Deployable Payloads:** None **Attached PLB Payloads:** 1. United States Microgravity Payload-2 (USMP-2) a. Experiments-5 2. Office of Aeronautics & Space Technology-2 (OAST-2) 3. Dexterous End Effector (DEE) 4. Shuttle Solar Backscatter Ultraviolet/A (SSBUV/A) 5. Limited Duration Space Environment Candidate Materials Exposure (LDCE) **GAS (Getaway Special): None**	**Crew Compartment Payloads** 1. Protein Crystal Growth Experiments (PCG) 2. Physiological System Experiment (PSE) 3. Commercial Protein Crystal Growth (CPCG) 4. Commercial Generic Bioprocessing Apparatus (CGBA) 5. Middeck O-Gravity Dynamics Experiments (MODE) 6. Bioreactor Demonstration System (BDS): Biotechnology Specimen Temperature Controller (BSTC) **Special Payload Mission Kits:** 1. Air Force Maui Optical Site Calibration Test (AMOS)

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-59 Endeavour Mission Duration: 269hrs 49mins 30secs	Apr 9, 1994 KSC	Apr 20, 1994 KSC	Cdr: Sidney M. Gutierrez Plt: Kevin P. Chilton MS: Linda M. Godwin MS: Jay Apt MS: M.R. Clifford MS: Thomas D. Jones	**Deployable Payloads: None** **Attached PLB Payloads:** 1. Space Radar Laboratory-1 (SRL-1) 2. Consortium for Materials Development in Space Complex Autonomous Payload-IV (CONCAP-IV) **GAS (Getaway Special):** 1. G-203, New Mexico State University 2. G-300, Matra Marconi Space 3. G-458, The Society of Japanese Aerospce Companies, Inc.	**Crew Compartment Payloads:** 1. Space Tissue Loss (STL) 2. Shuttle Amateur Radio Experiment -II (SAREX-II) 3. Toughened Uni-Piece Fibrous Insulation (TUFI) 4. Visual Function Tester-4 (VFT-4) **Special Payload Mission Kits: None**
STS-65 Columbia Mission Duration: 353hrs 55mins 00secs	Jul 8, 1994 KSC	Jul 23, 1994 KSC	Cdr: Robert D. Cabana Plt: James D. Halsell MS: Richard J. Hieb MS: Carl E. Walz MS: Leroy Chiao MS: Donald A. Thomas PS: Chiaki Naito-Mukai	**Deployable Payloads: None** **Attached PLB Payloads:** 1. International Microgravity Lab-2 (IML-2) a. Large Isothermal Furnace b. Electromagnetic Containerless Processing Facility c. Bubble, Drop and Particle Unit d. Critical Point Facility e. Space Acceleration Measurement System f. Quasi-Steady Acceleratioin Measurement g. Vibration Isolation Box Experiment System h. Advanced Protein Crystallization Facility i. Applied Research on Separation Methods Using Space Electrophoresis j. Free Flow Electrophoresis Unit k. Aquatic Animal Experiment Unit l. Thermoelectric Incubator/Cell Culture Kit m. Biorack n. Slow Rotating Centrifuge Microscope o. Spinal Changes in Microgravity p. Extended Duration Orbiter Medical Project	q. Performance Assessment Workstation r. Biostack s. Real-Time Radiation Monitoring Device 2. Orbital Acceleration Research Experiment (OARE) **GAS (Getaway Special): None** **Crew Compartment Payloads:** 1. Commercial Protein Crystal Growth (CPCG) 2. Shuttle Amateur Radio Experiment-II (SAREX-II) 3. Military Applications of Ship Tracks (MAST) **Special Payload Mission Kits:** 1. Air Force Maui Optical Site (AMOS)

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-64 Discovery Mission Duration: 262 hrs 49 mins 57 secs	Sep 9, 1994 KSC	Sep 20, 1994 EDW	Cdr: Richard N. Richards Plt: L.. Blaine Hammond MS: Jerry M. Linenger MS: Susan J. Helms MS: Carl J. Meade MS: Mark C. Lee	**Deployable Payloads:** 1. Shuttle Pointed Autonomous Research Tool for Astronomy (SPARTAN 201) **Attached PLB Payloads:** 1. Lidar in Space Technology Experiment (LITE) 2. Robotic Operated Materials Processing System (ROMPS) 3. Shuttle Plume Impingement Flight Experiment (SPIFEX) **GAS (Getaway Special):** 1. G-178, Charge Coupled Device (CCD) 2. G-254, Utah State University; Spacepak 1-4 3. G-325, Norfolk Public Schools Science & Technology Advanced Research (NORSTAR) 4. G-417, Beijing Institute of Environmental Testing 5. G-453, The Society of Japanese Aerospace Companies (SJAC), Superconducting and Bubble Formation	6. G-454, The Society of Japanese Aerospace Companies (SJAC), Crystal Growth Experiments 7. G-456, The Society of Japanese Aerospace Companies (SJAC), Electrophoresis and Microgravity Tests 8. G-485, European Space Agency/ESTEC FTD 9. G-506, Orbiter Stability Experiment (OSE) 10. G-562, Canadian Space Agency, QUESTS-2 **Crew Compartment Payloads** 1. Air Force Maui Optical Site (AMOS) 2. Biological Research in Canisters (BRIC) 3. Military Application of Ship Tracks (MAST) 4. Radiation Monitoring Experiment-III (RME-III) 5. Shuttle Amateur Radio Experiment-II (SAREX-II) 6. Solid Surface Combustion Experiment (SSCE) **Special Payload Mission Kits: None**
STS-68 Endeavour Mission Duration: 269 hrs 46 mins 08 secs	Sep 30, 1994 KSC	Oct 11, 1994 EDW	Cdr Michael A. Baker: Plt Terrence W. Wilcutt MS: Steven L. Smith MS Daniel W. Bursch MS Peter J. K. Wisoff MS Thomas D. Jones	**Deployable Payloads: None** **Attached PLB Payloads:** 1. Space Radar Laboratory-2 (SRL-2) **GAS (Getaway Special):** 1. G-316, Student Space Shuttle Program (SSSP) 2. G-503, Microgravity & Cosmic Radiation Effects on Diatoms (MCRED) Concrete Curing in Microgravity (ConCIM) Root Growth in Space (RGIS) Microgravity Corrosion Experiment (COMET) 3. G-541, Study breakdown of a planar solid/liquid interface during crystal growth **Special Payload Mission Kits: None**	**Crew Compartment Payloads** 1. Commercial Protein Crystal Growth (CPCG) 2. Biological Research in Canisters (BRIC) 3. Chromosomes & Plant Cell Division in Space Experiment (CHROMEX) 4. Cosmic Radiation Effects and Activation Monitor (CREAM) 5. Military Applications of Ship Tracks (MAST)

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-65 Discovery	Feb. 2, 1995 KSC	Feb. 11, 1995 KSC	Cdr: James D Wetherbee Plt: Eileen M. Collens MS: Bernard A. Harris, Jr. MS: Michael C. Roale MS: Janice Voss MS: Vladimir Georgievich Titov Mission Duration: 196 hrs 29 mins 36 secs	**Deployable Payloads:** 1. Shuttle Mir Rendezvous and Fly Around 2. SPARTAN 204 Science 3. Extravhicular Activities (EVA) **Attached PLB Payloads:** 1. SPACEHAB-3	2. Solid Surface Combustion Experiment (SSCE) 3. Air Force Maui Optical Site (AMOS) **GAS (Gateaway Special): None** **Special Payload Mission Kits: None**
STS-67 Endeavour	Mar. 3, 1995	Mar 18, 1995	Cdr: Steven S Oswald Plt: William G. Gregory MS: John M Grunsfeld MS: Wendy B. Lawrence MS: Tamara E. Jerrigan MS. Samuel T. Durrance MS: Ronald Parise Mission Duration: 399 hrs 09 mins 47 secs	**Deployable Paloads: None** **Attached PLB Payloads:** 1. ASTRO 2 Spacelab 2. Ultraviolet Telescope of the Johns Hopkins Univ. (HUT) 3. Ultraviolet Imaging Telescope of NASA/GSFC (UIT) 4. Photo-Polarimeter Telescope of the Univ of Wisconsin (WUPPE)	**GAS (Getaway Special):** 1. ASTRO-2 Getaway Special Canisters **Crew Compartment Payloads:** 1. Commercial MDA ITA Experiments (CMIX) 2. Protein Crystal Growth (PCG) Experiments 3. Middeck Active Control Experiment (MACE) 4. Shuttle Amateur Radio Experiment (SAREX-II)
STS-71 Atlantis	June 27, 1995	July 7, 1995	Cdr: Robert L. Gibson Plt: Charles J. Precourt MS: Ellen S. Baker MS: Gregory J. Harbaugh MS: Bonnie Dunbar MIR 19-Ascent Only; Cdr: Anatoly Y. Solovyev FE: Nikolai M. Budarin MIR 18-Descent Only; Cdr:Vladmir Dezhurov FE: Gennady Strekalov Norm Thagard Mission Duration: 235 hrs 23 mins 09 secs	**Deployable Payloads: None** **Attached PLB Payloads:** 1. Shuttle-Mir Rendezvous and Docking 2. Orbiter Docking System **Crew Compartment Payloads** 1. Shuttle-MIR Science 2. Protein Crystal Growth Experiment 3. Protocol Activities 4. IMAX 5. Shuttle Amateur Radio Experiment-II (SAREX)	**GAS(Getaway Specials): None** **Special Payload Mission Kits: None**

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-70 Discovery Mission Duration: 214 hrs 21 mins 09 secs	July 13, 1995 KSC	July 22, 1995 KSC	Cdr: Terren T. Hendricks Plt: Kevin R. Kregel MS: Mary E. Weber MS: Donald A. Thomas MS: Nancy J. Curie	**Deployable Payloads:** 1. Tracking and Data Relay Satellite (TDRS-7) 2. Inertial Upper Stage (IUS) **Attached PLB Payloads:** 1. Biological Research in Canisters (BRIC) 2. Bioreactor Development Systems (BDS) 3. Commercial Protein Crystal Growth (CPCG) 4. National Institues of Health R-2 (NIR R-2) 5. Space Tissue Loss-B (STL-B) 6. Midcourse Space Experiment (MSX) **GAS (Getaway Special): None**	**Crew Compartment Payloads:** 1. Hand-Held, Earth-Oriented, Cooperative, Real-Time, User-Friendly, Location Targeting and Environmental Systems (HERCULES) 2. Microencapsulation in Space-B (MIS-B) 3. Military Application of Ship Tracks (MAST) 4. Radiation Monitoring Equipment-III (RME-III) 5. Shuttle Amateur Radio Equipment (SAREX) 6. Window Experiment (WINDEX) 7. Visual Function Tester-4 m(VFT-4) **Special Payload Mission Kits: None**
STS-69 Endeavour Mission Duration: 260 hrs 29 mins 56 ses	Sept. 7, 1995 KSC	Sept. 18, 1995 KSC	Cdr: David M. Walker Plt: Kenneth D. Cockrell PLC: James S. Voss MS Jim Newman MS Michael L. Gernhardt	**Deployable Payloads:** 1. Wake Shield Facility-2 (WSF-2) 2. SPARTAN 201-03 **Attached PLB Payloads** 1. International Extreme Ultraviolet Hitchhiker(IEU) 2. Solar Extreme Ultraviolet Hitchhiker (SEH) 3. Capillary Pumped Loop-1/Gas Bridge Assembly (CAPL-2/GBA) **GAS (Getaway Special):** 1. G-515, European Space Agency, Noordwijk, The Netherlands Control Flexibility Interaction Experiment 2. G-645, Millcreek Township School District, Erie, PA McDowell High School, LORD Corp. 3. G-702, The Microgravity Smoldering Combustion Experiment (MSC) NASA Lewis Research Center 4. G-726, The Joint Damping Experiment (JDX) NASA Langley Research Center	**Crew Compartment Payloads:** 1. Space Tissue Loss/National Institutes of Health-Cells (STL/NIH-C) 2. Commercial Generic Bioprocessing Apparatus-7 (CCBA) 3. Biological Research In Canister (BRIC 4. Electrolysis Performance Improvement Concept Study (EPICS) 5. Commercial MDA ITA Experiments (CMIX) **Special Payload Mission Kits: None**

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-73 Columbia Mission Duration: 381 hrs 53 mins 17 secs	Oct. 20, 1995 KSC	Nov. 5, 1995 KSC	Cdr: Kenneth D. Bowersox Plt: Kent Rominger MS: Kathryn Thornton MS: Catherine Coleman MS: Michael Lopez-Alegria PS: Fred Leslie PS: Albert Sacco	**Deployable Payloads: None** **Attached PLB Payloads:** 1. United States Microgravity Laboratory-2 (USML-2) a. Surface Tension Driven Convection Experiment b. Drop Dynamics Experiment c. Geophysical Fluid Flow Cell Experiment d. Crystal Growth Furnace e. Protein Crystal Growth Experiments f. Astroculture Facility and Experiment 2. Orbital Acceleration Research Experiment (OARE) **GAS (Getaway Special): None**	**Crew Compartment Payloads:** 1. Education Experiments **Special Payload Mission Kits: None**
STS-74 Atlantis Mission Duration: 196 hrs 31 mins 42 secs	Nov. 12, 1995 KSC	Nov. 20, 1995 KSC	Cdr: Ken Cameron Plt: Jim Halsell MS: Chris Hadfield MS: Jerry Ross MS: William McArthur	**Deployable Payloads: None** **Attached PLB Payloads:** 1. Docking Module w/Solar Arrays 2. Orbital Docking System 3. IMAX Cargo Bay Camera 4. GLOW-4 (GPP) 5. Photogrammetric Appecdage Structural Dynamics Experiment (PASDE) 6. Shuttle Glo Experiment (GLO-4)	**GAS (Gateaway Special: None** **Crew Compartment Payloads:** 1. Shuttle Amateur Radio Experimemt-II (SAREX-II) 2. Detailed Test/Supplementary Objectives (DTOs/DSOs) **Special Payload Mission Kits: None**

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-72 Endeavour Mission Duration: 214 hrs 01 mins 47 secs	Jan. 11, 1996 KSC	Jan 20, 1996 KSC	Cdr: Brian Duffy Plt: Brent W. Jett MS: Leroy Chiao MS: Daniel T. Barry MS: Winston E. Scott MS: Koichi Wakata	**Deployable Payloads:** 1. Deployed and retrieved SPARTAN 206 Flyer 2. Retreived Japanese Space Flyer Unit **Attached PLB Payloads** 1. Shuttle Solar Backscatter Untraviolet (SSBUV-8) 2. Shuttle Laser Altimeter Payload (SLA-1/GAS(5)) **GAS (Getaway Special):** 1. G-342, USAF Academy FLEXBEAM-2 2. G-459, Protein Crystal Growth Experiment and Ballast Can with Sample Return Experiment	**Crew Compartment Payloads:** 1. Space Tissue Loss (STL/NIH-C) 2. Pool Boiling Experiment (PBE) 3. Thermal Energy Storage (STE-2) **Special Payload Mission Kits: None**
STS-75 Columbia Mission Duration: 377 hrs 40 mins 21 secs	Feb. 22, 1996 KSC	Mar. 9, 1996 KSC	Cdr: Andrew M. Allen Plt: Scott J. Horowitz PL-CDR: Franklin Chang-Diaz MS: Jeffrey A. Hoffman MS: Claude Nicollier MS: Maurizio Cheli PS: Umberto Guidoni	**Deployable Payloads: None** **Attached PLB Payloads**: 1. Tethered Satellite System Reflight (TSS-1R) 2. United States Microgravity Payload (USMP-3) a. Advanced Automated Directional Solidification Furnace (AADSF) b. Space Acceleration Measurement System (SAMS) c. Orbital Acceration Research Experiment (OARE) d. Isothermal Dendritic Growth Experimet. (IDGE)	**GAS (Gateaway Special: None** **Crew Compartment Payloads:** **Special Payload Mission Kits: None**

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-76 Atlantis Mission Duration: 221 hrs 15 mins 53 secs	Mar 22, 1996 KSC	Mar 31, 1996 EAFB MIR 21 - Ascent Only;	Cdr: Kevin P. Chilton Plt: Richard A Seaffoss MS: Linda Godwin MS: Ronald Sega MS: Michael R Clifford MS: Shannon Lucid	**Deployable Payloads:** 1. MIR Environmental Effects Payload **Attached PLB Payloads:** 1. Orbiter Docking System 2. SPACEHAB Module a. Russian Logistics b. EVA Tools c. American Logistics d. Science or Technology Exoeriments e. Risk Mitigationa Experiments **GAS (Getaway Special):** 1. Trapped Ions inSpace (TRIS)	**Crew Compartment Payloads:** 1. Shuttle Amateur Radio Experiment(SAREX) 2. KidSat **Special Payload Mission Kits: None**
STS-77 Endedavour Mission Duration: 240 hrs 39 mins 18 secs	May 19, 1996 KSC	May. 29, 1996 KSC	Cdr: John H Casper Plt: Curtis L Brown MS: Daniel W Bursch MS: Mario Runco, Jr. MS: Marc Garneau MS: Andrew S.W. Thomas	**Deployable Payloads: None** 1. SPARTAN 207/1AE 2. Passive Aerodynamically Stablized Magnetically Damped Satellite (PAMS) 3. Satellite Test Unit (STU) **Attached PLB Payloads:** 1. SPACEHAB Module /Experiments a. Advnaced Seperation Process for Organic Materials b. Commercial Generic Bioprocessing Apparatus c. Plant Generic Bioprocessing Apparatus d. IMMUNE-3 e. Commericail Protein Crystal Growth f. Space Experiment Faculity 2. TEAMS-01	**GAS (Gateaway Special: None** 1. CAG-056: Gamma-ray Astrophysics Mission 2. G-142, G-144: Autonomous Material Sci Experiments 3. Detailed Test/Supplementary Objectives (DTOs/DSOs) 4. G-163 Diffusion Coefficient Measurment Facility **Special Payload Mission Kits: None**

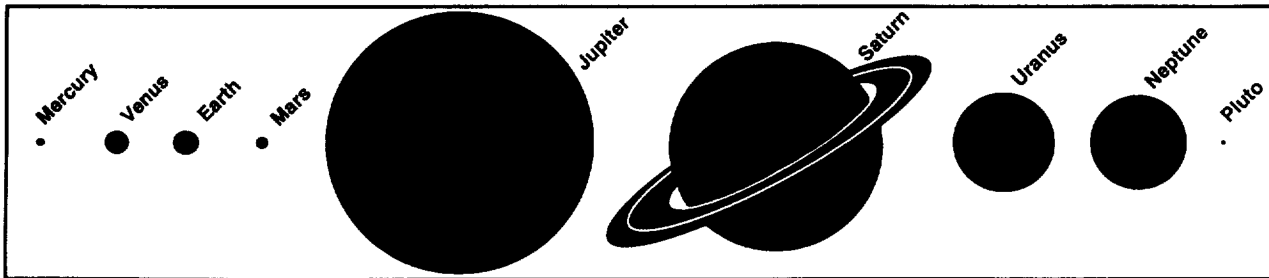
Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-78 Columbia Mission Duration: 405 hrs 47 mins 45 secs	Jun. 20, 1996 KSC	Jul. 7, 1996 KSC	Cdr: Terence T. Henricks Plt: Kevin R. Kregel MS: Susan J. Helms MS: Richard M. Linnehan MS: Charles E. Brady, Jr. PS: Jean-Jacques Favier PS: Robert Brent Thirsk	**Deployable Payloads: None** **Attached PLB Payloads:** 1. Life and Microgravity Spacelab (LMS) a. Musculoskeletal Investigations b. Metabolic Investigations c. Pulmonary Investigation d. Human Behavior and Performance Investigations e. Neuroscience Investigations f. Space Biology Experiments g. Bibble, Drop and Particle Unit h. Advance Gradient Heating Facility i. Advanced Protein Crystallization Facility j. Accelermeters	**GAS (Getaway Special): None** **Crew Compartment Payloads:** 1. Shuttle Amateur Radio Experiment-II **Special Payload Mission Kits: None**
STS-79 Atlantis Mission Duration: 243 hrs 18 mins 26 secs	Sep 14, 1996 KSC	Sep 26, 1996 KSC	Cdr: William F. Readdy Plt: Terence W. Wilcutt MS: Thomas D. Akers MS: Jerome Apt MS: Carl E. Walz MIR-23, Ascent Only: MS: John Blaha MIR-22, Desent Only: MS: Shannon Lucid MIR-22, Desent Only: Cdr: Valery Korzum MIR-22, Desent Only: FE: Alexandrer Kaleri	**Deployable Payloads: None** **Attached PLB Payloads:** 1. Spacehab Module 2. Orbital Docking System 3. IMAX Cargo Bay Camera	**GAS (Gateaway Special: None** **Crew Compartment Payloads:** 1. Extreme Temperature Translation Furnace (ETTF) 2. Commercial Protein Crystal Growth (CPCG) Experiments 3. Mechanics of Granular Materials 4. Shuttle Amateur Radio Experiment (SAREX) **Special Payload Mission Kits: None**

Summary of Shuttle Payloads and Experiments

Flight	Launch Date	Landing Date	Crew	Payloads and Experiments	
STS-80 Columbia Mission Duration: 423 hrs 53 mins 18 secs	Nov 19, 1996 KSC	Dec. 7, 1995 KSC	Cdr: Kenneth D. Cockrell Plt: Kent V. Rominger MS: Tamara E. Jernigan MS: Thomas D. Jones MS: F. Story Musgrave	**Deployable Payloads:** 1. Orbiting and Retrievable Far and Extreme Ultraviolet Spectrograph-Shuttle Pallet Sattelite II(ORFEUS-SPAS II) 2. Wake Shield Facility-3 (WSF-3) **Attached PLB Payloads:** 1. Visualization in an experimental Water Capilary Pumped Loop (VIEW-CPL) **GAS (Getaway Special):** 1. Space Experiment Module (SEM)	**Crew Compartment Payloads:** 1. NIH-R4 2. CCM-A 3. Biological Research in Canister (BRIC)) 4. Commercial MDA ITA Experiment (CMIX-5) **Special Payload Mission Kits: None**

The Planets



	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
Mean Distance from Sun									
Millions of Kilometers	57.9	108.2	149.6	227.9	778.3	1,429	2,875	4,504	5,900
Millions of Miles	36	67.2	93	141.6	483.6	888.2	1,786	2,799	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	4,878	12,104	12,755	6,790	142,796	120,660	51,118	49,528	2,300 Appx.
Miles	3,031	7,521	7,926	4,219	88,729	74,975	31,763	30,775	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 700,000 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.

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 used radar-mapping techniques to provide ultrahigh-resolution images of the surface.

Magellan has revealed a landscape dominated by volcanic features, faults, and impact craters. Hugh 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.

The successful Magellan mission ended on October 12, 1994, when the spacecraft was commanded to drop lower into the fringes of the Venusian atmosphere during an aerodynamic experiment and it burned up, as expected. Magellan mapped 98 percent of the planet's surface with radar and compiled a high-resoluttion gravity map of 95 percent of the planet.

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.

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 36,000km (22,000 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.

The TOPEX/POSEIDON satellite, a joint NASA/French mission and part of the Missior to Planet Earth, is providing information of unprecedented accuracy about global ocean circulation. Radar altimeter measurements of sea height level in the mid Pacific, accurate within 5 cm. (2 in.), demonstrate the presence of a strong El Nino current in the 1994-95 winter. This has great importance for long range weather forecasting. Another element of the Mission to Planet Earth, the Total Ozone Monitoring Satellite (TOMS), stopped transmitting in Dec. '94 after exceeding its design lifetime by a year. This joint NASA/Russian effort provided essential data on ozone density and global distributioin for the past 3 years. TOMS data are showing us how human activities can alter Earth's global environment. Two more TOMS satellites are to be flown by February, 1996.

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.

Seven 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. 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.

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. The Mars Observer mission, launched on Sept. 25,1992, lost contact with Earth on April 21, 1993, just 3 days before it was to enter orbit around Mars.

NASA will continue to explore Mars, which a new exploration strategey called the Mars Surveyor program, calls for start of development of a small orbiter that will be launched in November 1996 to study the surface of the red planet.

The Mars Surveyor orbiter will lay the foundation for a series of missions to Mars in a decade-long program of Mars exploration. The missions will take advantage of launch opportunities about every 2 years as Mars comes into alignment with Earth.

The orbiter planned for launch in 1998 would be even smaller than the initial Mars Surveyor orbiter and carry the remainder of the Mars Observer science instruments. It would act as a communications relay satellite for a companion lander, launched the same year, and other landers in the future, such as the Russian Mars '96 lander. The U.S. Pathfinder lander, set to land on Mars in 1997, will operate independently of the Mars orbiter.

