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Lyndon B. Johnson Space Center
Houston, Texas

Preface

DURING AMERICA'S SPACE SHUTTLE FLIGHTS press and public attention focuses on the Johnson Space Center in Houston. The press and public often put questions to JSC technical and management staff. This fourth JSC Almanac supplies answers for many such questions, and provides an informational resource for speeches to general interest groups. This Almanac is not necessarily comprehensive or definitive. It is not intended as a statement of JSC or NASA policy. However, it does provide a much needed compilation of information from diverse sources. These sources are given as references, permitting the reader to obtain additional information as required. While every effort has been made to ensure accuracy and to reconcile statistics, users requiring the most up-to-date and accurate information should contact the office supplying the information at issue. The Almanac is updated periodically as needed. The following offices were responsible for supplying material for this update.

AC	Director's Office	Organizational Structure
AH	Human Resources Office	JSC Workforce
BB	Procurement Office	Procurement Activities
LA	Comptroller's Office	NASA/JSC Budget Activities Economic Impact JSC Workforce
KA	Space Station Projects Office	Spacecraft Dimensions/Flight Summary Information
CA	Flight Crew Operations	NASA Manned Space Program Summaries
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Readers with suggestions for corrections or improvements to this Almanac should report them to Management Services Division/JM.

William A. Larsen
Chief, Management Services Division

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I. History of NASA

I. History of NASA

ON MARCH 3, 1915, President Woodrow Wilson signed a Navy appropriations bill with a rider establishing the National Advisory Committee for Aeronautics (NACA) to address the United States effort in aeronautical research. In June 1920, the first NACA facility opened in Langley, Virginia (see map). In August 1939, a second facility was authorized at Moffett Field, California (Ames), followed soon by another in Cleveland, Ohio (Lewis Research Center).

The space age began on October 4, 1957, when the U.S.S.R. launched Sputnik I, the first orbiting artificial Earth satellite. That event sparked intense interest of the United States in space exploration. Congressional committees quickly developed a space policy that was signed on July 29, 1958 by President Dwight Eisenhower. The National Aeronautics and Space Act created a civilian agency to conduct research in the fields of aeronautics and space science. It designated the United States as a leader in the utilization of space research for peaceful scientific and engineering purposes.

NASA's first Administrator, Keith Glennan, was appointed on October 1, 1958. The Deputy Administrator was Hugh L. Dryden. Its initial organizational core consisted of 8000 employees of NACA, and certain elements of the Department of Defense concerned with scientific Earth satellite and lunar probes, the International Geophysical Year Satellite Program (Vanguard), the Army's von Braun Team and its Saturn Launch Vehicle Project, and the Jet Propulsion Laboratory. It was the first agency created from so many diverse programs that exhibited geometric growth in its early years.

NASA was different in both its method and its goals from other Government agencies. Created largely as a national response to Soviet space initiatives, it was organized to achieve specific objectives. Unlike NACA, it directed a large-scale research and development program performed largely under contract with industry. NASA's highest total employment year was in 1965, when it employed 34,300 (8.3 percent) Federal employees and 376,700 (91.7 percent) private sector contractor employees. Its unusual scientific, technological, and management challenges during the early years made NASA an agency different from all the others. NASA inherited personnel and programs from other established research and development agencies of the Government and thereby quadrupled in 10 years. NASA also displayed an uncommon unity of general management as its top managers worked together in interlocking roles rather than in a multilevel management structure. An extensive documentation system was established with an open-loop communications system to ensure that engineering specifications and technical management decisions were implemented properly. By law, NASA's programs were open and unclassified, allowing it to operate continuously under public scrutiny. ❑

NASA Major and Component Installations

Ames Reserch Center
(California)

Hugh L. Dryden Flight Research Facility
ARC Component
(California)

Jet Propulsion Laboratory
(California)

Lyndon B. Johnson Space Center
(Texas)

White Sands Test Facility
JSC Component
(New Mexico)

George C. Marshall Space Flight Center
(Alabama)

Michoud Assembly Facility
MSFC Component
(Louisiana)

Slidell Computer Complex
MSFC Component
(Louisiana)

Lewis Research Center
(Ohio)

Langley Research Center
(Virginia)

John F. Kennedy Space Center
(Florida)

John C. Stennis Space Center
(Mississippi)

NASA Headquarters
(Washington, D.C.)

Goddard Space Flight Center
(Maryland)

Wallops Flight Facility
GSFC Component
(Virginia)

II. History of JSC

II. History of JSC

ONE OF NASA's first programs was Project Mercury. The Space Task Group at Langley Research Center under Robert R. Gilruth was initially formed with 36 members. Within 2 years, the efforts supporting Project Mercury had grown so large that a new installation was sought. Twenty sites for the new facility were considered in Florida, Louisiana, Texas, Missouri, California, and Massachusetts. In September 1961, NASA Administrator James E. Webb announced that Houston had been selected. With the commitment of President John F. Kennedy, on May 25, 1961, to a lunar landing mission, the Space Task Group was redesignated as the Manned Spacecraft Center in November 1961.

In September 1961, NASA requested the assistance of the Army Corps of Engineers in the design and construction of the new center to be built on 1020 acres of land given to Rice University by the Humble Oil and Refining Company (now Exxon). Rice deeded the land to the Government, and another 600 acres was purchased from Rice. The first phase of construction began in April 1962; the first permanent facilities were completed in September 1963. Final construction of all initial facilities was completed in April 1964. The first move of personnel from Langley to Houston occurred in October 1962. Because construction of permanent facilities had not yet been completed, personnel were located in temporary converted apartment buildings, offices, and industrial buildings at 12 sites in southeast Houston plus facilities at Ellington Air Force Base (now Ellington Field). In February 1964, personnel began occupying the permanent facilities at Clear Lake. In February 1973, the Center was renamed the Lyndon B. Johnson Space Center (JSC) in honor of the late President.

The JSC is now one of the nine major NASA field installations. The Center has been responsible for developing the Gemini spacecraft, the Apollo command and service module, and the lunar module. Modifications to the command and service module for the Skylab and Apollo-Soyuz Test Project were also engineered at JSC. Currently, JSC is responsible for the design, development, and production of the Space Shuttle Orbiters including integrating all major elements into the Space Shuttle system; testing of manned spacecraft systems; development and integration of space flight experiments; application of space technology; medical and space science research; selection and training of astronauts; operation of manned space flights.

Concurrent with the establishment of JSC, NASA realized that a specialized spacecraft propulsion test capability would be needed within the Agency to support the tight Apollo program schedules imposed by the Kennedy mandate. Accordingly, the White Sands Test Facility (WSTF) was constructed near Las Cruces, New Mexico, to perform space systems testing of a hazardous nature. The isolated location and stable climate were ideally suited for large-scale, noisy, or hazardous tests. Propulsion testing began in 1964 with development and certification tests of the Apollo service propulsion system, lunar and service module reaction control subsystems, and the lunar module ascent and descent engines. Materials and components test laboratories were added in 1967 to support recovery from the Apollo fire, and these laboratories continue to provide unique test support for the Space Shuttle and now the Space Station programs. In the mid-1970's, the Shuttle orbital maneuvering subsystem and reaction control subsystem engines were qualified, and testing of these systems is continuing. Presently, WSTF is preparing to support long-term testing for the Space Station Program.

The present and future of space exploration come together when astronauts test experiments and hardware for Space Station on Shuttle missions. Astronauts are training for spacewalks to develop our experience base for on orbit assembly and maintenance of Space Station.

Space Center Houston opened in October 1992. Space Center Houston is supported and directed by a non-profit foundation. JSC cooperates with Space Center Houston by opening its doors to tour groups and loaning historic space hardware formerly housed at the Building 2 visitor's center. Its relationship with Space Center Houston is part of Johnson Space Center's ongoing effort to enhance public understanding of the space program.❑

III. NASA Manned Space Program Summaries

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PROJECT MERCURY

Project Mercury, America's first manned space flight program, officially began on October 7, 1958. Seven astronauts were chosen in April 1959. The program consisted of six flights totaling 53 hours in space and was filled with a number of firsts. The first manned suborbital flight was on May 5, 1961, when Alan B. Shepard, Jr., was launched aboard Freedom 7 and became the first American in space. The second suborbital flight with Virgil I. Grissom resulted in the first loss of a spacecraft in the history of manned flight when the Liberty Bell sank before recovery ships arrived. After this flight, Redstone boosters were replaced by Atlas rockets for the remaining Mercury flights. On February 20, 1962, John H. Glenn, Jr., aboard Friendship 7 became the first American to orbit the Earth. On October 3, 1962, Walter M. Schirra, Jr., landed Sigma 7 successfully in the Pacific Ocean. All previous flights had Atlantic recoveries. Finally, on May 16, 1963, L. Gordon Cooper concluded the $392.6 million program by completing 22 orbits in 34 hours in Faith 7. The Project Mercury program successfully met all of its objectives — to place a manned spacecraft in Earth orbit and then recover the man and spacecraft safely, to demonstrate man's ability to survive and perform in the space environment, and to develop basic space technology and hardware for future manned space flight programs.

PROJECT GEMINI

On December 7, 1961, NASA announced a plan to develop a two-man spacecraft. On January 3, 1962, this program officially became Project Gemini. It was created to develop technologies essential for a lunar mission (i.e., rendezvous and docking), building an experience base to bridge the gap between Projects Mercury and Apollo. Its major objectives were to develop the orbital mechanics of rendezvous and docking, to perfect methods of reentry and landing, and to gain additional information on the medical and physiological effects of weightlessness on crewmembers during long-duration flights. The first Gemini flight on April 8, 1964, was unmanned in order to check the structural aspects of the spacecraft. The first manned Gemini flight was a three-orbit mission on March 23, 1965, with Virgil I. Grissom and John W. Young. The first extravehicular activity occurred during Gemini IV when Edward H. White II became the first American to walk in space. The first docking of two vehicles in space occurred on March 16, 1966, during Gemini VIII with Neil A. Armstrong and David R. Scott aboard. During Gemini XI in September 1966, a number of firsts were accomplished: rendezvous and docking with the Agena target vehicle during the first revolution, tethering of two spacecraft, rendezvous using onboard computations, docking practice, and automatic reentry. The November 1966 Gemini XII flight, with James A. Lovell, Jr. and Buzz Aldrin, marked the end of the $1.3 billion Gemini Program in which 20 astronauts logged 969 total flight hours with 12 hours of extravehicular activity.

PROJECT APOLLO

On May 25, 1961, President John F. Kennedy established the main goal for the Apollo Program — to land Americans on the Moon before the end of the decade and return them safely to Earth. Other goals included establishing the technology to meet other space efforts, carrying out scientific exploration of the Moon, developing man's capability to work in the lunar environment, and achieving preeminence in space for the United States.

Initial planning for the Saturn I rocket had begun in 1957. In January 1962, NASA announced the development of the Saturn V, the largest rocket vehicle ever to fly. Boeing Company received the contract for the first stage, North American Rockwell for the second stage, and Douglas Aircraft Corporation for the third stage called the S-IV B. Later in 1962, NASA announced that the Saturn IB, which combined the first stage of the Saturn I and the third stage of the Saturn V, would be used for the Earth orbital tests of the Apollo spacecraft. In August 1961, the Massachusetts Institute of Technology was selected to develop the Apollo spacecraft guidance and navigation system and that same year North American Rockwell was selected for the Apollo Spacecraft Command and Service Module Program. On November 7, 1962, Grumman Aircraft Engineering Corporation was selected to design and build the lunar module. The first phase of the Saturn launch vehicle program was completed in 1965. Testing of the Apollo command and service module was completed in 1966.

January 27, 1967, was a tragic day for the Apollo Program. A fire caused by electrical arcing from the wiring in a near-total oxygen environment inside an Apollo spacecraft during ground testing at Launch Complex 34 at the Kennedy Space Center (KSC) resulted in the deaths of Virgil I. Grissom, Edward H. White II. and Roger B. Chaffee. Later that year, the program resumed testing, and on November 9, 1967, the first flight test of the Apollo/Saturn V space vehicle was successfully completed. Apollo 4, as it was designated, had demonstrated the restart-in-orbit capability of its third stage and the ability of the Apollo spacecraft to re-enter the Earth's atmosphere at lunar mission return speeds. Testing of the lunar module was done on Apollo 5 and the final unmanned test flight, Apollo 6, was launched April 4, 1968.

The first manned Apollo flight, Apollo 7, lifted off from Launch Complex 34 at KSC on October 11, 1968. All subsequent Apollo launches were from Complex 39. The Apollo spacecraft was successfully tested, and the first live television broadcast from a manned space vehicle was made. History's first manned flight from Earth to another planetary body began on December 21, 1968, when Frank Borman, William A. Anders, and James A. Lovell, Jr., orbited the Moon and transmitted the first live television pictures showing the full Earth. Apollo 9 was the first all-up manned flight of the Apollo/Saturn V space vehicle, the first manned flight of the lunar module, and the first Apollo extravehicular activity (by Russell L. Schweickart). The dress rehearsal for the first lunar landing was done aboard Apollo 10 as the lunar module descended to within 8.4 nautical miles of the Moon. Also, the first color pictures were telecast back to Earth.

Apollo 11 attained the national goal set by President Kennedy in 1961. Launched on July 16, 1969, the lunar module touched down in the Moon's Sea of Tranquility at 4:18 p.m. EDT, July 20. At 10:56 p.m. EDT that evening, Neil A. Armstrong stepped onto the lunar surface followed by Buzz Aldrin. Command module pilot Michael Collins orbited above. During a 2-1/2 hour Moon exploration, 44 pounds of lunar samples were collected. Apollo 12 landed in the Ocean of Storms in November 1969, near the unmanned Surveyor III which had been on the Moon for 2-1/2 years. The crew brought back 75 pounds of lunar material and several pieces of the Surveyor. The mission demonstrated the ability to land at a selected point and included deployment of the first Apollo Lunar Surface Experiments Package for continuous scientific data collection on the lunar surface. Apollo 13 was launched April 11, 1970, to land on the Fra Mauro uplands area of the Moon. A rupture of the service module oxygen tank on April 13 caused a power failure of the command and service module electrical system which prevented the lunar landing. Using the lunar module for life support and propulsion, James A. Lovell, Jr., Fred W. Haise, Jr., and John L. Swigert, Jr., returned safely to Earth on April 17. Apollo 14 in February 1971, took over the mission planned for Apollo 13 and brought back 94 pounds of lunar samples. On Apollo 15, David R. Scott and James B. Irvin explored the Hadley Apennine region of the Moon in the first lunar rover vehicle, collecting 171 pounds of lunar material. The Descartes highlands provided the background for the Apollo 16 crew in April 1972, to gather 210 pounds of lunar rock and soil samples, again using a lunar rover vehicle. The final Apollo mission, Apollo 17, was launched at night on December 7, 1972. Dr. Harrison H. Schmitt became the first scientist-astronaut to land on the Moon as he and Eugene A. Cernan explored the Taurus-Littrow site and collected more than 240 pounds of samples. Project Apollo ended with the splashdown of Apollo 17 on December 19, 1972.

The $25 billion Project Apollo Program surpassed the goal set by President Kennedy by exploring the Moon twice before the end of the 1960's. The six lunar landings provided scientists with enough sample materials, photographs, and electronic data to establish preliminary findings about the Moon which included

- A lunar history time scale
- General agreement that "sea" regions are lava flow and that most craters are projectile impacts
- Support that the Moon has been inactive for the last 2 to 3 billion years
- A stronger than expected and variable magnetic field and a hotter than expected interior
- Distinct differentiation between the chemical composition of the Moon and that of the Earth

SKYLAB PROGRAM

The Skylab Orbital Workshop was launched May 14, 1973. During launch, the meteoroid shield needed to protect the workshop from tiny space particles and the Sun's heat was lost along with one solar wing. As a result, the entire Skylab program was endangered as high temperatures made the 100-ton workshop uninhabitable, threatening foods, medicines, and films. On May 25, Charles Conrad, Jr., Dr. Joseph P. Kerwin, and Paul J. Weitz were finally launched toward Skylab to begin their first task of erecting a mylar parasol to shade the area left unprotected by the missing shield and then begin their 28-day mission conducting experiments from their 269-mile high orbit. The second Skylab team of Alan L. Bean, Jack R. Lousma, and Owen K. Garriott lifted off on July 28 for their 59-day mission. The third and final Skylab mission began on November 16 as Gerald P. Carr, William R. Pogue, and Edward G. Gibson started their 84-day stay in space. A highlight of this third mission was extensive observation and photography of the Comet Kohoutek. The $2.6 billion Skylab program ended on July 11, 1979, when the space station re-entered the Earth's atmosphere near southeastern Australia after more than 6 years in space and 34,981 orbits. Major accomplishments were made in solar and stellar astronomy, in detailed study of the Earth's resources from orbit, in using weightlessness for materials processing research, and in proving that man can work productively in space for extended periods.

APOLLO-SOYUZ TEST PROJECT

The $250 million Apollo-Soyuz Test Project, the world's first international manned space flight, was designed to test compatible rendezvous and docking systems for manned spacecraft in an effort to open the way for an international space rescue capability. On July 15, 1975, three American astronauts (Thomas P. Stafford, Vance D. Brand, and Donald K. Slayton) and two Russian cosmonauts (Aleksey A. Leonov and Valeriy N. Kubasov) were launched 7-1/2 hours apart. On July 17, docking of the Soyuz and Apollo spacecraft was accomplished and they remained together for 2 days while their crews conducted joint experiments and transfer operations.

This mission marked the first time that voice, television, and telemetry were relayed between an orbiting Apollo spacecraft and the ground via the ATS-6 communications satellite. This new technique more than tripled the communications coverage otherwise available. The Soyuz mission ended on July 21 and the Apollo mission ended on July 24, successfully meeting all the primary objectives which included rendezvous, docking, crew transfer, and control center-crew interaction.

SPACE SHUTTLE PROGRAM

The Space Shuttle Program was developed to achieve a national objective of providing economical access to space for research and commerce. Via reusable vehicles, payloads such as satellites can be delivered or retrieved. International involvement in scientific experiments and significant usage by the Department of Defense are also part of the program.

The Space Shuttle flight system is composed of the Orbiter, an external tank that contains all the propellant used by the three main engines, and two solid rocket boosters. The Orbiter is about the size and weight of a DC-9 commercial air transport plane, is designed to fly 100 missions lasting from 7 to 30 days each with a maximum crew of seven, and can carry payloads of up to 65,000 pounds into orbit. Each of the three main engines is fed propellants from the external tank which holds 1,550,000 pounds of liquid hydrogen and oxygen at lift-off and is the only part of the Shuttle system that is not reusable. Each solid rocket booster contains the largest solid rocket motor ever flown and the first one ever designed for reuse. (See the Spacecraft Dimensions/Flight Summary Information section for measurement statistics for the Space Shuttle system.)

On April 12, 1981, a new era in manned space flight began as America's first reusable Space Shuttle and the first winged and wheeled spacecraft, Columbia, was launched with John W. Young and Robert L. Crippen. This maiden flight was followed by three other orbital flight tests, the last one being launched on June 27, 1982. By April 1984, the Space Shuttle and her crew had flown four test flights and seven operational missions and had successfully demonstrated the ability to rescue and repair damaged spacecraft in orbit as well as perform numerous experiments.

In January 1986 the *Challenger* accident occurred, grounding the fleet for two and a half years. During this time management, operations, and hardware changes were made to enhance Shuttle safety and return to flight. Work began on *Endeavour* in 1987. The September 29, 1988 launch of *Discovery* marked the resumption of Shuttle operations. Shuttle missions became directed increasingly toward conducting scientific research in Earth orbit and preparing the way for Space Station, scheduled for deployment from the Shuttle in the late 1990s.

Each Shuttle mission is unique and major highlights of the program are as follows.

Space Shuttle Program Highlights

STS	Dates	Highlights
1	April 12-14,1981	First use of solid rockets on a manned vehicle First time astronauts rode a new type of spaceship on its first flight
2	November 12-14, 1981	First time r[illegible]ed spaceship was reflown with second crew First operation of remote manipulator arm
3	March 22-30, 1982	Land at White Sands
5	November 11-16, 1982	First operational STS flight
6	April 4-9, 1983	First flight of *Challenger* Launch of first Tracking and Data Relay Satellite
7	June 18-24, 1983	First American woman in space (Sally K. Ride)
8	August 30-September 5, 1983	First night launch of Space Shuttle First American black astronaut in space (Guion S. Bluford, Jr.)
9	November 28-December 8, 1983	Spacelab 1 First West European in space (Ulf Merbold) First non-NASA American astronaut in space (Bryon K. Lichtenberg, Massachusetts Institute of Technology)
41-B	February 3-11, 1984	First untethered flight of astronauts using manned maneuvering units (Bruce McCandless II and Robert L. Stewart) First landing at Kennedy Space Center
41-C	April 6-13, 1984	First use of a direct ascent trajectory First planned repair of an orbiting satellite (Solar Maximum Mission)
41-D	August 30-September 5, 1984	First launch of *Discovery* First commercial payload specialist (Charles D. Walker, McDonnell Douglas) First Shuttle flight from which three satellites were deployed
41-G	October 5-13, 1984	First Canadian in space (Marc Garneau) First flight with two women (Sally K. Ride and Kathryn D. Sullivan) First spacewalk by an American woman (Kathryn D. Sullivan)
51-C	January 24-27, 1985	First STS dedicated Department of Defense mission
51-D	April 12-19, 1985	First flight of an elected official (Senator E. J. "Jake" Garn, Utah)
51-B	April 29-May 6, 1985	Spacelab 3 First time American astronauts flew with live mammals aboard
51-F	July 29-August 6, 1985	Spacelab 2
51-J	October 3-7, 1985	First flight of *Atlantis*
61-A	October 30-November 6, 1985	First Space Shuttle mission largely financed and operated by another nation (West Germany) First flight with eight crewmembers

Space Shuttle Program Highlights *(concluded)*

STS	Dates	Highlights
61-B	November 26-December 3, 1985	First Mexican in space (Rodolfo Neri Vela)
61-C	January 12-18, 1986	First flight of a U.S. Representative (Bill Nelson, Fla.) First Spanish broadcast (Franklin R. Chang-Díaz)
26	September 29-October 3, 1988	First Shuttle launch since the loss of the *Challenger*
30	May 4-8, 1989	First planetary probe from Shuttle (Magellan to Venus)
40	June 5-14, 1991	First flight dedicated to researching effects of microgravity on human body (Spacelab Life Sciences)
48	September 12-18, 1991	International Microgravity Laboratory 1
45	March 24-April 2, 1992	First Belgian in space (Dirk Frimout)
49	May 7-May 16, 1992	First flight of *Endeavour*; first three-person EVA
50	June 25-July 9, 1992	United States Microgravity Laboratory 1; first Extended Duration Orbiter (EDO) cryogenic pallet
47	September 12-20, 1992	Spacelab Japan 1; first black female astronaut (Mae Jemison); 50th Shuttle mission

SPACE STATION *(program under review)*

Space Station Freedom is the critical stepping stone to the continued exploration of space. Before we journey far beyond the boundaries of Earth, we must uncover the secrets of effectively living and working in the space environment. Space Station will provide the means of learning essential techniques to ensure the health and well being of future space travelers as well as providing the opportunity to learn methods of building and maintaining large structures in space.

Many of NASA's recent Shuttle missions serve as precursors to Space Station and preview the potential benefits to be gained from a permanent space presence. In January 1992 STS-42, International Microgravity Laboratory 1 mission, carried a U.S. and international crew, which foreshadows the international Space Station. Crew members from the United States, as well as Canada and Europe, conducted experiments on the behavior of materials and living things in weightlessness. In June 1992 STS-50 lifted off carrying the United States Microgravity Laboratory (USML 1). The flight set an all-time Orbiter duration record and demonstrated the knowledge to be gained from extended stays. It provided critical information in the areas of fluid dynamics, crystal growth, combustion science, biological science, and technology demonstration. The April 1992 flight of STS-49, most famous for the dramatic Intelsat satellite rescue, illustrates the need for Space Station. No amount of rehearsal on Earth can replace the experience to be gained by working there.

The Johnson Space Center plays a major role in the development of this country's first permanent orbiting space station.

The Space Station Projects Office is responsible for design and development of many of Station's hardware and distributed systems. This includes the station's integrated truss (or backbone), resource nodes, airlock, and mobile transporter. Distributed systems include the data management system (DMS), thermal control system (TCS), communications and tracking system (C&T), and guidance, navigation and control system (GN&C). In addition, the Projects Office is responsible for software development and verification. All of this work is carried out with the support of Engineering, Life Sciences, and Flight Crew Directorates.

The Mission Operations Projects Office is responsible for mission planning and analysis, training, crew operations, flight operations execution, logistics, medical operations, and operations facility development.

The Shuttle Program Office is involved in working interfaces between the Shuttle and Space Station while the Flight Crew Office provides input to all aspects of the Program. Another JSC office involved in the Space Station effort is the Assured Crew Return Vehicle project office. This office is investigating means of rescuing the Station's crew should an emergency develop.