Asteroids

The solar system is populated by thousands of small planetesimals called asteroids that orbit the Sun in a broad belt between Mars and Jupiter. Some of these are of rocky composition, others are mainly iron and nickel; they are fragments and rocky splinters generated by the same processes that built the planets some four and a half billion years ago. Metallic asteriods are hought to be fragments of the central cores of small short-lived planets that were broken up soon
after they formed by massive collisions with other similar objects; some of the rocky splinters may be pieces of the outer layers of such exploded planets while others could be primitive planet-building materials accumulated into rocks but that was never used in planet building.

The largest asteriod is called 1 Ceres (all asteriods have a number in their name) and is only 770km (480 mi) across; much smaller than the Moon. Most of the thousands of asteriods that are known are much smaller, in the 1 to 10 km size range. Innumerable, still small, fragments frequently collide with the Earth and, as they burn-up in the atmosphere, causing meteor trails. Some of the larger fragments reach the ground intact and become part of the meteorite collectioins in our museums. A few large asteriod collisions are recorded on the Earth's surface as craters. One of the best examples is the Baringer Meteor Crater near Winslow, Arizona. Some of the best preserved meteorites are found on the ice cap of Antarctica, however, not all of these come from asteriods, some may be debris from comets, and some pieces are thought to have originated on the surface of Mars.

The Galileo spacecraft passed twice through the asteriod belt on its six year journey from the Earth to Jupiter. On each occasioin it visited an asteroid and made scientific measurements impossible from the Earth. On October 29, 1991, Galileo encountered 951 Gaspra at a distance of 1600 km to reveal a conical shaped, scared and fractured, rock some 18 km long with a lightly cratered landscape; almost two years later, on August 28, 1993, Galileo passed by another larger asteroid, 243 Ida, at a distance of 2400 km to reveal an object of even more bizarre shape. In addition the data from the spacecraft showed that this asteroid has a satellite in orbit around it which has been named Dactyl. Ida itself is irregular in shape, some 56 km long and 24 km across. Its surface is covered by a deep layer of rubble on which many craters, fractures and boulders are superposed. Before the Galileo encounters it was expected that Ida, which is a member of the Koronis family of asteroids (an asteriod family is a group of asteriods on very small orbits that formed as the result of a castastrophic collisioin that broke up the parent asteriod), was relatively young, that is , it formed as the result of a recent collision, while Gaspra was expected to be relatively old. The surprising result of the Galileo investigiations was to turn these ideas entirely around. Ida's densely craterd surface proved it to be very old, perhaps 1-2 billion years. Gaspra's lightly crated surface showed it to have been formed relatively recently, a mere 200 million years ago

NASA will send the Near Earth Asteriod Rendevous (NEAR) spacecraft to orbit the asteriod 433 EROS in January 1999. The density, rotation, composition, and topography of the silicate rock asteriod will be measured..

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 so far has taken 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.

"The year 1994 was one of great excitement in space science. In July some 20 fragments of the comet Shoemaker-Levy 9 crashed into Jupiter. An event of this magnitude occurs perhaps once in 1000 years. The knowledge that the comet would hit Jupiter came far too late to launch a spacecraft from earth that could arrive in the near vicinity in time for the event. The initial impacts were on the far side of the planet and went unobserved. However Jupiter's very rapid rotation (1day =10 hours) allowed the Hubble Space Telescope (HST) and other earth based and space based telescopes to observe the impact scars when they were only a few minutes old. Some of them were as large as Earth. The time evolutioin of the scars serves to test our understanding of energy depostion and fluid dynamics. The impacts briefly removed the curtain of hight clouds that normally obscure our view to reveal details about the composition of Jupiter's lower atmosphere. There is controversy about how much of the sulfur and water observed arose from Jupiter as opposed to the cometary matter. Our observations yielded a rich store of data that will keep scientists occupied for some time to come.

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

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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. "Astronomers using NASAs Hubble Space Telescope (HST) have identified the presence of an extremely tenuous atmosphere of molecular oxygen around Europa. Is is so thin that the surface pressure is barely one hundred billion that of Earth. Free moleular oxygen is expected from the action of extreme ulraviolet radiation of Europa's water. The greatest significance of the observation is the astonishing sensitivity afforded by the HST." 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.

A mission to Saturn, planned for launch in October 1997, may help answer many of the questions raised by the Voyager flybys about the Saturnian system. Called Cassini, the joint U.S. European Space Agency mission consists of an Orbiter and an instrumented probe call Huygens supplied by ESA. The mission is designed to complete an orbital surveillance of the planet and unveil Saturn's largest moon, Titan, by dropping the Huygens probe through Titan's intriguingly Earth-like atmosphere.

Cassini will fly by Venus twice as well as by Earth and Jupiter before arriving at Saturn in November 2004 to begin a 4-year orbital tour of the ringed planet and its 18 moons. The Hurgens probe will descend to the surface of Titan in June 2005.

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 showcase, 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.

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 each other. Pluto's and Charon's rotational period and Charon's period of revolution are all 6.4 Earth days.

No spacecraft has ever visited Pluto, however, a Pluto Fast Flyby mission is being studied for a possible launch in 1999-2000.

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.

Planetary Exploration

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Venera 1 USSR	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.
Mariner 1 USA	Venus Flyby	Jul 22, 1962		Destroyed shortly after launch when vehicle veered off course.
Sputnik 19 USSR	Venus Probe	Aug 25, 1962		Unsuccessful Venus attempt.
Mariner 2 USA	Venus Flyby	Aug 27, 1962	Dec 14, 1962	First successful planetary flyby. Provided instrument scanning data. Entered solar orbit.
Sputnik 20 USSR	Venus Probe	Sep 1, 1962		Unsuccessful Venus attempt.
Sputnik 21 USSR	Venus Probe	Sep 12, 1962		Unsuccessful Venus attempt.
Sputnik 22 USSR	Mars Probe	Oct 24, 1962		Spacecraft and final rocket stage blew up when accelerated to escape velocity.
Mars 1 USSR	Mars Probe	Nov 1, 1962		Contact was lost when the spacecraft antenna could no longer be pointed towards Earth.
Sputnik 24 USSR	Mars Probe	Nov 4, 1962		Disintegrated during an attempt at Mars trajectory from Earth parking orbit.
Zond 1 USSR	Venus Probe	Apr 2, 1964		Communications lost. Spacecraft went into solar orbit.
Mariner 3 USA	Mars Flyby	Nov 5, 1964		Shroud failed to jettison properly; Sun and Canpous not acquired; spacecraft did not encounter Mars. Transmissions ceased 9 hours after launch. Entered solar orbit.
Mariner 4 USA	Mars Flyby	Nov 28, 1964	Jul 14, 1965	Provided first close-range images of Mars, confirming the existence of surface craters. Entered solar orbit.
Zond 2 USSR	Mars Probe	Nov 30, 1964		Passed by Mars; failed to return data. Went into solar orbit.

Planetary Exploration

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Venera 2 USSR	Venus Probe	Nov 12, 1965	Feb 27, 1966	Passed by Venus, but failed to return data.
Venera 3 USSR	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 USSR	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.
Mariner 5 USA	Venus Flyby	Jun 14, 1967	Oct 19, 1967	Advanced instruments returned data on Venus' surface temperature, atmosphere, and magnetic field environment. Entered solar orbit.
Venera 5 USSR	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.
Venera 6 USSR	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.
Mariner 6 USA	Mars Flyby	Feb 24, 1969	Jul 31, 1969	Provided high-resolution photos of Martian surface, concentrating on equatorial region. Entered solar orbit.
Mariner 7 USA	Mars Flyby	Mar 27, 1969	Aug 5, 1969	Provided high-resolution photos of Martian surface, concentrating on southern hemisphere. Entered solar orbit.
Venera 7 USSR	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.

Planetary Exploration

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Cosmos 359 USSR	Venus Lander	Aug 22, 1970		Unsuccessful Venus attempt; failed to achieve escape velocity.
Mariner 8 USA	Mars Orbiter	May 8, 1971		Centaur stage malfunctioned shortly after launch.
Cosmos 419 USSR	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 USSR	Mars Orbiter and Lander	May 19, 1971	Nov 27, 1971	Landing capsule separated from spacecraft and made first, unsuccessful attempt to soft land. Lander carried USSR pennant. Orbiter continued to transmit data.
Mars 3 USSR	Mars Orbiter and Lander	May 28, 1971	Dec 2, 1971	Landing capsule separated from spacecraft and landed in the southern hemisphere. Onboard camera operated for only 20 seconds, transmitting a small panoramic view. Orbiter transmitted for 3 months.
Mariner 9 USA	Mars Orbiter	May 30, 1971	Nov 13, 1971	First interplanetary probe to orbit another planet. During nearly a year of operations, obtained detailed photographs of the Martian moons, Phobos and Deimos, and mapped 100 percent of the Martian surface. Spacecraft is inoperable in Mars orbit.
Pioneer 10 USA	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.
Venera 8 USSR	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 USSR	Venus Lander	Mar 31, 1972		Unsuccessful Venus probe; escape stage misfired leaving craft in Earth orbit.

Planetary Exploration

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Pioneer 11 USA	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.
Mars 4 & 5 USSR	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, preventing orbit insertion. As it passed the planet, Mars 4 returned one swath of pictures and some radio occultation data. Mars 5 was successfully placed in orbit, but operated only a few days, returning photographs of a small portion of southern hemisphere of Mars.
Mars 6 & 7 USSR	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 data during descent, but transmissions abruptly ceased when the landing rockets were fired. Mars 7 descent module was separated from the main spacecraft due to a problem in the operation of one of the onboard systems, and passed by the planet.
Mariner 10 USA	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. Spacecraft is inoperable in solar orbit.
Venera 9 USSR	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 hrs 53 mins.
Venera 10 USSR	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.

Planetary Exploration

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Viking 1 USA	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. Both Orbiters took a total of 52,000 images during their mission; approximately 97% percent of the surafce was imaged. Orbiter 1 operated until August 7, 1980, when it used the last of its attitude control gas. Lander 1 ceased operating on Nov 13, 1983.
Viking 2 USA	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. The two Landers took 4,500 images of the surface and provided over 3 million weather reports. 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 2 USA	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.
Voyager 1 USA	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.
Pioneer Venus 1 USA	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.
Pioneer Venus 2 USA	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.

Planetary Exploration

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Venera 11 USSR	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 USSR	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 USSR	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 USSR	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 USSR	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 USSR	Venus Orbiter	Jun 7, 1983	Oct 16, 1983	Provided computer mosiac images of a strip of the northern continent. Soviet and U.S. geologists cooperated in studying and interpreting these images.
Vega 1 & 2 USSR	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.

Planetary Exploration

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Phobos 1 & 2 USSR	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 control error. Phobos 2 was successfully inserted into Martian orbit in January 1989 to study the Martian surface, atmosphere, and magnetic field. On March 27, 1989, communications with Phobos 2 were lost and efforts to contact the spacecraft were unsuccessful.
Magellan USA	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 USA	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 descend 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.
Mars Observer USA	Mars Orbiter	Sep 25, 1992		Communication was lost with the Mars Observer on August 21, 1993, 3 days before the orbit insertion burn.
Galileo Probe USA	Jupiter Orbiter	Oct 18, 1989	Dec 7, 1995	A Planetary Probe was released from the Galileo Spacecraft with seven instruments: a helium abundance detector, an atmospheric structure instrument, a neutral mass spectrometer, a radiometer, a nephelometer, a lightning detector and an energetic particle detector. When the probe enters the Jupiter atmosphere the Galileo spacecraft will have been maneuvered overhead to receive the telemetry signals.

Planetary Exploration

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Mars Global Surveyor (MGS)	Remote-sensing Orbiter	Nov. 7, 1996		Provide mapping of soil and atmospheric composition from two different orbits. After 180 days of high apogee atmospheric mapping the Surveyor will be "aerobraking" into a lower orbit to map the surface features. The mapping will be done by a thermal emission spectrometer, a laser altimeter and three linescan cameras at visual wave-lengths. The telemetry signals from the spacecraft will enable estimation of Martian atmospheric profile.
Mars Pathfinder	Mars Lander	Dec. 4, 1996		Patherfinder along with a small rover named Sojourner on board, will land on the surface of Mars cushioned by baloons. The lander and rover are both solar powered with backup batteries. The lander has three instruments: an Imager for the Mars Pathfinder (IMP), Atmospheric Structure Instrument/Meteorology package (ASI/MET); the rover houses an Alpha, Proton, X-ray Spectrometer (APXS), and color cameras. The lander has one-gigabyte of memory to store and transmit data from its instruments as well as from the instruments on the rover.

Lunar Exploration

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Pioneer 1 USA	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 USA	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 USA	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.
Luna 1 USSR	Lunar Impact	Jan 2, 1959		Intended to impact the Moon; carried instruments to measure radiation. Passed the Moon and went into solar orbit.
Pioneer 4 USA	Lunar Probe	Mar 3, 1959	Mar 4, 1959	Passed within 37,300 miles from the Moon; returned excellent data on radiation. Entered solar orbit.
Luna 2 USSR	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 USSR	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.
Pioneer P-3 USSR	Lunar Orbit	Nov 26, 1959		Payload shroud broke away 45 seconds after liftoff. Did not achieve orbit.
Ranger 1 USA	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.

Lunar Exploration

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Ranger 2 USA	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 USA	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 USA	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 USA	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.
Sputnik 25 USSR	Lunar Probe	Jan 4, 1963		Unsuccessful lunar attempt.
Luna 4 USSR	Lunar Orbiter	Apr 2, 1963		Attempt to solve problems of landing instrument containers. Contact lost as it passed the Moon. Barycentric orbit.
Ranger 6 USA	Lunar Photo	Jan 30, 1964	Feb 2, 1964	TV cameras failed; no data returned. Impacted in the Sea of Tranquility area.
Ranger 7 USA	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 USA	Lunar Photo	Feb 17, 1965	Feb 20, 1965	Transmitted high quality photographs before impacting in the Sea of Tranquility area.
Ranger 9 USA	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.

Lunar Exploration

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Luna 5 USSR	Lunar Lander	May 9, 1965	May 12, 1965	First soft landing attempt. Retrorocket malfunctioned; spacecraft impacted in the Sea of Clouds.
Luna 6 USSR	Lunar Lander	Jun 8, 1965		During midcourse correction maneuver, engine failed to switch off. Spacecraft missed Moon and entered solar orbit.
Zond 3 USSR	Lunar Probe	Jul 18, 1965		Photographed lunar far side and transmitted photos to Earth 9 days later. Entered solar orbit.
Luna 7 USSR	Lunar Lander	Oct 4, 1965	Oct 7, 1965	Retrorockets fired early; crashed in Ocean of Storms.
Luna 8 USSR	Lunar Lander	Dec 3, 1965	Dec 6, 1965	Retrorockets fired late; crashed in Ocean of Storms.
Luna 9 USSR	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 USSR	Lunar Probe	Mar 11, 1966		Unsuccessful lunar attempt. Reentered March 16, 1966.
Luna 10 USSR	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.
Surveyor 1 USA	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 USA	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.
Luna 11 USSR	Lunar Orbiter	Aug 24, 1966		Second lunar satellite. Data received during 277 orbits. Selenocentric orbit.

Lunar Exploration

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Surveyor 2 USA	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.
Luna 12 USSR	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.
Lunar Orbiter 2 USA	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.
Luna 13 USSR	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.
Lunar Orbiter 3 USA	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.
Surveyor 3 USA	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 USA	Lunar Orbiter	May 4, 1967	May 8, 1967	Provided the first pictures of the lunar south pole. Impacted the Moon on Oct 6, 1967.
Surveyor 4 USA	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 USA	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.

Lunar Exploration

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Surveyor 5 USA	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 USA	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 USA	Lunar Lander	Jan 7, 1968	Jan 9, 1968	Landed near the crater Tycho. Returned stereo pictures of the surface and of rocks that were of special interest. Provided first observation of artificial light from Earth.
Luna 14 USSR	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 USSR	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 USSR	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 USSR	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.
Zond 7 USSR	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.

Lunar Exploration

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
Cosmos 300 USSR	Lunar Probe	Sep 23, 1969		Unsuccessful lunar attempt. Reentered September 27, 1969.
Cosmos 305 USSR	Lunar Probe	Oct 22, 1969		Unsuccessful lunar attempt. Reentered October 24, 1969.
Luna 16 USSR	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 USSR	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 USSR	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 USSR	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 USSR	Lunar Orbiter	Sep 28, 1971		From lunar orbit, studied Moon's gravitational field; transmitted TV pictures of the surface. Selenocentric orbit.

Lunar Exploration

SPACECRAFT	MISSION	LAUNCH DATE	ARRIVAL DATE	REMARKS
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.
Clementine USA	Lunar Flyby	Jan 25, 1994		Carrying ultraviolet/visible and near-infrared cameras, mineralogical mapping of the moon will enhance the scientific knowledge of the surface for future exploration. The mission failed in its attempt to flyby the asteroid Geographos.

Unofficial Tabulation of CIS (USSR) Payloads

	1957-1959	1960-1969	1970-1979	1980-1989	1990	1991	1992	1993	1994	1995	1996	TOTAL
Almaz	--	--	--	--	--	1	0	0	0	0	0	1
Buran	--	--	--	1	0	0	0	0	0	0	0	1
Cosmos	--	317	831	906	66	54	55	38	37	27	11	2342
Ekan	--	--	4	15	0	0	1	0	0	0	0	21
Electro	--	--	--	--	--	--	--	--	1	--	--	1
Electron	--	4	0	0	0	0	0	0	0	0	0	4
Express	--	--	--	--	--	--	--	--	1	--	--	1
Foton	--	--	--	2	1	1	1	0	0	0	0	5
Gals	--	--	--	--	--	--	--	--	1	1	1	3
Gamma	--	--	--	--	1	0	0	0	0	0	0	1
Geo-1k	--	--	--	--	--	--	--	--	1	0	0	1
Gorizont	--	--	3	16	3	2	3	2	1	0	2	32
Granat	--	--	--	1	0	0	0	0	0	0	0	1
Informator	--	2	12	0	0	1	0	0	0	0	0	15
Interball Tail	--	--	--	--	--	--	--	--	--	1	1	2
Intercosmos	--	--	6	3	0	1	0	0	0	0	0	10
Iskra	--	--	--	3	0	0	0	0	0	0	0	3
Koronas	-	--	--	--	--	--	--	--	1	0	0	1
Kristall	--	--	--	0	1	0	0	0	0	0	0	1
Kvant	--	--	--	2	0	0	0	0	0	0	0	2
Luch	--	--	--	--	--	--	--	--	1	1	0	2
Luna	3	12	9	0	0	0	0	0	0	0	0	24
Mars	--	1	6	0	0	0	0	0	0	0	1	8
Meteor	--	2	32	18	2	2	0	1	1	0	0	58
Mir	--	--	--	1	0	0	0	0	0	0	0	1
Molniya	--	15	63	18	6	5	4	5	2	1	2	155
Nadezhda	--	--	--	1	1	1	0	0	1	0	0	4
Okean	--	--	--	1	1	1	0	0	1	0	0	4
TOTAL	3	353	966	1025	82	69	64	46	50	31	18	2708

Unofficial Tabulation of CIS (USSR) Payloads (cont'd)

	1957-1959	1960-1969	1970-1979	1980-1989	1990	1991	1992	1993	1994	1995	1996	TOTAL
Phobos	--	--	--	2	0	0	0	0	0	0	0	2
Photon-10	--	--	--	--	--	--	--	--	--	1	0	1
Pion	--	--	--	--	--	--	2	0	0	0	0	2
Polyot	--	2	0	0	0	0	0	0	0	0	0	2
Priroda	--	--	--	--	--	--	--	--	--	--	1	1
Prognoz	--	--	7	3	0	0	0	0	0	0	0	10
Progress	--	--	7	36	4	4	5	5	5	5	3	74
Proton	--	4	0	0	0	0	0	0	0	0	0	4
Radio	--	--	2	6	0	0	0	0	0	0	0	8
Radio Rusto	--	--	--	--	--	--	--	--	1	1	0	2
Raduga	--	--	5	20	3	2	0	2	3	1	1	37
Resurs	--	--	--	5	4	4	4	3	1	1	0	22
Salyut	--	--	6	1	0	0	0	0	0	0	0	7
Soyuz	--	8	27	28	3	2	2	2	3	2	2	79
Spektr	--	--	--	--	--	--	--	--	--	1	0	1
Sputnik	3	9	0	0	0	0	0	0	0	0	0	12
Start	--	--	--	--	--	--	0	1	0	0	0	1
Tsikada	--	--	--	--	--	--	--	--	--	1	0	1
Vega	--	--	--	2	0	0	0	0	0	0	0	2
Venera	--	5	6	4	0	0	0	0	0	0	0	15
Voskhod	--	2	0	0	0	0	0	0	0	0	0	2
Vostok	--	4	--	0	0	0	0	0	0	0	0	4
Zond	--	9	1	0	0	0	0	0	0	0	0	10
No Designation	--	6	--	--	--	--	--	--	--	--	--	6
TOTAL	3	49	61	107	14	12	13	13	13	13	7	305

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	122.8	3054	557	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

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	127.4	3417	512	33.4	45.4	Solar-powered magnesium sphere with magnetometer boom; provided a comprehensive survey of the Earth's magnetic field, surveyed location location of lower edge of 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.
Explorer (S-46) (U)	Juno II (U)	Mar 23		DID NOT ACHIEVE ORBIT			16.0	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.

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 I (S) Beta 2	Thor-Able II 148 (S)	Apr 1	98.3	695	658	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 80 (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	102.5	1361	395	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 (L/V #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	96.3	614	549	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.
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.

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)
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	14.5	1465	479	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.
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	100.0	791	723	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.

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 (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 S-1 booster propulsion system; verification of aerodynamic/structural design of 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.
Mercury (MA-5) (S) A-Iota 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.

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 IV (S) Beta 1	Thor-Delta (7) (S)	Feb 8	99.9	812	694	48.3	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.
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	99.4	889	573	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	5642	947	44.8	77.1	First privately built satellite to conduct communication experiments. First telephone and TV 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.

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)
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	97.6	652	635	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	105.2	1022	987	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.
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	7436	1323	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	104.1	1159	745	52.0	100.7	Measure micrometeoroid puncture hazard to structural skin samples. First statistical sample; flux level found to lie between estimated extremes. (WFF)

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS			WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
				Apogee (km)	Perigee (km)	Incl (deg)		
1963								1963
Syncom I (U) 1963 04A	Thor-Delta (16) (S)	Feb 14		CURRENT ELEMENTS NOT MAINTAINED			39.0	First test of a communication satellite in geosynchronous orbit. Initial communication tests successful; all contact was 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 a belt of neutral helium around the Earth.
Telstar II (S) 1963 13A	Thor-Delta (18) (S)	May 7	225.3	10807	967	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 were 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	92.7	415	398	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.
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 were 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 the 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.

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)
Centaur Test II (S) 1963 47A	Atlas-Centaur (AC-2) (S)	Nov 27	104.6	1485	468	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	98.5	711	663	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	7535	1966	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/LH2 fueled second stage (S-IV). 11,146 measurements taken.
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	DOWN APR 12, 1964				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)

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)
Saturn I (SA-6) (S) 1964 25A	Saturn I (SA-6) (S)	May 28		DOWN JUN 1, 1964			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	103.6	1001	855	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.
OGO I (U) 1964 54A	Atlas-Agena B 195 (S)	Sep 4		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;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	104.3	1054	872	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)

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)
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 atmospheres. (WSMC)
Explorer 25 (S) 1964 76B			114.6	2354	522	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.
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	118.9	2564	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, 1989			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.

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS			WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
				Apogee (km)	Perigee (km)	Incl (deg)		
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 52 minutes 31 seconds.
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	107.7	1312	929	41.2	60.8	Beacon Explorer; obtained data on Earth's gravitational field. Also carried laser tracking experiments.
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 performed a 22 minute EVA using the Zero-G Integral Propulsion Unit. Mission Duration: 97 hrs 56 mins 12 secs.
Tiros X (S) 1965 51A	Delta 32 (S)	Jul 1	100.1	807	722	98.8	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.

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)
Scout Test (S) Secor (S) 1965 63A	Scout 37 (S)	Aug 10	122.2	2419	1134	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 55 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.
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. Nineteen 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 the Gemini spacecraft and Atlas-Agena Target Vehicle. Telemetry was lost 375 seconds after launch of the target vehicle; Gemini launch was terminated at T-42 minutes.
Explorer 29 (S) 1965 89A	Delta 34 (S)	Nov 6	120.3	2274	1113	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	664	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 Alouette II (S) 1965 98A	Thor-Agena B (S)	Nov 29	120.0 118.3	2859 2708	501 501	79.8 79.8	98.9 146.5	Make related studies of ionospheric composition and temperature variations. Provided excellent data from regions of the ionosphere never before investigated. Cooperative with Canada. (WSMC)
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 01 seconds.
French 1A (S) 1965 101A	Scout 39 (S)	Dec 6	98.8	708	696	75.9	71.7	Study VLF wave propagation in the ionosphere and magnetosphere and measure electron densities. Cooperative with France. (WSMC)

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 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)
ESSA I (S) 1966 08A	Delta 36 (S)	Feb 3	99.7	806	684	97.8	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	1412	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 GATV (S) 1966 19A	Titan II 8 (S) Atlas-Agena D 5302 (S)	Mar 16 Mar 16		LANDED MAR 17, 1966 DOWN SEP 15, 1967			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.
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	100.6	793	783	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	1174	1091	100.6	413.7	Provided global weather photography on 24-hour basis for meteorological research and operational use. (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)
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.
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 20 minutes 50 seconds.
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	142.9	4703	645	40.8	173.0	Radiation research satellite for the USAF. Reimbursable (DOD). (WFF)
Pageos I (S) 1966 56A	Thor-Agena D (S)	Jun 23	177.0	5599	2533	84.5	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 89 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.

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)
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/spacecraft development flight to test Command Module heat shield and obtain launch vehicle and spacecraft data.
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 5306 (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	1483	1384	100.9	147.4	Replaced ESSA I in Tiros Operational Satellite (TOS) system. Sophisticated cameras and sensors provided valuable information about the world's weather patterns/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	37229	3123	16.9	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 34 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	1436.0	35817	35750	14.3	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 rocket failed, leaving the capsule in orbit. No useful scientific data obtained.

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	1323	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	113.5	1419	1352	102.0	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. 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.
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)

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 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)
ATS III (S) 1967 111A	Atlas-Agena D 5103 (S)	Nov 5	1436.1	35844	35730	14.2	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.

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 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	1482	1407	102.2	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)
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)	Thor-Agena D (U)	May 18		DID NOT ACHIEVE ORBIT			571.5	Experimental meteorological satellite; also carried Secor 10 (DOD) as a secondary payload. Booster malfunctioned; destruct signal sent by Range Safety Officer. (WSMC)
Secor 10 (U)						20.4		
Explorer 38 (S) 1968 55A	Delta 57 (S)	Jul 4	224.2	5869	5825	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.

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 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			117.9	2494	677	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	1428	101.4	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).
ESRO IA (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	Delta 60 (S)	Nov 8			HELIOCENTRIC ORBIT		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.
TETR 2 (S) 1968 100B					DOWN SEP 19, 1979			
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).
OAO II (S) 1968 110A	Atlas-Centaur (AC-16) (S)	Dec 7	99.9	759	750	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	101.8	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 0 minutes 42 seconds.

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) 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	127.7	3471	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	1422	101.4	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 0 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	107.2	1128	1069	100.0	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	100.0	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 hrs 3 mins 23 secs.
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.

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 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 Tranquillity 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, 1988			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	1447.5	36031	35986	13.9	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		18.1	67.1	Deep space probe to study magnetic disturbances in interplanetary space. Vehicle malfunctioned; destroyed 8 minutes 3 seconds into powered flight by Range Safety Officer.
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	110.8	2155	371	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 24 seconds.
Skynet A (S) 1969 101A	Delta 74 (S)	Nov 21		ELEMENTS NOT AVAILABLE			242.7	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) 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	1431	101.3	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	1431	101.3	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	1044	1038	99.2	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	35798	35779	12.9	242.7	Communications satellite for NATO. Reimbursable (NATO).
Nimbus D (S) 1970 25A	Thor-Agena (S)	Apr 8	107.1	1096	1086	99.9	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	1084	1082	99.8	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.
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	36634	33842	13.9	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 CIII (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.

NASA Major Launch Record

1970

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)
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 58 seconds.
NATOSAT 2 (S) 1971 09A	Delta 82 (S)	Feb 2	1436.1	35830	35744	13.7	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	1421	1355	8.2	264.0	Study electron production and loss, and large scale transport of ionization in the ionosphere. Cooperative with Canada. (WSMC)
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 P&F Subsat (S) 1971 63D	Saturn V SA-510 (S) SM	Jul 26 Aug 4	LANDED AUG 7, 1971 IMPACTED MOON JUL 30, 1971				51655.0 36.3	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 Subsatellite spring-launched from SM in lunar orbit. Mission Duration 295 hours 11 minutes 53 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)
CAS/EOLE (S) 1971 71A	Scout 75 (S)	Aug 16	99.7	837	652	50.2	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		DOWN JAN 10, 1992			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	1445.5	36013	35928	10.3	1387.1	Fourth generation satellite to provide increased capacity for Comsat's global commercial communications network. Reimbursable (Comsat).
1972								**1972**
Intelsat IV F-4 (S) 1972 03A	Atlas-Centaur (AC-28) (S)	Jan 22	1442.4	35921	35896	9.7	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 5 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	1438.6	35858	35811	10.7	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)
ERTS-A (S) 1972 58A	Delta 89 (S)	Jul 23	103.0	908	896	99.3	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	99.2	725	713	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	99.9	796	707	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	1446	102.0	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	1452	1446	102.0	15.9	
Telesat A (ANIK) (S) 1972 90A	Delta 92 (S)	Nov 9	1457.1	36258	36136	10.8	544.3	First of a series of domestic communications satellites for Canada. Reimbursable (Canada). (WSMC)
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	1099	1086	99.8	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.

NASA Major Launch Record

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS			WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
				Apogee (km)	Perigee (km)	Incl (deg)		
Telesat B (ANIK-2) (S) 1973 23A	Delta 94 (S)	Apr 20	1443.0	35970	35873	9.4	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	Augment NOAA's satellite world-wide weather observation capabilities. Vehicle second stage malfunctioned. Reimbursable (NOAA). (WSMC)
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 1416 hours 11 minutes 9 seconds.
Intelsat IV F-7 (S) 1973 58A	Atlas-Centaur (AC-31) (S)	Aug 23	1452.4	36138	36072	9.7	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 84 (S)	Oct 30	105.2	1123	885	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	116.1	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: 2016 hours 1 minute 16 seconds.

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 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.
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	100.3	867	677	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	35907	35907	9.1	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	1412.1	35440	35190	12.5	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	1442.2	35928	35883	8.9	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)

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)
ITOS-G (S) 1974 89A	Delta 104 (S)	Nov 15	114.9	1457	1442	101.9	345.0	ITOS-G - To augment NOAA's satellite world-wide weather observation capabilities. Reimbursable (NOAA).
Intasat (S) 1974 89B			114.8	1457	1439	101.9	20.4	Intasat - Conduct worldwide observations of ionospheric total electron counts. Cooperative with Spain.
Oscar (S) 1974 89C			114.8	1457	1437	101.9	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	1443.0	35949	35894	8.1	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	1436.9	35828	35775	11.6	435.0	Communication satellite for the United Kingdom. Reimbursable (UK).
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	1440.6	35896	35853	11.9	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	911	899	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-6 (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	101.6	851	815	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	1439.5	35872	35833	8.2	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	36133	36015	8.1	1387.1	Fourth generation satellite to provide increased capacity for Comsat's commercial communications network. Last of the IV series. 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)
Nimbus F (S) 1975 52A	Delta 111 (S)	Jun 12	107.4	1111	1098	99.8	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.
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 Viking A Lander (S) 1975 75C	Titan IIIE Centaur 88 (S)	Aug 20		AEROCENTRIC ORBIT LANDED ON MARS JUL 20, 1976			2324.7 571.5	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.
Symphonie B (S) 1975 77A	Delta 114 (S)	Aug 29	1440.4	35880	35861	12.1	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 Viking B Lander 1975 83C	Titan IIIE Centaur 89 (S)	Sep 9		AEROCENTRIC ORBIT LANDED ON MARS SEP 3, 1976			2324.7 571.5	Second Mars Orbiter and Lander mission to conduct systematic investigation of Mars. Soft landed on Mars on September 3, 1976. Returned excellent scientific data.
Intelsat IVA F-1 (S) 1975 91A	Atlas-Centaur (AC-36) (S)	Sept 25	1441.0	35914	35852	8.1	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		DOWN MAY 26, 1991			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	1435.7	35801	35756	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.

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)
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	1445.8	36084	35873	8.2	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.
CTS (S) 1976 04A	Delta 119 (S)	Jan 17	1437.1	35887	35726	12.2	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	1444.5	35968	35933	8.3	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	1436.1	35797	35777	10.4	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	1460.1	36501	36010	7.8	867.7	Second RCA domestic communications Satellite. Reimbursable (RCA).
NATO IIIA (S) 1976 35A	Delta 122 (S)	Apr 22	1442.3	36008	35806	10.1	670.0	Third-generation communications satellite for NATO. Reimbursable (NATO)
LAGEOS (S) 1976 39A	Delta 123 (S)	May 4	225.4	5945	5838	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	35921	35905	8.0	1490.1	First domestic communications satellite for Comsat. Reimbursable (Comsat).
Air Force P76-5 (S) 1976 47A	Scout 94 (S)	May 22	105.4	1044	981	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	35813	35760	9.5	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	1439.1	35867	35821	8.0	573.8	Communication Satellite for Indonesia. Reimbursable (Indonesia).
Comstar B (S) 1976 73A	Atlas-Centaur (AC-40) (S)	Jul 22	1436.2	35791	35784	7.9	1490.1	Second domestic communications satellite for Comsat. Reimbursable (Comsat).

MISSION/ Intl Design	LAUNCH VEHICLE	LAUNCH DATE	PERIOD (Mins.)	CURRENT ORBITAL PARAMETERS			WEIGHT (kg)	REMARKS (All Launches from ESMC, unless otherwise noted)
				Apogee (km)	Perigee (km)	Incl (deg)		
ITOS H (S) 1976 77A	Delta 126 (S)	Jul 29	116.2	1518	1505	102.1	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)
Marisat C (S) 1976 101A	Delta 127 (S)	Oct 14	1436.0	35791	35779	10.9	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	1436.2	35789	35788	9.9	670.0	Third-generation communications satellite for NATO. Reimbursable (NATO).
Palapa B (S) 1977 18A	Delta 129 (S)	Mar 10	1439.5	35873	35831	6.9	573.8	Second Communication Satellite for Indonesia. Reimbursable (Indonesia).
GEOS/ESA (U) 1977 29A	Delta 130 (U)	Apr 20	734.1	38283	2874	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 41A	Atlas-Centaur (AC-39) (S)	May 26	1448.1	36075	35966	7.0	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	1435.8	35797	35762	10.2	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	1451.0	36152	36001	10.4	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	1438.7	35925	35750	8.3	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.
Transat (S) 1977 106A	Scout 97 (S)	Oct 27	106.8	1096	1060	89.7	93.9	Improved Transit navigation satellite for the U.S. Navy. Reimbursable (DOD). (WSMC)
Meteosat (S) 1977 108A	Delta 136 (S)	Nov 22	1435.9	35815	35748	11.3	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	1455.8	36182	36162	9.8	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	1441.4	35901	35877	6.5	1515.0	Provide increased telecommunications capacity for Intelsat's global network. Reimbursable (Comsat).
IUE-A (S) 1978 12A	Delta 138 (S)	Jan 26	1435.6	41343	30210	33.8	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	1436.1	35798	35776	10.5	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	916	894	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	904	893	99.2	27.3	
PIX-I (S) 1978 26C				CURRENT ELEMENTS NOT MAINTAINED			34.0	
Intelsat IVA F-6 (S) 1978 35A	Atlas-Centaur (AC-48) (S)	Mar 31	1435.6	35801	35753	6.5	1515.0	Provide increased telecommunications capacity for Intelsat's global network. Reimbursable (Comsat).

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)
BSE/Japan (S) 1978 39A	Delta 140	Apr 7	1435.2	35796	35740	11.0	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, 1981				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	1452.6	36124	36092	8.5	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	35808	35761	9.1	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	100.1	765	761	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 the batteries. (WSMC)
Comstar C (S) 1978 68A	Atlas-Centaur (AC-41) (S)	Jun 29	1451.8	36181	36004	6.3	1516.0	Third domestic communications satellite for Comsat. Reimbursable (Comsat).
GEOS-B/ESA (S) 1978 71A	Delta 143 (S)	Jul 14	1449.1	36056	36033	11.1	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.
Tiros-N (S) 1978 96A	Atlas-F (S)	Oct 13	101.7	845	829	98.7	1405.0	Third generation polar orbiting environmental spacecraft to provide improved meteorological and environmental data. Operated by NOAA. (WSMC)

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)
Nimbus-G (S) 1978 98A Cameo 1978 98B	Delta 145 (S)	Oct 24	104.0 104.0	955 966	940 924	99.1 99.6	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).
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	1462.2	36307	36283	6.9	706.0	Third-generation communications satellite for NATO. Reimbursable (NATO).
Telesat D (S) 1978 116A	Delta 147 (S)	Dec 15	1442.7	35943	35887	5.8	887.2	Fourth domestic communications satellite for Canada. Reimbursable (Canada).
1979								**1979**
SCATHA (S) 1979 07A	Delta 148 (S)	Jan 30	1418.4	42737	28140	9.4	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	1461.3	36334	36222	9.2	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	100.7	801	786	98.6	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	1441.0	35889	35874	4.6	571.5	Domestic communications satellite for Western Union. Reimbursable (WU).
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	788.9	35423	8385	8.2	895.4	Third RCA domestic communications satellite. Contact was lost shortly after apogee motor firing. Reimbursable (RCA).

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)
1980								**1980**
Fltsatcom C (S) 1980 04A	Atlas-Centaur (AC-49) (S)	Jan 17	1436.7	35885	35710	8.4	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	1451.3	36713	35453	8.6	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	1436.1	35798	35775	8.5	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	1442.5	35946	35878	5.3	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	35806	35769	3.8	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	35791	35785	6.4	1484.0	Fourth domestic communications satellite for Comsat. Reimbursable (Comsat).
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 53 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	1436.6	35808	35785	5.7	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).

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-8 F-1 (S) 1981 50A	Atlas-Centaur (AC-56) (S)	May 23	1438.2	35856	35799	4.4	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	101.7	847	829	98.9	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	23286	505 DOWN FEB 19, 1983	88.8	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	1460.4	36311	36209	8.1	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	1436.2	35797	35778	4.4	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	Delta 157 (S)	Oct 6			DOWN MAR 5, 1991		437.0	Solar Mesosphere Explorer, an atmospheric research satellite to study reactions between sunlight, ozone and other chemicals in the
UoSAT 1 (S) 1981 100B					DOWN OCT 13, 1989		52.0	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 12 seconds.
RCA-D (S) 1981 114A	Delta 158 (S)	Nov 19	1438.6	35846	35826	1.8	1081.8	Fourth RCA domestic communications satellite. Reimbursable (RCA).
Intelsat V F-3 (S) 1981 119A	Atlas-Centaur (AC-55) (S)	Dec 15	1436.1	35801	35770	3.4	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	1446.0	35988	35970	1.1	1081.8	RCA domestic communications satellite. Reimbursable (RCA).
Westar IV (S) 1982 14A	Delta 160 (S)	Feb 25	1443.4	35934	35923	1.1	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	1435.3	35791	35751	3.4	1928.2	Advanced series of spacecraft to provide increased telecommunications capacity for Intelsat's global network. Reimbursable (Comsat).

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 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 hrs 4 mins 46 secs.
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	1451.4	36149	36023	0.8	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 9 minutes 31 seconds.
Landsat D (S) 1982 72A	Delta 163 (S)	Jul 16	98.8	705	693	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	1438.5	35851	35814	1.5	1238.3	Commercial communications satellite for Canada. Reimbursable (Canada).
Intelsat V-E F-5 (S) 1982 97A	Atlas-Centaur (AC-60) (S)	Sep 28	1436.1	35819	35754	2.9	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	35795	35779	1.7	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	1436.2	35799	35776	1.2	3344.8	SBS-C (Reimbursable - SBS) and Telesat-C (Reimbursable - Canada). Demonstrated ability to conduct routine space operations. Mission
Telesat-E (S) 1982 110C		Nov 12	1436.1	35796	35796	01.3	4443.4	duration 122 hours 14 minutes 26 seconds.
1983								**1983**
IRAS (S) 1983 04A	Delta 166 (S)	Jan 25	102.9	903	884	99.0	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. Lewis Research Center Plasma
PIX II (S) 1983 04B			102.3	882	851	100.0		Interaction Experiment (PIX), to investigate interactions between high voltage systems and space environment, activated by Delta after IRAS separation.

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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)
NOAA-8 (S) 1983 22A	Atlas 73E (S)	Mar 28	101.0	817	793	98.5	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	1436.1	35797	35777	6.6	17014.0	
RCA F (S) 1983 30A	Delta 167 (S)	Apr 11	1442.0	35956	357847	0.1	1116.3	RCA domestic communications satellite. Reimbursable (RCA).
GOES 6 (S) 1983 41A	Delta 168 (S)	Apr 28	1435.4	35785	35758	4.5	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).
Intelsat V-F F-6 (S) 1983 47A	Atlas-Centaur (AC-61) (S)	May 19	1436.2	35797	35779	1.9	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	1436.1	35793	35780	1.2	4443.4	
Palapa-B-1 (S) 1983 59C		Jun 18	1436.1	35790	35784	2.4	4521.5	
SPAS-01 (S) 1983 59F		Jun 18	RETRIEVED JUN 24, 1983					
AF P83-1 (S) 1983 63A	Scout 103 (S)	Jun 27	100.6	819	754	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	1436.1	35791	35782	0.0	519.0	Hughes Communications, Inc. communications satellite. Reimbursable (Hughes).
Telsat 3A (S) 1983 77A	Delta 171 (S)	Jul 28	1436.2	35796	35780	0.1	635.0	AT&T communications satellite. Reimbursable (AT&T).

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 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	35811	35765	3.0	3391.0	
RCA G (S) 1983 94A	Delta 172 (S)	Sep 8	1436.2	35803	35772	0.0	1121.3	RCA domestic communications Satellite. Reimbursable (RCA).
Galaxy 2 (S) 1983 98A	Delta 173 (S)	Sep 22	1436.2	35792	35783	0.0	579.0	Hughes Communications satellite. Reimbursable (Hughes).
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 (Reimbursable - WU), and Palapa B-2 (Reimbursable - Indonesia). Both PAM's failed; both satellites retrieved on STS 51-A mission. Rendezvous tests performed with IRT, using deflated target. Evaluated Manned Maneuvering Unit (MMU) and Manipulator Foot Restraint (MFR). First STS landing at KSC. Mission duration 191 hours 15 minutes 55 seconds.
Westar 6 (U) 1984 11B		Feb 3	RETRIEVED NOV 16, 1984 (51-A)				3309.0	
IRT (S) 1984 11C		Feb 3	DOWN FEB 11, 1984				234.0	
Palapa B-2 (U) 1984 11D		Feb 6	RETRIEVED NOV 16, 1984 (51-A)				3419.0	
Landsat 5 (S) 1984 21A	Delta 174 (S)	Mar 1	98.8	703	695	98.2	1947.0	Earth resources technology satellite to provide continuing Earth remote sensing data. Instruments included a multispectral scanner and thematic mapper. Reimbursable (NOAA). UoSAT sponsored by AMSAT (Reimbursable - AMSAT). (WSMC)
UoSAT (S) 1984 21B			98.0	670	653	97.8	52.0	
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; SMM retrieved and repaired in Cargo Bay; redeployed April 12. Mission duration 167 hours 40 minutes 7 seconds.
LDEF (S) 1984 34B		Apr 6	RETRIEVED JAN 20, 1990 (STS-32)				9670.0	
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).

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)
AMPTE	Delta 175 (S)	Aug 16						Three active magnetospheric particle tracer explorers: Charge Composition Explorer (CCE) provided by the U.S.; Ion Release Module (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 Cooperative.
CCE (S) 1984 88A			730.9	39217	1784	64.4	242.0	
IRM (S) 1984 88B			2653.4	113818	402	27.0	605.0	
UKS (S) 1984 88C			2659.6	113417	1002	26.9	77.0	
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	1436.2	35795	35780	0.0	3344.0	
Syncom IV-2 (S) 1984 93C		Aug 31	1463.0	35787	35779	04.1	6889.0	
Telstar 3-C (S) 1984 93D		Sep 1	1436.2	35793	35783	0.0	3402.0	
Galaxy C (S) 1984 101A	Delta 176 (S)	Sep 21	1436.2	35793	35782	0.1	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	96.4	590	578	57.0	2449.0	
NOVA III (S) 1984 110A	Scout 104 (S)	Oct 11	108.9	1199	1149	89.9	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	1436.2	35796	35780	0.0	3420.0	
Syncom IV-1 (S) 1984 113C		Nov 10	1466.8	36427	36341	2.8	6889.0	
NATO III-D (S) 1984 115A	Delta 177 (S)	Nov 13	1436.2	35796	35780	1.4	761.0	Fourth in a series of communication satellites for NATO. Reimbursable (NATO).
NOAA-9 (S) 1984 123A	Atlas 39E (S)	Dec 12	101.8	854	834	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. Deployed unannounced payload for DOD. (Reimbursable - (DOD)). Mission duration 73 hours 33 minutes 23 seconds.
DOD (S) 1985 10B				ELEMENTS NOT AVAILABLE				
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). Syncom Sequencer failed to start, despite attempts by crew; remained inoperable until restarted by crew of 51-I (August 1985). Mission duration 167 hours 55 minutes 23 seconds.
Telesat-I (S) 1985 28B		Apr 13	1436.1	35796	35778	0.0	3550.0	
Syncom IV-3 (S) 1985 28C		Apr 12	1436.2	35803	35772	3.3	6889.0	
STS 51-B (S) Spacelab-3 1985 34A	Shuttle (S) (Challenger)	Apr 29		LANDED AT DFRF MAY 6, 1985 DOWN DEC 15, 1986		•	47.6	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 168 hours 8 minutes 46 seconds.
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 Spartan 1. Mission duration 169 hours 38 minutes 52 seconds.
Morelos-A (S) 1985 48B		Jun 17	1436.1	35793	35781	0.0	3443.0	
ARABSAT-A (S) 1985 48C		Jun 18	1434.4	35891	35614	1.0	3499.0	
TELSTAR 3-D (S) 1985 48D		Jun 19	1436.1	35789	35783	0.0	3437.0	
SPARTAN 1 (S) 1985 48E		Jun 20		RETRIEVED JUN 24, 1985			2051.0	
Intelsat VA F-11 (S) 1985 55A	Atlas-Centaur (AC-64) (S)	Jun 29	1436.1	35804	35769	0.1	1996.7	Second in a series of improved Commercial Communications Satellites for Intelsat. Reimbursable (Comsat).