Space Station when complete will measure 353 feet from end to end — the size of a football field with end zones. It will weigh nearly 300 tons — the size of a fully loaded 747 jet — and its solar arrays will generate enough electrical power to run five earthbound households. Four crew members will live on board for stays of up to two months. They will work 10-hour days conducting life science and microgravity research.

At JSC, the Space Station's development and design is well underway. In fact, development testing of many of its systems is in progress, and fabrication of flight hardware has begun. In less than a year the program will complete its Critical Design Review, a major milestone on the way to First Element Launch (FEL) in March 1996. ❑

IV. Spacecraft Dimensions/Flight Summary Information

IV. Spacecraft Dimensions/ Flight Summary Information

U. S. MANNED SPACECRAFT DIMENSIONS

Mercury

Height:	2.9 meters (9.5 feet)
Maximum diameter:	1.9 meters (6.2 feet)
Weight	1,451 kilograms (3,200 pounds)
Habitable volume:	1.02 cubic meters (36 cubic feet)

Gemini

Height:	5.5 meters (18 feet)
Maximum diameter:	3 meters (10 feet)
Weight:	3,402 kilograms (7,500 pounds)
Habitable volume:	1.56 cubic meters (55 cubic feet)

Apollo

Command Module

Height:	3.5 meters (11.4 feet)
Maximum diameter:	3.9 meters (12.8 feet)
Weight:	5,330 kilograms (12,850 pounds)
Habitable volume:	5.95 cubic meters (210 cubic feet)

Service Module

Height:	7.5 meters (24.6 feet)
Diameter:	3.9 meters (12.8 feet)
Weight:	24,550 kilograms (54,120 pounds)

Lunar Module

Height:	7 meters (23 feet) legs extended
Diameter:	9.4 meters (31 feet) across legs
Weight:	3,900 kilograms (8,600 pounds)
Habitable volume:	4.5 cubic meters (158.8 cubic feet)

Skylab Space Station

Total cluster:	(Orbital Workshop, Apollo Command/Service Modules, Airlock, Multiple Docking Adapter, Apollo Telescope Mount, Solar Arrays, Payload Shroud)
Length:	35.5 meters (117 feet)
Maximum diameter:	27.5 meters (90 feet) across solar arrays
Weight:	90,606 kilograms (199,750 pounds)
Habitable volume:	360 cubic meters (12,711 cubic feet)

Skylab Workshop Only

Length:	14.6 meters (48 feet)
Diameter:	6.7 meters (22 feet)
Weight:	35,380 kilograms (78,000 pounds)
Habitable volume:	275 cubic meters (9,710 cubic feet)

U. S. MANNED SPACECRAFT DIMENSIONS *(concluded)*

Apollo - Soyuz (U.S. - U.S.S.R.)

Apollo Command Module

Height:	3.5 meters (11.4 feet)
Length:	3.66 meters (12 feet)
Diameter:	3.9 meters (12.8 feet)
Weight:	5,830 kilograms (12,850 pounds)
Habitable volume:	5.95 cubic meters (210 cubic feet)

Apollo Service Module

Height:	7.5 meters (24.6 feet)
Length:	6.71 meters (22 feet)
Diameter:	3.9 meters (12.8 feet)
Weight:	24,550 kilograms (54,120 pounds)

Apollo Docking Module

Length:	3.05 meters (10 feet)
Diameter:	1.52 meters (5 feet)
Weight:	2,012 kilograms (4,426 pounds)
Habitable volume:	4.53 cubic meters (160 cubic feet)

Soyuz Orbital Module

Diameter:	2.29 meters (7.5 feet)
Length:	2.65 meters (8.7 feet)

Soyuz Descent Module

Diameter:	2.29 meters (7.5 feet)
Length:	2.20 meters (7.2 feet)

Soyuz Instrument Module

Diameter:	2.29 meters (7.5 feet)
Length:	2.77 meters (9.75 feet)
Total weight of Soyuz:	6,800 kilograms (14,991 pounds)

Shuttle Orbiter

Height:	17.27 meters (56.67 feet) landing gear down
Length:	37.24 meters (122.2 feet)
Weight:	74,844 kilograms (165,000 pounds) empty
Habitable volume:	71,508 cubic meters (2,525 cubic feet)
Wingspan:	23.79 meters (78.06 feet)
Payload bay:	Diameter – 4.57 meters (15 feet) Length – 18.29 meters (60 feet)
Maximum cargo weight:	29,484 kilograms (65,000 pounds)

Sources: The Early Years: Mercury to Apollo-Soyuz, NASA Information Summaries, November 1985.
Apollo-Soyuz Test Project, NASA Facts, NASA/JSC, 1975.
Apollo-Soyuz by Walter Froehlich, NASA EP-109.
Space Shuttle Transportation System, Press Information, Rockwell International, Space Division, Office of Public Affairs, June 1977.

MANNED SPACE LAUNCH BOOSTER VEHICLE DIMENSIONS

Mercury - Redstone

Height:	25.3 meters (83 feet)
Weight:	28,123 kilograms (62,000 pounds)
Thrust:	346,944 newtons (78,000 pounds)
Propellants:	Ethyl alcohol, water, liquid oxygen

Mercury - Atlas

Height:	29 meters (95 feet)
Weight:	117,900 kilograms (259,920 pounds)
Thrust:	1,601,280 newtons (360,000 pounds)
Propellants:	RP - 1 (refined kerosene), liquid oxygen

Gemini - Titan II

Height:	32.9 meters (108 feet)
Weight:	136,080 kilograms (300,000 pounds)
Thrust:	1,912,640 newtons (430,000 pounds)
Propellants:	50% unsymmetrical dimethylhydrazine plus 50% hydrazine, nitrogen tetroxide

Apollo - Saturn IB

Height:	68 meters (223 feet)
Weight:	544,320 kilograms (1,200,000 pounds)
Thrust:	7,116,800 newtons (1,600,000 pounds)
Propellants:	First Stage - RP - 1 (refined kerosene), liquid oxygen
	Second Stage - liquid hydrogen, liquid oxygen

Apollo - Saturn V

Height:	110.6 meters (363 feet)
Weight:	2,812,320 kilograms (6,200,000 pounds)
Thrust:	First Stage - 33,360,000 newtons (7,500,000 pounds)
	Second Stage - 4,448,000 newtons (1,000,000 pounds)
	Third Stage - 889,600 newtons (200,000 pounds)
Propellants:	First Stage - RP - 1 (refined kerosene), liquid oxygen
	Second Stage - liquid hydrogen, liquid oxygen
	Third Stage - liquid hydrogen, liquid oxygen

Space Shuttle

External Tank

Height:	47 meters (154.2 feet)
Weight:	33,503 kilograms (73,861 pounds) empty
Diameter:	8.38 meters (27.5 feet)
Propellants:	Liquid hydrogen, liquid oxygen

Solid Rocket Boosters

Height:	45.46 meters (149.16 feet)
Weight:	(1,255,790 pounds) each
Diameter:	3.70 meters (12.16 feet)
Thrust:	15,041 newtons (3,316,500 pounds) each
Propellants:	Ammonium perchlorate (oxidizer); aluminum (fuel)

3 Main Engines

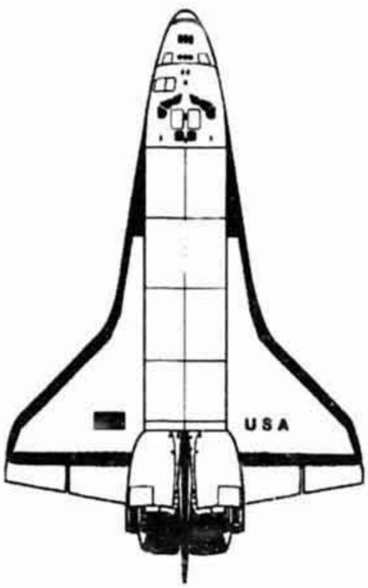
Height:	4.22 meters (13.83 feet) each
Weight:	3,001 kilograms (6,618 pounds) each
Thrust:	1,668,000 newtons (375,000 pounds) each at sea level
Propellants:	Liquid hydrogen, liquid oxygen

2 On-Orbit Maneuvering Engines

Thrust:	26,668 newtons (6,000 pounds) each at vacuum

Sources: The Early Years: Mercury to Apollo-Soyuz, NASA Information Summaries, November 1985.
Space Shuttle Transportation System, Press Information, Rockwell International Space Division, Office of Public Affairs, June 1977 and March 1982.

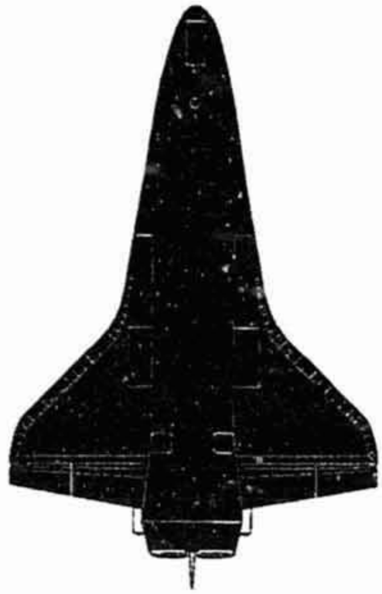
Space Shuttle Orbiter



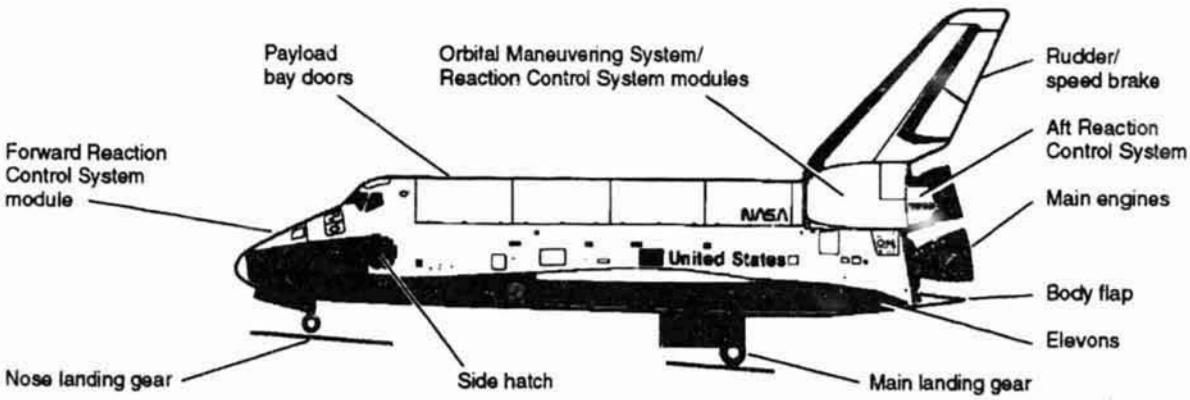
Top view

Front view

Rear view



Bottom view



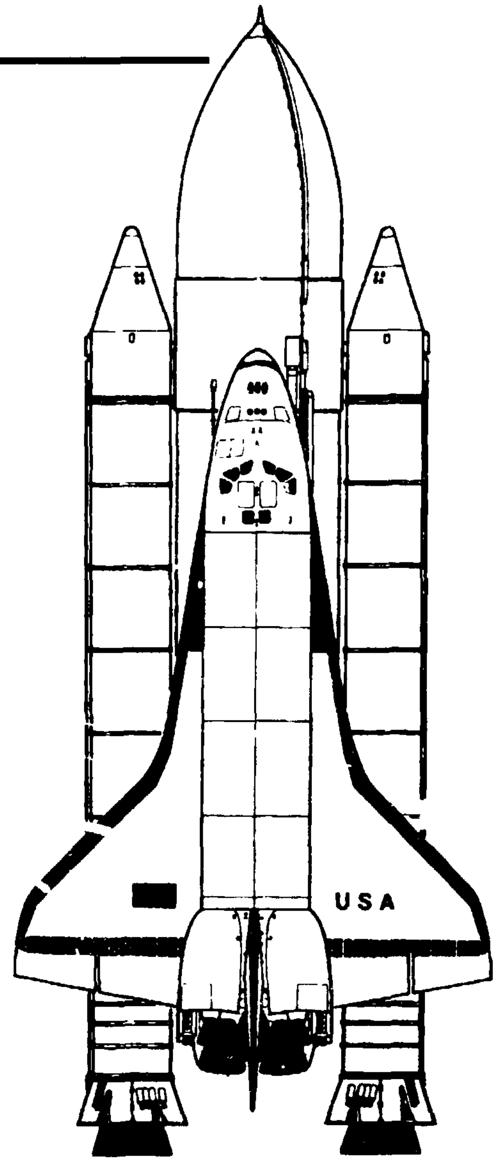
DIMENSIONS AND WEIGHT

Wing span	23.79 m	(78.064 ft)
Length	37.24 m	(122.17 ft)
Height	17.25 m	(56.58 ft)
Span across aft wheels	6.91 m	(22.67 ft)
Gross takeoff weight		Variable
Gross landing weight		Variable
Inert weight (approximate)	74,844 kg	(165,000 lb)

MINIMUM GROUND CLEARANCES

Body flap (aft end)	3.68 m	(12.07 ft)
Main gear (door)	0.87 m	(2.85 ft)
Nose gear (door)	0.90 m	(2.95 ft)
Wingtip	3.63 m	(11.92 ft)

External Tank



TOTAL WEIGHT

Empty:	35,425	kilograms
	(78,100	pounds)
Gross:	756,441	kilograms
	(1,667,677	pounds)

PROPELLANT WEIGHT

Liquid oxygen:	616,493	kilograms
	(1,359,142	pounds)
Liquid hydrogenn:	102 618	kilograms
	(226,237	pounds)
Total:	719,112	kilograms
	(1,585,379	pounds)

PROPELLANT VOLUME

Liquid oxygen tank:	541,482	liters
	(134,060	gallons)
Liquid hydrogen tank:	1,449,905	liters
	(383,066	gallons)
Total:	1,991,387	liters
	(526,126	gallons)

(Propellant densities of 1138 and 70.8 kg/m^3 (71.07 and 4.42 lb/ft^3) used for liquid oxygen and liquid hydrogen, respectively)

DIMENSIONS

Liquid oxygen tank:	16.3	meters
	(53.5	feet)
Liquid hydrogen tank:	29.6	meters
	(97	feet)
Intertank:	6.9	meters
	(22.5	feet)

Solid Rocket Boosters

STATISTICS FOR EACH BOOSTER
THRUST AT LIFT-OFF
11,790 kilonewtons (2,650,000 pounds)

PROPELLANT
Atomized aluminum powder (fuel), 16 percent

Ammonium perchlorate (oxidizer), 69.83 percent

Iron oxide powder (catalyst), 0.17 percent (varies)

Polybutadiene acrylic acid acrylonitrile (binder), 12 percent
Epoxy curing agent, 2 percent

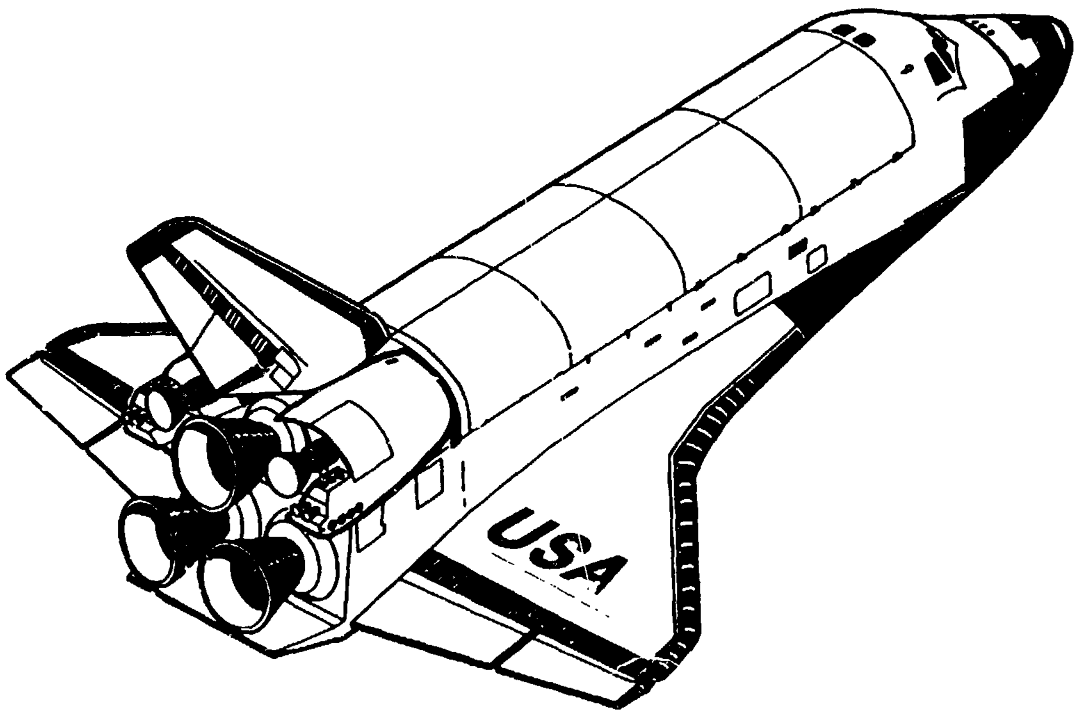
WEIGHT

Empty:	87,550	kilograms
	(193,000	pounds)
Propellant:	502,125	kilograms
	(1,107,670	pounds)
Gross:	589 670	kilograms
	(1,300,000	pounds)

THRUST OF BOTH BOOSTERS AT LIFT-OFF
23,575 kilonewtons (5,300,000 pounds)

GROSS WEIGHT OF BOTH BOOSTERS AT LIFT-OFF
1,179,340 kilograms (2,600,000 pounds)

Space Shuttle Main Engines



THRUST
Sea level: 1,670 kilonewtons (375,000 pounds)

Vacuum: 2,100 kilonewtons (470,000 pounds)

(Note: Thrust given at rated or 100-percent power level)

THROTTLING ABILITY
65 to 109 percent of rated power level

SPECIFIC IMPULSE
Sea level: $356.2 \frac{N/s}{kg} \left(363.2 \frac{lbf/s}{lbm}\right)$

Vacuum: $4464 \frac{N/s}{kg} \left(455.2 \frac{lbf/s}{lbm}\right)$

(Given in newtons per second of kilograms of propellant and pounds-force per second to pounds-mass of propellant)

CHAMBER PRESSURE
20,480 kN/m^2 (2,970 psia)

MIXTURE RATIO
6 parts liquid oxygen to 1 part liquid hydrogen (by weight)

AREA RATIO
Nozzle exit to throat area 77.5 to 1

WEIGHT
Approximately 3,000 kilograms (6,700 pounds)

LIFE
7.5 hours, 55 starts

VERTICAL STABILIZER
8.01 meters (26.31 feet)

BODY FLAP
12.6 square meter (135.8 square foot) area
6.1 meters (20 feet) wide

AFT FUSELAGE
5.5 meters (18 feet) long
6.7 meters (22 feet) wide
6.1 meters (20 feet) high

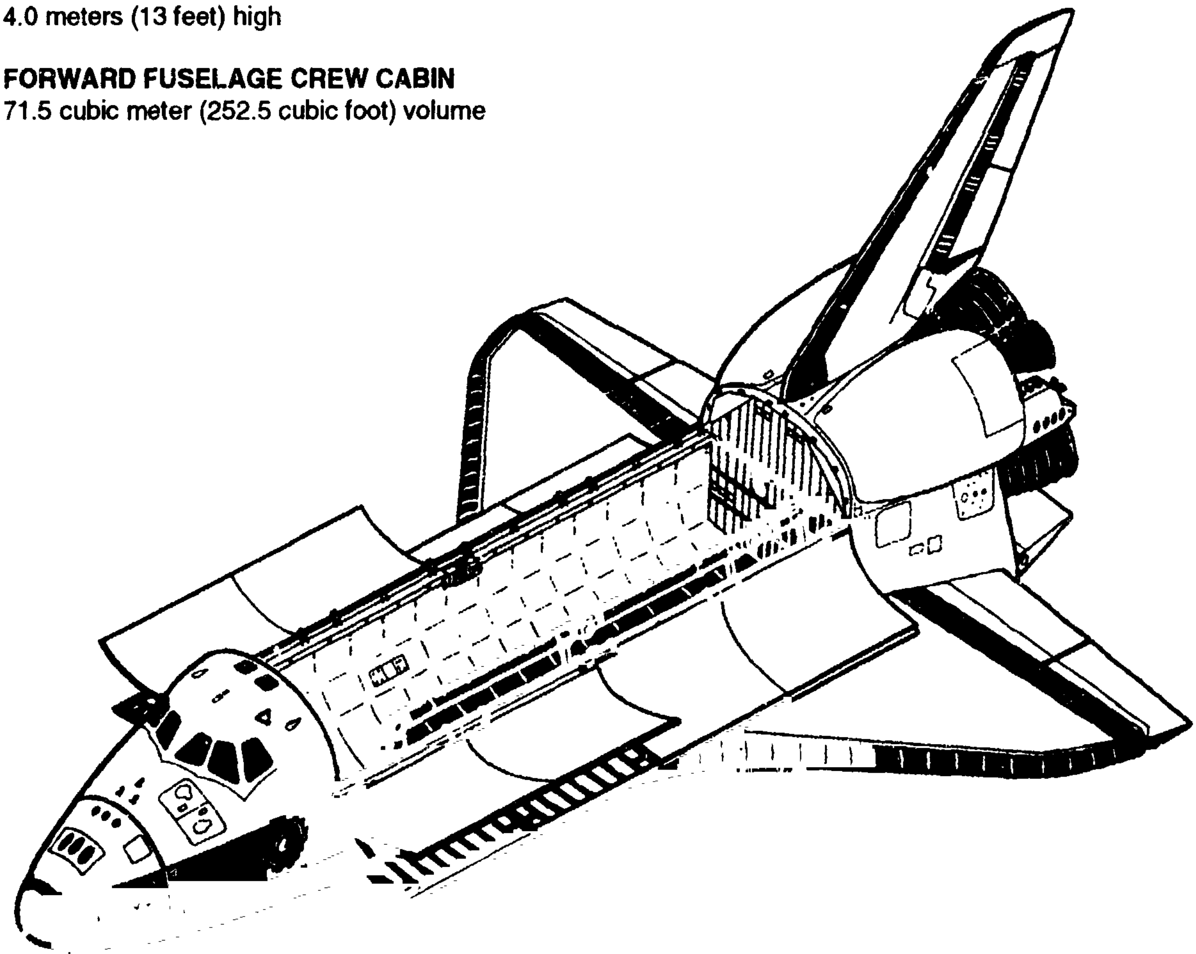
MID FUSELAGE
18.3 meters (60 feet) long
5.2 meters (17 feet) wide
4.0 meters (13 feet) high

FORWARD FUSELAGE CREW CABIN
71.5 cubic meter (252.5 cubic foot) volume

PAYLOAD BAY DOORS
18.3 meters (60 feet) long
4.6 meters (15 feet) in diameter
148.6 square meters (1,600 square feet) surface area

WING
18.3 meters (60 feet) long
1.5 meter (5 foot) maximum thickness

ELEVONS
4.2 meters (13.8 feet)
3.8 meters (12.4 feet)



NASA Major Launch Record – Manned Programs

Mission	Launch vehicle	Launch (landing)	Mission duration hr:min:sec	Remarks
Big Joe (Mercury)	Atlas	September 9, 1959 (Suborbital)	00:13:00	Test of the Mercury capsule. Capsule recovered successfully after reentry test.
Little Joe 1 (LJ-6)	Little Joe	October 4, 1959 (Suborbital)	00:05:10	Test of the Mercury capsule to qualify the booster for use with the Mercury test program.
Little Joe 2 (LJ-1A)	Little Joe	November 4, 1959 (Suborbital)	00:08:11	Test of the Mercury capsule to test the escape system. Vehicle functioned perfectly, but escape rocket ignited several seconds too late.
Little Joe 3 (LJ-2)	Little Joe	December 4, 1959 (Suborbital)	00:11:06	Test of the Mercury capsule, included escape system test and biomedical tests with monkey (Sam) aboard, to demonstrate high altitude abort at max q.
Little Joe 4 (LJ-1B)	Little Joe	January 21, 1960 (Suborbital)	00:08:35	Test of the Mercury capsule, included escape system test and biomedical tests with monkey (Miss Sam) aboard.
Mercury (MA-1)	Atlas	July 29, 1960 (Failed orbit)	00:00:65	Test of Mercury capsule reentry. The Atlas exploded 65 seconds after launch.
Little Joe 5 (LJ-5)	Little Joe	November 8, 1960 (Suborbital)	00:02:22	Test of the Mercury capsule to qualify capsule system. Capsule did not separate from booster.
Mercury (MR-1A)	Redstone	December 19, 1960 (Suborbital)	00:15:45	Test of Mercury spacecraft. Impacted 235 miles down range after reaching an altitude of 135 miles and a speed of nearly 4,200 mph. Capsule recovered about 50 minutes after launch.
Mercury (MR-2)	Redstone	January 31, 1961 (Suborbital)	00:16:39	Test of Mercury capsule. Included biomedical tests with chimpanzee (Ham) aboard.
Mercury (MA-2)	Atlas	February 21, 1961 (Suborbital)	00:17:56	Test of Mercury capsule; upper part of Atlas strengthened by 8-inch wide stainless steel band. Capsule recovered less than 1 hour after launch.
Little Joe 5A	Little Joe	March 18, 1961 (Suborbital)	00:23:48	Test of Mercury capsule; escape rocket motor fired prematurely prior to capsule release.
Mercury (MR-BD)	Redstone	March 24, 1961 (Suborbital)	00:08:23	Test of launch vehicle for Mercury flight to acquire further experience with booster before manned flight was attempted.
Mercury (MA-3)	Atlas	April 25, 1961 (Failed orbit)	00:00:40	Flight test of Mercury capsule. Destroyed after 40 seconds by range safety officer when the inertial guidance system failed to pitch the vehicle toward the horizon.
Little Joe 5B	Little Joe	April 28, 1961 (Suborbital)	00:05:25	Flight test to demonstrate ability of escape and sequence systems to function properly at max q.
Mercury (Freedom 7)	Mercury-Redstone 3	May 5, 1961 (May 5, 1961)	00:15:22	Suborbital flight with Alan Shepard, Jr.