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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)
STS 51-F (S) Spacelab-2 1985 63A	Shuttle (S) (Challenger)	Jul 29	LANDED AT EAFB AUG 6, 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.
PDP (S) 1985 63B			RETRIEVED JUL 29, 1985					
Navy SOOS-I 1985 66A (S)	Scout 105 (S)	Aug 2	107.9	1255	999	89.9	64.2	Two Navigation Satellites for the U.S. Navy. Reimbursable (DOD). (WSMC)
1985 66B (S)			107.9	1256	999	89.9	64.2	
STS 51-I (S) 1985 76A	Shuttle (S) (Discovery)	Aug 27	LANDED AT EAFB SEP 3, 1985					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.
Aussat-1 (S) 1985 76B		Aug 27	1436.1	35798	35777	0.0	3445.5	
ASC (S) 1985 76C		Aug 27	1436.1	35794	35778	0.0	3406.1	
Syncom IV-4 (U) 1985 76D		Aug 29	1430.1	35843	35809	3.2	6894.7	
Intelsat VA F-12 (S) 1985 87A	Atlas-Centaur (AC-65) (S)	Sep 28	1436.1	35801	35772	0.1	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 44 minutes 38 seconds.
STS 61-A (S) Spacelab D-1 1985 104A	Shuttle (S) (Challenger)	Oct 30	LANDED AT EAFB NOV 6, 1985					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.
GLOMR (S) 1985 104B			DOWN DEC 26, 1986				267.6	

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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)
STS 61-B (S) 1985 109A	Shuttle (S) (Atlantis)	Nov 26		LANDED AT EAFB DEC 3, 1985				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.
Morelos-B (S) 1985 109B		Nov 27	1436.1	35793	35780	0.0	4539.6	
Aussat-2 (S) 1985 109C		Nov 27	1436.2	35796	35779	0.0	4569.1	
Satcom (S) 1985 109D		Nov 28	1436.2	35797	35779	0.0	7225.3	
OEX Target 1985 109E				DOWN MAR 2, 1987				
AF-16	Scout 106 (S)	Dec 12						Air Force instrumented test vehicle. (Dual Payload) Reimbursable (DOD). (WFF)
1985 114A (S)				DOWN MAY 11, 1989				
1985 114B (S)				DOWN AUG 9, 1987				
1986								**1986**
STS 61-C (S) 1986 03A	Shuttle (S) (Columbia)	Jan 12		LANDED AT EAFB JAN 18, 1986				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.
SATCOM (S) 1986 03B		Jan 12	1436.2	35796	35780	0.0	7225.3	
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.
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	101.0	816	796	98.5	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)

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)
AF P87-11 (S) Polar Bear 1986 88A	Scout 107 (S)	Nov 13	104.8	1014	954	89.6		Scientific satellite to study the atmospheric effect on electromagnetic propagation. Reimbursable (DOD). (WSMC)
Fltsatcom (F-7) (S) 1986 96A	Atlas-Centaur (AC-66) (S)	Dec 4	1436.2	35849	35728	0.4	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	1436.2	35800	35775	0.4	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).
Fltsatcom (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	Scout 108 (S)	Sep 16						Two Transit navigation satellites in a stacked configuration for the U.S. Navy. Reimbursable (DOD). (WSMC)
1987 80A (S)			107.1	1178	1011	90.4	64.5	
1987 80B (S)			107.2	1180	1010	90.4	64.5	
1988								**1988**
DOD (SDI) (S) 1988 08A	Delta 181 (S)	Feb 8		DOWN MAR 1, 1988				Strategic Defense Initiative Organization (SDIO) Payload. Reimbursable (DOD).
San Marco D/L (S) 1988 26A	Scout 109 (S)	Mar 25		DOWN DEC 6, 1988			273.0	Explore the relationship between solar activity and meteorological phenomena. Cooperative with Italy. (San Marco)
SOOS-3	Scout 110 (S)	Apr 25					129.6	Two Transit navigation satellites in a stacked configuration for the U.S. Navy. Reimbursable (DOD). (WSMC)
1988 33A (S)			108.5	1302	1013	90.3		
1988 33B (S)			108.5	1300	1012	90.3		
Nova II 1988 52A	Scout 111 (S)	Jun 16	108.9	1199	1149	90.0	170.5	Improved Transit Navigation Satellite for the U.S. Navy. Reimbursable (DOD). (WSMC)
SOOS-4	Scout 112 (S)	Aug 25					128.2	Two Transit navigation satellites in a stacked configuration for the U.S. Navy. Reimbursable (DOD). (WSMC)
1988 74A (S)			107.3	1175	1030	89.9		
1988 74B (S)			107.3	1173	1031	89.9		
NOAA-H (S) 1988 89A	Atlas 63E (S)	Sep 24	101.9	855	838	99.1	1712.0	Operational environmental satellite for NOAA. Carried Search and Rescue instruments provided by Canada and France. 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)
STS-26 (S) 1988 91A	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.
TDRS-3 (S) 1988 91B		Sep 29	1436.2	35804	35772	0.1	2224.9	
STS-27 (S) 1988 106A	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.
DOD (S) 1988 106B			ELEMENTS NOT AVAILABLE					
1989								**1989**
STS-29 (S) 1989 21A	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.
TDRS-D (S) 1989 21B			1436.1	35808	35768	0.0	2224	
STS-30 (S) 1989 33A	Shuttle (S) (Atlantis)	May 4	LANDED AT EAFB MAY 8, 1989					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 28 seconds.
Magellan (S) 1989 33B			TRANS-VENUS TRAJECTORY					
STS-28 (S) 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 0 minutes 08 seconds.
Fltsatcom (S) 1989 77A	Atlas-Centaur (AC-68) (S)	Sep 25	1436.1	35701	35774	2.9	1863	Navy Communications satellite to provide communications between aircraft, ships and ground stations for DOD. Reimbursable (DOD).
STS-34 (S) 1989 84A	Shuttle (S) (Atlantis)	Oct 18	LANDED AT EAFB OCT 23, 1989					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 22 seconds.
Galileo (S) 1989 84B			ELEMENTS NOT AVAILABLE					
COBE (S) 1989 89A	Delta 2 (S)	Nov 18	102.6	885	873	99.0	2206	Cosmic Background Explorer spacecraft to provide the most comprehensive observations to date of radiative content of the universe.
STS-33 (S) 1989 90A	Shuttle (S) (Discovery)	Nov 23	LANDED AT EAFB NOV 28, 1989					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 46 seconds.
DOD (S) 1989 90B			ELEMENTS NOT AVAILABLE					

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) 1990
1990								
STS-32 (S) 1990 2A Syncom IV-5 (S) 1990 2B	Shuttle (S) (Columbia)	Jan 9	1436.2	LANDED AT EAFB JAN 20, 1990 35815	35759	2.7	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 hrs 0 mins 37 secs.
STS-36 (S) 1990 19A DOD (S) 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 22 seconds.
Pegsat (S) 1990 28A	Pegasus (S) (Orb Sci)	Apr 5	94.1	539	410	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.
STS-31 (S) 1990 37A HST (S) 1990 37B	Shuttle (S) (Discovery)	Apr 24	96.6	LANDED AT EAFB APR 29, 1990 598	591	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 6 seconds.
Macsat (S) 1990 43A 1990 43B	Scout 113 (S)	May 9	98.3 98.3	755 752	601 600	89.9 89.9	89.9	Two Multiple Access Communications Satellites (MACSATs) to provide global store-and-forward message relay capability for DOD Users. Reimbursable (DOD). (VAFB)
ROSAT (S) 1990 49A	Delta 2 (S)	Jun 1	95.6	557	542	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 (S) 1990 65A	Atlas-Centaur (AC-69) (S)	Jul 25	614.4	34781	345	18.0		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.

NASA Major Launch Record

1990

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 (S) 1990 90A Ulysses (S) 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 10 minutes 3 seconds.
STS-38 (S) 1990 97A DOD (S) 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 54 minutes 27 seconds.
STS-35 (S) 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 5 minutes 7 seconds.
1991								**1991**
STS-37 (S) 1991 27A GRO (S) 1991 27B	Shuttle (S) (Atlantis)	Apr 5	92.0	LANDED AT EAFB APR 11, 1991 376	370	28.5	15900.0	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 32 min 45 sec.
STS-39 (S) 1991 31A IBSS (S) 1991 31B	Shuttle (S) (Discovery)	Apr 28		LANDED AT KSC MAY 6, 1991 DOWN 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 SDIO. Mission Duration: 199 hrs 26 min 17 sec.
NOAA-12 (S) 1991 32A	Atlas-E (S)	May 14	101.2	824	806	98.7	1418.0	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. (WSMC)

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-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. Jerrigan, 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 mins 14 secs.
REX (S) 1991 45A	Scout (S)	Jun 29	101.3	867	769	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. (VAFB)
STS-43 (S) 1991 54A	Shuttle (S) (Atlantis)	Aug 2		LANDED AT KSC AUG 11, 1991				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 hours 22 minutes 27 seconds.
TDRS-E (S) 1991 54B			1436.1	35793	35779	0.0	2226.9	
STS-48 (S) 1991 63A	Shuttle (S) (Discovery)	Sep 12		LANDED AT EAFB SEP 18, 1991				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 27 mins 51 secs.
UARS (S) 1991 63B			96.2	580	573	57.0	6532.2	
STS-44 (S) 1991 80A	Shuttle (S) (Atlantis)	Nov 24		LANDED AT EAFB DEC 1, 1991				Tenth Atlantis flight with 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: 166 hrs 52 mins 27 secs.
DSP (S) 1991 80B		Nov 25		ELEMENTS NOT AVAILABLE				
1992								**1992**
STS-42 (S) 1992 2A	Shuttle (S) (Discovery)	Jan 22		LANDED AT EAFB JAN 30, 1992				Fourteenth Discovery flight with Ronald J. Grabe, Steven S. Oswald, Norman E. Thagard, William F. Readdy, David C. Hilmers, Roberta L. Bondar, and Ulf D. Merbold. The International Microgravity Laboratory (IML-1) studied the effects of microgravity on living organisms and materials processes. Mission duration: 193 hrs 15 mins 43 secs.

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-45 (S) 1992 15A	Shuttle (S) (Atlantis)	Mar 24		LANDED AT KSC APR 2, 1992				Eleventh Atlantis flight with Charles F. Bolden, Brian K. Duffy, Kathryn D. Sullivan, David C. Leetsma, C. Michael Foale, Dirk D. Frimout and Bryon K. Lichtenburg. The Atmospheric Laboratory for Applications and Science (ATLAS 1) studied stmospheric science, solar science, space physics and astronomy. Mission Duration: 214 hrs 10 mins 24 secs.
STS-49 (S) 1992 26A	Shuttle (S) (Endeavour)	May 2		LANDED AT EAFB MAY 16, 1992				First flight of Endeavour with Daniel C. Brandenstein, Kevin P. Chilton, Richard J. Hieb, Bruce E. Melnick, Pierre J. Thout, Kathryn C. Thornton, and Thomas D. Akers. On orbit repair of the Intelsat VI satellite and redeployment with new kick motor. Assembly of Station by Extravehicular Activity Methods (ASEM), while attached to the cargo bay. Mission duration: 213 hrs 17 mins 38 secs.
EUVE (S) 1992 31A	Delta II (S)	Jun 7	95.1	529	514	28.4	3250	The Extreme Ultraviolet Explorer (EUVE), designed to study the extreme ultraviolet (EUV)portion of the electromagnetic spectrum as well as selected EUV targets, in order to create a definitive map and catalog of these sources.
STS-50 (S) 1992 34A	Shuttle (S) (Columbia)	Jun 25		LANDED AT KSC JUL 9, 1992				Twelfth Columbia flight with Richard N. Richards, Kenneth D. Bowersox, Bonnie J. Dunbar, Carl J. Meade, Ellen S. Baker, and Lawrence J. Delucas. The First United States Microgravity Laboratory (USML-1) studied scientific and technical questions in materials science, fluid dynamics, biotechnology and combustion science. Mission duration: 331 hrs 30 mins 4 secs.
SAMPEX (S) 1992 38A	Scout (S)	Jul 3	96.6	679	509	81.7		First of the Small Explorer (SMEX) fleet, carrying four cosmic ray monitoring instruments, to study solar energetic particles, anomalous cosmic rays, galactic cosmic rays, and magnetospheric electrons.
GEOTAIL (S) 1992 44A	Delta II (S)	Jul 24	4750.6	508542	41363	22.4	1009	Joint mission between the United States and Japan to study the geomagnetic tail region of the magnetosphere. Geotail will also measure the physics of the magnetosphere, the plasma sheet, reconnection and neutral line formation to better understand fundamental magnetosphere processes.
STS-46 (S) 1992 49A EURECA 1992 49B	Shuttle (S) (Atlantis)	Jul 31	 94.6	LANDED AT AUG 8, 1992 503	 499	 28.5		Twelfth Atlantis flight with Loren J. Shriver, Andrew M. Allen, Jeffrey A. Hoffman, Franklin R. Chang-Diaz, Claude Nicollier, Marsha S. Ivins, and Franco Malerba. Deployed ESA'S European Retrievable Carrier (EURECA), a platform placed in orbit for 6 months offering conventional services to experimenters. Tested Tethered Satellite System (TSS-1), a joint program between the United States and Italy. Mission duration: 191 hrs 16 mins 7 secs.

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-47 (S) (Spacelab-J) 1992 61A	Shuttle (S) (Endeavour)	Sep 12		LANDED AT KSC SEP 20, 1992				Second Endeavour flight with Robert L. Gibson, Curtis L. Brown, Mark C. Lee, N. Jan Davis, Mae C. Jemison, Jerome Apt, and Mamoru Mohri. The Spacelab J mission, a joint mission between the U.S. and Japan, performed a series of 43 exlore the effects of producing new materials in the micogravity of space, and the study of living organisms in the organisms in the environission duration: 190 hrs 30 mins 23 secs.
Topex/Poseidon (S) 1992 52A	Ariane 42P (S)	Aug 10	112.4	1342	1330	66.0		U.S. French Satellite to help define the relationship between the Earth's oceans and climate. NASA payload launched on commercial Ariane vehicle. Joint NASA/CNES mission.
Mars Observer (S) 1992 63A	Titan III (S)	Sep 25		TRANS-MARTIAN TRAJECTORY				After an 11-month cruise, the Mars Observer (MO) will arrive at Mars and be inserted into orbit to examine the surface for elemental and mineralogical composition, global surface topography, gravity field and magnetic field determination and climatological conditions. The Mars Balloon Relay (MBR), on the Mars Observer, will relay communications from Mars landers that will be sent by the Russians in 1995.
STS-52 (S) 1992 70A LAGEOS (S) 1992 70B	Shuttle (S) (Columbia)	Oct 22	222.5	LANDED AT KSC NOV 1, 1992 5950	5616	52.7		Thirteenth Columbia flight with James D. Wetherbee, Michael A. Baker, William M. Sheperd, Tamara E. Jernigan, and Charles L. Veach. The Laser Geodynamics Satellite (LAGEOS) is a cooperative mission of the U.S. and Italy to obtain precise measurements of the crustal movement and gravitational field. The U.S. Microgravity Payload-2 (USMP-2), carried in the cargo bay, is one in a series of payloads for scientific experimentation and material processing in a reduced gravity. Mission duration: 236 hrs 56 mins 13 secs.
MSTI-1 (S) 1992 78A	Scout (S)	Nov 21	91.2	378	292	96.7		DOD/SDIO payload.
STS-53 (S) 1992 86A	Shuttle (S) (Discovery)	Dec 2		LANDED AT EAFB DEC 9, 1992				Fifteenth Discovery flight with David M. Walker, Robert Cabana, Guion S. Bluford, James Voss, and M. Richard Clifford. This was a DOD mission. Mission duration: 175 hrs 19 mins 47 secs.
1993								**1993**
STS-54(S) 1993 3A TDRS F 1993 3B	Shuttle(S) (Endeavour)	Jan 13	1432.0	LANDED AT KSC JAN 19, 1993 35717	35697	0.5		Third Endeavour flight with John H. Casper, Donald R. McMonagle, Mario Runco, Jr., Gregory Harbaugh, Susan Helms. A TDRS satellite was deployed to continue support of the Shuttle network systems. Mission duration: 143 hrs 38 mins 19 secs.

NASA Major Launch Record

1993

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)
1993								1993
STS-56(S) 1993 23A	Shuttle (S) (Discovery)	Apr 8	LANDED AT KSC APR 17, 1993					Sixteenth Discovery flight with Kenneth Cameron, Steven S. Oswald, C. Michael Foale, Kenneth Cockrell and Eileen Ochoa. A Spartan satellite was deployed to study the solar corona. The ATLAS-2 was used to measure upper atmospheric variatioins around the Earth. Mission Duration: 222 hs 08 min 24 secs.
SPARTAN-201 1993 23B		Apr 8	90.3	311	295	57.0		
STS-55 (S) 1993 27A	Shuttle (S) (Columbia)	Apr 26	LANDED AT KSC MAY 6, 1993					Fourteenth Columbia flight with Steven R. Nagel, Terence T. Henricks, Charles Precourt, Bernard Harris, Jr., Ulrich Walter and Hans Schlegel. The German, Spacelab D-2, was flown to study automation androbotics, material and life sciences, the Earth and its atmosphere and astronomy. Mission Duration: 239 hrs 39 min 59 secs
STS-57(S) 1993 37A	Shuttle (S) (Endeavour)	Jun 21	LANDED AT EAFB Jul 1, 1993					Fourth Endeavour flight with Ronald J. Grabe, Brian J. Duffy, G. David Low, Nancy J. Sherlock, Peter J. K. Wisoff and Janice E. Voss. Retrieved ESA's European Retrievable Carrier (EURECA), a platform placed in orbit on STS-46. SPACEHAB-1 was carried in the cargo bay for experiments sponsored by NASA, the U.S. Commerce and ESA. Mission Duration: 23hrs 44 mins 54 secs.
RADCAL (S) 1993 41A	Scout (S)	Jun 25	101.3	885	750	89.3		Radar Calibration Satellite(RADCAL) will be used to calibrate U.S. radar tracking stations Expected life of this sattelite is 24 months.
NOAA-13(S) 1993-50A	Atlas-G(S)	Aug 9	102.0	861	845	98.9		This weather observation satellite failed to function in orbit and was determined to be a failure.
STS-51 (S) 1993 58A	Shuttle (S) (Discovery)	Sep 12	LANDED AT KSC Sep 22, 1993					Seventeenth Discovery flight with Frank Culbertson, Willian F. Readdy, James H. Newman, Daniel W. Bursch and Carl E. Walz.The Advanced Communications Technology Satellite(ACTS) will be used to pioneer new initiatives in communicatioins technology. The Orbiting and Retrievable Far and Extreme Ultraviiolet Spectrometer-Shuttle Pallet System(ORFEUS-SPA) , is as astrophysics mission designed to study very hot and cold matter in the universe Mission duration 236 hrs 11 mins 11 secs
ACTS 1993-58B			1437.8	35929	35709	0.2		
ORFEUS-SPA 1993-58C			DOWN SEP 22, 1993					

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)
1993								1993
STS-58(S) 1993 65A	Shuttle (S) (Columbia)	Oct 18		LANDED AT EAFB NOV 1, 1993				Fifteenth Columbia flight with John E. Blaha, Richard Searfoss, David A. Wolf, Margaret Rhea Seddon, Shannon W. Lucid, William McArthur,Jr. and Martin J. Fettman. Spacelab Life Sciences-2(SLS-2) was a mission dedicated to the study of cardiovascular, regulatory, neurovestibular and musculoskeletal systems, to gain more knowledge on how the human body adapts to the space environment. Mission Duration: 336 hrs 12 min 32 sec.
STS-61(S) 1993 75A	Shuttle (S) (Endeavour)	Dec 2		LANDED AT KSC Dec 13, 1993				Fifth Endeavour flight with Richard O. Covey, Kenneth D. Bowersox, F. Story Musgrave, Thomas D. Akers, Jeffery A. Hoffman, Kathryn C. Thornton and Claude Nicollier. This flight was the first on-orbit service of the Hubble Space Telescope(HST). The Solar Array(SA's), the Wide Field/Planetary Camera(WFPC-II), and the Corrective Optics Space Telescope Axial Replacement(COSTAR) were some of the major units serviced. Mission duration: 259 hrs 58 mins 35 secs.
1994								1994
STS-60(S) 1994 6A	Shuttle (S) (Discovery)	Feb 3		LANDED AT KSC FEB 11, 1994				Eighteenth Discovery flight , with Charles Bolden, Ken Reightler, Ronald Sega, Franklin Chang-Diaz, Jan Davis and Sergei Krikalev as flight crew members. This was the first flight with a Russian cosmonaut on board. The Wake Shield Facility was unsuccessful when it failed to deploy its 3 meter shield. SPACEHAB-2 carried 12 payloads for experimentation in materials processing and biotechnology. Mission duration 199 hrs 09 mins 22 secs.
Galaxy 1R	Delta II (S)`	Feb 19	713.1	37253	2871	25.6		A geostationary satellite, Galaxy IR, was put into orbit to replace the aging Galaxy 1. It will operate with 24 C-band transponders.
STS-62(S) 1994 15A	Shuttle (S) (Columbia)	Mar 9		LANDED AT KSC MAR 18, 1994				Sixteenth Columbia flight, with John Gasper, Andrew Allen, Pieree Thuot, Charles Gemar and Marsha Ivins as flight crew members. The United States Microgravity Payload-2 (USMP-2) made its second flight to study microgravity on materials and fundamental science. Mission duration 335 hrs 16 mins 41 secs.

NASA Major Launch Record

1994

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)
1994								1994
STS-59 1994 20A	Shuttle (S) Endeavour	Apr 9		LANDED AT KSC APRIL 20, 1994				Sixth Endeavour flight, with Sidney M. Gutierrez, Kevin P. Chilton, M.R. Clifford, Linda M. Godwin, Jay Apt and Thomas D. Jones as flight crew members. The Space Radar Laboratory-1(SRL-1) payload in the cargo bay gave scientist detailed information on human-induced environmental changes from the natural forms of global change. The Measurement of Air Pollution From Satellite(MAPS) was also in the cargo bay . It measured carbon monoxide in the troposphere and lower atmosphere. Mission duration: 269 hrs 49 mins 30 secs
GOES 8 1994-22A	Atlas 1	Apr 13	192.4	42687	191	27.4		The GOES-8 meteorological geostationary spacecraft has instruments on board for high resolution visible and UV imagers and "sounders" for temperature and moisture profiles
STS-65 1994 39A	Shuttle Columbia	Jul 8		LANDED AT KSC JULY 23, 1994				Seventeenth Columbia flight, with Robert D. Cabana, James D. Halsell Richard J. Hieb, Carl E. Walz, Leroy Chiao, Donald A. Thomas and Chiaki Naito-Mukai as crew members. The International Microgravity Laboratory-2(IML-2) will use furnaces and other facilities to produce a variety of material structures, from crystals to metal alloys. Over 80 investigations will be studied as prepared by over 200 scientist from six space agencies. Mission duration: 353 hrs 55 mins 00 secs
STS 64 1994 59A SPARTAN 1 1994 59B	Shuttle Discovery	Sep 9		LANDED AT EDW SEPTEMBER 20, 1994 DOWN SEPTEMBER 20, 1994				Nineteenth Discovery flight, with Richard N. Richards, Susan J. Helms, L. Blaine Hammond, Jerry M. Linenger, Carl J. Meade and Mark C. Lee as crew members. The Lidar in Space Technology Experiment(LITE) will be used to better explain our climate. LITE will help us understand the human impact on the atmosphere and enable us to improve our measurements of the clouds, particles in the atmosphere and the Earth. SPARTAN will be deployed from the Shuttle to study the acceleration and velocity of the solar wind and it will also measure the Sun's corona. Mission duration: 262 hrs 49 mins 57 secs

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) 1994
1994								
STS-68(S) 1994 62A	Shuttle (S) (Endeavour)	Sep 30		LANDED AT EDW OCT 11, 1994				Seventh Endeavour flight with, Michael A. Baker, Terence W. Wilcutt, Steven L. Smith, Daniel W. Bursch, Peter J.K. Wisoff and Thomas D. Jones as flight crew members. The Space Radar Laboratory-2 is comprised of the Spaceborne Imaging Radar-C/X Band Synthic Aperture Radar (SIR-C/X-SAR). and the Measurement of Air Pollution from Satellite (MAPS). Mission Duration 269 hrs 46 mins 08 secs
WIND(S) 1994 71A	Delta II	Nov 1		VARIABLE ORBITAL PARAMETERS			1250 .0	Measure the solar wind plasma and magnetic field besides several instruments to measurevery energetic particles and gamma rays.
STS-66 (S) 1994 73A CRISTA-SPAS 1994 73B	Shuttle (S) (Discovery)	Nov 3		LANDED AT EDW NOV 14, 1994 DOWN NOV 14, 1994				Nineteenth Discovery flight with, Donald R. McMonagle, Ellen Ochoa, Curtis L. Brown, Joseph R. Tanner, Jean-Francois Clervoy and Scott Parazynski as flight crew members. The Atmospheric Laboratory for Applications and Science Spacelab(ATLAS) studied the middle atmosphere's chemical makeup. Seven expeirments made up this science experiment. CRISTA-SPAS operated independently of the Shuttle after its release from the Remote Manipulator System. This experiment studied the trace gases in the middle atmosphere and measured winds, wave interaction, turbulence and other processes. Mission Duration: 262 hrs 32 mins 20 secs
NOAA-14 (S) 1994-89 A	Atlas-E	Dec 30		472	468		1030.0	The primary objective is to acquire daily global information for short and long term forecasting. The satellite will be part of the operational polar satellite system.