NASA Major Launch Record – Manned Programs *(continued)*

Mission	Launch vehicle	Launch (landing)	Mission duration hr:min:sec	Remarks
Mercury (Liberty Bell 7)	Mercury-Redstone 4	July 21, 1961 (July 21, 1961)	00:15:37	Suborbital flight with Virgil I. Grissom. After landing, the spacecraft was lost, but pilot was rescued from water.
Mercury (MA-4)	Atlas	September 13, 1961 (September 13, 1961)	01:49:20	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.
Saturn Test	Saturn I	October 27, 1961 (Suborbital)		Launch vehicle development test of propulsion system of the S-1 booster; verification of aerodynamic and structural design of entire vehicle.
Mercury (MS-2)	AF 609A Blue Scout	November 1, 1961 (Failed Orbit)	00:00:44	Orbital test of Mercury tracking network. First stage exploded 26 seconds after liftoff; other three stages destroyed by Range Safety Officer 44 seconds after launch.
Mercury (MA-5)	Atlas	November 29, 1961 (November 29, 1961)	03:20:59	Final flight test of all Mercury systems prior to manned orbital flight with chimpanzee Enos on board. Spacecraft and chimpanzee recovered after two orbits.
Mercury (MA-6) (Friendship 7)	Atlas	February 20, 1962 (February 20, 1962)	04:55:23	First U.S. manned orbital flight. John H. Glenn, Jr., made three orbits of Earth. Capsule and pilot recovered after 21 minutes in the water.
Saturn Test (SA-2)	Saturn I	April 25, 1962 (Suborbital)		Launch vehicle test; carried 95 tons of ballast water in upper stages, which was released at an altitude of 65 miles to observe effect on upper region of the atmosphere (Project High Water).
Mercury (MA-7) (Aurora 7)	Atlas	May 24, 1962 (May 24, 1962)	04:56:05	Orbital flight with M. Scott Carpenter. Reentered under manual control after three orbits.
Mercury (MA-8) (Sigma 7)	Atlas	October 3, 1962 (October 3, 1962)	09:13:11	Orbital flight with Walter M. Schirra, Jr. Made six orbits of the Earth.
Saturn (SA-3)	Saturn I	November 16, 1962 (Suborbital)		Launch vehicle development flight. Second Project High Water released 95 tons of water at an altitude of 90 n. mi.
Saturn Test (SA-4)	Saturn I	March 28, 1963 (Suborbital)		Launch vehicle development test. Programmed in-flight cutoff of one of eight engines successfully demonstrated propellant utilization system function.
Mercury (MA-9) (Faith 7)	Atlas	May 15, 1963 (May 16, 1963)	34:19:49	Orbital flight with L. Gordon Cooper, Jr. Various tests and experiments performed. Capsule reentered after 22 orbits.
Little Joe II	Little Joe	August 28, 1963 (Suborbital)	00:01:39	Apollo launch vehicle test. Booster qualification test with dummy payload.
Saturn I (SA-5)	Saturn I	January 29, 1964		Launch vehicle de[illegible]est. Fifth flight of Saturn I; first Block II Saturn, first live flight of the [illegible]led second stage (S-IV). 1,146 measurements taken.

NASA Major Launch Record – Manned Programs *(continued)*

Mission	Launch vehicle	Launch (landing)	Mission duration hr:min:sec	Remarks
Gemini I	Titan II	April 8, 1964		Qualification of Gemini spacecraft configuration and Gemini launch vehicle combination in launch environment through orbital insertion phase.
Apollo Abort (A-001)	Little Joe	May 13, 1964 (Suborbital)	00:05:50	Vehicle development test to demonstrate Apollo spacecraft atmospheric abort system capabilities.
Saturn I (SA-6) (AS-101)	Saturn I	May 28, 1964		Vehicle development test. First flight of unmanned model of the Apollo spacecraft. 106 measurements taken.
Saturn I (SA-7)	Saturn I	September 18, 1964 (September 22, 1964)		Demonstrate launch vehicle/spacecraft compatibility and tested launch escape system. Telemetry obtained from 131 separate and continuous measurements.
Apollo Abort	Little Joe	December 8, 1964 (Suborbital)	00:07:23	First test of Apollo emergency detection system at abort altitude.
Gemini II	Titan II	January 19, 1965 (Suborbital)	00:18:16	Demonstrate structural integrity of reentry module heat protection during maximum heating rate reentry and demonstrate variable lift on reentry module.
Gemini III	Titan II	March 23, 1965 (March 23, 1965)	04:52:31	First manned orbital flight of the Gemini program, with astronauts Virgil I. Grissom and John W. Young. Manually controlled reentry after three orbits.
Apollo Abort	Little Joe II	May 19, 1965 (Suborbital)	00:05:02	Demonstration of abort capability of Apollo spacecraft. Launch escape demonstration at high altitude not accomplished due to malfunction of Little Joe II booster.
Gemini IV	Titan II	June 3, 1965 (June 7, 1965)	97:56:11	Second flight with James A. McDivitt and Edward H. White II. During flight, White donned pressure suit and performed extravehicular activity (EVA) using zero-g integral propulsion unit. EVA duration — 22 minutes.
Gemini V	Titan II	August 21, 1965 (August 29, 1965)	190:56:14	Orbital flight with L. Gordon Cooper and Charles Conrad, Jr. Performed simulated rendezvous maneuvers and other experiments.
Gemini VI	Titan II	October 25, 1965		Simultaneous countdown of Gemini spacecraft and Atlas/Agena target vehicle. Telemetry from Agena target vehicle lost 375 minutes after launch; Gemini launch terminated at T–42 minutes.
Gemini VII	Titan II	December 4, 1965 (December 18, 1965)	330:35:31	Fourth mission with Frank Borman and James A. Lovell, Jr. Astronauts flew part of mission without pressure suits.
Gemini VI-A	Titan II	December 15, 1965 (December 16, 1965)	25:51:24	Fifth mission with Walter M. Schirra, Jr., and Thomas P. Stafford. Rendezvous in space (with Gemini VII spacecraft) accomplished.
Apollo Abort (A-004)	Little Joe	January 20, 1966 (Suborbital)	00:06:50	Apollo development flight to demonstrate launch escape system performance. Last unmanned ballistic flight.

NASA Maj[illegible] Launch Record – Manned Programs *(continued)*

Mission	Launch vehicle	Launch (landing)	Mission duration hr:min:sec	Remarks
Apollo Saturn (SA-201)	Saturn IB	February 26, 1966	00:37:00	Launch vehicle development flight; carried unmanned Apollo spacecraft.
Gemini VIII	Titan II	March 16, 1966 (March 17, 1966)	10:41:26	Agena target launched from Complex 14 and manned Gemini launched from Complex 19. Astronauts [illegible] A. Armstrong and David R. Scott accomplished rendezvous and docking. Attitude and maneuver thruster malfunction caused docked spacecraft to tumble. Astronauts separated vehicles and terminated mission early; EVA not accomplished. First Pacific Ocean landing.
Gemini IX-A	Titan II	June 3, 1966 (June 6, 1966)	7[illegible]:20:50	Seventh mission with Thomas P. Stafford and Eugene A. Cernan. Target vehicle shroud failed to separate, docking not achieved. EVA successful, but evaluation of astronaut maneuvering unit not achieved.
Apollo Saturn (SA-203)	Saturn IB	July 5, 1966 (July 5, 1966)		Launch vehicle development flight; evaluated S-IVB stage vent and restart capability.
Gemini X	Titan II	July 18, 1966 (July 21, 1966)	70:46:39	Eighth mission with John W. Young and Michael Collins. Performed first docked vehicle maneuvers; standup EVA of 87 minutes, umbilical EVA of 27 minutes.
Apollo Saturn A-202)	Saturn IB	August 25, 1966 (Suborbital)	01:33:00	Apollo launch vehicle and spaceacraft development flight to test command module heat shield and obtain launch vehicle and spacecraft data.
Gemini XI	Titan II	September 12, 1966 (September 15, 1966)	71:17:08	Ninth mission with Charles Conrad, Jr., and Richard F. Gordon, Jr. Rendezvous and docking achieved. Umbilical and standup EVA performed as well as tethered spacecraft experiment.
Gemini XII	Titan II	November 11, 1966 (November 15, 1966)	94:35:31	Last Gemini flight with James A. Lovell, Jr., and Buzz Aldrin. Rendezvous and docking achieved. Two EVAs performed.
Apollo 4 (SA-501)	Saturn V	November 9, 1967 (November 9, 1967)	00:08:30	Launch vehicle/ spacecraft development flight. First launch of Saturn V; carried unmanned Apollo command/ service module.
Apollo 5 (SA-204)	Saturn IB	January 22, 1968 (January 24, 1968)		First flight test of lunar module; verified ascent and descent stages; propulsion systems and restart operations.
Apollo 6 (SA-502)	Saturn V	April 4, 1968 (April 4, 1968)	00:08:30	Launch vehicle and spacecraft development flight. Launch vehicle engines malfunctioned; spacecraft systems performed normally. Mission judged partially successful.
Apollo 7	Saturn IB	October 11, 1968 (October 22, 1968)	260:09:03	First manned flight of Apollo spacecraft with Walter M. Schirra, Jr., Donn F. Eisele, and Walter Cunningham. Performed Earth orbit operations.

NASA Major Launch Record – Manned Programs *(continued)*

Mission	Launch vehicle	Launch (landing)	Mission duration hr:min:sec	Remarks
Apollo 8	Saturn V	December 21, 1968 (December 27, 1968)	147:00:42	First manned Saturn V flight with Frank Borman, James A. Lovell, Jr., and William A. Anders. First manned lunar orbit mission; provided closeup look at Moon during 10 lunar orbits.
Apollo 9	Saturn V	March 3, 1969 (March 13, 1969)	241:01:54	Earth orbital flight with James A. McDivitt, David R. Scott, and Russell L. Schweickart. First flight of lunar module. Performed rendezvous, docking, and EVA.
Apollo 10	Saturn V	May 18, 1969 (May 26, 1969)	192:03:00	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.
Apollo 11	Saturn V	July 16, 1969 (July 24, 1969)	195:18:35	First lunar landing and return to Earth with Neil A. Armstrong, Michael Collins, and Buzz Aldrin. Landed in the Sea of Tranquility on July 20; deployed TV camera and EASEP experiments; performed EVA, returned lunar soil samples.
Apollo 12	Saturn V	November 14, 1969 (November 24, 1969)	244:36:25	Second lunar landing and return with Charles Conrad, Jr., Richard F. Gordon, Jr., and Alan L. Bean. Landed in the Ocean of Storms on November 19; deployed TV camera and ALSEP experiments; two EVAs performed; collected core sample and lunar materials; photographed and retrieved parts from Surveyor III spacecraft.
Apollo 13	Saturn V	April 11, 1970 (April 17, 1970)	142:54:41	Third lunar landing attempt with James A. Lovell, Jr., John L. Swigert, Jr., and Fred W. Haise, Jr. Pressure lost in service module oxygen system; mission aborted; lunar module used for life support.
Apollo 14	Saturn V	January 31, 1971 (February 9, 1971)	261:01:57	Third lunar landing with Alan B. Shepard, Jr., Stuart A. Roosa, and Edgar D. Mitchell. Landed in the Fra Mauro area on February 5; performed EVA; deployed lunar experiments; returned lunar samples. Particles and Fields (P&F) subsatellite spring-launched from service module in lunar orbit.
Apollo 15	Saturn V	July 26, 1971 (August 7, 1971)	295:11:53	Fourth lunar landing with David R. Scott, Alfred M. Worden, and James B. Irwin. Landed at Hadley Rille on July 30; performed EVA with lunar roving vehicle; deployed experiments.
Apollo 16	Saturn V	April 16, 1972 (April 27, 1972)	265:51:59	Fifth lunar landing mission with John W. Young, Thomas K. (Ken) Mattingly II, and Charles M. Duke, Jr. Landed at Descartes on April 20. Deployed camera and experiments; performed EVA with lunar roving vehicle. Deployed P&F subsatellite in lunar orbit.
Apollo 17	Saturn V	December 7, 1972 (December 19, 1972)	301:51:59	Sixth and last lunar landing mission with Eugene A. Cernan, Ronald E. Evans, and Harrison H. (Jack) Schmitt. Landed at Taurus-Littrow on December 11. Deployed camera and experiments, performed EVA with lunar roving vehicle. Returned lunar samples.

NASA Major Launch Record – Manned Programs *(continued)*

Mission	Launch vehicle	Launch (landing)	Mission duration hr:min:sec	Remarks
Skylab 1	Saturn V	May 14, 1973		Unmanned launch of first U.S. space station. Workshop incurred damage during launch. Repaired during follow-on manned missions.
Skylab 2	Saturn IB	May 25, 1973 (June 22, 1973)	672:49:49	First visit to Skylab workshop with Charles (Pete) Conrad, Jr., Joseph P. Kerwin, and Paul J. Weitz. Deployed parasol-like thermal blanket to protect hull and reduce temperatures within workshop; freed jammed solar wing.
Skylab 3	Saturn IB	July 28, 1973 (September 25, 1973)	1427:09:04	Second 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.
Skylab 4	Saturn IB	November 16, 1973 (February 8, 1974)	2017:15:32	Third 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 EVAs.
Apollo-Soyuz Test Project	Saturn IB	July 15, 1975 (July 24, 1975)	217:28:23	Apollo spacecraft with Thomas P. Stafford, Vance D. Brand, and Donald K. Slayton rendezvoused and docked with Soyuz 19 spacecraft with Alexei Leonov and Valeri Kubasov on July 17, 1975.
STS-1	Shuttle (Columbia)	April 12, 1981 (April 14, 198)	54:20:32	First manned orbital test flight of the Space Shuttle with John W. Young and Robert L. Crippen aboard to verify the combined performance of the Shuttle vehicle.
STS-2	Shuttle (Columbia)	November 12, 1981 (November 14, 1981)	54:13:13	Second orbital test flight of the Space Shuttle with Joe H. Engle and Richard H. Truly to verify the combined performance of the Shuttle vehicle. OSTA-1 payload demonstrated capability to conduct scientific research in attached mode.
STS-3	Shuttle (Columbia)	March 22, 1982 (March 30, 1982)	192:04:45	Third orbital test flight of the Space Shuttle with Jack R. Lousma and C. Gordon Fullerton to verify the combined performance of the Shuttle vehicle. OSS-1 scientific experiments conducted from the cargo bay.
STS-4	Shuttle (Columbia)	June 27, 1982 (July 4, 1982)	169:09:40	Fourth and last orbital test flight of the Space Shuttle with Thomas K. Mattingly II and Henry W. Hartsfield, Jr., to verify the combined performance of the Shuttle vehicle. Carried first operational getaway special canister for Utah State University and payload DOD 82-1.
STS-5	Shuttle (Columbia)	November 11, 1982 (November 16, 1982)	122:14:26	First operational flight of the Shuttle with Vance D. Brand, Robert F. Overmyer, Joseph P. Allen IV, and William B. Lenoir. Two satellites deployed: SBS-C (commercial reimbursable) and TELESAT-C (Canada reimbursable). Demonstrated ability to conduct routine space operations.

NASA Major Launch Record – Manned Programs *(continued)*

Mission	Launch vehicle	Launch (landing)	Mission duration hr:min:sec	Remarks
STS-6	Shuttle (Challenger)	April 4, 1983 (April 9, 1983)	120:23:42	Second operational flight of the Shuttle with Paul J. Weitz, Karol J. Bobko, Donald H. Peterson, and F. 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.
STS-7	Shuttle (Challenger)	June 18, 1983 (June 24, 1983)	146:23:59	Third operational flight of Shuttle with Robert L. Crippen, Frederick H. Hauck, John M. Fabian, Sally K. Ride (first U.S. woman in space), and Norman E. Thagard. Deployed two communications satellites. TELESAT (Canada reimbursable) and PALAPA (Indonesia reimbursable). Carried out experiments including launching and recovering SPAS 01.
STS-8	Shuttle (Challenger)	August 30, 1983 (September 5, 1983)	145:08:43	Fourth operational flight of Shuttle with Richard H. Truly, Daniel C. Brandenstein, Dale A. Gardner, Guion S. Bluford, Jr. (first black astronaut), and William E. Thornton. First night launch and landing. Deployed INSAT (India reimbursable), performed tests and experiments.
STS-9	Shuttle (Columbia)	November 28, 1983 (December 8, 1983)	247:47:24	First Spacelab mission 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 multidiscipline science payload, carried in Shuttle cargo bay.
STS 41-B	Shuttle (Challenger)	February 3, 1984 (February 11, 1984)	191:15:55	Fourth Challenger flight with Vance D. Brand, Robert L. Gibson, Bruce McCandless II, Ronald E. McNair, and Robert L. Stewart. Deployed WESTAR (Western Union reimbursable), and PALAPA B-2 (Indonesia reimbursable). Both PAMs failed; both satellites retrieved on 51-A mission. Rendezvous tests performed with IRT, using deflated target. Evaluated manned maneuvering unit (MMU) and manipulator foot restraint (MFR). First landing at KSC.
STS 41-C	Shuttle (Challenger)	April 6, 1984 (April 13, 1984)	167:40:07	Fifth Challenger flight with Robert L. Crippen, Francis R. Scobee, Terry J. Hart, George D. Nelson, and James D. A. van Hoften. LDEF deployed; Solar Maximum Mission retrieved and repaired in cargo bay, redeployed April 12.
STS 41-D	Shuttle (Discovery)	August 30, 1984 (September 5, 1984)	144:56:04	First Discovery flight with Henry W. Hartsfield, Jr., Michael L. Coats, Richard M. Mullane, Steven A. Hawley, Judith A. Resnik, and Charles D. Walker. Deployed SBS (commercial reimbursable), LEASAT (commercial reimbursable) and TELSTAR (AT&T reimbursable), carried out experiments including OAST-1 solar array.

NASA Major Launch Record – Manned Programs *(continued)*

Mission	Launch vehicle	Launch (landing)	Mission duration hr:min:sec	Remarks
STS 41-G	Shuttle (Challenger)	October 5, 1984 (October 13, 1984)	197:23:33	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 Earth; performed scientific experiments using OSTA-3 and other instruments.
STS 51-A	Shuttle (Discovery)	November 8, 1984 (November 16, 1984)	191:44:56	Second Discovery flight with Frederick H. Hauck, David M. Walker, Joseph P. Allen IV, Anna L. Fisher, Dale A. Gardner. Deployed TELESAT (Canada reimbursable) and SYNCOM IV-1 (Hughes reimbursable). Retrieved and returned PALAPA B-2 and WESTAR 6 (launched on 41-B).
STS 51-C	Shuttle (Discovery)	January 24, 1985 (January 27, 1985)	73:33:23	Third Discovery flight with Thomas K. (Ken) Mattingly II, Loren J. Shriver, Ellison S. Onizuka, James F. Buchli, and Gary E. Payton. Unannounced payload for DOD (reimbursable).
STS 51-D	Shuttle (Discovery)	April 12, 1985 (April 19, 1985)	167:55:23	Fourth Discovery flight with Karol J. Bobko, Donald E. Williams, M. Rhea Seddon, S. David Griggs, Jeffrey A. Hoffman, Charles D. Walker, and E. J. "Jake" Garn (U.S. Senator). Deployed SYNCOM (Hughes reimbursable) and TELESAT (Canada reimbursable). SYNCOM sequencer failed to start, despite attempts by crew, remained inoperable until restarted by crew of 51-I.
STS 51-B	Shuttle (Challenger)	April 29, 1985 (May 6, 1985)	168:08:46	Seventh Challenger flight with Robert F. Overmyer, Frederick D. Gregory, Don L. Lind, Norman E. Thagard, William E. Thornton, Lodewijk van den Berg, and Taylor G. Wang. Spacelab 3 mission conducted applications, science, and technology experiments. Deployed Northern Utah Satellite (NUSAT). Global Low Orbiting Message Relay Satellite (GLOMR) failed to deploy and was returned.
STS 51-G	Shuttle (Discovery)	June 17, 1985 (June 24, 1985)	169:38:52	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 (Mexico reimbursable), ARABSAT (Saudi Arabia reimbursable) and TELSTAR (AT&T reimbursable). Deployed and retrieved SPARTAN-1.
STS 51-F	Shuttle (Challenger)	July 29, 1985 (August 6, 1985)	190:45:26	Eighth Challenger flight with Charles G. Fullerton, Roy D. Bridges, Jr., Karl G. Henize, Anthony W. England, F. Story Musgrave, Loren W. Acton, and John-David F. Bartoe. Conducted experiments in Spacelab 2. Deployed Plasma Diagnostic Package (PDP), which was retrieved 6 hours later.

NASA Major Launch Record – Manned Programs *(continued)*

Mission	Launch vehicle	Launch (landing)	Mission duration hr:min:sec	Remarks
STS-51-I	Shuttle (Discovery)	August 27, 1985 (September 3, 1985)	170:17:42	Sixth Discovery flight with Joe H. Engle, Richard O. Covey, James D. van Hoften, William F. Fisher, John M. Lounge. Deployed AUSSAT (Australia reimbursable), ASC (American Satellite Co. reimbursable), and SYNCOM IV-4 (Hughes reimbursable). After reaching geosynchronous orbit, SYNCOM IV-4 ceased functioning. Repaired SYNCOM IV-3 (launched by 51-D).
STS 51-J	Shuttle (Atlantis)	October 3, 1985 (October 7, 1985)	97:44:38	First Atlantis flight with Karol J. Bobko, Ronald J. Grabe, Robert L. Stewart, David C. Hilmers, and William A. Pailes. DOD mission.
STS 61-A	Shuttle (Challenger)	October 30, 1985 (November 6, 1985)	168:44:51	Ninth Challenger flight with Henry W. Hartsfield, Jr., Steven R. Nagel, Bonnie J. Dunbar, James F. Buchli, Guion S. Bluford, Jr., Ernst Messerschmid (West Germany), Reinhard Furrer (Germany), and Wubbo J. Ockels (The Netherlands). Spacelab D-1 mission to conduct scientific experiments. Deployed GLOMAR. Carried materials experiment assembly (MEA) for on-orbit processing of materials science experiments specimens.
STS 61-B	Shuttle (Atlantis)	November 26, 1985 (December 3, 1985)	165:04:49	Second Atlantis flight with Brewster H. Shaw, Jr., Bryan D. O'Conner, Mary L. Cleave, Sherwood C. Spring, Jerry L. Ross, Rudolfo Neri Vela (MORELOS), Charles D. Walker (MDAC). Deployed MORELOS (Mexico reimbursable), AUSSAT (Australia reimbursable) and SATCOM (RCA reimbursable). Demonstrated construction in space with EASE and ACCESS.
STS 61-C	Shuttle (Columbia)	January 12, 1986 (January 18, 1986)	146:03:51	Sixth Columbia flight with Robert L. Gibson, Charles F. Bolden, Jr., Franklin R. Chang-Díaz, George D. Nelson, Steven A. Hawley, Robert J. Cenker (RCA), and C. William Nelson (Congressman). Deployed SATCOM (RCA reimbursable). Evaluated material science lab payload carrier and processing facilities. Carried HHG-1 to accommodate GAS payloads.
STS 51-L	Shuttle (Challenger)	January 28, 1986 (Failed orbit)	00:00:73	Tenth Challenger flight with Francis R. Scobee, Michael J. Smith, Judith A. Resnik, Ellison S. Onizuka, Ronald E. McNair, Gregory B. Jarvis (Hughes). S. Christa McAuliffe (teacher). Approximately 73 seconds into flight, Challenger was lost.
STS-26	Shuttle (Discovery)	September 29, 1988 (October 3, 1988)	97:00:57	Seventh Discovery flight with Frederick H. Hauck, Richard O. Covey, John M. Lounge, David C. Hilmers, and George D. Nelson. Deployed second Tracking and Data Relay Satellite.
STS-27	Shuttle (Atlantis)	December 2, 1988 (December 6, 1988)	105:06:19	Third Atlantis flight with Robert L. Gibson, Guy S. Gardner, Richard M. Mullane, Jerry L. Ross, and William M. Shepherd. DOD mission.