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 704 1995-001A	Atlas-2AS	Jan 10						Geostationary communications spacecraft launched from Cape Canaveral. It is parked over the Indian Ocean to provide radio and TV coverage to the Middle East, Africa and parts of Europe.
STS-63 1995-004A	Shuttle(S) (Discovery)	Feb 3		LANDED AS KSC FEB 11, 1995				Twentieth Discovery flight, with James D. Wetherbee, Eileen M. Collen, Bernard A. Harris, Jr., Michael C. Foale, Janice Voss, and Vladimir Georglevich Titovas as flight crew members. The cargo bay deployable payloads were Shuttle-Mir Rendezvous and fly around, SPARTAN 204 Science, and EVA activities. In-cabin payloads were SPACEHAB-3 and AMOS. Mission Duration: 196 hrs 29 mins 36 secs
STS-67 1995-007A	Shuttle(S) (Endeavour)	Mar 2		LANDED AT EDW MAR 18, 1995				Eighth Endeavour flight, with Steven S. Oswald, William G Gregory, John M. Grunsfeld, Wendy B. Lawrence, Tamare E. Jerrigan, Samuel T. Durrance, and Ronald Parise as flight crew members. Cargo Bay Payloads consisted of ASTRO-2 Spacelab with three UV telescopes. Crew cabin Payloads consisted of Commercial MDA ITA (CMIX), Protein Crystal Growth Experiments, Middeck Active Control Experiment (MACE), and Shuttle Amateur Radio Experiment (SAREX). Mission Duration: 399 hrs 09 mins 47 secs
GOES-J 1995-025A	Atlas-1	May 23						Named GOES-9 after launch, this geostationary meterological spacecraft will first cover the central United States. Later the spacecraft will be moved to cover either the east or west coast. The instruments onboard will provide cloud cover images and monitor atmospheric temperatures and moisture at many altitudes.

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-71 1995-30A	Shuttle (Atlantis)	June 27		LANDED AT KSC JUL 7, 1995				Fourteenth Atlantis flight, with Robert L. "Hoot" Gibson, Charles J. Precourt, Ellen S. Baker, Gregory J. Harbaugh, Bonnie Dunbar, Anatoly Y. Solovyev(MIR-19-Ascent Only), Gennady Strekalovas (MIR-18-Entry Only), Norm Thagard(MIR-18-Entry Only) crew members. Cargo Bay Payloads consisted of Shuttle-MIR rendezvous and docking, Orbit Docking system, and Shuttle-MIR Science. Cargo Bay Activities consisted of U.S./Russian Space Cooperation and STS-71/MIR Protocol Activities. In-Cabin Payloads consisted of IMAR and Shuttle Amateur Radio Experiment-II(SAREX-II). Mission Duration: 235 hrs 23 mins 09 secs
STS-70 1995-35A	Shuttle (Discovery)	July 13		LANDED AT KSC JUL 22, 1995				Twenty-First Discovery flight, with Terrence T. "Tom" Hendricks, Kevin R. Kregel, Donald A. Thomas, Nancy J. Curkie and Mary E. Weber crew members. Cargo Bay Payloads consisted of Tracking and Data Relay Satellite and Inertial Upper Stage. Middeck Payloads consisted of Biological Research in Canisters(BRIC), Bioreactor Development System(BDS), CPCG, NIH R-2, STL-B and MSX. Mission Duration: 214 hrs 21 mins 09 secs
TDRS-7 1995-35B	STS-70	July 13						An American Geostationary Tracking and Relay Satellite launched from STS-70. It relays data between spacecraft and between spacecraft and ground stations in F and Ku bands. TDRS is parked on 150 W longitude for testing. After tests are completed TDRS will be moved to another latitude.
STS-69 1995-48A	Shuttle (Endeavour)	Sept 7		LANDED AT KSC SEP 18, 1995				Ninth Endeavour flight with David M. Walker, Kenneth D. Cockrell, James S. Voss, James H. Newman and Michael L. Gernhardt as flight crew members. Cargo Bay payloads consisted of the second flight of the Wake Shield Facility, the deployment and recaputure of the Spartan 201 and the International Extreme Hitchiker. Other payloads on the flight were the Capillary Pumped Loop-2 Gas Bridge Assembly, Electrolysis Performance Improvement Concept Study, National Institutes of Health-Cell-4 and the Thermal Energy Storage Experiment. Mission Duration: 260hrs 28 min 56 secs

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-73 1995-56A	Shuttle Columbia	Oct 20		LANDED AT KSC NOV 5, 1995				Eighteenth Columbia flight with Kenneth D. Bowersox, Kent Rominger, Kathryn Thornton, Catherine Coleman, Michael Lopez-Alegria, Albert Sacco and Fred Leslie as crew members. The United States Microgravity Laboratory -2 (USML-2) was the prime payload on this flight. Experiments on gravity in combustion flame spreadiing, semiconductor crystals and theoretical models of fluid physics were tested. The Orbital Acceleration Measurement System (SAMS), High-Packed Digital Television Demonstration and Three Dimensional Microgravity Accelerometer (3DMA) were on this flight. Mission Duration: 381 hrs 52 mins 21 secs
STS-74 1995-61A	Shuttle Atlantis	Nov 12		LANDED AT KSC NOV 20, 1995				Fifteenth Atlantis flight withKenneth Cameron, James Halsell, Jerry Ross, William McArthur and Chris Hadfield as crew members. This was the second mission to link up with the MIR space station. The Russian built Docking Module was attaced to the Kristall module of the MIR. This Docking module will be used in future docking between the Shuttle and MIR Space Station. The cargo bay also carried the Photogrammetric Appendage Structrual Dynamics Experiment (PASDE) Mission Duration196 hrs 30 mins 54 secs
SOHO 1995-65A	Atlas-2AS	Dec 2					1,850 kg	An ESA-NASA spacecraft was launched from Cape Canaveral Air Station. It carried three American and nine European instruments to observe the sun and its corona. It was maneuvered to orbit around the first Lagrangian point(L-1) at 1,500,000 km in the sunward direction. The instruments will measure the intensity and polarization of light scattered by the coronal electrons, and the compostion of cold and hot plasma ejected by the Sun.
GALAXY 3R 1995-69A	Atlas-2A	Dec 15						A Geostationary communications spacecraft launched from Cape Canaveral Air Station. After parking at 95 degrees W longitude the spacecraft provided 140 television channels to Mexico, the Caribbean, and Central American countries through its 24 C-band and 324 Ku-band transponders.

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-72 1996 01A	Shuttle (Endeavour)	Jan 11		LANDED AT KSC JAN 20, 1996				Tenth Endeavour flight with Brian Duffy, Brent Jett, Winston Scott Daniel Barry and Kiochi Wakata as flight crew members. The Japanese Space Flyer Unit (SFU) was captured after being launched on March 17, 1995. The deployment and retrieval of the OAST-Flyer with four experiments on board. Also carried on the flight was the Shuttle Solar Backscatter Ultraviolet Experiment, Shuttle Laser Altimeter Payload, Space Tissue Loss Experiment and three Getaway Specials. Mission Duration: 218hrs 00mins 41secs
NEAR 1996-008A	Delta 2	Feb 17					818kg	NEAR (Near Earth Astroid Rendezvous) will orbit around the Eros asteriod. This satellite will first pass by the asteriod 253-Mathild and return by Earth for a gravity boosted speed increase to make the final voyage to Eros. Once in orbit it will provide infrared images, x-ray, gamma-ray spectrometer and magnetomter data. Also on board is a laser range finder and a radioscience instrument.
STS-75 1996-012A	Shuttle (Columbia)	Feb 22		LANDED AT KSC MAR 7, 1996				Nineteenth Columbia flight with Andrew Allen, Scott Horowitz, Jeff Hoffman, Maurizio Cheli, Claude Nicollier, Franklin Chang-Diaz and Umberto Guidoni as the crew members. The deployment of the Tether Satellite System (TSS) ended when the tether broke. The satellite was lost when it reentered the atmosphere. As part of the USMP-3 cargo bay experiments where the Advanced Automated Directional Solidification Furnace (AADSF), Critical Fluid Light Scattering Experiment (Zeno) and the IDGE, OARE, MEPHISTO experiments. There were also three Middeck Glovebox Facility Combustion Investigations (MGBX). Missiona Duration: 328 hrs 14 mins 00 secs
Polar 1996-013A	Delta 2	Feb 24	938.1	50,551	5,100	85.9	1,300 kg	Last element of the International Solar-Terrestrial Program (ISTP/GGS). The satellite is in a polar orbit with eleven instruments to measure magnetospheric hot plasma, plasma waves, electric/magnetic fields, x-rays, energitic particles and visible light and UV cameras to map auroral displays.

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-76 1996-018A	Shuttle (Atlantis)	March 22		LANDED AT KSC MAR 30, 1996				Sixteenth Atlantis flight with Kevin Chilton, Rick Searfoss, Ron Sega, Rich Clifford and Linda Godwin as crew members while Shannon Lucid, Yuri Onufriendo and Yuri Usachev were being taken to the Space Station MIR.The third docking with MIR included over1,900 lbs of supplies. The mission would include the SPACEHAB module, middeck experiments and a Get Away Special. Mission Duration: 221hrs 15 mins 53 secs
STS-77 1996-032A	Shuttle (Endeavour)	May 19		LANDED AT KSC MAY 29, 1996				Eleventh Endeavour flight with John H Casper, Curtis Brown, Daniel Bursch, Mario Runco, Marc Garneau and Andrew Thomas as crew members. A Spartan 207 platform was released from the shuttle, with the Inflatable Antenna Experiment (IAE). The PAMS-STU spacecraft was also released from the Shuttle to test attitude stabilization then re-enter the atmosphere. Mission Duration: 240 hrs 40 mins 10 secs
STS-78 1996-036A	Shuttle (Columbia)	June 20		LANDED AT KSC JUL 7, 1996				Twenteeth Columbia flight with Terence Henricks, Kevin Kregel, Susan Helms, Richard Linneham, Charles Brady, Jean-Jacques Favor and Robert Thirsk as crew members. This flight carried the Life and Microgravity Spacelab (LMS-1) in its cargo bay. There were 22 experiments conducted in the LMS involving fish embryos, rats, Bonzai plants, fluid dynamics, metallurgy and protein crystal growth. Thirteen of the life science experiments were devoted to the study of microgravity and its effects on the the human physiology. Mission Duration: 405 hrs 47 mins 30 secs

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-79 1996-57A	Shuttle (Atlantis)	Sept 19		LANDED AT KSC SEPT 26, 1996				Seventeenth Atlantis flight with William Readdy, Terrence Wilcutt, Thomas Akers, John Blaha, Jay Apt and Carl Walz as flight crew members. This flight will be the fourth to rendzvous and dock with the MIR space station. This was the fist exchange of astronaut when John Blaha replaced Shannon Lucid, who had been on the MIR since late March. This was the first Shuttle to carry a double SPACEHAB module. The forward portion of this module was used to conduct experiments while on orbit, while the aft portion was used to house food, clothing, experimental supplies and spare equipment to be transferred to the MIR. Mission Duration: 243 hrs 18 mins 26 secs
MGS 1997-62A	Delta 2	Nov 7		DUE TO ARRIVE AT MARS SEP, 1997				The Mars Global Surveyor (MGS) is being sent to Mars to remote-sense the atmosphere and soil composition. After completing 180 days of high apogee senseing, an "aerobraking orbit" will descend the MGS to a low circular "mapping orbit". The surface of Mars will be mapped by a thermal emmision spectrometer, a laser altimeter and three linescan cameras at visual wavelengths.
STS-80 1996-65A	Shuttle (Columbia)	Nov 19		LANDED AT KSC DEC 7, 1996				Twenty first Columbia flight with Kenneth Cockrell, Kent Rominger, Tamara Jernigan, Thomas Jones and F. Story Musgrave as the flight crew members. Two satellites, the Wake Shield Facility (WSF) and the Retrievable Far & Extreme Ultraviolet Spectrograph-Shuttle Pallet Satellite II (ORFEUS-SPAS II) were both deployed and retrieved on this flight. The WSF was flown to test the growth of thin semi conductor films for advanced electronics. The ORFEUS-SPAS II will observe the evolution of stars,structure of galaxies and the nature of interstellar mediums. The astronauts will test a variety of tools and instruments for future station operations. Mission Duration: 426 hrs 53 mins 18 secs
Mars Pathfinder 1996-68A	Delta 2	Dec 4		DUE TO ARRIVE ON MARS JUL 4, 1997				The Pathfinder will land on Mars cushioned by inflatable airbags. The Sojourner, Pathfinder microver, with Alpha, Proton, X-ray Spectrometer and color cameras will transmit data to the Pathfinder Lander. The solar powered Lander will then transmit its research data and Sojourner data from Mars.

Section C

Aeronautics & Space Transportation Technology

Office of Aeronautics & Space Transportation Technology (OASTT)

The OASTT directs the agency's aeronautics research and development programs, including the High-Speed Research Program which is creating and refining the technology and addressing the environmental challenges supporting the development of a future U.S. high speed civil transport aircraft.

The Transportation Technology efforts focus on NASA's Reusable Launch Vehicle (RLV) Program, a government/industry partnership aimed at demonstrating single-stage -to-orbit technology required for reducing the cost of access to space. Through DC-XA, X-34 and X-33 demonstration flights, along with additional demonstration programs in flight- and ground-based, results will allow the country to proceed with full-scale commercial programs that will create new opportunities for space access while significantly improving U.S. economic competitiveness in the world-wide marketplace.

The office also researches advanced technology for subsonic aircraft, manages NASA's weather-related flight safety research, works to improve inspection methods for aging aircraft, propulsion research and development of advanced piloting and air traffic control aids. In addition, it directs numerous flight research programs using high-performance aircraft such as the SR-71, F/A-18, and F-16XL. It also manages fundamental aeronautics research in aerodynamics, fluid dynamics, structural mechanic, hypersonics and human factor issues such as the interaction of pilots with highly-automated cockpits.

The (OASTT) has institutional management responsibility for Ames Research Center, Mountain View, CA; Dryden Flight Research Center, Edwards, CA; Langley Research Center, Hampton, VA; and Lewis Research Center, Cleveland, OH.

Airplane Program

The research Airplane Program, an effort by NASA and the Space Administration and the military services, was conceived near the end of World War II to perform flight studies with a series of specially-constructed research aircraft in the then unexplored transonic-low-supersonic characteristics of full-scale aircraft in flight.

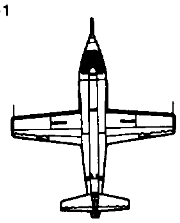
Although supersonic flight was first achieved in 1947, further research in the program resulted in increases in knowledge about the dynamics of manned flight in winged aircraft at speeds up to and in excess of 4500 mph and at altitudes up to and greater than 350,000 feet. Two general categories of aircraft were obtained for the research airplane program: (1) those obtained to explore new areas of performance such as the X-1, D-558 I, X-2 AND X-15; and (2) those obtained to investigate the effects of different configurations, such as the X-3, X-4, X-5,XB-70 and the lifting bodies.

The outstanding contributions of this research program include providing important information on previously unexplored aircraft characteristics; validating the transonic-supersonic characteristics predicted by wind-tunnel tests and analytical techniques; and the intangible benefit of providing confidence in the achievement of safe, controllable transonic-supersonic flight.

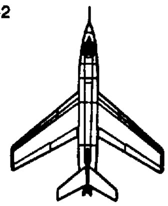
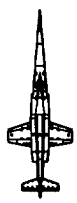
NACA/NASA X-PLANES

The "X" designation, originally "XS" for experimental Supersonic, applied to a family of experimental aircraft not intended for production beyond a limited number built solely for flight research. The D-558-1 and -2 did not bear the "X" label but were clearly intended for the same purpose. This was also true of the non-X-designated lifting bodies, whereas the XB-70 was originally intended to be a production bomber, and the XF-92A was expected to be a production fighter. Neither of the two latter aircraft actually went into production, and both models became significant research aircraft, hence their inclusion here.

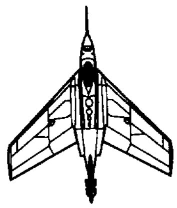
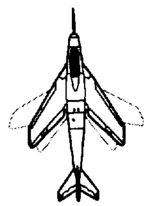
Summary of "X" Experimental Aircraft

AIRCRAFT	FLIGHT DATES	NUMBER OF FLIGHTS	REMARKS
X-1  Manufacturer and # of Airframes: Bell Aircraft built three of the original X-1s, plus an X-1A, an X-1B, an X-1D, and there was also an X-1E rebuilt from the X-1 #2.	1946-1958	214	Joint program among the NACA, the Air Force, and Bell Aircraft. The bullet-shaped, rocket-powered aircraft became the first airplane to break the sound barrier on Oct. 14, 1947. Flight research by the NACA continued through such advanced models as the X-1B and X-1E, providing a wealth of aerodynamic information for use in correlating wind-tunnel data with actual flight data and for designing later high-performance aircraft.
D-558-1 Manufacturer and # of Airframes: Douglas, three	1947-1953	225	Joint program among the NACA, the Navy-Marine Corps., and Douglas Aircraft. The straight-winged, turbojet-powered "Skystreak" collected data in the transonic region and stability, control, loads buffeting, and handling qualities.
D-558-2 Manufacturer and # of Airframes: Douglas, three	1948-1956	312	Joint program among the NACA, the Navy-Marine Corps,. and Douglas Aircraft. The swept-wing aircraft flown with both turbo-jet and rocket power set an altitude record of 83,235 ft. on Aug. 21, 1953, and a speed record on Nov. 20, 1953, when it became the first aircraft to reach Mach 2. The "Skyrocket" collected data about handling qualities, wing loads, and stability and control, especially pitch-up.

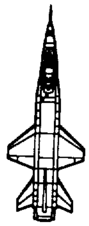
Summary of "X" Experimental Aircraft

AIRCRAFT	MANUFACTURER	AIRFRAMES	FLIGHT DATES	FLIGHTS	REMARKS
XF-92A	Convair	1	1948-1953 NACA flts.; others by Convair and the Air Force	25	Joint program among the NACA, the Air Force, and Convair to test the country's first delta-wing air-craft. Stability and control, pitch-up, and lift-over drag measurements obtained from this program contributed to the technology used to develop the F-102, F-106, XF2Y-1 Sea Dart, and B-58 aircraft.
X-2 	Bell	2	1954-1956	17	Joint program with the Air Force, although the NACA never flew the swept-wing, rocket-powered aircraft designed to fly Mach 3. The NACA supported the Air Force with advice and data analysis. The X-2 did become the first aircraft to reach Mach 3, recording a Mach 3.2 speed on its last flight, which destroyed the aircraft and killed the Air Force pilot because of inertial coupling. It collected data on aerodynamic heating, stability and control effectiveness at high speeds and altitudes. The X-2 was also the first aircraft to fly higher than 100,000 feet on Sept. 7, 1956, when it reached 126,200 feet 20 days before the aircraft reached Mach 3.2
X-3 	Douglas	1	1952-1955	26	This slender, jet-powered aircraft tested such new materials as titanium and collected data on stability and control, pressure, distribution, and flight loads. The X-3 failed to achieve the high speeds for which it was designed but pioneered in the use of titanium and contributed to the development of aircraft tire technology.

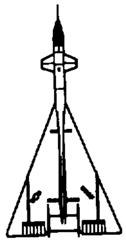
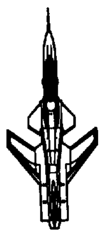
Summary of "X" Experimental Aircraft

AIRCRAFT	MANUFACTURER	AIRFRAMES	FLIGHT DATES	FLIGHTS	REMARKS
X-4 	Northrop	2	1948-1953	90	In a joint program with the Air Force and Northrop, the NACA conducted most of the flights in this semi-tailless aircraft (which had no horizontal stabilizer). Powered by two turbojet engines and featuring swept wings, the X-4 helped demonstrate that tail surfaces are important for proper control effectiveness but that a properly configured semi-tailless airplane was a viable platform for research on dynamic stability and also provided data (from tufts) on airflow anomalies.
X-5 	Bell	2	1951-1953 Air Force-NACA flights plus a few others by Bell and the Air Force	133	The X-5 completed all of the research goals originally set for the first aircraft capable of variably sweeping its wings in flight. Demonstrating wing sweep from 20 to 60 degrees, the aircraft verified NACA wind-tunnel predictions of reduced drag and improved performance resulting from increased wing sweep as it approached Mach 1. Even the vicious spinning characteristics of the X-5 yielded a wealth of data for determining poor aircrafts spin disign.

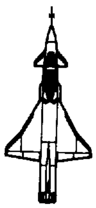
Summary of "X" Experimental Aircraft

AIRCRAFT	MANUFACTURER	AIRFRAMES	FLIGHT DATES	FLIGHTS	REMARKS
X-15 	North American Aviation	3	1959-1968	199	This joint program by NASA, the Air Force, and the Navy operated the most remarkable of all the rocket research aircraft. Composed of an internal structure of titanium and a skin surface of a chrome-nickel alloy known as Inconel X, the X-15 first set speed records in the Mach 4-6 range with Mach 4.43 on Mar 7, 1961; Mach 5.27 on June 23, 1961; Mach 6.04 on Nov. 9, 1961; and Mach 6.7 on Oct 3, 1967. The airplane set an altitude record of 354,200 feet (67 miles) on Aug. 22, 1963, and provided an enormous wealth of data on hypersonic air flow, aerodynamic heating, control and stability at hypersonic speeds, reaction controls for flight above the atmosphere, piloting techniques for reentry, human factors, and flight instrumentation of relevance not only to aeronautics but to spaceflight.
Lifting bodies					
M2-F1 M2-F1 M2-F3 HL-10 X-24A & 24B	DFRC Northrop Northrop Northrop Martin	1 of each	1963-1975	223 Does not include nearly 400 car tows of the M2-F1	This joint program between the Air Force and NASA demonstrated the ability of pilots to maneuver and safely land a wingless vehicle designed to fly back to Earth from space and be landed like an aircraft at a pre-determined site. The information generated by the lifting body program contributed to the data base led to the development of today's shuttle program, especially its approach and landing techniques. The rocket-powered lifting bodies (all but the unpowered M2-F1) have have also contributed to the upcoming X-33 space technology demonstrator and the X-38.

Summary of "X" Experimental Aircraft

AIRCRAFT	MANUFACTURER	AIRFRAMES	FLIGHT DATES	FLIGHTS	REMARKS
XB-70 	North American	2	1964-1969	129	The joint program among North American Rockwell, the Air Force, and NASA featured the world's largest experimental aircraft with a delta wing and hinged wing tips that could be folded down to a 65° angle to improve stability at the aircraft's supersonic speeds of up to Mach 3, a speed at which the Valkyrie was designed to ride its own shock wave. The program used the Valkyrie to conduct fundamental flight research at high speeds for use in designing future supersonic aircraft, both military and civilian. The aircraft produced a significant quantity of information on supersonic flight at up to Mach 3 speeds in areas such as noise (including sonic booms), potential flight corridors, validation of wind-tunnel data, flight control, operational problems, and clear-air turbulence.
X-29 	Grumman	2	1984-1992	437	In a joint program involving the Defense Advanced Research Projects Agency, the Air Force, NASA, Grumman, and the other contractors, this single-engine jet-powered aircraft investigated the use of advanced composite materials,a forward-swept wing with a thin supercritical airfoil, a variable-incidence canard, a computerized fly-by-wire flight control system to overcome the aircraft's inherent instability, behavior at high angles of attack, and a vortex flow-control system (among other technologies). On Dec. 13, 1985, the X-29 became the first forward-swept-wing airplane in the world to exceed Mach 1 in level flight, and flight results showed that a highly unstable aircraft with forward-swept wings could be flown safely with good control response up to about a 40° angle of attack. The flight instructor also added to engineers' understanding of advanced composites, used increaslingly in aircraft construction, and digital flight control systems.

Summary of "X" Experimental Aircraft

AIRCRAFT	MANUFACTURER	AIRFRAMES	FLIGHT DATES	FLIGHTS	REMARKS
X-30			1986-1994 Only a 1/3 scale concept demonstrator was built, "flown" only in a high-temperature tunnel.		This joint effort by NASA, the Department of Defense, and five major contractors explored development of technologies for a new generation of aerospace vehicles for hypersonic cruise in the atmosphere or single-stage-to-orbit using airbreathing primary propulsion and horizontal takeoff and landing. Although a full-scale aircraft was never built because Congress ended funding in1994, the program had expected such a vehicle to fly at Mach 25. The program developed significant advances in high-temperature, carbon-carbon materials, lightweight titanium and beryllium alloys, and high strength, corrosion-resistant titanium-alloy composites. These technologies and the program's work with supersonic-combustion ramjet propulsion will all be useful to subsequent U.S. aerospace efforts in the hypersonic area.
X-31 	Rockwell Aerospace North American Aircraft Deutsche Aerospace	2	1990-1995	555	In a joint program with the Defense Advanced Research Projects Agency, the U.S. Navy, the German Federal Ministry of Defense, Deutsche Aerospace, Rockwell International, the U.S. Air Force, and NASA, the Enhanced Fighter Maneuverability demonstrator showed the value of using thrust vectoring (by means of carbon-carbon paddles) coupled with advanced flight control systems to provide high maneuverability and controlled flight at high angles of attack. Featuring a delta-shaped, composite, twisted camber wing and strakes on the rear fuselage, the X-31 achieved stabilized flight at 70° angle of attack. With nose strakes added to increase stability, the aircraft exhibited remarkable "post-stall" maneuverability, such as a 180° turn at an extremely high angle of attack, known as the "Herbst maneuver."

Aeronautical Research and Technology Budget Plans

(In Thousands of Dollars)	FY 96	FY 95	FY 94	FY 93	FY 92	FY91	FY 90	FY 89	FY 88	FY 87
Research and Technology Base	430,600	354,300	420,300	451,547	343,297	336,400	321,764	309,563	257,150	271,111
Systems Technology/Focused Programs										
Rotocraft systems technology					4,900	5,100	3,556	4,800	4,529	18,700
High performance aircraft systems technology					10,700	10,500	9,691	11,000	5,430	25,985
Advanced propulsion systems technology					15,180	15,000	13,152	13,952	17,955	28,220
Numerical aerodynamic simulation		46,200	48,100	47,930	45,400	44,100	41,798	39,685	39,018	29,984
Materials and structures systems technology		24,300	25,700	24,388	37,562	39,900	28,143	19,200	8,818	
High-speed research	233,300	221,300	197,200	116,995	76,400	44,000	24,494			
High performance computing and communications	32,200	51,600	63,600	30,359	16,980	17,000				
Advanced subsonic technology	169,800	125,800	89,300	12,425	5,000					
Hypersonic technology program				33,118						
Transatmospheric Research and Technology			20,000		4,136	95,000	59,027	69,400	52,500	45,000
Construction of Facilities		22,000	203,000	52,600	42,700	32,600	54,449	52,500	42,800	18,800
National Aeronautical Facilities		35,000								
Total	**865,900**	**880,500**	**1,067,200**	**769,362**	**602,255**	**639,600**	**556,074**	**520,100**	**428,200**	**437,800**

Aeronautical Research and Technology Funding

As of September 30, 1996

	FY1996	FY1995	FY 1994	FY 1993	FY 1992	FY 1991	FY 1990	FY 1989 & Prior
Aeronautical Programs								
Aerodynamics	100,900	111,200	139,140					
Propulsion and power	58,300	64,600	72,475					
Materials and structures	42,500	37,800	49,075					
Controls, guidance, and human factors	98,900	46,300	65,640					
Flight systems	101,100	55,000	60,440					
Systems analysis	9,900	11,400	7,530					
Hypersonics/advanced research	19,000	20,000	26,000					
Total	430,600	354,000	420,300					

Section D

Procurement, Funding and Workforce

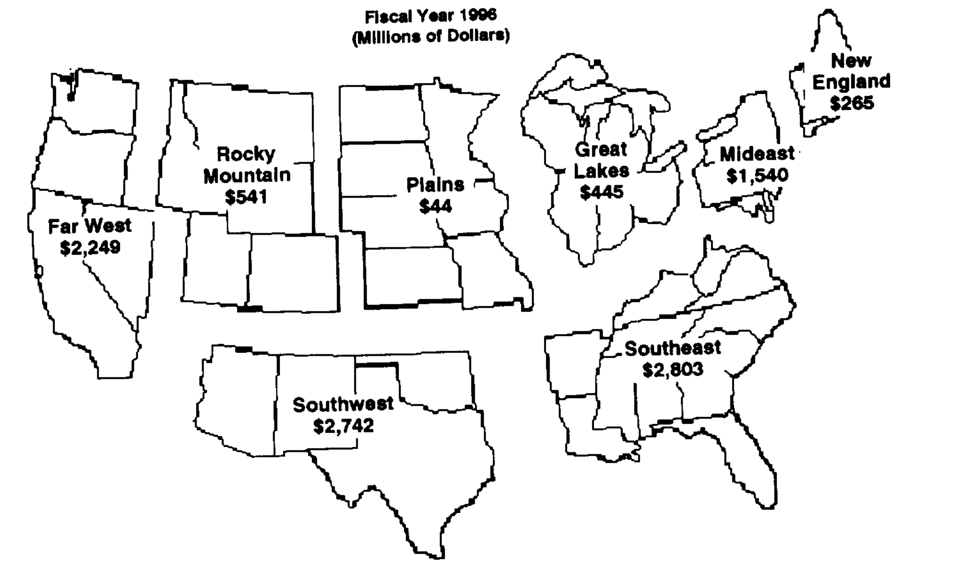
NASA Contract Awards By State

(FY 1996)

State	Total (Thousands)	Business (Thousands)	Educational & Nonprofit (Thousands)
Alabama	656,030	622,737	33,293
Alaska	9,244	--	9,244
Arizona	71,234	44,481	26,753
Arkansas	731	204	527
California	2,133,903	1,916,072	217,831
Colorado	130,385	95,433	34,952
Connecticut	94,447	92,255	2,192
Delaware	2,616	1,089	1,527
District of Columbia	67,092	30,970	36,122
Florida	1,110,241	1,087,333	22,908
Georgia	26,411	13,710	12,701
Hawaii	8,640	757	7,883
Idaho	367	76	291
Illinois	19,665	7,584	12,081
Indiana	42,046	38,283	3,763
Iowa	9,081	807	8,274
Kansas	3,880	1,619	2,261
Kentucky	2,251	1,118	1,133
Louisiana	362,358	357,532	4,826
Maine	1,285	584	701
Maryland	1,159,418	995,195	164,223
Massachusetts	145,492	34,770	110,722
Michigan	24,377	7,612	16,765
Minnesota	10,521	7,212	3,309
Mississippi	129,255	123,009	6,246
Missouri	16,123	11,149	4,974
Montana	6,380	241	6,139
Nebraska	1,544	192	1,352
Nevada	1,707	787	920
New Hampshire	19,013	6,064	12,949
New Jersey	179,687	171,543	8,144
New Mexico	55,132	45,375	9,757
New York	44,908	21,126	23,782
North Carolina	12,498	1,282	11,216
North Dakota	941	0	941
Ohio	324,525	303,879	20,646
Oklahoma	9,282	932	8,350
Oregon	8,584	3,935	4,649
Pennsylvania	86,322	70,088	16,234
Rhode Island	2,807	257	2,550
South Carolina	2,757	286	2,471
South Dakota	1,461	93	1,368
Tennessee	22,271	15,996	6,275
Texas	2,606,413	2,545,432	60,978
Utah	402,849	398,186	4,663
Vermont	1,505	1,035	470
Virginia	448,075	414,693	33,382
Washington	104,128	94,106	10,022
West Virginia	29,814	8,304	21,510
Wisconsin	34,362	22,046	12,316
Wyoming	829	131	698
TOTAL	**$10,644,887**	**$9,617,603**	**$1,027,284**

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 *



* 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 1996)

Installation	Awards ($M)	Percent
TOTAL	**$12,699.2**	**100.0**
Marshall Space Flight Center	2,234.9	17.6
Goddard Space Flight Center	2,381.7	18.8
Johnson Space Center	3,291.7	25.9
Kennedy Space Center	1,090.8	8.6
NASA Management Office/JPL	1,211.3	9.5
Lewis Research Center	635.9	5.0
Headquarters	578.6	4.6
Ames Research Center	533.3	4.2
Langley Research Center	489.3	3.9
Stennis Space Center	143.3	1.1
Dryden Flight Research Center	108.4	0.8

Awards Through Other Government Agencies (FY 1996)

Agency	Awards ($M)	Percent
TOTAL	**$484.7**	**100.0**
Over $25,000	**390.5**	**80.6**
Air Force	199.7	41.2
Navy	58.0	12.0
Energy Department	35.8	7.4
Army	26.1	5.4
National Science Foundation	17.3	3.6
Interior Department	18.7	3.8
Commerce Department	13.7	2.8
Defense Department	6.7	1.4
Other Government Agencies	14.5	3.0
$25,000 and Under	**94.2**	**19.4**

Awards Placed Outside The United States (FY 1996)

Place of Performance	Awards ($Thousands)
TOTAL	**$193,521***
Direct NASA Awards	**$192,427**
Australia	11,955
Bermuda	363
Brazil	25
Canada	48,442
Chile	3,355
France	57
Germany	316
Ireland	36
Israel	34
Netherlands	1,041
Norway	42
New Zealand	19
Peru	189
Puerto Rico	3,006
Russia	104,992
Spain	12,660
Sweden	1,250
Switzerland	685
United Kingdom	3,471
Ukraine	489
Placed Through Other Government Agencies	**$1,094**
Canada	15
Guam	902
Puerto Rico	177

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

Contract Awards by Type of Effort

Category	Number of Contracts	Total (Millions)
TOTAL	**5,716**	**$9, 617.6***
Research and Development	**1,756**	**3,523.3**
Aeronautics & Space Technology	659	481.5
Space Science & Applications	339	201.1
Space Flight	71	640.6
Space Operations	21	69.0
Commercial Programs	49	11.3
Space Station	33	1,529.3
Other Space R&D	456	527.6
Other R&D	128	62.9
Services	**1,435**	**4,268.7**
ADP & Telecommunication	165	593.9
Maintenance, Repair & Rebuilding of Equipment	126	1,187.9
Operation of Government-owned Facilities	37	167.2
Professional, Administrative & Management Support	275	1,423.8
Utilities & Housekeeping	97	153.9
Construction of Structures & Facilities	91	225.0
Maintenance, Repair, Alteration of Real Property	306	154.7
Other Services	338	362.3
Supplies & Equipment	**2,525**	**1,825.6**
Ammunition & Explosives	9	338.7
Space Vehicles	44	1,132.4
Engines, Turbines & Components	9	16.7
Electrical/Electronic Equipment Components	93	14.5
Communication, Detection & Coherent Radiation Equipment	113	12.4
Instruments & Laboratory Equipment	360	24.4
ADP Equipment, Software, Supplies & Support Equipment	1,460	211.0
Fuels, Lubricants, Oils & Waxes	26	13.0
Other Supplies & Equipment	411	62.5

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

Distribution of NASA Procurements

(In Millions of Dollars)

Fiscal Years 1961 - 1983

*Included in Government

	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 7T	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

Distribution of NASA Procurements

(In Millions of Dollars)

Fiscal Years 1984 - 1996

*Included in Government

	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94
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	10,716.7	10,497.9	9,965.7
(Small Business)	(556.2)	(644.7)	(671.3)	(786.3)	(801.4)	(857.3)	(924.3)	(968.3)	(1,010.6)	(1,060.7)	(1,150.2)
Educational	22.6	256.9	276.6	315.4	370.3	464.2	513.6	592.0	659.3	707.8	730.9
Nonprofit	98.6	103.1	119.0	119.1	129.5	180.0	200.6	244.0	297.8	336.6	311.0
JPL	533.1	724.6	891.3	1,005.6	979.9	1,058.1	1,106.8	1,139.6	1,229.6	1,029.8	1,093.4
Government	494.3	535.1	489.7	594.9	734.6	543.2	610.4	693.4	498.6	508.4	642.6
Outside U.S.	38.1	35.4	47.1	34.3	55.9	63.3	62.3	72.7	76.2	79.9	169.5
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	13,478.2	13,160.4	12,913.1

	FY 95	FY 96
Total Business	10,311.5	9,801.6
(Small Business)	(1,171.2)	(1,162.5)
Educational	814.4	745.7
Nonprofit	311.1	287.9
JPL	1,135.0	1,188.3
Government	562.7	484.7
Outside U.S.	206.7	191.8
Total	13,341.4	12,699.2

One Hundred Educational And Nonprofit Institutions Listed According To Total Awards Received (FY1996)

INSTITUTION TOTAL AWARDS TO EDUCATIONAL & NONPROFIT INSTITUTIONS		AWARDS (THOUSAND)	AWARDS (PERCENT)
1. STANFORD UNIVERSITY		72,785	7.04
2. JOHNS HOPKINS UNIVERSITY		60,748	5.88
3. ASSN UNIV RESEARCH & ASTRONOMY	(N)	55,272	5.35
4. SMITHSONIAN UNIVERSITY INSTITUTION	(N)	45,998	4.45
5. MASS INSTITUTE OF TECHNOLOGY		37,883	3.67
6. UNIVERSITIES SPACE RESEARCH	(N)	31,425	3.04
7. CALIFORNIA INSTITUTE OF TECHNOLOGY		25,098	2.43
8. UNIVERSITY OF ARIZONA		21,700	2.10
9. NEW MEXICO STATE UNIV LAS CRUCES		19,596	1.90
10. NATIONAL ACADEMY OF SCIENCES	(N)	19,013	1.84
11. UNIVERSITY OF CALIFORNIA BERKELEY		18,444	1.78
12. UNIVERSITY OF MARYLAND COLLEGE PARK		18,337	1.77
13. WHEELING JESUIT COLLEGE		17,567	1.70
14. UNIVERSITY OF COLORADO BOULDER		16,335	1.58
15. AMTECH INC. CALIFORNIA	(N)	16,051	1.55
16. UNIVERSITY OF ALABAMA HUNTSVILLE		14,534	1.41
17. UNIV CORP ATMOSPHERIC RESEARCH	(N)	12,589	1.22
18. UNIVERSITY OF NEW HAMPSHIRE		11,654	1.13
19. UNIVERSITY OF MICHIGAN ANN ARBOR		11,322	1.10
20. UNIVERSITY OF WISCONSIN MADISON		10,937	1.06
21. UNIVERSITY OF ALABAMA BIRMINGHAM		10,460	1.01
22. UNIVERSITY OF CALIFORNIA SAN DIEGO		10,131	.98
23. HARVARD UNIV		9,693	.94
24. UNIVERSITY OF CALIFORNIA LOS ANGELES		9,532	.92
25. PENNSYLVANIA STATE UNIVERSITY UP		9,356	.91
26. UNIVERSITY OF ALASKA FAIRBANKS		9,194	.89
27. UNIVERSITY OF WASHINGTON		8,973	.87
28. UNIVERSITY OF TEXAS AUSTIN		8,017	.78
29. OKLAHOMA STATE UNIVERSITY		7,799	.75
30. UNIVERSITY OF HAWAII		7,674	.74
31. UNIVERSITY OF HOUSTON		7,519	.73
32. CHARLES STARK DRAPER LABS	(N)	6,801	.66
33. UNIVERSITY OF IOWA		6,739	.65
34. GEORGIA INSTITUTE OF TECHNOLOGY		6,414	.62
35. CORNELL UNIVERSITY		5,817	.56
36. SOUTHWEST RESEARCH INSTITUTE	(N)	5,786	.56
37. ROTORCRAFT INDUSTRY TECH. ASSN.	(N)	5,748	.56
38. OHIO AEROSPACE INSTITUTE	(N)	5,273	.51
39. UNIVERSITY OF VIRGINIA		5,188	.50
40. OHIO STATE UNIVERSITY		4,940	.48
41. UNIVERSITY OF FLORIDA		4,900	.47
42. COLUMBIA UNIVERSITY		4,835	.47
43. UNIVERSITY OF CHICAGO		4,787	.46
44. RESEARCH TRIANGLE INSTITUTE	(N)	4,326	.42
45. PRINCETON UNIVERSITY		4,234	.41
46. SAN JOSE STATE UNIVERSITY		4,125	.40
47. UNIVERSITY OF CALIFORNIA SANTA BARBARA		4,093	.40
48. RESEARCH & DEVELOPMENT INSTITUTE	(N)	4,050	.39
49. FLORIDA A & M UNIVERSITY		3,989	.39

Educational and Nonprofit Institutions

One Hundred Educational And Nonprofit Institutions Listed According To Total Awards Received
(FY1996)

50. UNIVERSITY OF SOUTHERN CALIFORNIA		3,978	.38
51. UNIVERSITY OF MIAMI		3,940	.38
52. TEXAS A & M UNIVERSITY		3,922	.38
53. OREGON STATE UNIVERSITY		3,853	.37
54. OLD DOMINION UNIVERSITY		3,842	.37
55. CARNEGIE MELLON UNIVERSITY		3,782	.37
56. C I E S I N	(N)	3,582	.35
57. CASE WESTERN RESERVE UNIVERSITY		3,571	.35
58. UNIVERSITY OF CALIFORNIA RIVERSIDE		3,555	.34
59. AUBURN UNIVERSITY AUBURN		3,528	.34
60. LOMA LINDA UNIVERSITY		3,500	.34
61. RICE UNIVERSITY		3,346	.32
62. WASHINGTON UNIVERSITY ST. LOUIS		3,291	32
63. HAMPTON UNIVERSITY		3,261	.32
64. S E T I INSTITUE	(N)	3,176	31
65. STATE UNIV NEW YORK STONY BROOK		3,100	.30
66. VIRGINIA POLYTECHNIC INSTITUE		3,073	.30
67. CLARK ATLANTA UNIVERSITY		3,058	.30
68. BOSTON UNIVERSITY		3,055	.30
69. UTAH STATE UNIVERSITY		3,042	.29
70. LOGISTICS MANAGEMENT INSTITUTE	(N)	3,037	.29
71. AEROSPACE CORP.	(N)	2,875	.28
72. HOWARD UNIVERSITY		2,865	.28
73. NORTH CAROLINA STATE UNIVERSITY		2,858	.28
74. UNIVERSITY OF CALIFORNIA IRVINE		2,843	.28
75. UNIV MINNESOTA MINNEAPOLIS ST. PAUL		2,841	.27
76. TENNESSEE STATE UNIVERSITY		2,774	.27
77. CITY OF HAMPTON	(N)	2,773	.27
78. NORTH CAROLINA A & M STATE UNIVERSITY		2,772	.27
79. UNIVERSITY OF HOUSTON CLEAR LAKE		2,755	.27
80. GEORGE WASHNGTN UNIVERSITY		2,741	.27
81. UNIVERSITY OF ILLINOIS URBANA		2,688	.26
82. ARIZONA STATE UNIVERSITY		2,570	.25
83. FLORIDA INTERNATIONAL UNIVERSITY		2,497	.24
84. UNIVERSITY OF MARYLAND BALTIMORE		2,434	.24
85. COLORADO STATE UNIVERSITY		2,399	.23
86. UNIVERSITY ILLINOIS URBANA CHAMPAGNE		2,273	.22
87. UNIVERSITY OF CALIFORNIA DAVIS		2,181	.21
88. MOREHOUSE COLLEGE		2,162	.21
89. PURDUE UNIVERSITY		2,110	.20
90. SOUTHWEST FNDTN RESEARCH & EDUC.	(N)	2,050	.20
91. UNIVERSITY OF NEW MEXICO		2,045	20
92. RUTGERS STATE UNIVERSITY PISCATAWAT		2,024	.20
93. SMART VALLEY INC.	(N)	2,000	.19
94. FLORIDA STATE UNIVERSITY		1,975	.19
95. UNIVERSITY MASSACHUSETTS AMHERT		1,974	.19
96. QUALITY EDUCATION MINORITIES	(N)	1,965	.19
97. S R I INTERNATIONAL CORP.	(N)	1,962	.19
98. WEST VIRGINIA UNIV RESEARCH CORP.	(N)	1,953	.19
99. LOUISIANA STATE UNIV BATON ROUGE		1,905	.18
100. UNIVERSITY OF SOUTH FLORIDA		1,878	.18
**OTHER		16,271	15.70

Principal Contractors (Business Firms)

One Hundred Contractors (Business Firms) Listed According To Total Awards Received
(FY1996)

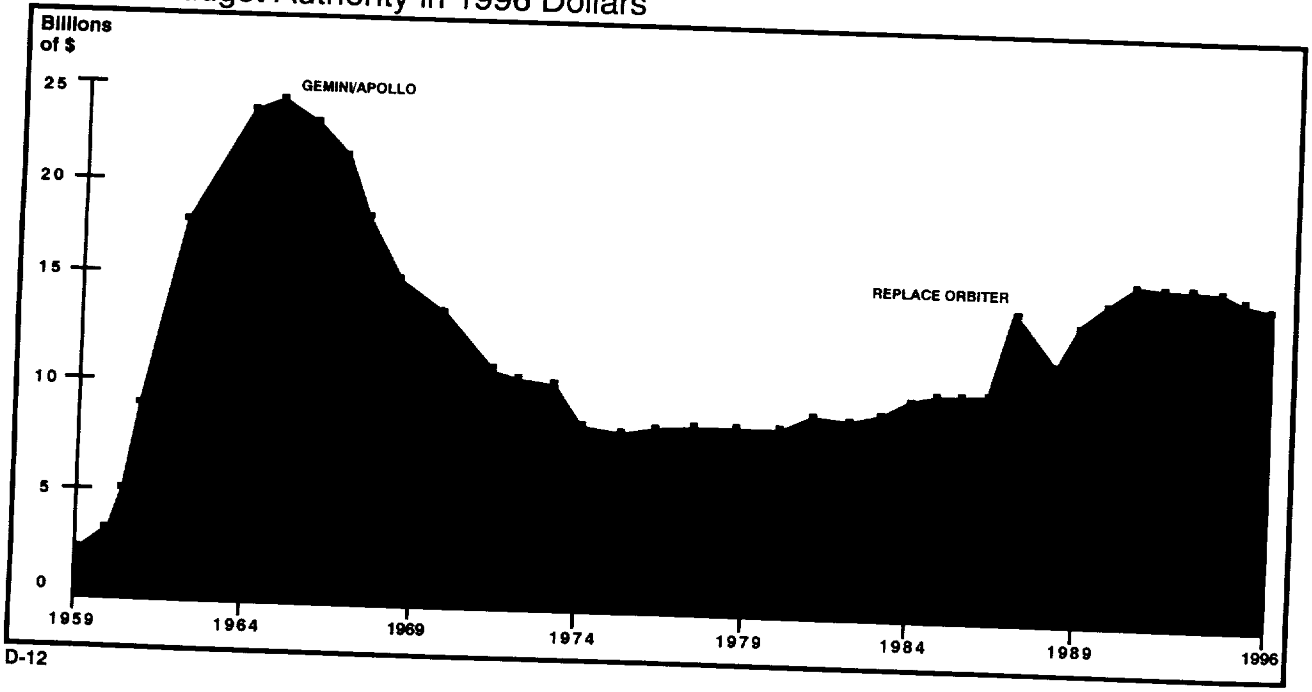
CONTRACTOR		(THOUSANDS)	PERCENT
TOTAL AWARDS TO BUSINESS FIRMS		$9,800,819	100.00
1. BOEING CO.		1,607,774	16.40
2. LOCKHEED MARTIN CORP.		833,387	8.50
3. ROCKWELL INTERNATIONAL CORP.		756,319	7.72
4. UNITED SPACE ALLIANCE LLC		544,424	5.55
5. THIOKOL CORP.		396,184	4.04
6. MCDONNELL DOUGLAS CORP.		388,587	3.96
7. ROCKWELL SPACE OPERATIONS INC.		292,423	2.98
8. T R W INC.		287,339	2.93
9. ALLIED SIGNAL TECHNICAL SERVICES		285,084	2.91
10. COMPUTER SCIENCES CORP.		213,543	2.18
11. E G & G FLORIDA INC.		175,147	1.79
12. LOCKHEED MARTIN ENGRG & SCIENCE CO.		165,571	1.69
13. UNITED TECHNOLOGIES CORP		162,456	1.66
14. LOCKHEED MARTIN AEROSPACE CORP.		160,630	1.64
15. USBI BOOSTER PRODUCTION CO.		157,096	1.60
16. HUGHES AIRCRAFT CO.		152,864	1.56
17. HUGHES INFORMATION TECH. CORP		133,486	1.36
18. BOEING COMMERCIAL AIRPLANE GROUP		83,045	.85
19. JOHNSON CONTROLS WORLD SERVICES		68,806	.70
20. BAMSI INC.		59,322	.61
21. GENERAL ELECTRIC CO.		58,383	.60
22. GRUMMAN AEROSPACE CORP.		57,729	.59
23. ORBITAL SCIENCES CORP.		56,204	.57
24. STERLING SOFTWARE US INC.		55,433	.57
25. SANTA BARBARA RESEARCH CENTER		53,707	.55
26. SPACE SYSTEMS LORAL INC.		50,018	.51
27. BALL AEROSPACE & TECH. CORP.		47,347	.48
28. HUGHES S T X CORP.		46,966	.48
29. CORTEZ III SERVICE CORP.		45,527	.46
30. SPACEHAB TRAINING INC.	(S)	44,831	.46
31. HUGHES TRAINING INC.		43,629	.45
32. CALSPAN CORP.		39,939	.41
33. RAYTHEON SERVICE CO.		39,508	.40
34. TELEDYNE INDUSTRIES INC.		35,988	.37
35. AEROJET GENERAL CORP.		35,439	.36
36. LOCKHEED MARTIN SERVICES INC.		35,262	.36
37. LOCKHEED SPACE OPERATIONS CO.		33,825	.35
38. JACKSON & TULL INC.	(S)(D)	33,683	.34
39. SWALES & ASSOCIATES INC.	(S)	33,450	.34
40. NYMA INC.	(S)(D)	31,787	.32
41. CRAY RESEARCH INC.		31,677	.32
42. SILICON GRAPHICS INC.		30,925	.32
43. SCIENCE APPLICATION INTL CORP.		30,426	.31
44. KRUG LIFE SCIENCES INC.		30,387	.31
45. GENERAL ELECTRIC UTC JV		29,900	.31
46. C T A INC.		28,331	.29
47. DYNCORP		28,319	.29
48. JOHNSON ENGINEERING CORP	(S)	28,058	.29
49. GOVERNMENT MICRO RESOURCES	(S)(D)	27, 989	.29