NASA Major Launch Record – Manned Programs *(continued)*

Mission	Launch vehicle	Launch (landing)	Mission duration hr:min:sec	Remarks
STS-29	Shuttle (Discovery)	March 13, 1989 (March 17, 1989)	119:38:52	Eighth Discovery flight deployed TFRS-D/IUS. Crew members were Michael Coats, John Blaha, James Bagian, James Buchli, and Robert Springer.
STS-30	Shuttle (Atlantis)	May 4, 1989 (May 8, 1989)	121:00:09	Fourth Atlantis flight deployed Magellan (Venus probe)/IUS. Crew members were David Walker, Ronald Grabe, Norman Thagard, Mary Cleave, and Mark Lee.
STS-28	Shuttle (Columbia)	August 8, 1989 (August 13, 1989)	121:00:09	Eighth Columbia flight was a classified DOD mission. Crew members were Brewster Shaw, Richard Richards, David Leestma, James Adamson, and Mark Brown.
STS-34	Shuttle (Atlantis)	October 18, 1989 (October 23, 1989)	119:39:24	Fifth Atlantis flight deployed Galileo (Jupiter probe)/IUS. Crew members were Donald Williams, Michael McCulley, Ellen Baker, Franklin Chang-Díaz, and Shannon Lucid.
STS-33	Shuttle (Discovery)	November 22, 1989 (November 27, 1989)	120:06:49	Ninth Discovery flight was a classified DOD mission. Crew members were Frederick Gregory, John Blaha, Manley Carter, F. Story Musgrave, and Kathryn Thornton.
STS-32	Shuttle (Columbia)	January 9, 1990 (January 20, 1990)	261:00:37	Ninth Columbia flight with Daniel C. Brandenstein, James D. Wetherbee, Bonnie J. Dunbar, Marsha S. Ivins, G. David Low. Deployed Syncom IV-5. Carried out NASA experiments.
STS-36	Shuttle (Atlantis)	February 28, 1990 (March 4, 1990)	106:18:23	Sixth Atlantis flight with John D. Creighton, John H. Casper, David C. Hilmers, Richard M. Mullane, Pierre J. Thuot. DOD mission.
STS-31	Shuttle (Discovery)	April 24, 1990 (April 29, 1990)	121:16:05	Tenth Discovery flight with Loren J. Shriver, Charles F. Bolden, Bruce McCandless, Steven A. Hawley, Kathryn D. Sullivan. Deployment of Hubble Space Telescope. Carried out NASA and Air Force experiments.
STS-41	Shuttle (Discovery)	October 6, 1990 (October 10, 1990)	98:11	Eleventh Discovery flight with Richard N. Richards, Robert D. Cabana, Bruce E. Melnick, William M. Shepherd, Thomas D. Akers. Deployed Ulysses (solar polar probe). Carried out NASA and Air Force experiments.
STS-38	Shuttle (Atlantis)	November 15, 1990 (November 20, 1990)	117:55	Seventh Atlantis mission with Richard O. Covey, Frank L. Culbertson, Robert C. Springer, Carl J. Meade, Charles D. Gemar. DOD mission.
STS-35	Shuttle (Columbia)	December 2, 1990 (December 11, 1990)	215:06	Tenth Columbia flight with Vance Brand, Guy S. Gardner, John M. Lounge, Jeffrey A. Hoffman, Robert A. R. Parker, Ronald A. Parise, Samuel T. Durrance. Carried Astro-1. Carried out NASA and Air Force experiments.
STS-37	Shuttle (Atlantis)	April 5, 1991 (April 10, 1991)	120.02	Eighth Atlantis mission with Steven R. Nagel, Kenneth D. Cameron, Linda M. Godwin, Jerome Apt, Jerry Ross. Deployed the Gamma Ray Observatory.
STS-39	Shuttle (Discovery)	April 28, 1991 (May 6, 1991)	199:04	Twelfth Discovery mission with Michael L. Coats, L. Blaine Hammond, Guion S. Bluford, Jr., Richard J. Hieb, Charles Lacy Veach, Gregory J. Harbough. Donald R. McMonagle.

NASA Major Launch Record – Manned Programs *(concluded)*

Mission	Launch vehicle	Launch (landing)	Mission duration hr:min:sec	Remarks
STS-40	Shuttle (Columbia)	June 5, 1991 (June 10, 1991)	219.08	Eleventh Columbia flight with Brian O'Connor, Sid Guiterrez, Tamara Jernigan, Rhea Seddon, James Bagian. Spacelab Life Sciences-1 carried out life sciences research.
STS-43	Shuttle (Atlantis)	August 2, 1991 (August 11, 1991)	213:22:26	Ninth Atlantis mission deployed TDRS-E/IUS. Crew members were John Blaha, Michael Baker, James Adamson, David Low, and Shannon Lucid.
STS-48	Shuttle (Discovery)	September 12, 1991 (September 18, 1991)	128:28:17	Thirteenth Discovery mission deployed Upper Atmosphere Research Satellite (UARS). Crew members were John Creighton, Kenneth Reightler, Mark Brown, James Buchli, and Charles Gemar.
STS-44	Shuttle (Atlantis)	November 24, 1991 (December 1, 1991)	170:52:36	Tenth Atlantis mission deployed DSP-IUS. Crew members were Frederick Gregory, Terence Henricks, F. Story Musgrave, Mario Runco, James Voss, and Thomas Hennen.
STS-42	Shuttle (Discovery)	January 22, 1992 (January 30, 1992)	193:15:43	Fourteenth Discovery mission carried International Microgravity Laboratory 1. Crew members were Ronald Grabe, Steven Oswald, Norman Thagard, William Readdy, David Hilmers, Roberta Dunbar, and Ulf Merbold.
STS-45	Shuttle (Atlantis)	March 24, 1992 (April 2, 1992)	214:10:24	Eleventh Atlantis mission, carried ATLAS 1 and SSBUV. Crew members were Charles Bolden, Brian Duffy, Kathryn Sullivan, David Leestma, C. Michael Foale, Dirk Frimout, and Byron Lichtenberg.
STS-50	Shuttle (Columbia)	June 25, 1992 (July 9, 1992)	331:30:04	Twelfth Columbia flight carried United States Microgravity Laboratory 1, EDO cryogenic pallet. Crew members were Richard Richards, Kenneth Bowersox, Bonnie Dunbar, Ellen Baker, Carl Meade, Eugene Trinh, and Lawrence Delucas.
STS-49	Shuttle (Endeavour)	May 7, 1992 (May 16, 1992)	213:17:38	First flight of Endeavour performed INTELSAT VI reboost and ASEM tasks. Crew members were Daniel Brandenstein, Kevin Chilton, Richard Hieb, Bruce Melnick, Pierre Thuot, Kathryn Thornton, and Thomas Akers.
STS-46	Shuttle (Atlantis)	July 31, 1992 (August 8, 1992)	191:15:02	Twelfth flight of Atlantis deployed EURECA and conducted TSS-1 operations. Crew members were Loren Shriver, Andrew Allen, Claude Nicollier, Marsha Ivins, Jeffrey Hoffman, Franklin Chang-Díaz, and Franco Malerba.
STS-47	Shuttle (Endeavour)	September 12, 1992 (September 20, 1992)	190:30:22	Second flight of Endeavour carried Spacelab-J. Crew members were Robert Gibson, Jerome Apt, Curtis Brown, Mark Lee, Jan Davis, Mae Jemison, and Mamoru Mohri.

Sources: NASA Pocket Statistics, January 1992
JSC Mission Flight Cards, STS 40-47

Summary of Project Mercury Experiments

Flight	Launch date	Payloads and experiments	
MA-6 (Freedom 7)	February 20, 1962	Ground Light Experiment Weather Photography Terrain Photography	Radiation to Astronaut Dosage Measurement Micrometeorite Studies
MA-7 (Aurora 7)	May 24, 1962	Ground Light Experiment Horizon-Definition Photography Weather Photography Terrain Photography	Radiation to Astronaut Dosage Measurement Tethered Balloon Experiment Liquid Behavior at Zero-Gravity Micrometeorite Studies
MA-8 (Sigma 7)	October 3, 1962	Ground Light Experiment Weather Photography Terrain Photography Radiation to Astronaut Dosage Measurement	Emulsion Packs/Ionization Chambers Map Electron Flux External to Spacecraft Study of Various Ablative Materials Micrometeorite Studies
MA-9 (Faith 7)	May 15, 1963	Ground Light Experiment Flashing Light Experiment Horizon-Definition Photography Weather Photography Terrain Photography Dim-Lignt Photography	Radiation to Astronaut Dosage Measurement Emulsion Packs/Ionization Chambers Map Electron Flux External to Spacecraft Tethered Balloon Experiment Micrometeorite Studies

Source: Mercury Project Summary Including Results of the Fourth Manned orbital Flight, May 15 and 16, 1963.

Summary of Project Gemini Experiments Experiments

Flight	Launch date	Payloads and experiments	
III	March 23, 1965	Sea Urchin Egg Growth Radiation and Zero-G Effects on Blood	Reentry Communications
IV	June 3, 1965	In-Flight Exerciser In-Flight Phonocardiogram Bone Demineralization Electrostatic Charge Proton Electron Spectrometer	Tri-Axis Magnetometer Radiation in Spacecraft Simple Navigation Synoptic (Wide Angle) Terrain and Weather Photography Two-Color Earth's Limb Photography
V	August 21, 1965	Cardiovascular Conditioning In-Flight Exerciser In-Flight Phonocardiogram Bone Demineralization Human Otolith Function Electrostatic Charge Basic and Nearby Object Photography Celestial Photography	Surface Photography Space Object Radiometry Astronaut Visibility Zodiacal Light Photography Synoptic (Wide-Angle) Terrain and Weather Photography Cloud Top Spectrometer Visual Acuity
VI	December 15, 1965	Radiation in Spacecraft Synoptic (Wide Angle) Weather Photography	Synoptic (Wide-Angle) Terrain Photography
VII	December 4, 1965	Cardiovascular Conditioning In-Flight Exerciser In-Flight Phonocardiogram Proton Electron Spectrometer Celestial Radiometry Simple Navigation Visual Acuity Star Occultation Navigation	Bioassays of Body Fluids Bone Demineralization Calcium Balance Study Tri-Axis Magnetometer Space Object Photography Astronaut Visibility Landmark Contract Measurements Optical COmmunications
VIII	March 16, 1966	Bioassays of Body Fluids	Frog Egg Growth

Summary of Project Gemini Experiments *(concluded)*

Flight	Launch date	Payloads and experiments	
IX	June 3, 1966	Bioassays of Body Fluids Airglow Horizon Photography Astronaut Maneuvering Unit Agena Micrometeorite Collection	Zodiacal Light Photography Micrometeorite Collection UHF/VHF Polarization Measurements Landmark Contrast Measurements
X	July 18, 1966	Tri-Axis magnetometer Synoptic (Wide Angle) Terrain Photography Synoptic (Wide Angle) Weather Photography Ion Wake Measurement Ion Sensing Attitude Control Bremsstrahlung Spectrometer	Zodiacal Light Photography Micrometeorite Collection Ultraviolet Astronomical Camera Agena Micrometeorite Collection Beta Spectrometer Star Occultation Navigation
XI	September 12, 1966	Mass Determination Radiation and Zero-G Effects on Blood Nuclear Emulsion Night Image Intensification Ion Wake Measurement Color Patch Photography	Synoptic (Wide Angle) Terrain Photography Synoptic (Wide Angle) Weather Photography Airglow Horizon Photography Ultraviolet Astronomical Camera Dim Light Photography/Orthicon
XII	November 11, 1966	Tri-Axis magnetometer Airglow Horizon Photography Micrometeorite Collection Frog Egg Growth Beta Spectrometer Libration Regions Photographs Manual Navigation Sightings	Synoptic (Wide Angle) Terrain Photography Synoptic (Wide Angle) Weather Photography Ultraviolet Astronomical Camera Ion-Sensing Attitude COntrol Bremsstrahlung Spectrometer Sodium Vapor Cloud Lunar Ultraviolet Spectral Reflectance

Source: Gemini Program Summary. NASA Facts, JSC-11813, NASA/JSC.

Summary of Project Apollo Experiments

Flight	Launch date	Payloads and experiments	
8	December 21, 1968	Cosmic Ray Detector (Helmets)	Lunar Mission Photography
11	July 16, 1969	Lunar Field Geology Soil Mechanics Passive Seismic Solar Wind Composition	Lunar Sample Analysis Laser Ranging Retro-Reflector Lunar Dust Detector Cosmic Ray Detector (Helmets)
12	November 14, 1969	Cosmic Ray Detector (Helmets) Lunar Multispectral Photography Candidate Exploration Sites Photography Lunar Sample Analysis Lunar Surface Magnetometer Suprathermal Ion Detector Cold Cathode Ion Gage Surveyor III Analysis	Lunar Field Geology Selenodetic Reference Point Update Soil Mechanics Passive Seismic Solar Wind Spectrometer Solar Wind Composition Lunar Dust Detector Lunar Surface Closeup Photography
14	January 31, 1971	Bistatic Radar Candidate Exploration Sites Photography Selenodetic Reference Point Update Dim Light Photography Soil Mechanics Passive Seismic Portable Magnetometer Charged Particle Lunar Environment Suprathermal Ion Detector Command Module Orbital Science Photography	S-Band Transponder (CSM/LM) Apollo Window Meteoroid Transearth Lunar Photography Gegenschein From Lunar Orbit Lunar Field Geology Lunar Sample Analysis Active Seismic Laser Ranging Retro-Reflector Solar Wind Composition

Summary of Project Apollo Experiments *(continued)*

Flight	Launch date	Payloads and experiments	
15	July 26, 1971	Bistatic Radar Magnetometer (Subsatellite) Apollo Window Meteoroid Gamma-Ray Spectrometer Alpha Particle Spectrometer Service Module Orbital Photography Gegenschein From Lunar Orbit Command Module Photography Soil Mechanics Passive Seismic Heat Flow Solar Wind Spectrometer Suprathermal Ion Detector Lunar Dust Detector	S-Band Transponder (CSM/LM) S-Band Transponder (Subsatellite) Particle Shadows/Boundary Layer X-Ray Fluorescence Mass Spectrometer Visual Observations From Lunar Orbit Ultraviolet Photography (Earth and Moon) Lunar Field Geology Lunar Sample Analysis Lunar Surface Magnetometer Lunar Ranging Retro-Reflector Solar Wind Composition Cold Cathode Gage
16	April 16, 1972	Bistatic Radar Magnetometer (Subsatellite) Apollo Window Meteoroid Gamma-Ray Spectrometer Alpha-Particle Spectrometer Service Module Orbital Photography Gegenschein From Lunar Orbit Command Module Photography Soil Mechanics Passive Seismic Lunar Surface Magnetometer Heat Flow Cosmic Ray Detector (Sheets)	S-Band Transponder (CSM/LM) S-Band Transponder (Subsatellite0 Particle Shadows/Boundary Layer (Subsatellite) X-Ray Fluorescence Mass Spectrometer Visual Observations From Lunar Orbit Ultraviolet Photography (earth and Moon) Lunar Field Geology Lunar Sample Analysis Active Seismic Portable Magnetometer Solar Wind Composition Far Ultraviolet Camera/Spectroscope

Summary of Project Apollo Experiments *(concluded)*

Flight	Launch date	Payloads and experiments	
17	December 7, 1972	S-Band Transponder (CSM/LM)	Lunar Sounder
		Infrared Scanning Radiometer	Apollo Window Meteoroid
		Gamma-Ray Spectrometer	Far Ultraviolet Spectrometer
		Service Module Orbital Photography	Visual Observations From Lunar Orbit
		Command Module Photography	Lunar Field Geology
		Soil Mechanics	Lunar Sample Analysis
		Seismic Profiling	Heat Flow
		Lunar Surface Gravimeter	Traverse Gravimeter
		Surface Electrical Properties	Lunar Neutron Probe
		Cosmic Ray Detector (Sheets)	Lunar Ejecta and Meteorites
		Lunar Atmospheric Composition	Long-Term Lunar Surface Exposure

Sources: Project Apollo. NASA Facts, NASA/JSC
Apollo Program Summary Report, JSC-09423, April 1975.

Summary of Skylab Experiments

Flight	Launch date	Payloads and experiments	
SL-1/2	May 14, 1973	Mineral Balance	Ultraviolet Stellar Astronomy
	(Workshop)	Nuclear Emulsion	L-Band Radiometer
	May 25, 1973	Bacteria and Spores	Gallium Arsenide Crystal Growth
	(Crew)	Ultraviolet Emissions From Pulsars	Ultraviolet From Quasars
		Objects Within Mercury's Orbit	Volcanic Study
		Atmospheric Absorption of Heat	ATM Contamination Measurement
		Thermal Control Coatings (Instrument Unit)	Sphere Forming
		Exothermic Brazing	Metals Melting
		Transuranic Cosmic Rays	Ultraviolet Panorama
		Human Vestibular Function	Bioassay of Body Fluids
		Specimen Mass Measurement	Vectocardiogram
		Bone Mineral Measurement	Cytogenic Studies of the Blood
		Lower Body Negative Pressure	Man's Immunity In Vitro Aspects
		Blood Volume and Red Cell Life Span	Red Blood Cell Metabolism
		Special Hematologic Effects	Sleep Monitoring
		Time and Motion Study	Metabolic Activity
		Body Mass Measurement	White Light Coronagraph
		Ultraviolet X-Ray Solar Photography	Ultraviolet Spectrometer
		X-Ray Spectrographic Telescope	Dual X-Ray Telescope
		Ultraviolet Spectrograph/Heliograph	Earth Terrain Camera
		Multispectral Photographic Facility	Infrared Spectrometer
		Ultraviolet Airglow Horizon Photography	Multispectral Scanner
		Gegenschein/Zodiacal Light	Particle Collection
		Radiation in Spacecraft	Materials Processing Facility
		Coronograph Contamination Measurements	Neutron Analysis
		Thermal Control Coatings (Airlock Module)	Astronaut Maneuvering Equipment
		Habitability of Crew Quarters	Crew Activities and Maintenance Study
		Contamination Measurements-Proton Spectrometer	In-Flight Aerosol Analysis
		Microwave Radiometer, Scatterometer, and Altimeter	

Summary of Skylab Experiments *(continued)*

Flight	Launch date	Payloads and experiments	
SL-3	July 28, 1973	Crew/Vehicle Disturbances	Libration Clouds
		Foot-Controlled Maneuvering Unit	X-Rays From Jupiter
		In Vitro Immunology	Web Formation
		Cytoplastic Streaming	Mass Measurement
		Human Vestibular Function	Indium Antimonide Crystals
		Effects of Zero Gravity on Single Human Cells	Mixed III-V Crystal Growth
		Passive Circadian Rhythm, Pocket Mice	Metal and Halide Eutectics
		Passive Circadian Rhythm, Vinegar Gnat	Silver Grids Melted in Space
		Magnetospheric Particle Composition	Copper-Aluminum Eutectic
		Vapor Growth of II-VI Compounds	Radiation in Spacecaft
		Immiscible Alloy Compositions	Thermal Control Coatings (Airlock Module)
		Radioactive Tracer Diffusion	Habitability of Crew Quarters
		Micro segregation in Gernamium	Astronaut Maneuvering Equipment
		Growth of Spherical Crystals	Crew Activities and Maintenance Study
		Whisker-Reinforced Composites	In-Flight Aerosol Analysis
		Coronograph Contamination Measurements	Neutron Analysis
		Materials Processing Facility	Gegenschein/Zodiacal Light
		Particle Collection	Ultraviolet Airglow Horizon Photography
		Mineral Balance	Specimen Mass Measurement
		Bioassay of Body Fluids	Bone Mineral Measurement
		Lower Body Negative Pressure	Vectorcardiogram
		Cytogenic Studies of the Blood	Man's Immunity In Vitro Aspects
		Blood Volume and Red Cell Life Span	Red Blood Cell Metabolism
		Special Hematologic Effects	Sleep Monitoring
		Time and Motion Study	Metabolic Activity
		Body Mass Measurement	White Light Coronagraph
		Ultraviolet X-Ray Solar Photography	X-Ray Spectrographic Telescope
		Ultraviolet Spectrometer	Dual X-Ray Telescope
		Ultraviolet Spectrograph/Heliograph	Earth Terrain Camera
		Multispectral Photographic Facility	Infrared Spectrometer
		Microwave Radiometer, Scatterometer and Altimeter	Multispectral Scanner

Summary of Skylab Experiments *(concluded)*

Flight	Launch date	Payloads and experiments	
SL-4	November 16, 1973	Crew/Vehicle Disturbances	X-Ray Stellar Classes
		Foot-Controlled Maneuvering Unit	Motor Sensory Performance
		Plant Growth and Phototropism	Capillary Study
		Neutron Analysis	Coronagraph Contamination Measurements
		In-Flight Aerosol Analysis	Astronaut Maneuvering Equipment
		Crew Activities and Maintenance Study	Habitability of Crew Quarters
		Thermal Control Coatings (Airlock Module)	Radiation in Spacecraft
		Ultraviolet Airglow Horizon Photography	Gegenschein/Zodiacal Light
		Particle Collection	Galactic X-Ray Mapping
		Transuranic Cosmic Rays	Magnetospheric Particle Composition
		Comet Kohoutek Photography	Materials Processing Facility
		Multipurpose Furnace System	Vapor Growth of II-VI Compounds
		Immiscible Alloy Compositions	Growth of Spherical Crystals
		Whisker-Reinforced Composites	Indium Antimonide Crystals
		Mixed III-V Crystal Growth	Copper-Aluminum Eutectic
		Zero-Gravity Flammability	Mineral Balance
		Bioassay of Body Fluids	Specimen Mass measurement
		Bone Mineral Measurement	Lower Body Negative Pressure
		Vectorcardiogram	Cytogenic Studies of the Blood
		Man's Immunity In Vitro Aspects	Special Hematologic Effects
		Blood Volume and Red Cell Life Space	Sleep monitoring
		Red Blood Cell Metabolism	Time and Motion Study
		Body Mass measurement	Metabolic Activity
		Ultraviolet X-Ray Solar Photography	White Light Coronagraph
		X-Ray Spectrographic Telescope	Dual X-Ray Telescope
		Ultraviolet Spectrometer	Multispectral Photographic Facility
		Ultraviolet Spectrograph/Heliograph	Earth Terrain Camera
		Infrared Spectrometer	Multispectral Scanner
		Microwave Radiometer, Scatterometer, and Altimeter	

Sources: Skylab: A Chronology by Roland W. Newkirk and Ivan D. Ertel, Washington, D.C.: NASA Headquarters, 1977.
MSFC Skylab Mission Report: Saturn Workshop, NASA TMX-64814, October 1974.

Summary of Apollo/Soyuz Test Project Experiments

Flight	Launch date	Experiments
Apollo/Soyuz	July 15, 1975	Microbial Exchange (Joint)
		Stratospheric Aerosol Measurement
		Multipurpose Furnace (Joint)
		Electrophoresis Technology
		Electrophoresis — German
		Crystal Growth
		Soft X-Ray
		Ultraviolet Absorption (Joint)
		Extreme Ultraviolet Survey
		Helium Glow
		Doppler Tracking
		Light Flash
		Biostack
		Geodynamics
		Earth Observations and Photography
		Zone-Forming Fungi (Joint)
		Artificial Solar Eclipse (Joint)
		Killifish Hatching and Orientation
		Cellular Immune Response
		Polymorphonuclear Leukocyte Response

Source: Apollo/Soyuz Report, Advances in the Astronautical Sciences, volume 34, edited by Chester M. Lee, NASA/JSC, 1977.