Principal Contractors (Business Firms)

One Hundred Contractors (Business Firms) Listed According To Total Awards Received
(FY1996)

50.	SVERDRUP TECHNOLOGY INC.		26,500	.27
51.	BIONETICS CORP.		25,903	.26
52.	UNISYS CORP.		24,933	.25
53.	I T T CORP.		24,895	.25
54.	BOEING COMPUTER SUPPORT SERVICES		24,657	.25
55.	ANALEX CORP.	(D)	22,755	.23
56.	N S I TECHNOLOGY SERV CORP.		22,178	.23
57.	I NET INC.	(D)	20,314	.21
58.	E G & G LANGLEY INC.		19,666	.20
59.	HONEYWELL INC.		19,611	.20
60.	ALLIEDSIGNAL INC.		19,129	.20
61.	MICRO CRAFT INC.	(S)	17,832	.18
62.	HERNANDEZ ENGINEERING INC.	(D)	17,250	.18
63.	GENERAL TECHNOLOGY INC. JV	(S)	17,227	.18
64.	R M S TECHNOLOGIES INC.	(D)	16,852	.17
65.	PRAXAIR INC.		14,518	.15
66.	BROWN & ROOT SERVICES CORP.		14,518	.15
67.	P H H HOMEQUITY CORP.		13,932	.14
68.	LOCKHEED ADVANCED DEV. CO.		13,833	.14
69.	GENERAL SCIENECS CORP.		13,430	.14
70.	UNISYS GOVERNEMENT SYSTEMS INC.		13,089	.13
71.	GILCREST ELECTRIC & SUPPLY CO.	(S)(D)	12,940	.13
72.	MANHATTAN CONSTRUCTION CO.		12,490	.13
73.	NATIVE AMERICAN SERVICES INC.	(S)(D)	11,845	.12
74.	IVEYS CONSTRUCTION INC.		11,832	.12
75.	VIRGINIA ELECTRIC & POWER CO.		11,570	.12
76.	RECOM TECHNOLOGIES INC.	(S)(D)	11,106	.11
77.	ANALYTICAL SERVICES & MAT INC.	(S)(D)	11,076	.11
78.	CLEVELAND ELECTRIC ILLUMINATING		10,847	.11
79.	FAIRCHILD SPACE & DEFENSE CORP.		9,961	.10
80.	DIGITAL EQUIPMENT CORP.		9,910	.10
81.	SERV AIR INC.		9,648	.10
82.	SUN MICROSYSTEMS FEDERAL INC.		9,570	.10
83.	CAELUM RESEARCH CORP.	(S)(D)	9,551	.10
84.	INTERMETRICS INC.		9,170	.09
85.	INTERNATIONAL BUSINESS MACHINES		8,896	.09
86.	OCEANEERING SPACE SYSTEMS		8,756	.09
87.	GOVERNMENT TECHNOLOGY SERV INC.	(S)	8,660	.09
88.	SCIENTIFIC & COMMERCIAL SYSTEMS	(S)(D)	8,635	.09
89.	SCIENCE SYSTEMS APPLICATIONS	(S)(D)	8,329	.08
90.	KELSEY SEYBOLD MEDICAL GROUP		8,190	.08
91.	CRAY GRUMMAN SYSTEMS		8,034	.08
92.	ANSTEC INC.	(S)(D)	7,901	.08
93.	TECHTRANS INTERNATIONAL INC.	(S)	7,779	.08
94.	MASON & HANGER SERVICES INC.		7,544	.08
95.	PIONEER CONTRACT SERVICES INC.	(S)	7,320	.07
96.	WYLE LABORATORIES		7,194	.07
97.	CENTENNIAL CONTRACTORS ENTERPRISES		7,021	.07
98.	SYSCON SERVICES INC.		6,949	.07
99.	DYNAMAC CORP.	(S)	6,846	.07
100.	BAY STATE COMPUTERS INC.	(S)(D)	6,835	.07
	OTHER*		1,052,828	10.74

NASA's Budget Authority in 1996 Dollars



Financial Summary

As Of September 30, 1995

(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	Trust Funds	Office Of Inspector General
1959	330.90	298.70	145.50	34.00	--	24.80	86.70	--	--
1960	523.90	486.90	401.00	255.70	--	54.30	91.00	--	--
1961	966.70	908.30	744.30	487.70	--	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	4,558.80	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	--	--

Financial Summary

(In Millions Of Dollars)

As Of September 30, 1995

Fiscal Year	Total Appropriations	Total Direct Obligations	Outlays: Total	Research & Development	Space Flight, Control & Data Communications	Construction Of Facilities	Research & Program Management	Trust Funds	Office of Inspector General	GSA Building Delegation
1983	6,817.70	6,723.90	6,663.90	5,316.20	--	108.10	1,239.60	--	--	--
1984	7,242.60	7,135.20	7,047.60	2,791.80	2,914.60	108.80	1,232.40	--	--	--
1985	7,552.20	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	10,621.00	8,603.70	7,591.40	2,436.20	3,597.30	149.00	1,408.90	--	--	--
1988	9,001.50	9,914.70	9,091.60	2,915.80	4,362.20	165.90	1,647.70	--	--	--
1989	10,897.50	11,315.80	11,051.50	3,922.40	5,030.20	190.10	1,908.30	0.50	--	--
1990	12,295.70	13,068.93	12,428.83	5,094.30	5,116.52	218.42	1,991.09	1.00	7.50	--
1991	14,014.62	13,973.54	13,877.64	5,765.48	5,590.28	326.31	2,185.06	1.02	9.49	--
1992	14,316.05	14,159.75	13,961.42	6,578.85	5,117.51	463.03	1,788.05	1.54	12.44	--
1993	14,323.39	14,118.47	14,306.23	7,086.12	5,025.16	556.77	1,621.64	1.12	14.63	0.79
1994	14,550.45	13,949.17	13,695.89	6,758.00	4,899.24	371.16	1,650.15	1.20	15.02	1.12
*1995	00,000.00	1500.30	5,114.26	3,286.34	1,408.87	305.09	98.38	1.13	--	--

NOTE: "TOTAL APPROPRIATIONS" shows actual amounts appropriated including the Office of Inspector General, all transfers, and all rescissions. It does not include the Trust Funds and the GSA Building Delegation.

* A new Financial Summary chart, on the following page, was added in the 1995 edition.

Financial Summary

As Of September 30, 1996

(in Millions of Dollars)

Fiscal Year	Total Approp	Total Direct Obligations	Outlays: Total	Outlays: Science, Aeronautics & Technology	Outlays: Human Space Flight	Outlays: Mission Support	Outlays: Office Of Inspector General	Outlays: 1994 & Prior Appropriations
1995	13,997.76	14,441.03	13,377.72	2,706.76	3,527.72	2,028.98	14.45	5.099.81
1996	13,884.59	13,810.51	13,881.70	5,017.82	5,452.02	2,372.25	16.28	- 1,023.33

Research and Development Funding By Program

(In Millions of Dollars) As of September 30, 1994

	FY1994	FY1993	FY 1992	FY 1991	FY 1990	FY 1989 - FY 1980	FY 1979	FY 1978	FY 1977 & Prior
Space Station	1,864.27	2,077.08	1,976.71	1,875.39	1,723.70	2037.89	--	--	--
Space Flight									
Space Shuttle	--	--	--	--	--	7659.30	1,637.60	1,348.80	4,599.70
Space Transp Cap Dev	584.70	496.98	559.49	594.62	546.02	6,788.90	299.70	263.80	3,946.20
STS Oper Capability Dev	(--)	(--)	(--)	(--)	(--)	(816.70)	(89.90)	(65.40)	(65.40)
Spacelab	(132.80)	(113.89)	(99.20)	(129.30)	(118.58)	(470.00)	(--)	(--)	(--)
Upper Stage	(--)	(--)	(59.70)	(82.40)	(79.70)	(832.90)	(--)	(--)	(--)
Payload Oper & Support Eqt	(116.73)	(124.92)	(110.86)	(93.42)	(58.54)	(329.60)	(--)	(--)	(--)
Eng & Tech Base (ETB)/DTMS	(180.53)	(214.15)	(210.80)	(208.50)	(181.60)	(1341.30)	(177.20)	(171.90)	(1,050.70)
Advanced Programs	(27.30)	(32.09)	(34.55)	(35.20)	(29.70)	(237.20)	(7.00)	(10.00)	(188.80)
Advanced Launch Systems	(19.94)	(9.60)	(27.98)	(--)	(--)	(144.70)	(--)	(--)	(--)
Advanced Transportation Tech.	(--)	(--)	(--)	(23.90)	(--)	(--)	(--)	(--)	(--)
Tethered Satellite Program	(7.40)	(3.40)	(16.40)	(21.90)	(27.30)	(83.20)	(--)	(--)	(--)
Orbital Maneuvering Veh (OMV)	(100.00)	(--)	(--)	(--)	(50.60)	(206.80)	(--)	(--)	(--)
STS Operations/Russian Coop	(--)	(--)	(--)	(--)	(--)	(2,368.60)	(--)	(--)	(--)
Skylab	(--)	(--)	(--)	(--)	(--)	(--)	(--)	(--)	(2,427.10)
Apollo Soyuz Test Project	(--)	(--)	(--)	(--)	(--)	(--)	(--)	(--)	(214.20)
Expendable Launch Vehicles	--	--	--	--	--	235.80	73.60	136.50	2,274.60
Completed Programs	--	--	--	--	--	--	--	--	22,020.10
Apollo	(--)	(--)	(--)	(--)	(--)	(--)	(--)	(--)	(20,443.60)
Gemini	(--)	(--)	(--)	(--)	(--)	(--)	(--)	(--)	(1,280.70)
Others	(--)	(--)	(--)	(--)	(--)	(--)	(--)	(--)	(295.80)
Total OSF	584.70	496.98	559.49	594.62	546.02	14,683.50	2,010.90	1,749.10	32,840.60
Commercial Programs									
Technology Utilization	--	28.91	32.08	24.05	23.40	117.20	9.10	9.10	75.30
Commercial Use of Space	--	132.84	113.63	62.79	32.41	96.70	--	--	--
Total OCP	--	161.75	145.75	86.84	55.81	253.00	9.10	9.10	75.30

Research and Development Funding By Program

As of September 30, 1994

	FY1994	FY1993	FY 1992	FY 1991	FY 1990	FY 1989-1980	FY 1979	FY 1978	FY 1977 & Prior
Aeronautics and Space Technology									
Current Programs									
Space Research & Technology	--	266.98	299.90	277.90	273.77	1522.40	98.30	88.70	432.30
Aeronautical Research & Tech	823.72	700.81	543.70	500.10	433.36	3130.30	264.10	228.00	1,021.40
Transatmospheric Res & Tech	19.68	--	4.08	93.79	58.29	164.80	--	--	--
Energy Tech. Applications	--	--	--	--	--	4.90	5.00	7.50	20.80
Prior Programs									
Apollo Applications Expr	--	--	--	--	--	--	--	--	1.00
Chemical & Solar Power	--	--	--	--	--	--	--	--	62.30
Basic Research	--	--	--	--	--	--	--	--	193.60
Space Vehicle Systems	--	--	--	--	--	--	--	--	332.20
Electronic Systems	--	--	--	--	--	--	--	--	272.00
Human Factor Systems	--	--	--	--	--	--	--	--	151.30
Space Power & Elec Prop Sys	--	--	--	--	--	--	--	--	385.40
Nuclear Rockets	--	--	--	--	--	--	--	--	512.80
Aeronautical Vehicles	--	--	--	--	--	--	--	--	365.40
Chemical Propulsion	--	--	--	--	--	--	--	--	451.20
Nuclear Power & Propulsin	--	--	--	--	--	--	--	--	44.10
Mission Analysis	--	--	--	--	--	--	--	--	16.00
Total OAST	843.40	967.79	847.68	869.38	765.42	4832.40	367.40	324.20	4,261.80
Space Tracking & Data Systems									
Tracking and Data Acquisition	19.27	22.93	21.73	19.75	19.08	1998.90	299.90	276.30	3,852.80
Safety, Reliability, Maintainability & Quality Assurance									
Standards & Practices	33.76	32.24	33.18	32.59	22.35	76.70	9.00	9.00	24.20
University Space Science & Technology Academic Program									
Academic Programs	53.45	69.15	44.24	37.43	23.00	--	--	--	--
Minority University Res. Prog	30.72	22.36	21.73	16.98	14.03	--	--	--	--
Total U.S.S.&T.A. P.	84.17	91.51	65.97	54.41	37.03	--	--	--	--

Research and Development Funding By Program

(In Millions of Dollars)

	FY1994	FY1993	FY 1992	FY 1991	FY 1990	FY 1989-1980	FY 1979	FY 1978	FY 1977 & Prior
Space Science and Applications									
Current Programs									
Physics & Astronomy	1,036.41	1,025.34	1,019.99	954.94	847.11	5059.30	281.80	223.10	2,196.30
Planetary Exploration	637.83	524.74	527.35	469.91	380.85	2721.80	181.90	146.70	3,550.20
Life Sciences	459.83	145.00	155.75	135.60	104.70	586.00	40.10	33.30	145.70
Space Applications	1,007.10	881.15	888.27	835.07	632.05	3807.40	271.90	232.10	2,092.60
Prior Programs									
Manned Space Science	--	--	--	--	--	--	--	--	46.40
Launch Vehicle Development	--	--	--	--	--	--	--	--	614.40
Bioscience	--	--	--	--	--	--	--	--	257.80
Space Flight Operations	--	--	--	--	--	--	--	4.00	58.30
Payload, Plan & Prog Integ	(--)	(--)	(--)	(--)	(--)	(--)	(--)	(4.00)	(58.30)
Total OSSA	3,141.17	2,591.36	2,591.36	2,395.52	1,964.71	12,449.50	775.70	639.20	8,961.70
Advanced Concepts & Technology	429.01								
Exploration	--	3.46	3.46	3.50	--	--	--	--	--
University Affairs	--	--	--	--	--	--	--	--	229.20
Operating Account	533.75	474.78	589.75	89.11	93.56	453.80	5.20	4.70	79.70
Total Program	7,533.50	7,094.30	6,827.61	6,023.52	5,227.69	36,464.90	3,477.20	3,011.60	50,325.30
Approp Trans & Adjustment	-4.20	-5.00	0.00	0.00	-7.00	224.10	0.00	1.40	301.00
Appropriation	7,089.30	6,827.61	6,023.52	5,220.69	36,734.00	3,477.20	3,013.00	50,626.30	50,626.30
Lapse Unoblig Bal incl	(1.12)	(1.12)	(1.16)	(1.32)	(1.68)	(7.4)	(0.3)	(0.3)	(.3)

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

Space Flight, Control And Data Communications Funding By Program

As of September 30, 1994

(In Millions of Dollars)	FY 1994	FY 1993	FY 1992	FY 1991	FY 1990	FY 1984 -1989
Space Flight						
Shuttle Prod & Oper Cap	1,012.75	1,045.48	1,295.75	1,295.07	1,189.84	10,005.33
Space Transportation Ops	2,550.08	2,804.94	2,928.36	2,976.73	2,628.41	10,540.32
Total OSF	3,562.83	3,850.42	4,223.61	4,271.80	3,818.25	20,545.65
SPACE SCIENCE & APPLICATIONS						
Expendable Launch Vehicles	303.34	--	179.85	--	--	--
Space Tracking & Data Systems	734.05	820.70	869.73	973.91	897.97	4671.75
Operating Account	234.98	207.83	258.76	10.13	9.39	79.79
Total Program	4,835.10	5,058.80	5,352.10	5,255.84	4,725.61	25,297.19
Approp Trans & Adjustment	18.40	27.20	-195.03	1,063.29	-170.71	-286.53
Appropriation	4,853.50	5,086.00	5,157.07	6,319.13	4,554.90	25,010.66
Lapse Unoblig Bal Incl	(0.30)	(1.21)	(0.43)	(0.41)	(0.82)	(2.6)

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

Research and Development Funding By Location

As of September 30, 1994

	FY1994	FY1993	FY 1992	FY 1991	FY 1990	FY 1989- 1980	FY 1979	FY 1978	FY 1977 & Prior
Headquarters	729.07	827.39	767.42	645.77	471.79	2,101.90	115.30	95.00	2,253.90
Ames Research Center	468.96	458.62	431.64	357.72	314.20	2,141.70	140.40	115.50	1,183.10
Dryden Flight Research Facility	--	--	--	--	--	46.90	13.10	18.60	242.00
Electronics Research Center	--	--	--	--	--	--	--	--	82.50
Goddard Space Flight Center	1,310.08	1,286.44	1,177.23	1,047.81	930.64	5,753.50	515.50	493.00	6,400.10
Jet Propulsion Laboratory	760.92	672.59	714.19	734.97	575.29	3800.00	236.80	201.40	3,017.90
Johnson Space Center	791.84	1,406.57	1,433.47	1,173.60	1,049.33	7,971.30	1,161.80	970.80	15,423.30
Kennedy Space Center	225.13	281.93	272.67	209.80	150.68	2,055.60	234.90	170.00	2,503.20
Langley Research Center	445.32	388.24	349.97	308.15	260.81	1,733.20	138.20	157.10	2,322.90
Lewis Research Center	547.99	761.58	681.66	559.20	500.26	2,607.0	148.50	133.60	2,864.60
Marshall Space Flight Center	880.08	964.68	974.43	968.32	959.89	8,607.70	785.20	630.90	13,293.10
NASA Pasadena Office	--	--	--	--	--	--	--	--	4.40
Pacific Launch Operations	--	--	--	--	--	--	--	--	0.30
Space Nuclear Systems Office	--	--	--	--	--	--	--	--	436.50
Space Station Project Office	1,012.94	--	--	--	--	--	--	--	--
Station 17	--	--	--	--	--	-506.80	-38.80	--	--
Stennis Space Cneter	21.73	26.26	24.93	18.18	14.80	124.10	9.20	10.00	21.50
Wallops Flight Facility	--	--	--	--	--	28.00	17.10	15.90	156.30
Western Support Office	--	--	--	--	--	--	--	--	119.70
Undistributed	--	339.44	--	--	--	--	--	--	--
Total Program	7,533.50	7,094.30	6,827.61	6,023.52	5,227.69	36,064.90	3,477.20	3,011.60	50,325.30
Approp Trans & Adjustment	-4.20	-5.00	0.00	0.00	-7.00	224.10	0.00	1.40	301.00
Appropriation	7,529.30	7,089.30	6,827.61	6,023.52	5,220.69	36,689.00	3,477.2	3,013.00	50,626.30
Lapse Unoblig Bal Incl	--	(1.12)	(1.16)	(1.32)	(1.68)	(26.0)	(0.3)	(1.8)	(0.3)

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

Mission Support Funding By Program/Location

As of September 30, 1996

(In Millions of Dollars)

By Program	FY 1996	FY 1995
Space Communication Services	269.40	206.60
Space, Reliability & Quality Assurance	37.60	38.70
Operating Account	--	--
Mission Support (Programmatic)	307.00	245.30
Mission Support (Res Operations Support)	438.09	475.79
Mission Support (Res & Program Managmt)	1,595.60	1,674.89
Mission Support (Construction of Facilities)	142.40	135.00
Total Mission Support	**2,483.09**	**2,530.98**
Approp. Trans. & Adjustment	--	41.92
Appropriation	**2,483.09**	**2,572.90**
Lapse Unoblig Bal Incl.		--

By Location	FY 1996	FY 1995
Headquarters	232.82	261.79
Ames Research Center	170.84	210.99
Dryden Flight Research Center	42.22	12.92
Goddard Space Flight Center	534.90	499.72
Jet Propulsion Laboratory	23.74	26.37
Johnson Space Center	371.16	380.45
Kennedy Space Center	246.19	276.05
Langley Research Center	214.95	225.53
Lewis Research Center	219.76	219.73
Marshall Space Flight Center	357.54	371.56
Space Station Project Office	--	--
Stennis Space Center	37.28	34.54
Undistributed	31.69	11.35
Total Program	**2,483.09**	**2,530.98**
Approp. Trans. & Adjustment		41.92
Appropriation		**2,572.90**
Lapse Unoblig Bal Incl.		--

Science, Aeronautics and Technology Funding By Program/Location

(In Millions of Dollars)

By Program	FY 1995	1996
Aeronautics Research and Technology	843.51	892.75
Space Access and Technology		
Space Access and Technology	603.25	673.64
Launch Services	333.80	37.52
Total S.A.T.	902.05	711.16
Mission Communications Services	480.44	440.49
Academic Programs		
Education Programs	56.30	59.30
Minority University Research Programs	45.86	45.90
Total A.P.	102.16	105.20
Mission to Planet Earth	1,243.50	1,241.60
Space Science		
Planetary Exploration	682.15	827.77
Physics and Astronomy	1,093.82	1,173.16
Total S.S.	1,775.97	2,000.93
Life & Microgravity Sci & Applications	465.35	437.94
Undistributed	--	56.00
Operating Account	11.61	12.03
Science, Aero. & Tech. (Programmatic)	5,824.59	5,898.10
Science, Aero. & Tech. (Construction of Facilities)	39.00	30.80
TOTAL SCIENCE, AERO. AND TECH.	5898.59	5,928.90
Appropo. Trans. & Adjustment	-50.00	0.00
Appropriation	5,848.59	5,928.90
Expiring Unoblig Bal Incl.	.91	--

As of September 30, 1996

By Location	FY 1995	1996
Headquarters	640.16	545.63
Ames Research Center	441.97	425.35
Dryden Flight Research Center	31.43	103.14
Goddard Space Flight Center	1,902.69	1,802.69
Jet Propulsion Laboratory	1,058.16	1,028.56
Johnson Space Center	149.09	177.10
Kennedy Space Center	48.63	35.81
Langley Research Center	436.29	415.22
Lewis Research Center	535.17	538.84
Marshall Space Flight Center	638.25	647.36
Space Station Project Office	--	--
Stennis Space Center	16.75	66.47
Undistributed	0.00	142.73
Total Program	5,898.59	5,928.90
Approp. Trans. & Adjustment	-50.00	0,00
Appropriation	5,848.59	5,928.90
Expiring Unoblig Bal Incl.	.27	--

Human Space Flight Funding By Program/Location

(In Millions of Dollars)

By Program	FY 1995	1996
Space Flight		
Space Shuttle	3,137.61	3,123.37
Space Station	1,869.30	1,848.68
Russian Cooperative	150.10	129.20
Payload and Utilization Operations	319.95	314.86
Total OSF	5,476.96	5,416.11
Operating Account	5.44	8.29
Human Space Flight (Programmatic)	**5,482.40**	**5,424.40**
Human Space Flight (Const of Facilities)	**32.50**	**32.20**
TOTAL HUMAN SPACE FLIGHT	**5,514.90**	**5,456.60**
Approp. Trans. & Adjustment	--	--
Appropriation	**5,514.90**	**5,456.60**
Expiring Unoblig Bal Incl.	.27	--

As of September 30, 1996

By Location	FY 1995	1996
Headquarters	36.58	32.88
Ames Research Center	5.25	0.35
Dryden Flight Research Center	2.75	6.21
Goddard Space Flight Center	13.96	13.68
Jet Propulsion Laboratory	0.32	0.99
Johnson Space Center	2,828.26	2,926.12
Kennedy Space Center	1,053.63	942.26
Langley Research Center	2.10	1.78
Lewis Research Center	17.61	9.77
Marshall Space Flight Center	1,497.77	1,452.30
Space Station Project Office	0.00	0.00
Stennis Space Center	56.67	55.26
Undistributed	0.00	15.00
Total Program	5,514.90	5,456.60
Approp. Trans. & Adjustment	--	--
Appropriation	5,514.90	5,456.60
Expiring Unoblig Bal Incl.	.27	--