Summary of Shuttle Payloads and Experiments

Flight	Launch date	Payloads and experiments	
STS-1 (Columbia)	April 12, 1981	Development Flight Instrumentation	Passive Optical Sample Assembly Aerodynamic Coefficient Identification Package
STS-2 (Columbia)	November 12, 1981	OSTA-1 Development Flight Instrumentation Induced Environment Contamination Monitor Aerodynamic Coefficient Identification Package	Orbital Flight Test Pallet: Measurement of Air Pollution From Satellite Shuttle Multispectral Infrared Radiometer Features Identification and Location Equipment Ocean Color Experiment Shuttle Imaging Radar
STS-3 (Columbia)	March 22, 1982	OSS-1 Monodisperse Latex Reactor Experiment Continuous Flow Electrophoresis System Heflex Bioengineering Test	Development Flight Instrumentation Aerodynamic Coefficient Identification Package Getaway Special: Verification Canister
STS-4 (Columbia)	June 27, 1982	DOD 82-1 Monodisperse Latex Reactor Experiment Continuous Flow Electrophoresis System Vapor Phase Compression Freezer	Development Flight Instrumentation Induced Environment Contamination Monitor Getaway Special: Utah State University Student experiments; S-405 – The Effects of Diet, Exercise, and Zero-Gravity on Lipoprotein Profiles S-404 – The Effects of Prolonged Space Travel on Levels of Trivalent Chromium in the Body
STS-5 (Columbia)	November 11, 1982	Satellite Business Systems Satellite (SBS-C/PAM-D) Telesat Canada, Ltd. Satellite (ANIK-C/PAM-D) Atmospheric Luminosities Investigation (Glow Experiment)	Development Flight Instrumentation Effects of Interaction of Oxygen with Materials Getaway special: G-026-ERNO, West Germany Student experiments: SE81-5 – Formation of Crystals in Weightlessness SE81-2 – Growth of Porifera in Zero-Gravity SE81-9 – Convection in Zero-Gravity

Summary of Shuttle Payloads and Experiments *(continued)*

Flight	Launch date	Payloads and experiments	
STS-6 (Challenger)	April 4, 1983	Tracking and Data Relay Satellite (TDRS-A/IUS) Continuous Flow Electrophoresis System) Monodisperse Latex Reactor Nighttime/Daytime Optical Survey of Lightning	Radiation Monitoring Experiment Cargo Bay Stowage Assembly Getaway specials: G-005 – Asahi Shimban, Japan G-049 – USAF Academy G-381 – Park Seed Company, South Carolina
STS-7 (Challenger)	June 18, 1983	Telesat Canada, Ltd. Satellite (ANIK C-2/PAM-D) Indonesian Satellite (PALAPA-B1/PAM-D) OSTA-2 Shuttle Pallet Satellite (SPAS) Continuous Flow Electrophoresis System Monodisperse Latex Reactor Cargo Bay Stowage Assembly	Getaway specials: G-002 – Kayser Threde, West Germany G-005 – USAF/National Research Lab G-009 – Purdue University G-012 – RCA/Camden, New Jersey Schools G-033 – California Institute of Technology G-088 – Edsyn, Inc. G-345 – GSFC/National Research Lab
STS-8 (Challenger)	August 30, 1983	Indian National Satellite (INSAT/PAM-D) Payload Flight Test Article Shuttle Pallet Satellite Radiation Monitoring Equipment Oxygen Interaction and Heat Pipe Experiment Investigation of STS Atmospheric Luminosities Animal Enclosure Module Incubator – Cell Attachment Test	Continuous Flow Electrophoresis System Development Flight Instrumentation Getaway specials: G-346 – GSFC G-347 – Navy Research Lab G-348 – Office of Space Science G-475 – Asahi Shimban, Japan Philatelic Covers – U.S. Postal Service Student experiment: SE81-1 – Biofeedback
STS-9 (Columbia)	November 28, 1983	Spacelab 1 *(see "Summary of Spacelab Experiments")*	

Summary of Shuttle Payloads and Experiments *(continued)*

Flight	Launch date	Payloads and experiments	
STS 41-B (Challenger)	February 3, 1984	Indonesian Communications (PALAPA-B2/PAM-D) Western Union (WESTAR VI/PAM-D) Shuttle Pallet Satellite Acoustic Containerless Experiment System Isoelectric Focusing Experiment Integrated Rendezvous Target Radiation Monitoring Equipment Monodisperse Latex Reactor Cinema 360 Camera	Manipulator Foot Restraint Special Equipment Stowage Assembly Getaway specials: G-003 – Utah State University/University of Utah/ Brighton High School G-004 – Utah State University/Aberdeen University G-051 – GTE Laboratories, Inc. G-309 – Air Force Space Test Program G-349 – Goddard Space Flight Center Student experiment: SE81-10 – Effects of Zero-Gravity on Arthritis
STS 41-C (Challenger)	April 6, 1984	Long Duration Exposure Facility Solar Max Mission Flight Support System	Radiation Monitoring Equipment IMAX Camera Cargo Bay Stowage Assembly Cinema 360 Camera Student Experiment: Honeycomb Construction by Bee Colony
STS 41-D (Columbia)	August 30, 1984	SOS Satellite (SYNCOM-IV-2/LEASAT) AT&T Satellite (TELSTAR/PAM-D) Satellite Business System (SBS-D/PAM-D) OAST-1	Continuous Flow Electrophoresis System III IMAX Camera Radiation Monitor Experiment Clouds Photo Experiment Student experiment: SE82-14 – Growth of Single Indium Crystal
STS 41-G (Challenger)	October 5, 1984	OSTA-3 Earth Radiation Budget Satellite (ERBS) Large Format Camera Orbital Refueling System IMAX Camera Radiation Monitor Experiment Aurora Photography Experiment Thermoluminescent Dosimeter Experiment CANEX (Canadian Experiment)	Getaway specials: G-007 – Alabama Space and Rocket Center G-013 – Kayser Trede, West Germany G-032 – Asahi National Broadcasting Corporation, Japan G-038 – MSFC G-074 – McDonnell Douglas Company G-306 – Naval Research Lab/Air Force G-469 – GSFC G-518 – Utah State University

Summary of Shuttle Payloads and Experiments *(continued)*

Flight	Launch date	Payloads and experiments	
STS 51-A (Discovery)	November 8, 1984	Synchronous Communication Satellite (SYNCOM IV-1) Telesat Canada, Ltd. Satellite (ANIK-D2/PAM-D) Satellite Retrieval Pallets: PALAPA B-2 WESTAR-6	Diffusive Mixing of Organic Solutions Radiation Monitoring Experiment
STS 51-C (Discovery)	January 24, 1985	DOD – Classified	
STS 51-D (Discovery)	April 12, 1985	Telesat Canada, Ltd. Satellite (ANIK C-1/PAM-D) Synchronous Communication Satellite (SYNCOM IV-3) American Flight Electrocardiograph Continuous Flow Electrophoresis System Phase Partitioning Experiment	Getaway specials: G-035 – Asahi National Broadcasting Corporation, Japan G-471 – GSFC Student experiments: Statoliths in Corn Root Caps Effect of Weightlessness on the Aging of Brain Cells
STS 51-B (Challenger)	April 29, 1985	Spacelab 3 *(see "Summary of Spacelab Experiments")*	Getaway specials: G-010 – Northern Utah Satellite (NUSAT) G-303 – Global Low Orbiting Message Relay Satellite (GLOMR)
STS 51-G (Discovery)	June 17, 1985	AT&T Satelite (MORELOS-A/PAM-D) Saudi Arabian Communications Satellite (ARABSAT-A/PAM-D) Mexican Communications Satellite (TELSTAR 3-D/PAM-D) Shuttle Pointed Autonomous Research Tool for Astronomy (SPARTAN) French Echocardiograph Experiment Automated Directional Solidification Furnace High Precision Tracking Experiment	Getaway specials: G-007 – Alabama Space and Rocket Center/ Marshall Amateur Radio Club G-025 – ERNO, West Germany G-027 – DFVLR, West Germany G-028 – DFVLR. West Germany G-034 – Texas High School Students G-314 – National Research Lab

Summary of Shuttle Payloads and Experiments *(continued)*

Flight	Launch date	Payloads and experiments	
STS 51-F (Challenger)	July 29, 1985	Spacelab 2 *(see "Summary of Spacelab Experiments")*	Deployable/Retrievable Plasma Diagnostics Package Shuttle Amateur Radio Experiment (AMSAT)
STS 51-I (Discovery)	August 27, 1985	American Satellite Company (ASC-1/PAM-D) Australian Communications Satellite (AUSSAT-1/PAM-D) Synchronous Community Satellite (SYNCOM IV-4/PAM-D) Physical Vapor Transport of Organic Solids Experiment	SYNCOM IV-3 Repair Experiment
STS 51-J	October 3, 1985	DOD – Classified	
STS 61-A	October 30, 1985	Spacelab D-1 *(see "Summary of Spacelab Experiments")*	Global Low Orbiting Message Relay Satellite (GLOMR)
STS 61-B (Atlantis)	November 26, 1985	Mexican Communications Satellite (MORELOS/PAM-D) Australian Communications Satellite (AUSSAT-2/PAM-D) RCA Satellite (SATCOM KU-2/PAM-D) Experiment Assembly of Structures in Extravehicular Activity (EASE) Assembly Concept for Construction of Erectable *Space Structures* (ACCESS) IMAX Cargo Bay Camera	Continuous Flow Electrophoresis System Diffusive Mixing of Organic Solutions MORELOS Payload Specialist Experiments Getaway special: G-479 – Telesat Canada, Ltd.

Summary of Shuttle Payloads and Experiments *(continued)*

Flight	Launch date	Payloads and experiments	
STS 61-C (Columbia)	January 12, 1986	RCA Satellite (SATCOM KU-1/PAM-D2) Materials Science Laboratory Hitchhiker G-1 Environmental Monitoring Package Handheld Protein Crystal Growth Experiment Infrared Imaging Experiment Initial Blood Storage Experiment Comet Halley Active Monitoring Program Student experiments: SE82-19 – Measurement of Auxin Levels and Starch Grains in Plant Roots SE83-4 – Production of Paper Fiber in Space SE83-6 – Argon Injection as an Alternative to Honeycombing	Getaway specials: G-007 – Alabama Space and Rocket Center/ Marshall Amateur Radio Club G-062 – Pennsylvania State University/ General Electric G-310 – USAF Academy G-332 – Booker T. Washington Senior High School, Houston, Texas G-446 – All Tech Associates, Inc. G-449 – St. Mary's Hospital, Milwaukee, Wisconsin G-462 – GSFC/Johns Hopkins University G-463 – GSFC (GAP) G-464 – GSFC/University of California at Berkeley G-470 – GSFC/U.S. Department of Agriculture G-481 – Vertical Horizons G-494 – National Research Council of Canada
STS 51-L (Challenger)	January 28, 1986	Tracking and Data Relay Satellite (TDRS-B/IUS) Comet Halley Active Monitoring Program Spartan-203/Halley Fluid Dynamics Experiment Phase Partitioning Experiment Teacher in Space Project	Student experiments: SE82-4 – Effects of Weightlessness on Grain Formation and Strength in Metals SE82-5 – Utilizing a Semipermeable Membrane to Direct Crystal Growth in Zero-Gravity SE82-9 – Chicken Embryo Development in Space
STS-26 (Discovery)	September 29, 1988	OASIS-1 Tracking and Data Relay Satellite(TDRS-C/IUS) Automatic Directional Solidification Furnace Physical Vapor Transport of Organic Solids Infrared Communications Flight Experiment Protein Crystal Growth Experiment	Isoelectric Focusing Experiment Phase Partitioning Experiment Aggregation of Red Blood Cells Mesoscale Lightning Experiment Earth-Limb Radiance Experiment Shuttle Student Involvement Program Experiments
STS-27 (Atlantis)	December 2, 1988	DOD – Classified	

Summary of Shuttle Payloads and Experiments *(continued)*

Flight	Launch date	Payloads and experiments	
STS-29 (Discovery)	March 13, 1989	Tracking and Data Relay Satellite(TDRS-D/IUS) Air Force Maui Optical Site Calibration Test Space Station Heat Pipe Advanced Radiator Element (SHARE) Orbiter experiments Autonomous Supporting Instrumentation System (OASIS-1) Protein Crystal Growth – University of Alabama Chromosome and Plant Cell Division in Space IMAX Camera – IMAX of Canada	Getaway specials: SSIP 82-8 – Chicken Embryo Development SSIP 82-9 – Effect of Weightlessness of Bones Orthopedic Hospital/USC
STS-30 (Atlantis)	May 4, 1989	Magellan/IUS Fluids Experience Apparatus (FEA) Mesoscale Lightning Experiment (MLE) Air Force Maui Optical Site Calibration Test	
STS-28 (Columbia)	August 8, 1989	DOD – Classified	
STS-34 (Atlantis)	October 18, 1989	Galileo/IUS Shuttle Solar Backscatter Ultraviolet (SSBUV) Polymer Morphology Growth Hormone Concentration and Distribution in Plants (GHCD) – Michigan State University Sensor Technology Experiment – USAF TAC IMAX Camera Mesoscale Lightning Experiment Air Force Maui Optical Site Calibration Test	Getaway special: SE82-15 – Zero Gravity Growth of Ice Crystals
S.S-33 (Discovery)	November 22, 1989	DOD – Classified	

Summary of Shuttle Payloads and Experiments *(continued)*

Flight	Launch date	Payloads and experiments	
STS-32 (Columbia)	January 9, 1990	Syncom IV-5 American Flight Echocardiograph Air Force Maui Optical Site Calibration Test Characterization of Neurospora Circadian Rhythms Fluids Experiment Apparatus IMAX Camera	Latitude/Longitude Locator Mesoscale Lightning Experiment Protein Crystal Growth
STS-36 (Atlantis)	February 28, 1990	DOD — Classified	
STS-31 (Discovery)	April 24, 1990	Hubble Space Telescope IMAX/Cargo Bay Camera Ascent Particle Monitor Air Force Maui Optical Site Calibration Test	Investigation into Polymer Membrane Processing Protein Crystal Growth Radiation Monitoring Experiment Investigation of ARC and ION Behavior in Microgravity
STS-41 (Discovery)	October 6, 1990	Ulysses/IUS/PAM-S Shuttle Solar Backscatter Ultraviolet Intelsat Solar Array Coupon Air Force Maui Optical Site	Chromosome and Plant Cell Division in Space Voice Command System Solid Surface Combustion Experiment Investigation into Polymer Membrane Processing Physiological Systems Experiment Radiation Monitor Experiment
STS-38 (Atlantis)	November 15, 1990	DOD - Classified	
STS-35 (Columbia)	December 2, 1990	Astro-1 Air Force Maui Optical Site Ultraviolet Plume Instrument	Shuttle Amateur Radio Experiment

Summary of Shuttle Payloads and Experiments *(continued)*

Flight	Launch date	Payloads and experiments	
STS-37 (Atlantis)	April 5, 1991	Gamma Ray Observatory Crew Equipment Translation Aid Ascent Particle Monitor Air Force Maui Optical Site Calibration Test	Shuttle Amateur Radio Experiment Radiation Monitor Experiment III Protein Crystal Growth – Block II
STS-39 (Discovery)	April 28, 1991	Infrared Background Signature Survey Shuttle Pallet Satellite II Chemical Release Observation Critical Ionization Velocity	Advanced Liquid Feed Experiment Shuttle Liquid Feed Experiment Shuttle Kinetic Infrared Test Ultraviolet Limb Measurement Data System Experiment Ascent Particle Monitor
STS-40 (Columbia)	June 5, 1991	Spacelab Life Sciences (SLS-1) *(see "Summary of Spacelab Experiments")*	Getaway specials: 455 – Structure and Defects in Crystals 507 – Orbiter Stability Experiment 486 – Solder Experiments 286 – Foamed Metal Samples [illegible]1 – Solid State Micro Accelerator 52 – Gallium Arsenide Crystals 105 – Various Materials Processing in Microgravity
STS-43 (Atlantis)	August 2, 1991	Tracking and Data Relay Satellite (TDRS-E//US) Auroral Photography Experiment-B Bioserve-Instrumentation Technology Associates Materials Dispersion Apparatus (BIMDA) Investigations into Polymer Membrane Processing Air Force Maui Optical Site Space Station Heat Pipe Advanced Radiator Element II (SHARE II) Shuttle Solar Backscatter Ultraviolet (SSBUV)	Ultraviolet Plume Experiment Protein Crystal Growth-III

Summary of Shuttle Payloads and Experiments *(continued)*

Flight	Launch date	Payloads and experiments	
STS-48 (Discovery)	September 12, 1991	Upper Atmosphere Research Satellite (UARS) Shuttle Activation Monitor Radiation Monitoring Equipment-III Cosmic Radiation Effects and Activation Monitor Air Force Maui Optical System Ascent Particle Monitor	Protein Crystal Growth Mid-deck Zero-Gravity Dynamics Experiment Physiological and Anatomical Rodent Experiment Investigations into Polymer Membrane Processing
STS-44 (Atlantis)	November 24, 1991	Defense Support Program (DSP-IUS) Terra Scout Shuttle Activation Monitor Radiation Monitoring Equipment III Interim Operational Contamination Monitor	Ultraviolet Plume Experiment M88-1– Military Man in Space Air Force Maui Optical Site
STS-42 (Discovery)	January 22, 1992	International Microgravity Laboratory-1 *(see "Summary of Spacelab Experiments")*	Getaway Specials: Student Experiment 81-9 and Student Experiment 83-2 on GAS Beam Assembly
STS-45 (Atlantis)	March 24, 1992	Atmospheric Laboratory for Applications and Science-1 (ATLAS-1) Shuttle Solar Backscatter Ultraviolet Instrument (SSBUV) Radiation Monitoring Equipment-III Visual Function Tester-2 SAREX-II	Space Tissue Loss-01 Ultraviolet Plume Experiment Getaway specials: G-229 – Cloud Logic to Optimize Use of Defense System (CLOUD-1A)
STS-49 (Endeavour)	May 7, 1992	INTELSAT VI capture and reboost equipment	Assembly of Station by EVA Methods (ASEM) Commercial Protein Crystal Growth Ultraviolet Plume Experiment Air Force Maui Optical Site Calibration
STS-50 (Columbia)	June 25, 1992	United States Microgravity Laboratory-1 *(see "Summary of Spacelab Experiments")*	

Summary of Shuttle Payloads and Experiments *(concluded)*

Flight	Launch date	Payloads and experiments	
STS-46 (Atlantis)	July 31, 1992	European Retrievable Carrier (EURECA) Tethered Satellite System (TSS-1)	Evaluation of Oxygen Interaction with Material III/ Thermal Energy Management Processes 2A-3
STS-47	September 12, 1992	Spacelab-J *(see "Summary of Spacelab Experiments")*	Israeli Space Agency Investigation about Hornets Solid Surface Combustion Experiment Ultraviolet Plume Experiment SAREX II Getaway Special Payloads

Sources: NASA Pocket Statistics, January 1992
JSC Mission Flight Cards, STS-40–47

Spacelab Experiments

Spacelab Mission	Flight	Launch date	Experiments and experimental apparatus
Spacelab 1	STS-9	November 28, 1983	6 Astronomy and physics 4 Atmospheric physics 2 Earth observation 16 Life sciences 39 Materials sciences 5 Space plasma physics 1 Technology
Spacelab 3	ST 51-B	April 29, 1985	Solution Growth of Crystals in Zero Gravity Mercuric Iodide Crystal Growth Vapor Crystal Growth System Dynamics of Rotating and Oscillating Freed Drops Geophysical Fluid Flow Cell Experiment Atmospheric Trace Molecule Spectroscopy Very Wide Field Galactic Camera Aurora Observation Studies of the Ionization States of Solar and Galactic Cosmic Ray Heavy Nuclei Research Animal Holding Facility Urine Monitoring Investigation Autogenic Feedback Training
Spacelab 2	STS 51-F	July 29, 1935	Deployable/Retrievable Plasma Diagnostic Package Plasma Depletion Experiments for Ionospheric and Radio astronomical studies Small Helium Cooled Infrared Telescope Hard X-ray Imaging of Cluster of Galaxies and Other Extended X-ray Sources Elemental Composition and Energy Spectra of Cosmic Ray Nuclei Solar Magnetic and Velocity Field Measurement System Coronal Helium Abundance Spacelab Experiment High Resolution Telescope and Spectrograph Solar Ultraviolet Spectral Irradiance Monitor Properties of Supe.fluid Helium zero-g

Spacelab Experiments *(continued)*

Spacelab Missic	Flight	Launch date	Experiments and experimental apparatus
Spacelab D-1	STS 61-A	October 30, 1985	Werkstoff Labor (fluids science) Progresskammer (bubble transport media) MEDEA (materials science) Biowissenschaften (life sciences) Vestibular sled Biorack (life sciences) NAVEX (navigation) MEA (materials science)
Spacelab Life Sciences 1	STS-40	June 5, 1991	6 Body systems 6 Cardiovascular/cardiopulmonary 3 blood system 6 Musculoskeletal 3 Neurovestibular 1 Immune system 1 Renal/endocrine system
International Microgravity Laboratory-1	STS-42	January 22, 1992	Fluid Experiment System Vapor Crystal Growth System Mercuric Iodide Crystal Growth Organic Crystal Growth Experiment Cryostat Protein Crystal Growth Space Acceleration Monitoring System Critical Point Facility Gravitational Plant Physiology Facility Biorack Space Physiology Experiments Microgravity Vestibular iInvestigations Biostack Mental Workload and Performance Evaluation Radiation Monitoring Container/Dosimeter

Spacelab Experiments *(concluded)*

Spacelab Mission	Flight	Launch date	Experiments and experimental apparatus
United States Microgravity Laboratory-1	STS-50	June 25, 1992	Crystal Growth Facility Drop Physics Module Surface Tension Driven Convestion Experiment Apparatus Glovebox Facility Astroculture Extended Duration Orbiter Medical Project Generic Bioprocessing Apparatus Zeolite Crystal Growth Solid Surface Combustion Experiment Protein Cystal Growth Investigation into Polymer Membrane Processing
Spacelab-J	STS-47	September 12, 1992	NASA: 3 Materials science 6 Life sciences NASDA: 22 Materials science 11 Life sciences

Astronaut Listing – Active
(As of April 1993)

Name	Selection year	Missions flown					
		M	G	A	SL	A/S	STS
Akers, Thomas D	1987						2
Allen, Andrew M.	1987						1
Apt, Jerome	1985						2
Bagian, James P.	1980						2
Baker, Ellen S.	1984						2
Baker, Michael A.	1985						2
Blaha, John E.	1980						3
Bluford, Guion S., Jr.	1978						4
Bolden, Charles F., Jr.	1980						3
Bowersox, Kenneth D.	1987						1
Brown, Curtis L. Jr.	1987						1
Brown, Mark N.	1984						2
Bursch, Daniel W.	1990						
Cabana, Robert D.	1985						2
Cameron, Kenneth D.	1984						2
Casper, John H.	1984						2
Chang-Díaz, Franklin R.	1980						3
Chiao, Leroy	1990						
Chilton, Kevin P.	1987						1
Clifford, Michael R.U.	1990						1
Cockrell, Kenneth D.	1990						1
Collins, Eileen M.	1990						
Covey, Richard O.	1978						3
Culbertson, Frank L., Jr.	1984						1
Davis, N. Jan	1987						1
Duffy, Brian	1985						1
Dunbar, Bonnie J.	1980						3
Fisher, Anna L.	1978						1
Foale, C. Michael	1987						1
Gemar, Charles D.	1985						2
Gibson, Robert L.	1978						4
Godwin, Linda M.	1985						1
Grabe, Ronald J.	1980						3
Gregory, Frederick D.	1978						3
Gregory, William G.	1990						
Gutierrez, Sidney M.	1984						1
Halsell, James D. Jr.	1990						
Hammond, L. Blaine, Jr.	1984						1
Harbaugh, Gregory J.	1987						2
Harris, Bernard A., Jr.	1990						
Hartsfield, Henry W., Jr.	1969						3
Helms, Susan J.	1990						1
Henricks, Terence T.	1985						1
Hieb, Richard J.	1985						2
Hoffman, Jeffrey A.	1978						3
Ivins, Marsha S.	1984						2

Astronaut Listing – Active *(concluded)*

(As of April 1993)

Name	Selection year	Missions flown					
		M	G	A	SL	A/S	STS
Jernigan, Tamara E.	1985						2
Jones, Thomas D.	1990						
Lee, Mark C.	1984						2
Leestma, David C.	1980						3
Low, G. David	1984						2
Lucid, Shannon W.	1978						3
McArthur, William S., Jr.	1990						
McMonagle, Donald R.	1987						2
Meade, Carl J.	1985						2
Musgrave, F. Story	1967						4
Nagel, Steven R.	1978						3
Newman, James H.	1990						
Ochoa, Ellen	1990						1
Oswald, Stephen S.	1985						2
Precourt, Charles J.	1990						
Readdy, William F.	1987						1
Reightler, Kenneth S., Jr.	1987						1
Richards, Richard N.	1980						3
Ross, Jerry L.	1980						3
Runco, Mario, Jr.	1987						2
Searfoss, Richard A.	1990						
Seddon, M. Rhea	1978						2
Sega, Ronald M.	1990						
Shepherd, William M.	1984						3
Sherlock, Nancy J.	1990						
Shriver, Loren J.	1978						3
Thagard, Norman E.	1978						4
Thomas, Donald A.	1990						
Thornton, Kathryn C.	1984						2
Thornton, William E.	1967						2
Thuot, Pierre, J.	1985						2
Veach, C. Lacy	1984						2
Voss, James S.	1987						2
Voss, Janice E.	1990						
Walker, David M.	1978						3
Walz, Carl E.	1990						
Weitz, Paul J.	1966				1		1
Wetherbee, James D.	1984						2
Wilcutt, Terence W.	1990						
Wisoff, Peter J. K.	1990						
Wolf, David A.	1990						
Young, John W.	1962		2	2			2

Astronaut Listing – Former

(As of April 1993)

Name	Selection year	Missions flown					
		M	G	A	SL	A/S	STS
Adamson, James C.	1984						2
Aldrin, Buzz	1963		1	1			
Allen, Joseph P., IV	1967						2
Anders, William A.	1963			1			
Armstrong, Neil A.	1962		1	1			
Bean, Alan L.	1963					1	1
Bobko, Karol J.	1969						3
Borman, Frank	1962		1	1			
Brand, Vance D.	1966					1	3
Brandenstein, Daniel C.	1978						4
Bridges, Roy D., Jr.	1980						1
Buchli, James F.	1978						4
Bull, John S.	1966						
Carpenter, M. Scott	1959	1					
Carr, Gerald P.	1966				1		
Cernan, Eugene A.	1963		1	2			
Chapman, Philip K.	1967						
Cleave, Mary L.	1980						2
Coats, Michael P.	1978						3
Collins, Michael	1963		1	1			
Conrad, Charles, Jr.	1962		2	1	1		
Cooper, L. Gordon, Jr.	1959	1	1				
Creighton, Richard O.	1978						3
Crippen, Robert L.	1969						4
Cunningham, Walter	1963			1			
Duke, Charles M., Jr.	1966			1			
England, Anthony W.	1967						1
Engle, Joe H.	1966						2
Fabian, John M.	1978						2
Fisher, William F.	1980						1
Fullerton, Charles G.	1969						2
Gardner, Dale A.	1978						2
Gardner, Guy S.	1980						2
Garriott, Owen K.	1965				1		1
Gibson, Edward G.	1965				1		
Glenn, John H., Jr.	1959		1				
Gordon, Richard F., Jr.	1963		1	1			
Haise, Fred W., Jr.	1966				1		
Hart, Terry J.	1978						1
Hauck, Fredrick H.	1978						3
Hawley, Steven A.	1978						3
Henize, Karl G.	1967						1
Hilmers, David C.	1980						4
Holmquest, Donald L.	1967						
Jemison, Mae C.	1987						1

Astronaut Listing – Former *(concluded)*
(As of April 1993)

Name	Selection year	Missions flown					
		M	G	A	SL	A/S	STS
Kerwin, Joseph P.	1965				1		
Lenoir, William B.	1967						1
Lind, Don L.	1966						1
Llewellyn, John A.	1967						
Lounge, John M. "Mike"	1980						3
Lousma, Jack R.	1966				1		1
Lovell, James A., Jr.	1962			2	2		
Mattingly, Thomas K., II	1966				1		2
McBride, Jon A.	1978						1
McCandless, Bruce II	1966						2
McCulley, Michael J.	1984						1
McDivitt, James A.	1962		1	1			
Melnick, Bruce E.	1987						2
Michel, F. Curtis	1965						
Mitchell, Edgar D.	1966			1			
Mullane, Richard M.	1978						3
Nelson, George D.	1978						3
O'Connor, Bryan D.	1980						2
Overmyer, Robert F.	1969						2
Parker, Robert A. R.	1967						2
Peterson, Donald H.	1969						1
Pogue, William R.	1966				1		
Ride, Sally K.	1978						2
Roosa, Stuart A.	1966			1			
Schirra, Walter M., Jr.	1959	1	1	1			
Schmitt, Harrison H.	1965			1			
Schweickart, Russell L.	1963			1			
Scott, David R.	1963		1	2			
Shaw, Brewster H., Jr.	1978						3
Shepard, Alan B., Jr.	1959	1		1			
Slayton, Donald K.	1959					1	
Spring, Sherwood C.	1980						1
Springer, Robert C.	1980						2
Stafford, Thomas P.	1962		2	1		1	
Stewart, Robert L.	1978						2
Sullivan, Kathryn D.	1978						3
Truly, Richard H.	1969						2
van Hoften, James D. A.	1978						2
Williams, Donald E.	1978						2
Worden, Alfred M.	1966			1			

Astronaut Listing – Deceased

(As of April 1993)

Name	Selection year	Missions flown M	G	A	SL	A/S	STS
Bassett, Charles A., II	1963						
Carter, Manley Lanier, Jr.	1984						1
Chaffee, Roger B.	1963						
Eisele, Donn F.	1963			1			
Evans, Ronald E.	1966			1			
Freeman, Theodore C.	1963						
Givens, Edward G., Jr.	1966						
Griggs, S. David	1978						1
Grissom, Virgil I.	1959	1	1				
Irwin, James	1966			1			
McNair, Ronald E.	1978						2
Onizuka, Ellison S.	1978						2
Resnik, Judith A.	1978						2
Scobee, Francis R.	1978						2
See, Elliott M., Jr.	1962						
Smith, Michael J.	1980						1
Swigert, John L., Jr.	1966			1			
Thorne, Stephen D.	1985						
White, Edward H., II	1962		1				
Williams, Clifton C., Jr.	1963						

Key: M = Mercury, G = Gemini; A = Apollo; SL = Skylab, A/S = Apollo/Soyuz; STS = Space Shuttle

Sources: Astronaut Fact Book. February, 1992, JSC Astronaut Office.

Payload Specialist Listing

(As of April 1993)

Name	Country	STS mission flown	Assignment
Acton, Loren W.	USA	51-F	Spacelab 2 Experiments
Akbar, Taufik	Indonesia	Alternate	Indonesian Space Experiments
Al-Bassam, Abdulmohsen Hamad	Saudi Arabia	Alternate	Arabsat Telecommunications Satellite
Al-Saud, Sultan Salman	Saudi Arabia	51-G	Arabsat Telecommunications Satellite
Bartoe, John-David F.	USA	51-F	Spacelab 2 Solar Experiments
Baudry, Patrick	France	51-G	Biomedical experiments
Belt, Michael E.	USA		Terra-Scout
Bondar, Roberta Lynn	Canada	42	IML-1
Boyle, Tony	England		
Brummer, Renate	Germany		Spacelab D-2
Buckey, Jay C., Jr.	USA		SLS-2
Butterworth, L. William	USA	Alternate	
Cenker, Robert J.	USA	61-C	RCA Satcom Ku-Band-1 Satellite
Chappell, Charles R.	USA	Atlas-1	
Chretien, Jean-Loup	France		
Crouch, Roger K.	USA		IML-1
Cunningham, Stephen L.	USA	Alternate	Syncom IV
Doi, Takao	Japan		Spacelab J
DeLucas, Lawrence J.	USA		USML-1
Durrance, Samuel T.	USA	35	Astro-1
Favier, Jean-Jacques	France		IML-2
Fettman, Martin J.	USA		SLS-2
Frimout, Dirk D.	USA		Atlas-1
Farrimond, Richard A.	Royal Army	Alternate	
Furrer, Reinhard	West Germany	61-A	Materials Science Experiments
Gaffney, F. Andrew	USA	40	SLS-1
Garn, Jake	USA	51-D	Observer
Garneau, Marc	Canada	41-G	Canadian Experiments
Guidoni, Umberto	Italy		TSS-1
Hennen, Thomas J.	USA		Terra-Scout
Hughes-Fulford, Millie	USA	40	SLS-1
Jarvis, Gregory B.	USA	51-L	Fluid Dynamics Experiment
Koszelak, Stanley N.	USA		Spacelab J
Lampton, Michael L.	USA		Atlas-1
Lichtenberg, Byron K.	USA	9	Atlas-1
Malerba, Francis	Italy		TSS-1
McAuliffe, S. Christa	USA	51-L	Teacher-in-Space Project
MacLean, Steven G.	Canada		CANEX-2
Merbold, Ulf	West Germany	9, 42	
Messerschmid, Ernst	West Germany	61-A	Materials Science Experiments

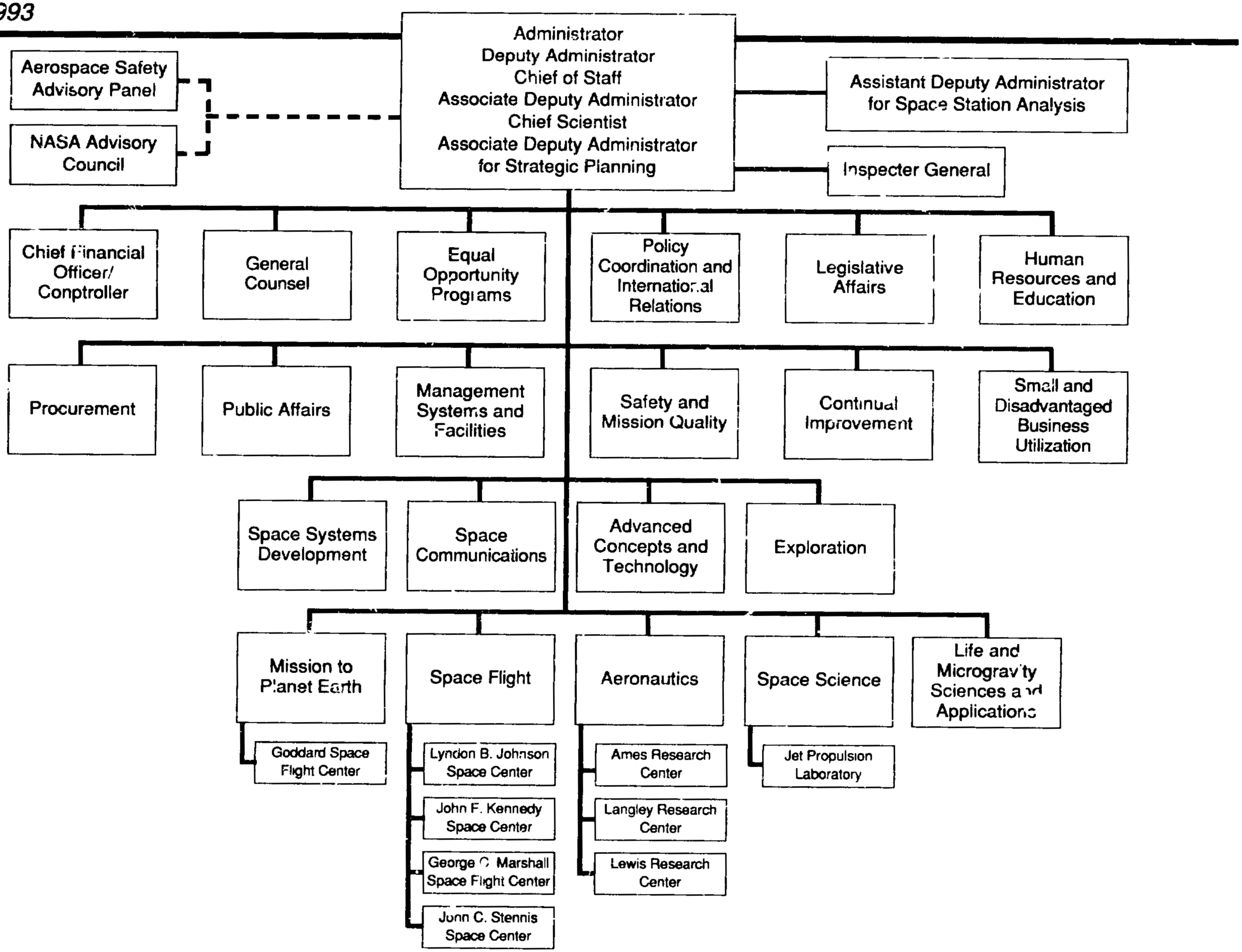
Payload Specialist Listing *(concluded)*
(As of April 1993)

Name	Country	STS mission flown	Assignment
Money, Kenneth	Canada	IML-1	
Mohri, Mamoru	Japan	47	Spacelab-J
Mukai, Chiaki	Japan		IML-2
Nelson, Bill	USA	61-C	Observer
Neri Vela, Rodolfo	Mexico	61-B	Human Physiology Experiments
Nicollier, Claude	France	STS-46	Human Physiology Experiments
Nordsieck, Kenneth H.	USA	Alternate	Astro-1
Ockels, Wubbo J.	Netherlands	61-A	Spacelab D-1 Experiments
Pailes, William A.	USA	51-J	DOD
Parise, Ronald A.	USA	35	Astro-1
Payton, Gary E.	USA	51-C	DOD
Peralta y Fabi, Ricardo	Mexico		
Phillips, Robert Ward	USA	Alternate	SLS-1
Prahl, Joseph M.	USA		USML-1
Prinz, Dianne K.	USA	Alternate	Spacelab 2 Experiments
Sacco, Albert, Jr	USA		USML-1
Schlegel, Hans	Germany		Spacelab D-2
Scully-Power, Paul Desmond	USA	41-G	Oceanography Experiments
Thiele, Gerhard	Germany		Spacelab D-2
Thirsk, Robert Brent	Canada	Alternate	
Trinh, Eugene H.	USA	Alternate	USML-1
Tryggvason, Bjarni	Canada		CANEX-2
van den Berg, Lodewijk	USA	51-B	Spacelab 3 Experiments
Walker, Charles David	USA	41-D 51-D	Continuous Flow Electrophoresis System
Walter, Ulrich	Germany		Spacelab D-2
Wang, Taylor G.	USA	51-B	Spacelab 3 Experiments
Williams, Bill Alvin	USA		
Wood, Nigel	England		
Wood, Robert Jackson	USA	Alternate	Continuous Flow Electrophoresis System
Young, Laurence	USA		SLS-2

Source: Astronaut Office

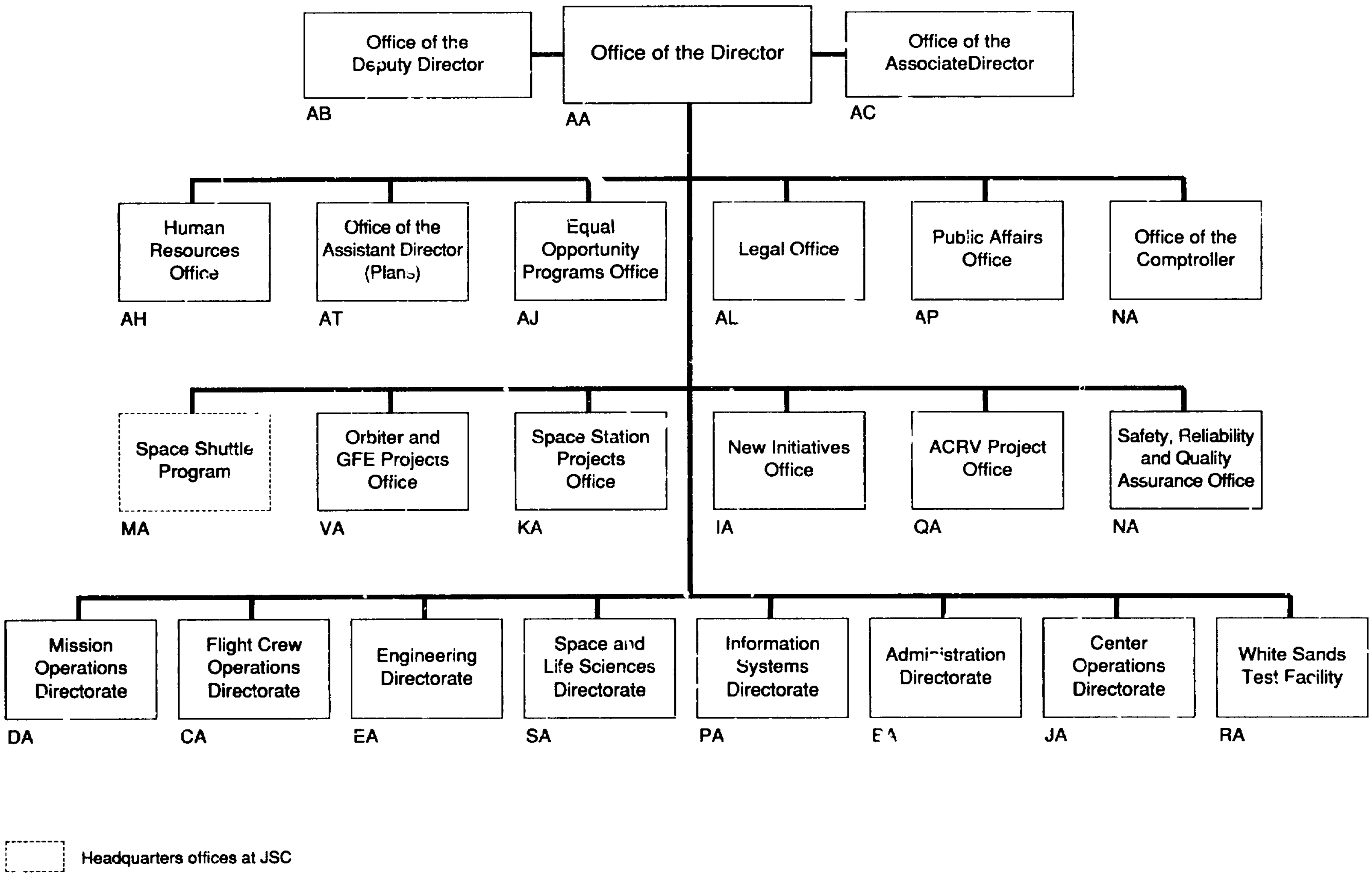
V. Organizational Structure

National Aeronautics and Space Administration
March 1993



National Aeronautics and Space Administration – Lyndon B. Johnson Space Center

April 1993



V. Organizational Structure

FUNCTIONS OF STAFF OFFICES

Comptroller

The Office of the Comptroller is the JSC focal point for financial planning and execution. The Office is responsible for the design and implementation of financial systems required for proper data collection and reporting and ensuring that Center-level financial and resource decisions are implemented. The Office reviews, approves, and implements financial policies and systems and integrates the planning, implementation, management, and control of all resources for which JSC is responsible. It provides the centralized policy framework for JSC resources, business management, and financial management activities. It also provides directorate-level business management offices that provide business-related expertise to technical organizations in the accomplishment of assigned technical tasks.

Equal Opportunity Programs

The Equal Opportunity Programs Office is responsible for planning, directing, and administering all Federal Equal Opportunity Programs relating to JSC employees, as well as certain aspects of contractor compliance programs relating to JSC contracts.

Human Resources

The Human Resources Office is responsible for planning, developing, and operating a personnel program designed to provide, develop, and maintain a qualified and motivated workforce. Specifically, it provides personnel advisory service to JSC managers; manages the civil service workforce system; develops and administers personnel management programs in areas of pay management and classification, employee utilization, selection and placement, employee relations, awards, employee development, and Government employee labor/management relations; and manages activities of the NASA Exchange at JSC. The Human Resources Office plans, develops, and implements JSC's training and employment programs in support of the Center's equal opportunity goals and objectives.

Legal

The Legal Office provides in-depth legal support to the Center's activities, including satellite installations and offices. Functions include providing ethics counseling and general legal services, participating in procurement activities, and providing advice and services in matters concerning intellectual property; administering the NASA Patent Program; providing advice and assistance to the Director and to JSC organizational components in planning, directing, and conducting Center activities which may have legal implications; identifying direct and indirect sources of legal authority to support necessary actions; conducting legal research and maintaining a law library; aiding in the development of new administrative techniques and identification of alternatives for the resolution of managerial problems within the framework of law, program schedules, and NASA administrative practices; and serving as the JSC primary point of contact on litigation and other legal matters within or beyond the Center.

Public Affairs

The Public Affairs Office is responsible for planning, directing, organizing, and coordinating all public affairs activities within JSC and providing advice and assistance to the Center Director and JSC organizations in all public affairs matters. General functions include preparing plans and programs and formulating policy for the dissemination of public information including general, technical, industrial, and educational materials and services. The Public Affairs Office also evaluates and advises the Center Director concerning the public impact of all JSC/NASA programs and develops a comprehensive program of public service and information to provide the widest practical and appropriate dissemination of information concerning JSC/NASA activities.

Safety, Reliability, and Quality Assurance

The Safety, Reliability, and Quality Assurance Office is responsible for the development and implementation of the overall safety, reliability, and quality assurance activities for JSC except in the specifically excluded areas of aviation safety and reliability and quality assurance operations in support of the Flight Crew Operations Directorate at Ellington Field, and environmental health, including radiological safety, in support of the Space and Life Sciences Directorate. It establishes policy, requirements, and criteria; ensures appropriate contractual implementation pertaining to these disciplines with the objectives of minimizing risks to avoid loss of life, injury of personnel, and loss of property to the maximum practical extent; and ensures that equipment meets established quality and reliability levels.

FUNCTIONS OF DIRECTORATES

Administration

The Administration Directorate is responsible for providing business management for JSC as an institution and, individually, for the various program/project offices and directorates. The functions are procurement, including planning, solicitation, selection, contract award, and contract management and its administration; program control, including integrated planning, scheduling, resources management, contract engineering, and performance assessment; and management analysis.

Flight Crew Operations

The Flight Crew Operations Directorate is responsible for the overall planning, direction, and management of flight crew operations and the JSC aircraft program activities. These responsibilities include selecting and training astronaut candidates; determining flight crew training and simulation requirements; recommending specific flight crew assignments; training and certifying payload specialists; providing flight crew external relations; participating in the development of integrated spacecraft flight crew plans and procedures; supporting the test and checkout of space vehicles; and contributing to the development, acquisition, maintenance, and safe operation of the training, administrative, and research support aircraft and supporting equipment and facilities at JSC.

Mission Operations

The Mission Operations Directorate plans, directs, manages, and implements overall mission operations for the Space Shuttle and Space Station programs; provides flight controller and flight crew training simulations; and designs, upgrades, maintains, and operates the Mission Control Center, the Space Station Control Center, mission simulators, and other major support facilities. Responsibilities include developing integrated flight crew and flight control plans and procedures; establishing requirements for simulation and flight control ground instrumentation; flight design; configuring Orbiter flight software; contributing to the development and integration of spacecraft and payload support systems; providing and directing real-time mission operations elements to support and control manned missions; and providing integrated concept development and requirements for Space Station Freedom assembly, operations management, systems and software analysis.

Engineering

The Engineering Directorate is responsible for providing engineering design, development, and test support for space flight programs assigned to JSC, such as the Space Shuttle, Space Station, and advanced spacecraft. The Directorate is organized into functional divisions, and support to the spacecraft program/project offices is provided by technical expertise from within the divisions. Disciplines within the Engineering Directorate include guidance, navigation, and control; electrical power generation, storage and distribution; all other avionic systems including data management, display and control, and instrumentation; telemetry and communications; structures and materials; thermal protection and thermal control; mechanical systems; robotics and advanced automation systems; propulsion, fluid management, and pyrotechnics; life support; spacesuits and extravehicular equipment; aerodynamics, aerothermodynamics, and aeroelasticity; flight software; and overall systems engineering and simulation. In addition, the Directorate maintains expertise in test facilities and computational complexes supporting the above disciplines.

Information Systems Directorate

The Information Systems Directorate (ISD) is responsible for implementing consistent institutional information services across the Johnson Space Center. This directorate, in conjunction with the

Information Resources Management (IRM) Council, forms the backbone of our long-range strategy for networks and information systems at the Center. The ISD specifically is charged with JSC digital networks and telecommunications, computer services, workstation support and training, generic software development and technology, and leadership and support of the IRM Council.

Center Operations

The primary role of the Center Operations Directorate is ensuring the availability of facilities and services necessary for the operation of the JSC. In fulfilling this role, the Directorate is responsible for providing and attending to the requirements of the JSC physical plant; managing the JSC facility maintenance and construction program; managing space flight research and history activities; and providing a wide range of basic institutional services to all Center organizations, including logistics, utilities, security, data management, photography, flight article fabrication, and printing.

Space and Life Sciences

The Space and Life Sciences Directorate (S&LSD) is responsible for the management and conduct of a broad range of applied and basic scientific research, related ground and flight experiments, and flight crew interfacing hardware and systems. Specific activities include the planning and implementation of programs/projects in human life sciences, human life sciences flight experiments, medical operations and health care, lunar and planetary geology, earth sciences, space science, advanced data acquisition and handling technology, and spacecraft and systems design related to flight crew habitability and productivity. Responsibilities also include the dissemination of new scientific findings and interfacing with the external scientific discipline users and organizations.

White Sands Test Facility

White Sands Test Facility (WSTF) is responsible for management, administration, engineering, technical support, and operations in support of development, qualification, and limits testing of spacecraft propulsion and power systems and components, and screening, compatibility, and certification testing of spacecraft-related materials, components, and subassemblies exposed to hazardous elements requiring remote locations or sizeable deployment areas. WSTF also conducts Shuttle landing/approach training aircraft operations, manages the alternate Orbiter landing site at White Sands Space Harbor, and provides range coordination and onsite management for selected NASA programs at White Sands Missile Range and Holloman Air Force Base. ❑

VI. Real Estate/Physical Location

VI. Real Estate/Physical Location

GENERAL LOCATION

The Lyndon B. Johnson Space Center is located approximately 25 miles southeast of downtown Houston. The site is 12 to 21 feet above mean sea level. One hundred forty-two buildings and an extensive tunnel system occupy the 1581-acre site. In addition, there are 37 acres at Ellington Field located approximately 5 miles north of the Center on State Highway 3 *(see maps)*.