Construction of Facilities Funding

As of September 30, 1994

(In Millions of Dollars)	FY 94	FY 93	FY 92	FY 91	FY 90	FY 89-80	FY 79-70	FY69-59
Ames Research Center	--	--	--	--	12.3	88.1	30.9	55.66
Dryden Flight Research Fac	--	--	--	4.0	--	16.8	2.1	6.1
Goddard Space Flight Center	25.6	19.8	23.5	16.6	16.0	31.1	16.7	83.8
Jet Propulsion Laboratory	2.9	--	4.3	30.2	4.9	44.6	20.6	42.2
Johnson Space Center	2.2	4.0	7.0	6.7	2.6	18.4	6.6	93.0
Kennedy Space Center	1.9	--	6.5	--	16.2	7.9	40.4	911.0
Langley Research Center	6.0	--	--	4.6	--	93.4	32.3	72.1
Lewis Research Center	8.2	--	--	16.0	--	50.3	24.8	111.2
Marshall Space Flight Center	2.6	--	5.2	--	--	24.5	5.1	140.2
Stennis Space Center	3.0	2.2	--	3.4	--	--	2.0	238.4
Wallops Flight Facility	5.2	--	3.5	5.5	--	3.2	3.1	38.1
Various Locations	15.6	33.8	11.4	17.6	2.6	98.8	62.1	660.1
Facility Planning & Design	21.5	23.3	27.9	28.0	26.3	129.7	92.0	58.7
Large Aero Fac	--	---	--	--	--	45.7	124.1	--
Minor Construction	14.0	14.0	12.9	11.0	10.0	52.1	28.5	--
Repair	36.0	31.9	31.7	28.2	28.0	175.4	--	--
Envir Compl & Rest. Program	50.0	40.0	36.0	32.0	30.0	49.9	--	--
Rehab & Mods *	36.0	34.0	34.8	32.9	35.0	233.3	122.9	--
Space Station Facilities	--	13.8	35.0	25.0	49.4	12.4	--	--
Shuttle Facilities	54.7	193.4	168.7	165.6	112.1	309.9	351.6	--
Shuttle Payload	--	--	--	--	--	31.1	11.7	--
Unallocated Plans & Design	--	--	--	--	--	0.4	--	--
Aero. Facils Revitalization	203.0	39.8	48.3	32.6	63.7	46.0	--	--
Advanced Launch System Fac	--	--	--	--	--	15.0	--	--
Trust Fund	--	--	--	--	--	15.0	--	--
Wake Shield Facility	--	--	--	3.0	2.2	--	--	--
Future Software Program	--	--	6.0	4.0	--	--	--	--
Earth Science Info Network	--	--	3.4	1.0	--	--	--	--

Construction of Facilities Funding (cont'd)

As of September 30, 1994

(In Millions of Dollars)	FY 94	FY 93	FY 92	FY 91	FY 90	FY 89-80	FY 79-70	FY 69-59
JSC Visitor Center	--	--	--	10.0	--	--	--	--
Deferred Rehab & Major Maint.	--	--	11.8	20.0	--	--	--	--
National Tech. Transfer Center	--	--	13.5	--	--	--	--	--
Chris Columbus Center	--	--	20.0	--	--	--	--	--
Indp Software Valid/Verif	--	--	10.0	--	--	--	--	--
Space Dynamics Laboratory	--	--	10.0	--	--	--	--	--
Delta College, HQ	--	8	--	--	--	--	--	--
High Speed Civil Transport	--	--	--	--	--	--	--	--
Electronics Research Center	--	--	--	--	--	--	--	24.6
Michoud Assembly Facility	--	--	--	--	--	--	--	43.7
Nuclear Rocket Dev Station	--	--	--	--	--	--	--	15.6
Pacific Launch Operations	--	--	--	--	--	--	--	2.4
Aeroacoustic Mod	--	25	--	--	--	--	--	--
Other	--	--	--	--	.	--	1.7	--
TOTAL PROGRAM	488.4	483.0	531.4	497.9	411.3	1,592.1	979.2	2,596.8
Approp Trans & Adjust	29.3	15.0	-6.4	0.0	190.0	248.8	-10.3	-105.7
Approp & Availability	517.7	498.0	525.0	497.9	601.3	1,840.9	968.9	2,491.1

*Included in Various Locations Prior to FY 1972

Personnel Summary

Onboard At End Of Fiscal Year*

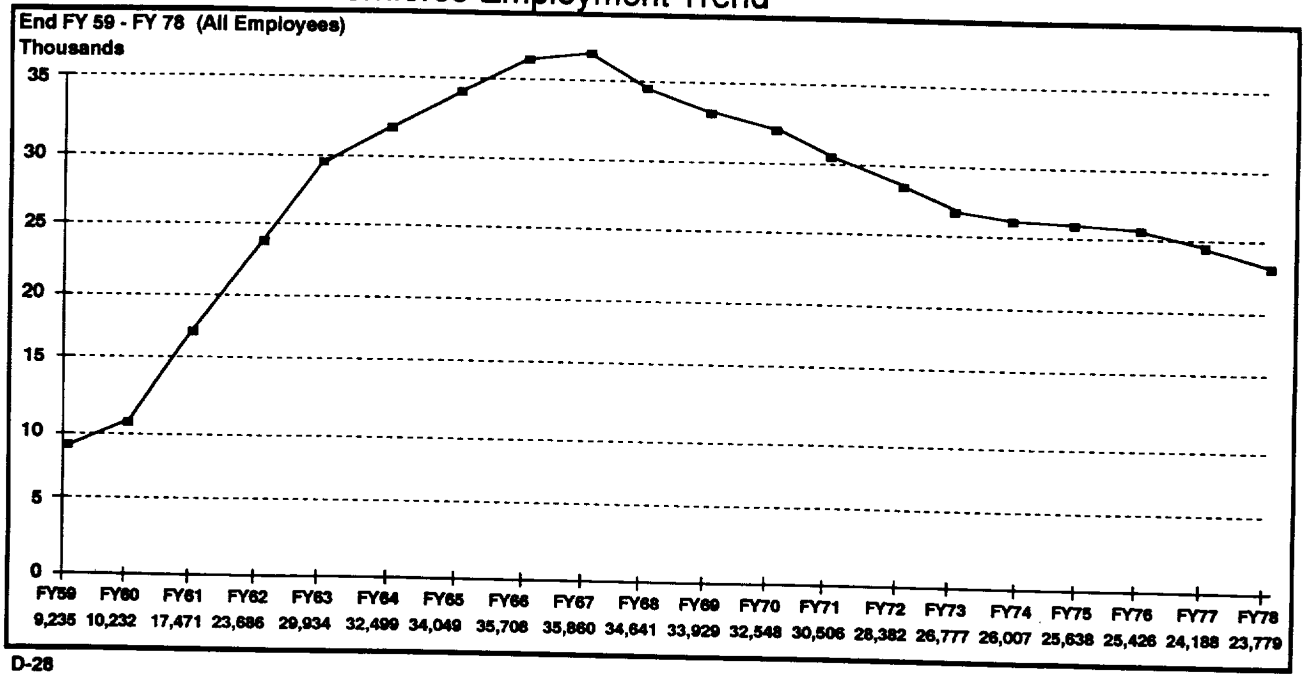
	FY59	FY60	FY61	FY62	FY63	FY64	FY65	FY66	FY67	FY68	FY69	FY70	FY71	FY 72
Headquarters	429	587	735	1,477	2,001	2,158	2,135	2,336	2,373	2,310	2,293	2,187	1,895	1,755
Ames Research Center	1,464	1,421	1,471	1,658	2,116	2,204	2,270	2,310	2,264	2,197	2,117	2,033	1,968	1,844
Dryden Flight Research Facility[1]	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
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
Kennedy Space Center	--	--	--	339	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	4,087	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
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	23,686	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	FY82	FY 83	FY 84	FY 85	FY 86
Headquarters	1,747	1,734	1,673	1,708	1,619	1,606	1,534	1,658	1,638	1,431	1,492	1,396	1,383	1,362
Ames Research Center	1,740	1,776	1,754	1,724	1,645	1,691	1,713	1,713	1,652	2,041	2,033	2,043	2,052	2,072
Dryden Flight Research Facility	509	531	544	566	546	514	498	499	491	434	--	--	--	--
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	3,621	3,668	3,541	3,629	3,679
Johnson Space Center	3,896	3,886	3,877	3,796	3,640	3,617	3,563	3,616	3,498	3,268	3,325	3,227	3,330	3,269
Kennedy Space Center	2,516	2,408	2,377	2,404	2,270	2,234	2,264	2,291	2,224	2,104	2,084	2,067	2,081	2,051
Langley Research Center	3,389	3,504	3,472	3,407	3,207	3,167	3,125	3,094	3,028	2,801	2,904	2,821	2,827	2,814
Lewis Research Center	3,368	3,172	3,181	3,168	3,061	2,964	2,907	2,901	2,782	2,485	2,632	2,624	2,715	2,598
Marshall Space Flight Center	5,287	4,574	4,337	4,336	4,014	3,808	3,677	3,646	3,479	3,332	3,351	3,223	3,284	3,260
Pasadena Office	39	39	35	--	--	--	--	--	--	--	--	--	--	--
Pacific Launch Operations Office	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Space Nuclear Systems Office	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Stennis Space Center	--	--	76	72	94	108	108	111	113	103	105	108	122	123
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	21,620	21,505	21,050	21,423	21,228

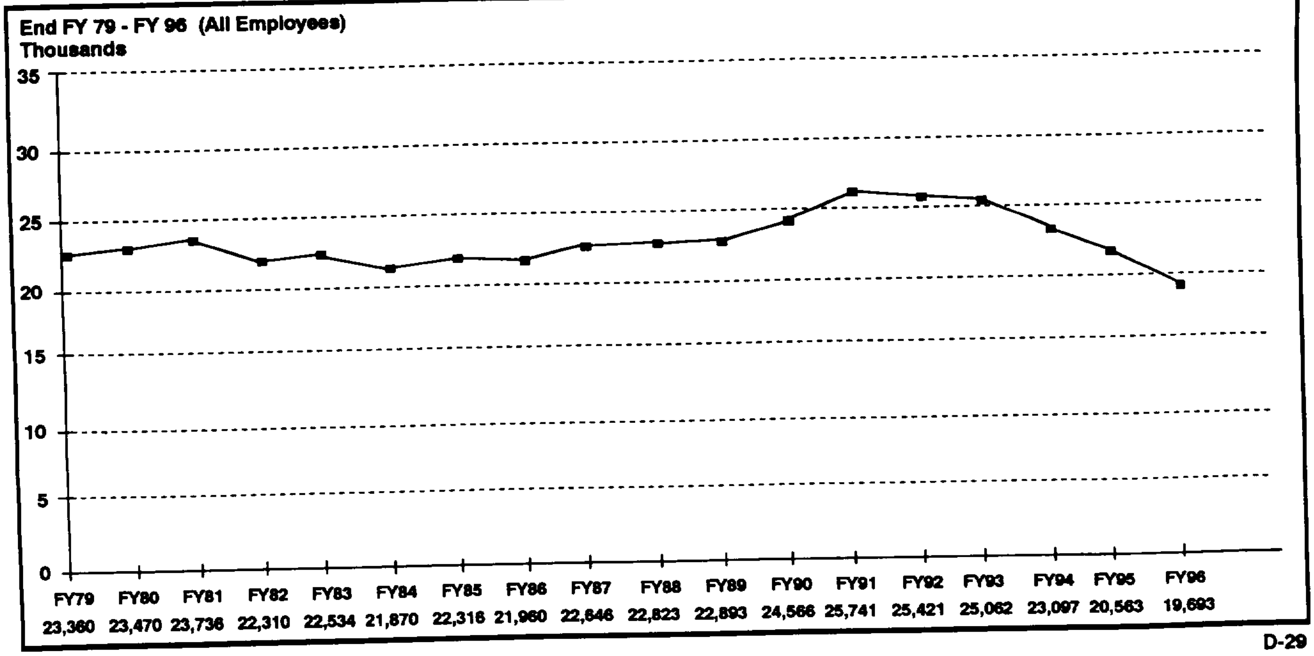
Personnel Summary

Year-End Strength	FY87	FY88	FY89	FY90	FY91	FY92	FY93	FY94	FY 95	FY 96
Headquarters	1,532	1,653	1,727	1,966	2,092	2,143	2,074	1,843	1,672	1,320
Ames Research Center	2,079	2,101	2,151	2,205	2,263	2,243	2,173	1,696	1,559	1,484
Dryden Flight Research Facility								434	428	445
Goddard Space Flight Center	3,648	3,626	3,735	3,873	3,999	3,964	3,910	3,824	3,544	3,469
Johnson Space Center	3,349	3,399	3,578	3,615	3,677	3,631	3,609	3,205	3,081	3,331
Kennedy Space Center	22,188	2,236	2,423	2,466	2,571	2,546	2,497	2,352	2,197	2,099
Langley Research Center	2,851	2,840	2,864	2,961	2,969	2,953	2,859	2,789	2,504	2,468
Lewis Research Center	2,663	2,649	2,749	2,728	2,835	2,799	2,731	2,457	2,258	2,200
Marshall Space Flight Center	3,384	3,340	3,609	3,619	3,788	3,715	3,627	3,311	3,111	3,074
Space Station Program Office								301	316	
Stennis Space Center	137	147	183	192	222	216	200	205	204	199
NASA Permanent	21,831	21,991	23,019	23,625	24,416	24,210	23,680	22,417	19,072	20,278
Other Than Permanent	815	832	874	941	1,325	1,211	1,382	680	1,491	360
NASA Total	22,646	22,823	23,893	24,566	25,741	25,421	25,062	23,097	20,563	20,638

NASA Civil Service Workforce Employment Trend

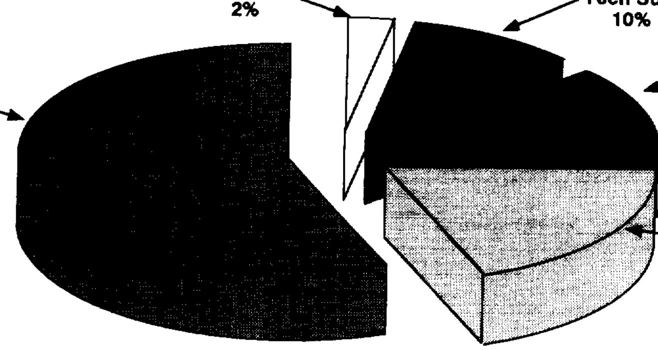


NASA Civil Service Workforce Employment Trend



Occupational Summary

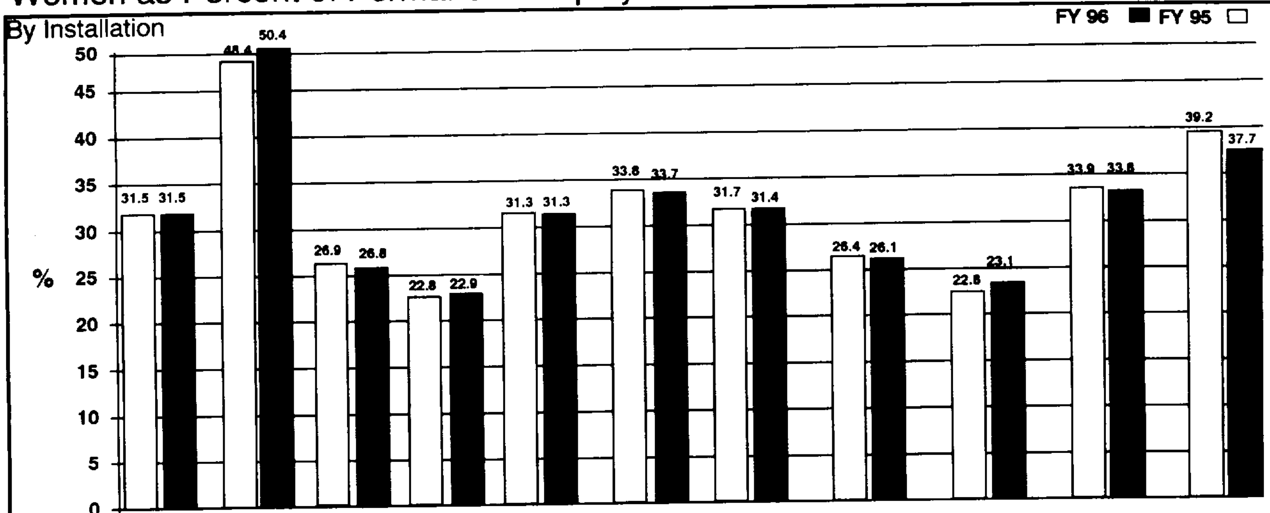
Permanent Personnel - 1/4/97



Occupation	Total NASA	HQ	ARC	DFRC	GSFC	JSC	KSC	LaRC	LeRC	MSFC	SSC	NASA-IG
S&E	11,385	300	858	187	2,043	2,193	1,219	1,228	1,222	2,017	118	0
Prof'l Admin	4,078	666	286	92	720	590	412	289	288	521	51	163
Clerical	1,854	250	115	19	309	326	160	203	136	285	29	22
Tech. Support	1,944	5	96	119	276	132	194	702	287	131	2	0
Wage System	432	0	117	28	69	2	0	0	216	0	0	0
Total	19,693	1,221	1,472	445	3,417	3,243	1,985	2,422	2,149	2,954	200	185

Women as Percent of Permanent Employees

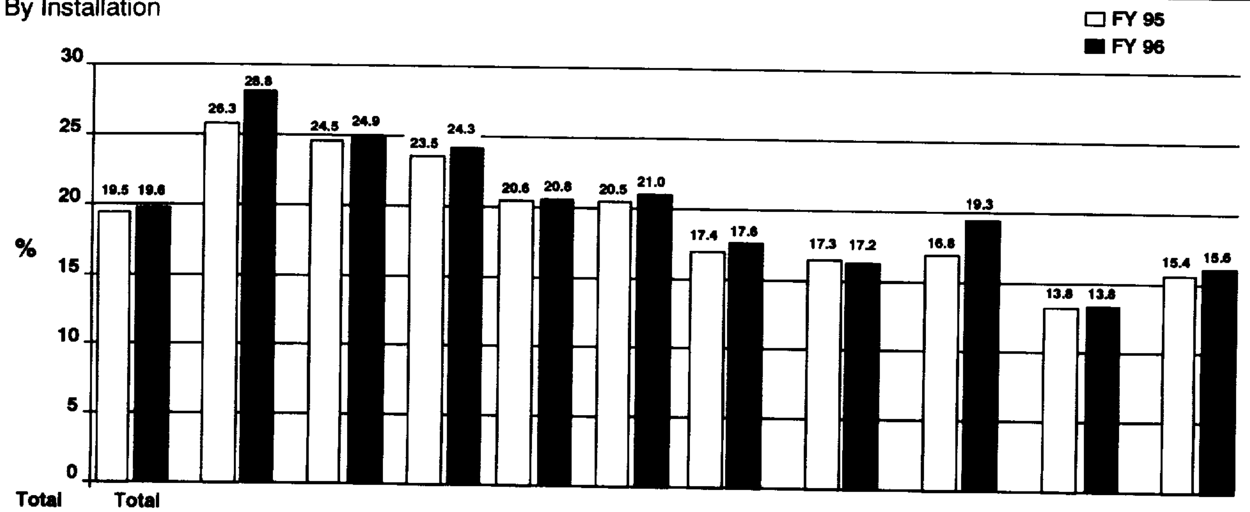
By Installation



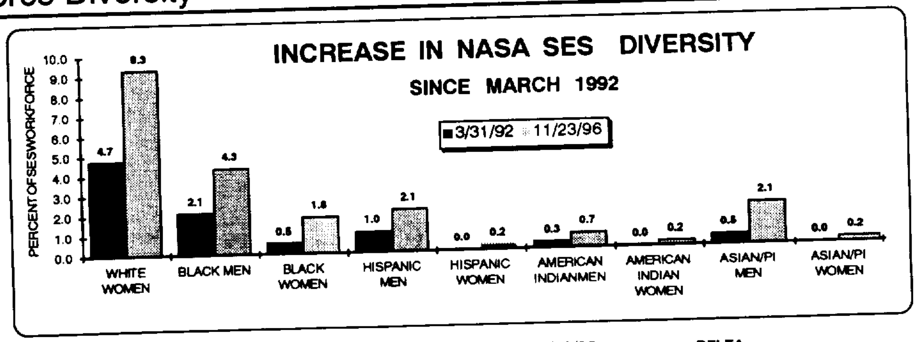
Total Women	Total NASA	HQ	ARC	DFRC	GSFC	JSC	KSC	LaRC	LeRC	MSFC	SSC
FY 95	6,489	786	411	100	1,095	1,029	678	656	510	1,044	78
FY 96	6,299	665	397	102	1,086	1,124	660	644	508	1,038	75
FY 83	4,874	612	412	--	875	724	495	570	433	722	31

Minorities as Percent of Permanent Employees

By Installation



Total Minorities	Total NASA	HQ	ARC	DFRC	GSFC	JSC	KSC	LaRC	LeRC	MSFC	SSC
FY 95	4,018	427	375	103	719	623	375	430	434	427	31
FY 96	3,949	380	369	108	720	699	369	425	425	423	31
FY 83	2,614	334	327	--	476	425	192	331	236	215	8



RSNO GROUP	3/31/92		11/23/96		DELTA	
	#	%	#	%	#	%
WHITEMEN	521	90.8	347	79.0	-174	-11.7
WHITEWOMEN	27	4.7	41	9.3	+14	+4.6
BLACK MEN	12	2.1	19	4.3	+7	+2.2
BLACK WOMEN	3	0.5	8	1.8	+5	+1.3
HISPANICMEN	6	1.0	9	2.1	+3	+1.0
HISPANICWOMEN	0	0.0	1	0.2	+1	+0.2
AMERICANINDIANMEN	2	0.3	3	0.7	+1	+0.3
AMERICANINDIANWOMEN	0	0.0	1	0.2	+1	+0.2
ASIAN/PACIFICISLANDER MEN	3	0.5	9	2.1	+6	+1.5
ASIAN/PACIFICISLANDER WOMEN	0	0.0	1	0.2	+1	+0.2
TOTAL	574		439		-135	
TOTALMINORITY	26	4.5	51	11.6	+25	+7.1
TOTAL WOMEN	30	5.2	52	11.8	+22	+6.6

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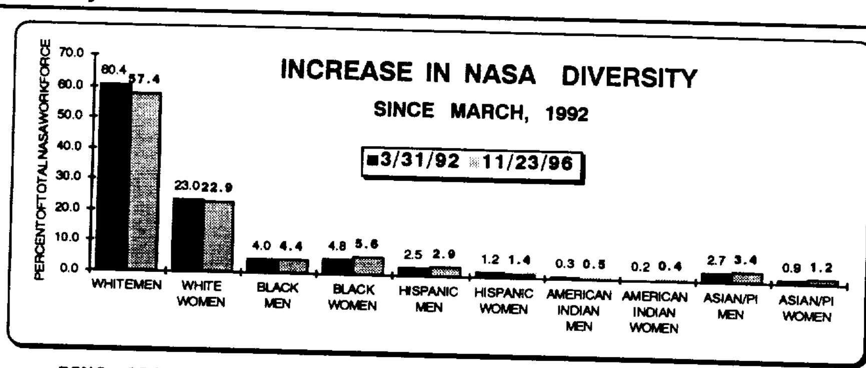

RSNO GROUP	3/31/92		11/23/96		DELTA	
	#	%	#	%	#	%
WHITE MEN	14,675	60.4	11,606	57.4	-3069	-3.0
WHITE WOMEN	5,594	23.0	4,639	22.9	-955	0
BLACK MEN	965	4.0	893	4.4	-72	+0.4
BLACK WOMEN	1,157	4.8	1,132	5.6	-25	+0.8
HISPANIC MEN	598	2.5	585	2.9	-13	+0.4
HISPANIC WOMEN	287	1.2	279	1.4	-8	+0.2
AMERICAN INDIAN MEN	67	0.3	100	0.5	+33	+0.2
AMERICAN INDIAN WOMEN	57	0.2	71	0.4	+14	+0.1
ASIAN/PACIFIC ISLANDER MEN	662	2.7	681	3.4	+19	+0.8
ASIAN/PACIFIC ISLANDER WOMEN	222	0.9	233	1.2	+11	+0.2
TOTAL	24,284		20,219		-4065	
TOTAL MINORITY	4,015	16.5	3,974	19.7	-41	+3.1
TOTAL WOMEN	7,317	30.1	6,354	31.4	-963	+1.3

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