Miscellaneous General Information

(As of September 1992)

• Acres of built-up roof	41.7
• Water storage on site, gallons	1.8M
• Sanitary sewer system, miles	16.05
• Maximum power, substation capacity, kilowatts	120
• Normal on-peak power load, kilowatts	32,500
• Electrical power distribution,voltage	12,470
• Transformers in power distribution	123
• Emergency water wells on site	2
• A/C capacity, tons approximately (normal)	18k
• A/C capacity, tons approximately (emergency)	3k
• Elevators	53
• Groundwater monitoring wells	56
• Steam generating capacity, pounds per hour	200k
• Overhead cranes and hoists	140
• Closed circuit TV sets	1,500
• Video conference facilities	5
• Items of manufacturing equipment	1,500
• Personal computers	7,138
• Acres of manufacturing floor space	2.7
• Technical library entries, local	1.2M
• Pages of printing produced annually	150M
• Pieces of mail handled annually	6.5M

Source: Technical Operations Office/JD4.

JSC Real Estate Statistics

(As of September 1992)

- **Real property**

Size	Acres	1,581
Buildings	Number	142
Space	Square feet	3.5M
Lease	Square feet	112k
Streets	Miles	8.3
Parking	Spaces	9,159
Elevation	Avg. + MSL	17.3
Book value	Acquired cost	$307M

- **Utilities**

Electricity	Kilowatt-hours	213M	$9.0M
Natural gas	Cubic feet	400M	$1.2M
Water	Gallons	290M	$0.14M
Telephones	Number of calls	232.5M	$6.1M

Source: Technical Operations Office/JD4.

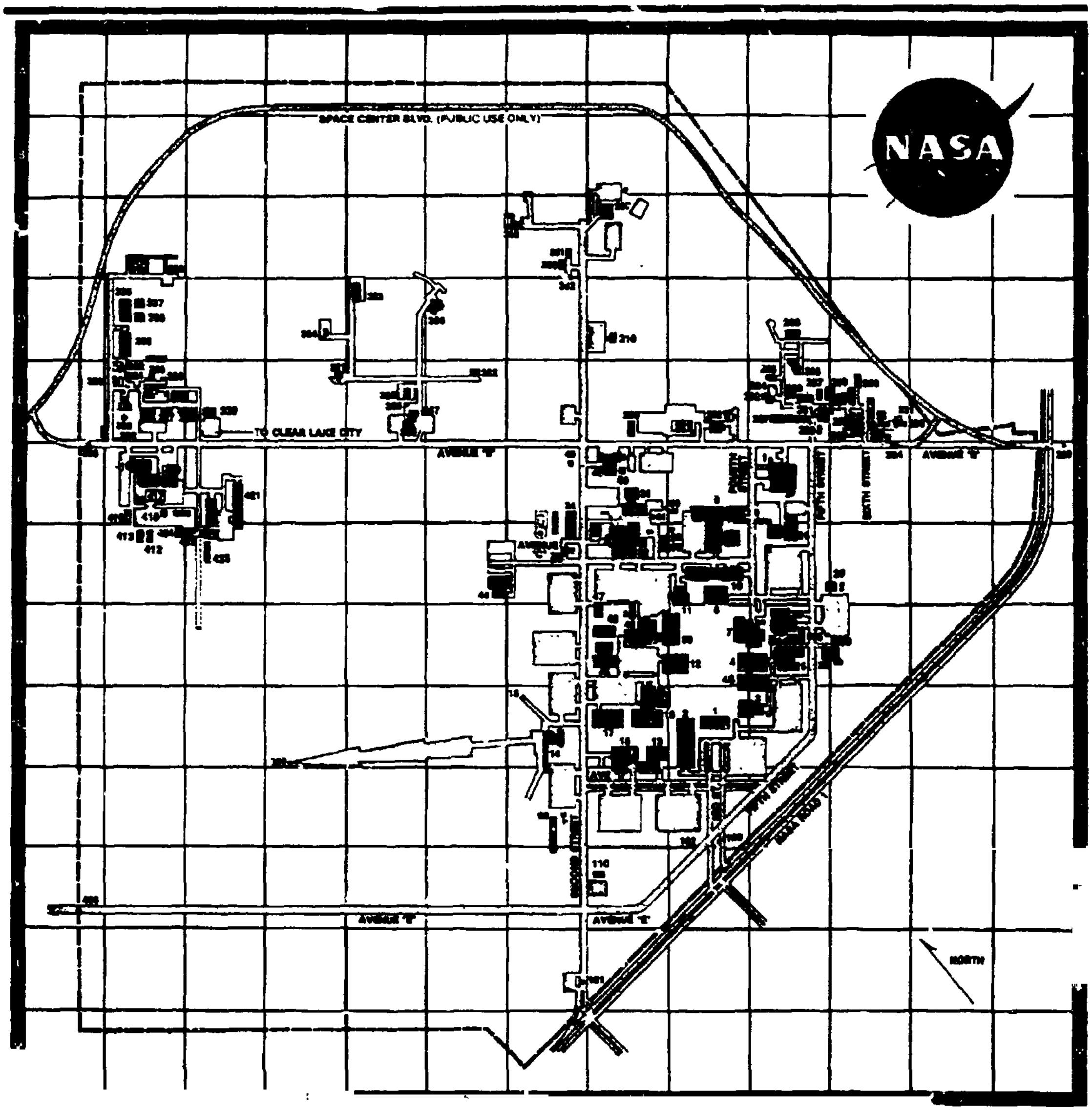
Capital Investment

(As of September 1992)

	JSC	WSTF
• Land (capitalization value)	$7.3M	(Permitted)
• Buildings, structures, and utilities (acquisition value)	$299M	$45.4M
• Equipment	$423.541M	(Contractor)
Subtotal	$729.8M	$45.4M
• Equipment, etc., on contractors' accounts	$215.3M	$26.7M
Subtotal	$945.1M	$72.3M
Total	$1017.4M	

Sources: Technical Operations Office/JD4.

Lyndon B. Johnson Space Center



Facility No.	Facility Name	Location
1	Project Management Building	H-8
2	Auditorium and Public Affairs Facility	H-8
3	Central Cafeteria	H-8, 10
4	Flight Operations Facility	H-8, 10
5	Mission Simulation and Training Facility	H-10
7	Crew Systems Laboratory	H-8, 10
8	Photographic Technology Laboratory	G-8
9	Systems Integration Facility	G-8
10	Technical Services Shop	G-8
11	Branch Cafeteria	G-8
12	Central Data Office	H-8
13	Structures and Mechanics Laboratory	H-8
14	Antenna and Tracking Development Laboratory	H-8
15	Experiments and Systems Laboratory	H-8
16	Avionics Systems Laboratory	H-8
17	Engineering and Applications Development Laboratory	H-8
18	Radar Boresight Range Control Building	I-7
20	Weather Instrumentation Tower - Wind and Weather	G-8
24	Central Heating and Cooling Plant	F, G-7
25	Fire Station	G-7
28	Auxiliary Chiller Facility	G-11
29	Weightless Environment Training Facility	H-10
30	Mission Control - Houston	H-8, 9
31	Planetary and Earth Sciences Laboratory	G-10
32	Space Environment Simulation Laboratory	G-[illegible]
33	Space Environment Effects Laboratory	G-8
34	Laboratory Support Facility	H-10
35	Mission Simulation Development Facility	H-10, 11
36	Bioengineering and Test Support Facility	F-8
37	Life Sciences Laboratory	F-10
38	Logistics Support Building	H-11
39	Domestic Satellite Earth Station Complex	F-8
40	Elevated Water Storage Tank	F-7
41	[illegible] Training Facility	F-8
[illegible]	Communications and Tracking Development Laboratory	G-8
44	Project Engineering Offices and Technical Library	H-8
46	[illegible] Computer Facility	H-8
47	[illegible] Bell Telephone Company Facility	H-8
48	Emergency Power Building (MCC-H)	H-8
49	Vibration and Acoustic Test Facility	F-8
50	Test Fixture Storage Facility	F-8

Facility No.	Facility Name	Location
[illegible]	Manned Space [illegible] Exhibit Complex	J-7
110	Security Control Center	L-7
[illegible]	Second Street Gatehouse	L-7
[illegible]	Third Street Exit Gatehouse	J-8
[illegible]	Third Street Entry Gatehouse	J-8
[illegible]	Avenue B East Gatehouse	F-13
210	JSC Child Care Center	D-8
207	Robert R. Gilruth Recreation Facility	C-8
[illegible]	Test Article Preparation Facility	E-8
221	138 KV Electrical Substation	E-8
[illegible]	Atmospheric and Re-Entry Materials and Structures Evaluation Facility	E-8
[illegible]	Cooling Tower Blowdown Pretreatment Facility	E-11
[illegible]	Administration Support Facility Annex	E-11
[illegible]	Administration Support Facility	E-11
[illegible]	Printing and Reproduction Facility	E-10
[illegible]	General Store Facility	E-10
[illegible]	Environmental Support Facility	E-10
[illegible]	Utility Annex	E-11
[illegible]	Controlled Storage Facility	E-11
[illegible]	Barge Docking Facility	F-10
[illegible]	Astronaut Selection and Isolation Quarters	E-11
[illegible]	Training and Test Facility	E-11
[illegible]	Planetary and Earth Sciences Laboratory Annex A	E-10
[illegible]	Storage Building No. 1 & 2	E-10
[illegible]	Health Physics Laboratory	E-10
[illegible]	Storage Building No. 3	E-10
[illegible]	Support Office Facility	E-10
[illegible]	Medical Experiments Data Facility	[illegible]-10
[illegible]	Space Materials Research Laboratory	E-10
[illegible]	Orbital Debris Tracking Radar Facility	D-10
[illegible]	Maintenance Spray Painting Facility	D-11
[illegible]	Avenue B West Gatehouse	E-2
[illegible]	[illegible] Cleaning Facility	F-1
[illegible]	Construction Materials Staging Facility	E-2
[illegible]	Water Treatment Plant Building	E-2
[illegible]	Construction Work Control Center	E-2
[illegible]	Classified Waste Disintegrator Facility	E-2
[illegible]	Maintenance Materials Staging and Shop Facility	E-2
[illegible]	Grounds Equipment Maintenance Facility	E-2

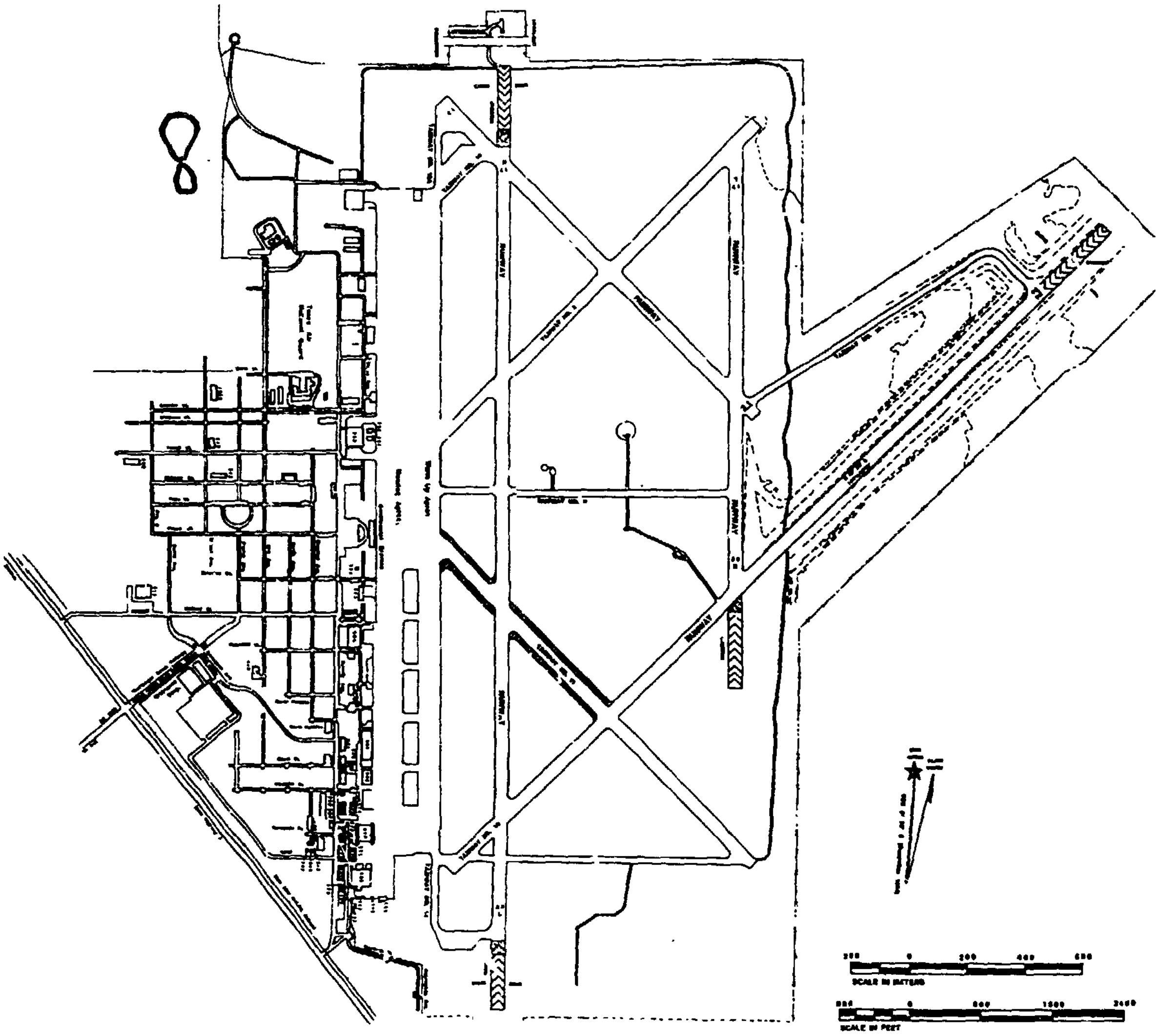
Facility No.	Facility Name	Location
327	Maintenance Work Control Center	E-2
[illegible]	Maintenance Painting Facility	E-2
[illegible]	Maintenance Shop Facility	E-2, 3
[illegible]	Maintenance and Operations Support Control Center	E-3
[illegible]	Central Water Collection Facility	E-2
[illegible]	Temporary Storage Warehouse	D-2
[illegible]	Logistical Support Warehouse	D-2
[illegible]	Test Equipment Warehouse	D-2
337	Logistic Supply Warehouse	D-3
[illegible]	Surplus Equipment Staging Warehouse	C-3
[illegible]	Above Ground Water Storage Tank	E-2
[illegible]	Thermochemical Test Area Support Laboratory	E-6
351	Thermal Vacuum Test Facility	E-4
[illegible]	Pyrotechnics Test Facility	E-6
[illegible]	Propulsion Test Facility	D-6
354	Cryogenics Test Facility	D-4
[illegible]	Chemical Storage Building	E-6
[illegible]	Fluid Systems Test Facility	D-6
357	Thermochemical Test Area Gatehouse	E-5
[illegible]	Propellant Fuel Waste Pretreatment Facility	C-7
[illegible]	Thermochemical Equipment Storage Facility	E-6
[illegible]	Hazardous Material Storage Facility	C-7
361	Central Gas Cylinder Storage Shed	C-7
[illegible]	Drum Storage Shed	C-7
400	Avenue E Gatehouse	K-1
412	Flight Document Storage Facility	G-2
[illegible]	Special Purpose Staging Facility	G-2
[illegible]	Rigging Equipment Storage Shelter	F-2
[illegible]	Installation Support Facility	F-2
417	Garage	F-2
[illegible]	Heavy Equipment Storage Shed	F-2
[illegible]	Logistical Services Offices	F-2
[illegible]	Shipping and Receiving Warehouse	F-2
421	General Supply Warehouse	F-2
[illegible]	Logistics Support Warehouse	F-2
[illegible]	Central Tape Storage Facility	G-2
[illegible]	Film Repository Facility	G-2
[illegible]	Logistics Support Depot	G-2
[illegible]	Microwave Transmitting Antenna Tower	I-4
T-[illegible]	Modular Office Complex	H-10

Ellington Field Statistics
(As of September 1992)

• **Real property**		
JSC-owned	Acres	37
JSC buildings	Number	24
Building space	Square feet	252k
Parking	Spaces	456
Acquired book value	Acquired cost	$13M
• **Runway and JSC aircraft**		
Maximum runway	Feet	10k
Aircraft apron	Acres	11.9
Trainers	T-38	29
STA	G2-MOD	4
Test	KC-135	1
	WB-57F (1 leased from USAF)	2
Executive	G-159	1
	G-2	5
• **Utilities**		
Electricity		$326k
Water/sewage		$34k
Gas		$45k

Source: Technical Operations Office/JD4.

Ellington Field

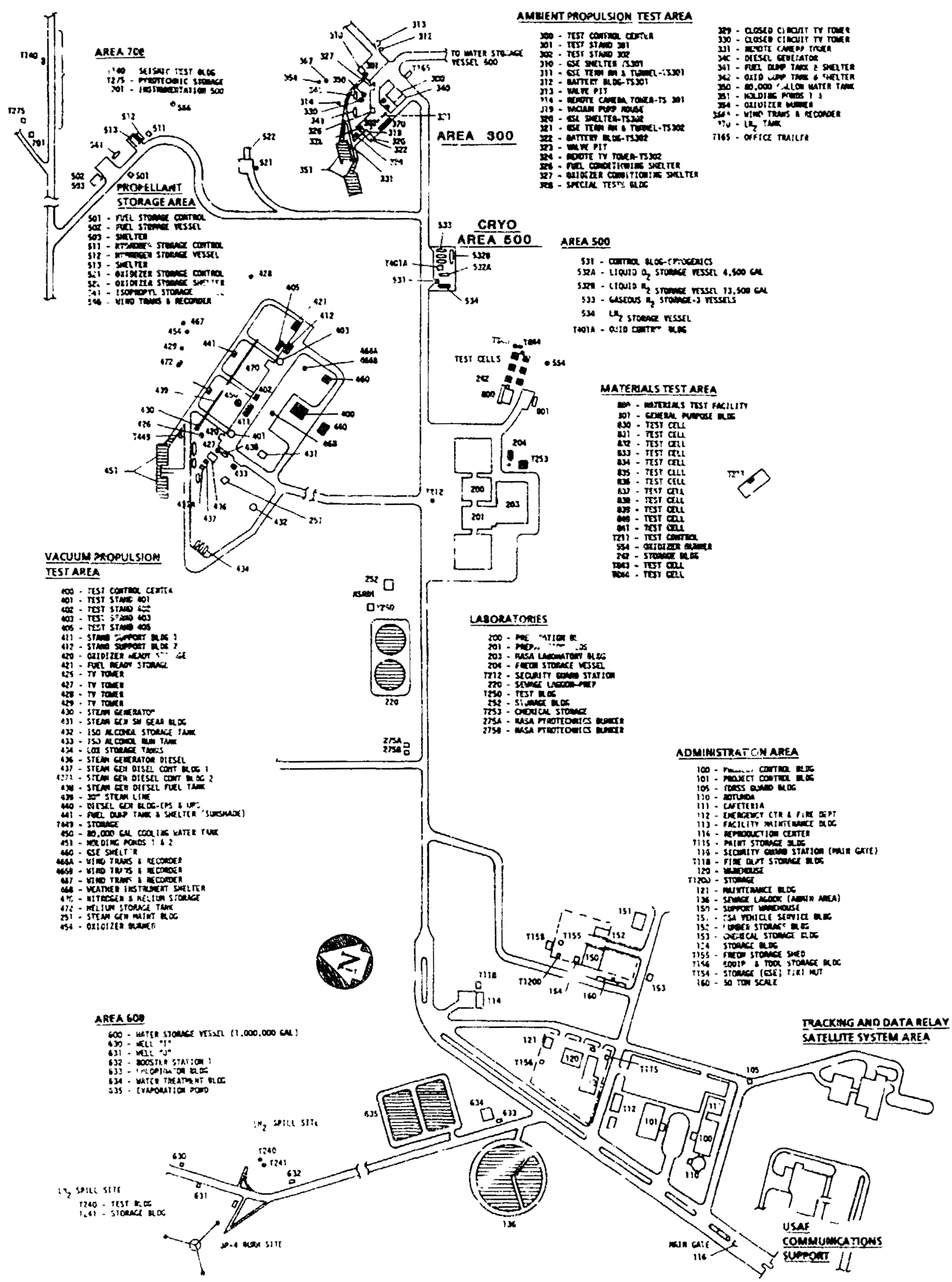


White Sands Test Facility Statistics

(As of September 1992)

• **Real property**			
Size	Acres		60,635
Buildings	Number		86
Space	Square feet		401k
Total runways (2)	Miles		13.2
Test stands	Ambient		3
	Vacuum		4
Book value	Acquired cost		$45.7M
• **Personal property**			$42M
• **Personnel**			
Civil service			93
Contractor			583
Other (TDRSS support)			534
• **Utilities**			
Electricity	Kilowatt-hours	10.8M	$719k
Natural gas	Cubic feet	18.9M	$720k
Water	Onsite pump		
• **Special systems**			
Alcohol storage	Gallons		70k
LOX storage	Gallons		111k
LN_2 storage	Gallons		45k
Helium storage	Cubic feet		130k

Source: Technical Operations Office/JD4.


AREA 700
AMBIENT PROPULSION TEST AREA
AREA 300
PROPELLANT STORAGE AREA
CRYO
AREA 500
MATERIALS TEST AREA
VACUUM PROPULSION TEST AREA
LABORATORIES
ADMINISTRATION AREA
AREA 600
TRACKING AND DATA RELAY SATELLITE SYSTEM AREA
USAF COMMUNICATIONS SUPPORT

Government-Owned Contractor Facilities

(As of September 1992)

NASA Industrial Plant — Downey

• **Real property**			
Size	Acres		166
Buildings	Number		51
Space	Square feet		1.9M
Book value	Acquired cost		$49.1M
• **Utilities**			
Electricity	Kilowatt-hours	103M	$7.9M
Natural gas	Cubic feet	182M	$865k

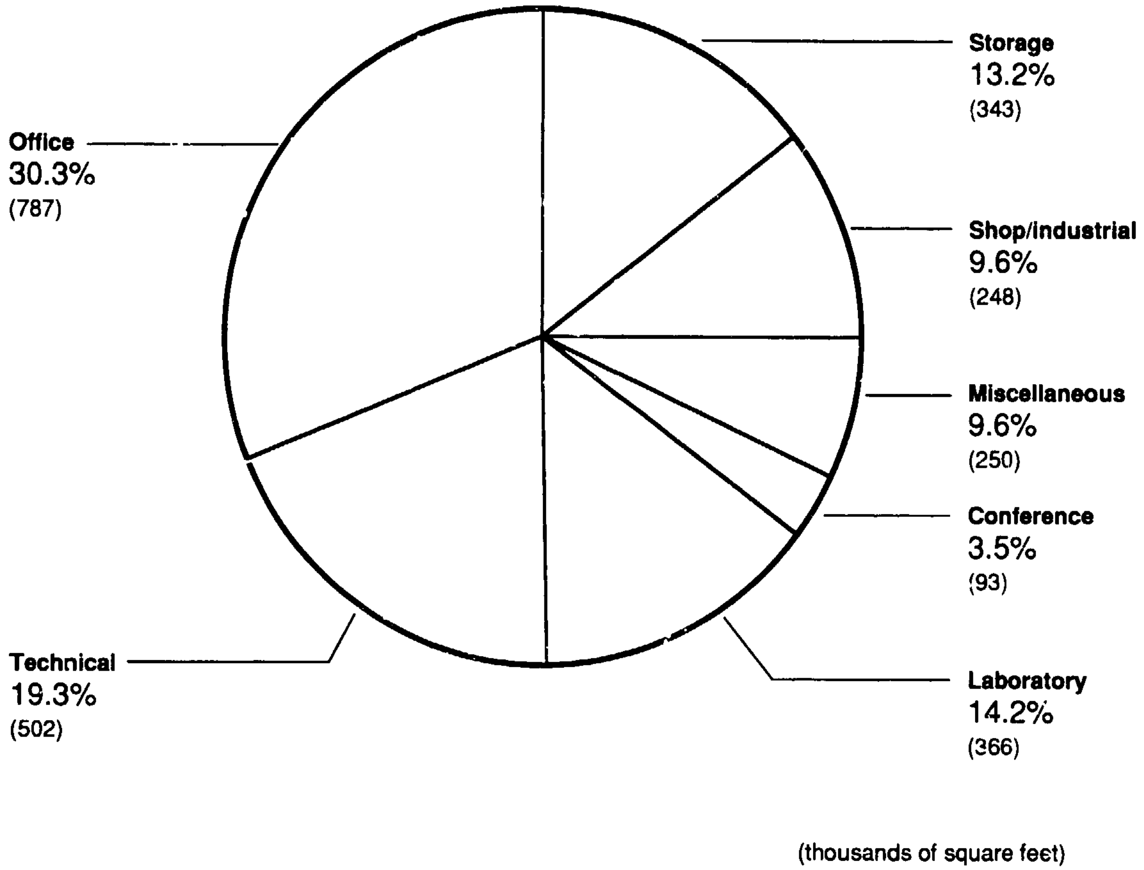
Air Force Plant No. 42 — Palmdale

• **Real property**		
Size	Acres	21.5
Buildings	Number	15
Space	Square feet	303k
Book value	Acquired cost	$13.0M

Source: Technical Operations Office/JD4

JSC Net Usable Building Space

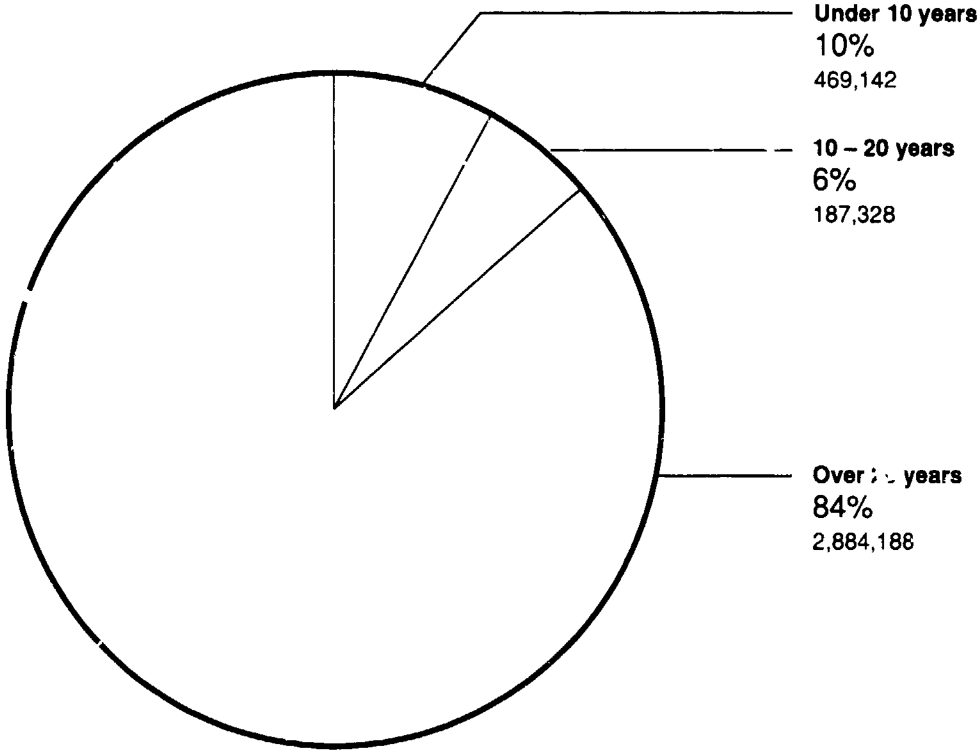
(As of September 1992)



Source: Technical Operations Office/JD4.

Age and Square Footage of Buildings at JSC

(As of September 1992)

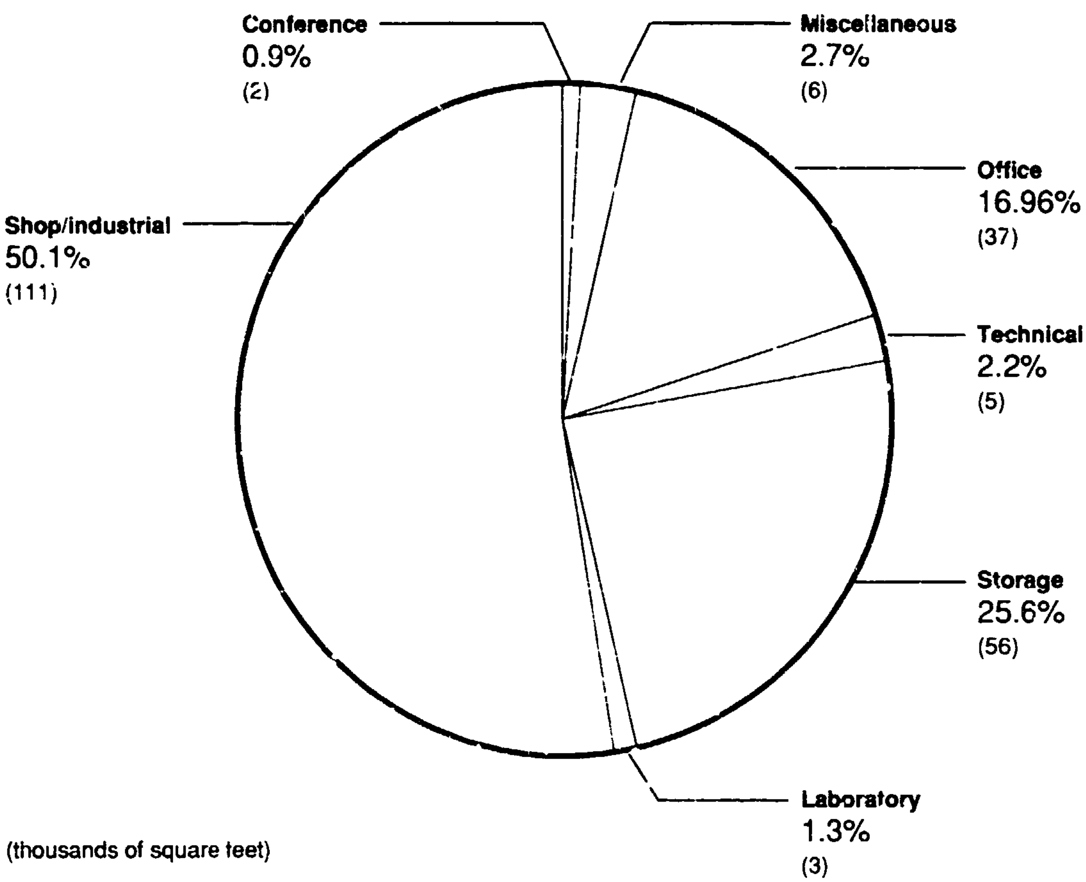


Total: 3,540,658 gross square feet

Source: Technical Operations Office/JD4.

Ellington Net Usable Building Space

(As of September 1992)



Source: Technical Operations Office/JD4

Facilities Activity at JSC

Approved construction

- **FY1992** $36.3M

  Addition for flight training and operations (Phase II)
  Modifications for Space Station Training Facility
  Replace central plant chillers (Phase II)
  Rehabilitate Tracking & Data Relay, WSTF

Programmed construction

- **FY1993** $15.9M

  Rehabilitate Aircraft Operations Facilities
  Replace central plant chilled water (Phase II)
  Modifications for Site Sewage Lift Station
  Modify Test Stand 302, WSTF

Source: Technical Operations Office/JD4.

VII. Training and Test Facilities/ Laboratories/Aircraft

VII. Training and Test Facilities/ Laboratories/Aircraft

ASTRONAUT TRAINING SIMULATORS

Single System Trainer
(Building 4)

The Single System Trainer consists of three Orbiter crew stations interfaced to a minicomputer. It is used to train personnel to understand and operate the Orbiter systems - one system at a time - as well as carriers such as the Spacelab, inertial upper stage, and payload assist module.

Spacelab Simulator
(Building 5)

The Spacelab Simulator consists of a full-scale, high-fidelity Spacelab core with an experiment module segment, subsystem racks, controls and displays, scientific airlock, and viewport. It does not include the tunnel area or any experiments. The trainer simulates activation, operation, and deactivation of the command and data management system, caution and warning system, environmental system with malfunction analysis, power and thermal management system, and the scientific airlock/viewport. During integrated training, the flight control team, the Payload Operations Control Center, and the Mission Control Center participate in the training sessions.

Shuttle Mission Simulator
(Building 5)

The Shuttle Mission Simulator supports flight crew and flight controller training for all facets of the Shuttle vehicle operations and in all systems tasks associated with the major flight phases. The Shuttle Mission Simulator facility consists of both a moving and fixed based station, instructor/operator stations, visual displays of window and camera views, large-scale data processing complex, signal interface equipment, and a network simulation system for integrated training with the Mission Control Center. The fixed base station is preferred for on-orbit activities. The motion base station has hydraulic equipment which allows the station to move with six degrees of freedom, making it the preferred simulator for ascent and entry practice. The simulator is used for full-scale rehearsals of flights including ascent, orbit activities, malfunctions, and entry. It also provides inertial upper stage modeling, remote manipulator system visual training, and a general payload model for conducting payload operations training.

CREW SYSTEMS LABORATORY
(Building 7)

11-foot Altitude Chamber

The 11-foot Altitude Chamber provides flight environment pressures for the training of flight crews in the operation of the extravehicular mobility unit.

Environmental Control and Life Support System Test Article

This test article was primarily used to evaluate and certify the Orbiter pressure control system, and now provides training for flight crews in pre- and post- extravehicular activity including airlock depressurization and repressurization. The facility internally represents the Orbiter crew cabin and is used in conjunction with other JSC altitude chambers to simulate a space environment.

SPACE SHUTTLE ORBITER TRAINING FACILITY
(Building 9A)

Orbiter Crew Compartment Trainer

The Orbiter Crew Compartment Trainer is a full-scale mockup of the Orbiter flight deck, middeck, and midbody with operational systems such as waste management, lighting, galley, sleep stations, and the airlock/extravehicular mobility unit used for emergency/safety training. During training sessions, the crewmember operates the closed-circuit television, cameras, lighting, food preparation equipment, waste management system, medical equipment, and portable oxygen systems. The trainer can be turned 90° to simulate launch and the airlock mockup allows for extravehicular activity training.

Manipulator Development Facility

The Manipulator Development Facility includes a full-scale aft crew station and a full-scale model of the remote manipulator system. Crewmembers get training in payload grappling, berthing, payload bay camera operation, visual operations, and Orbiter manipulator arm software operations.

SPACE STATION MOCKUP AND TRAINER FACILITY

(Building 9B)

The Space Station Mockup and Trainer Facility contains a full-scale mockup of the modules and nodes that will comprise Space Station Freedom. The mockup will contain the crew habitation quarters, the laboratory, the Japanese and European Space Agency modules, a logistics module that will house surplus food and equipment, and a crew escape and return vehicle. Four connecting resource nodes will serve as airlocks between docking vessels and the modules in addition to housing command and control equipment. Crews will begin training in the mockups 2 years before NASA launches the first flight carrying space station materials.

SPACE SYSTEMS AUTOMATED INTEGRATION AND ASSEMBLY FACILITY

(Building 9C)

The Space Systems Automated Integration and Assembly Facility (SSAIAF) is a large-scale, closed-loop dynamic test laboratory which has application to spacecraft docking and berthing, assembly, and maintenance. A key step in developing realistic space assembly and maintenance processes is the mechanical evaluation of task criteria in a ground-based, high-fidelity simulation environment that treats the component articles as a combined system. SSAIAF was designed to be the major facility used by Automation and Robotics Division to carry out its verification responsibility for manipulator/robotic assembly and maintenance on Space Station. SSAIAF will integrate interfacing hardware (such as a docking mechanism, a berthing mechanism, or V-guides and trunnions) with real-time computer simulations of Space Station and Shuttle manipulators/robots.

STRUCTURES TEST LABORATORY

(Building 13)

The 13,000-square foot Structures Test Laboratory is used for material property testing of metallic and nonmetallic materials at ambient, thermal, and/or vacuum conditions. Industrial load test frames and test systems can test specimens with tensile loading up to 600,000 pounds as well as compressive loading up to 800,000 pounds. A 12-channel load-control system is available for applying test loads to structural test articles which may be mounted to a rigid steel strongback with "T" slot faces and to wide flange steel beams embedded in the floor of the lab. Test data can be continuously recorded for 256 channels at a rate of 10 samples per second. Two overhead cranes and a forklift truck are available for facilitating the handling of test articles and test fixtures.

DYNAMIC DOCKING TEST SYSTEM

(Building 13)

The Dynamic Docking Test System is a large-motion, real-time docking simulator for full-scale testing of advanced docking systems in a zero-g environment. It was designed to physically accommodate the actual docking hardware of two spacecraft. Docking temperatures are also simulated. The test system provides a base that can be used to simulate different types of motion. Present plans involve using this base to simulate the dynamics that a robotic device would experience while performing tasks in space such as space station assembly.

ANECHOIC CHAMBER

(Building 14)

The Anechoic Chamber is used for making antenna pattern measurements in support of the Shuttle and other manned space flight programs. It was designed as a modified, flared, wavelength horn of all-metal construction with a radio frequency absorbing material on the inner surfaces of the shielded initial surfaces area. The testing area is 39 feet high, 60 feet long, and 40 feet wide and contains approximately 2500 square feet. A near field radiation pattern measuring facility allows for a scanning plot of nearly 40 feet by 40 feet, a capability required for advanced antenna system development.

SYSTEMS ENGINEERING SIMULATOR LABORATORY

(Building 16)

The Systems Engineering Simulator consists of three simulator bases used to perform engineering design studies with a man-in-the-loop configuration supporting both Shuttle and Space Station programs.

The Shuttle ascent/abort simulates powered atmospheric flight from lift-off through tank separation. Shuttle entry simulates unpowered atmospheric flight starting either at the entry interface or after tank separation in the case of aborts and ending after the Orbiter brakes to a stop on a runway. In the on-orbit configuration, simulations with the remote manipulator system, orbital maneuvering vehicle, manned maneuvering unit, and various payloads are performed in an Earth orbit environment. An Orbiter forward flight desk is used for the ascent/abort and entry simulations. An Orbital aft flight deck, a manned maneuvering crew station, and a space station cupola are used for the on-orbit simulations.

SHUTTLE AVIONICS INTEGRATION LABORATORY

(Building 16)

Built in 1974, the Shuttle Avionics Integration Laboratory (SAIL) is the central test facility where integrated open-loop and closed-loop verification tests of Shuttle avionics systems with flight software, flight procedures, ground support equipment, and payload interfaces are done prior to actual space flight, allowing engineers to detect problems and deficiencies early in the preflight test phase. The flight system consists of a full set of Shuttle avionics hardware including a cockpit with forward and aft stations and flight-type wiring. Propulsion systems and aerodynamic control systems are simulated to compute forces, moments, fuel consumption, and associated mass and inertial changes.

JSC AVIONICS ENGINEERING LABORATORY

(Building16)

The JSC Avionics Engineering Laboratory (JAEL) is an engineering laboratory which performs development and validation testing on new Orbiter avionics equipment being introduced into the program to replace obsolete technologies. JAEL activities are designed to perform extremely detailed testing of the hardware and software under a variety of conditions, constantly monitored by special test equipment to ensure that the combined hardware and software meet all requirements. One of the primary requirements/utilization of JAEL is testing of breadboard and prototype upgraded avionics hardware in an engineering environment conducive to rapid identification/correction of design anomalies. Another primary requirement/utilization of JAEL is the engineering analysis of potential software changes on flight control system performance utilizing closed-loop capability. JAEL is also used for development testing of prototype flight software requiring actual hardware interfaces.

SPACE FLIGHT FOOD FACILITY

(Building 17)

The Space Flight Food Facility provides for the preparation and packaging of all space flight food. It has the capabilities to prepare and freeze-dry foods, package foods under nitrogen for long-term storage, fabricate custom-molded flight food containers, package foods for space flight in a controlled environment, and provide long-term controlled environment storage for prepared foods.

ROBOTICS LABORATORY

(Building 17)

The Robotics Laboratory is designed to investigate the integration of robot hardware, computer vision systems, speech understanding systems, and high-level reasoning software in the areas of task planning and spatial reasoning as applied to the automation of space station functions. These facilities have been used to develop demonstrations of one-arm and two-arm robots performing automated satellite servicing.

WEIGHTLESS ENVIRONMENT TRAINING FACILITY

(Building 29)

The Weightless Environment Training Facility contains a 30-foot wide by 78-foot long by 25-foot deep pool which provides a controlled neutral buoyancy in water to simulate a zero-g environment. It provides crew training in the dynamics of body motion under weightless conditions during the performance of planned crew activities. A full-scale mockup of the Orbiter cabin middeck, airlock, and payload bay doors can be submerged in the pool. This configuration allows for training in emergency/survival techniques, hardware familiarization, airlock operation, and extravehicular activities in zero-g.

MISSION CONTROL CENTER

(Building 30)

Since Gemini IV in 1965, the Mission Control Center (MCC) has provided real-time ground support for all of America's manned space flights. From the time the launch vehicle clears the tower until the time the spacecraft lands, the MCC provides support for air-to-ground voice communications, spacecraft telemetry monitoring, medical monitoring, in-flight maneuvering and navigation activities plus support for onboard experiments and other spaceflight operations. The facility also provides a realistic environment in which to train flight operations personnel in performing Shuttle flight control functions and preparation for Space Station Freedom mission operations. In case of an emergency and control center shutdown, a backup facility at White Sands Test Facility can be activated and support a flight to its conclusion.

The MCC occupies all three floors of building 30 with the first floor dedicated to communications and computer equipment. Twenty to thirty flight controllers monitor mission command and control consoles in one of the two flight control rooms, but are supported by a large complement of engineers and other flight controllers who provide support from display consoles in numerous rooms throughout the building. Both control rooms can be used for mission operations. Operating in conjunction with the flight control rooms are Payload Operations Control Centers from which owners of payloads or experiments carried in the cargo bay of the Orbiter can monitor and control their payloads.

MISSION EVALUATION ROOM

(Building 30)

The Mission Evaluation Room (MER) is designed to accommodate the Space Shuttle Mission Evaluation Team during the general mission period from T-2 days through landing plus 4 days. The mission evaluation team provides preflight, real-time, and postflight engineering analysis for each mission. The team supports the prelaunch, turnaround, and integrated test activities at Kennedy Space Center and the flight operations and postflight evaluation at JSC. The mission evaluation team serves as the real-time interface between technical management in the MER and the flight control team in the Mission Control Center. The MER is the centralized location of the engineering community during a mission and quickly provides engineering expertise and consolidated analyses for in-flight checkout and evaluation of all vehicle subsystems. The facility provides work space, furnishings, and data for approximately 150 personnel in the areas of subsystem evaluation, administrative support, and data processing.

The MER is located in the third floor lobby wing of Building 30 and consists of four separate work areas. The MER is the prime mission evaluation team work area and provides necessary equipment and facilities for the mission evaluation team to function. The room includes eight system workstation tables, communication keysets, video displays controlled by manual select keyboards, telephones, television, and data retrieval and processing systems. The Mission Management Room is a secure conference room and includes a secure and nonsecure four-wire teleconference phone system. The Data Management Room is utilized in the prelaunch phase by the Launch System Evaluation Advisory Team (LSEAT) Working Group and is available for use by members of the Mission Evaluation Team after lift-off. The Administrative Support Room provides space for administrative support functions and includes facsimile equipment, reproduction equipment, word processing equipment, and a pneumatic tube data transport. The Mechanical and Data Distribution Room houses the air handler and communication interface equipment for the MER. The MER operates as a secure PCZ area and access to this room is restricted to temporary or permanent MER PCZ badges. The approximate floor space of the MER is 4576 square feet.

LUNAR CURATORIAL FACILITY
(Building 31)

Between 1969 and 1972, six Apollo spacecraft brought back 842 pounds of lunar rocks, core samples, sand, and dust from the lunar surface. The Lunar Curatorial Facility is the chief repository for these samples and maintains them in two separate environments — one for pristine samples and another for samples returned after analysis by investigators. Visiting scientists can also conduct tests and measurements on the samples in special rooms in the building. Another function of the Lunar Curatorial Facility is to prepare lunar samples to be used in schools, universities, and museums for education and display as well as for analysis by scientists throughout the world.

METEORITE PROCESSING LABORATORY
(Building 31)

The Meteorite Processing Laboratory performs the initial examination of all meteorites recovered from Antarctica by expeditions of the ANSMET project, a program funded by the National Science Foundation. From 1977 through 1984, ANSMET expeditions returned more than 2,000 meteorite samples. In recognition of the importance of meteorites as records of the earliest history of the solar system and as natural probes of the interplanetary space environment, NASA formalized an agreement with the National Science Foundation and the Smithsonian Institution to examine, document, and distribute these samples to the scientific community.

SPACE ENVIRONMENT SIMULATION LABORATORY CHAMBERS A AND B
(Building 32)

Chambers A and B have the capability for manned and unmanned development and qualification testing of complete spacecraft or major subsystem hardware in high-fidelity simulated thermal vacuum space environments. The outside dimensions of Chamber A are 65 feet in diameter and 120 feet in heighth. The working dimensions are 55 feet in diameter and 90 feet in heighth. Test articles can weigh up to 150,000 pounds. Chamber B has outside dimensions of 25 feet in diameter and 26 feet in heighth. Test articles can weigh up to 75,000 pounds. Chamber A can also be configured to generate thermal plasma simulating the ionosphere in low Earth orbit.

BIOMEDICAL OPERATIONS AND RESEARCH LABORATORY
(Building 37)

The Biomedical Laboratories are responsible for an array of biomedical and environmental analytical capabilities in support of NASA operations and biomedical research. With clinical, biochemistry, water and food, microbiology, and toxicology laboratories, activities include, but certainly are not limited to, medical evaluation of crewmembers and test subjects; routine analyses of various aspects of the Shuttle vehicles; and unique investigations of basic cellular and molecular processes. In addition to undertaking research activities to investigate and define the effects of microgravity on humans, current development efforts are underway in the Biotechnology Group to explore the utility of using microgravity as a tool for understanding basic cellular processes. Also, within the purview of the Biomedical Laboratories is the Environmental Health System project which is being developed to help meet the environmental health needs of the Space Station Freedom Program.

CARDIOVASCULAR LABORATORY
(Building 37)

The Cardiovascular Laboratory is devoted to increasing understanding of the many varied adjustments of the human circulatory system to space flight factors. It was used to support the development of the first and only operational countermeasure to the cardiovascular deficits of microgravity exposure, the fluid load countermeasure. The laboratory is also used for developing multinational space flight physiology experiments, for bed rest studies that simulate microgravity exposure, and for pilot studies that test new techniques and procedures for potential application in space flight.

ELECTRONIC SYSTEMS TEST LABORATORY
(Building 44)

The Electronic Systems Test Laboratory (ESTL) provides a controlled, calibrated radiofrequency (RF) environment for performing detailed functional performance evaluations of spacecraft communications equipment in an end-to-end configuration. Spacecraft RF communications equipment is a unique onboard system that has multiple remote functional interfaces, such as ground stations and relay satellites. Located within the ESTL are high-fidelity ground station systems, relay satellite systems, and spacecraft systems which are interconnected through a calibrated RF path and dynamic Doppler frequency shifter to provide an accurate reproduction of in-space RF operating conditions. Using this laboratory, prototype and production model communications equipment is tested in an integrated systems environment. These tests thoroughly evaluate its RF compatibility and performance under all anticipated mission conditions to provide cost-effective data for the equipment final design and mission operations activities.

CENTRAL COMPUTING FACILITY

(Building 46)

The Central Computing Facility houses data processing systems in support of institutional, administrative, engineering, and scientific activities as well as the National Space Transportation System and Space Station Freedom. A portion of the Central Information Network (CIN), the Center Information System (CIS), connections to the Program Support Communications Network (PSCN), and the NASANET provide support for institutional and administrative functions. CIN enables users to access applications on many different mainframes even though their workstations are not directly attached to the mainframe hosting the applications. CIS aids users in office automation with word processing, electronic mail, and information management capabilities. PSCN provides Agency-wide voice, data, and video telecommunications. NASANET provides access to various sources of administrative data across the Agency.

The Engineering Computation Facility provides a centralized scalar and vector processing capability to the JSC scientific and engineering community for computational intensive applications. In support of the National Space Transportation System, the Software Development Facility aids in the development of new capabilities for the Shuttle Orbiter onboard computers. The Central Computing Facility also houses two capabilities supporting Space Station Freedom. The Technical and Management Information System is an electronic information system for engineering and management, coordination, and integration of activities among NASA centers and Space Station Freedom and serves as the primary vehicle for transferring data between the contractors and NASA centers. The Space Station Information System contains all flight and ground-based information systems which participate or contribute directly to the day-to-day operations of Space Station Freedom.

VIBRATION AND ACOUSTIC TEST FACILITY

(Building 49)

The various vibration and acoustic laboratories are capable of performing a wide range of tests needed to evaluate all aspects of acoustic, vibration, structural dynamic, and shock problems. This facility provided extensive dynamic structural test support for Shuttle Orbiter certification. State-of-the-art techniques are used and the facility has unsurpassed low-frequency acoustic test capabilities and provides unparalleled features for accomplishing acoustic, mechanically induced vibration testing, and empirical modal analysis within one building.

ATMOSPHERIC REENTRY MATERIALS AND STRUCTURES EVALUATION FACILITY

(Building 222)

The 10-Mw Atmospheric Reentry Materials and Structures Evaluation Facility (ARMSEF), also known as the Arc-Jet, was originally constructed in 1966 to provide reentry environment testing of Apollo spacecraft nonreusable ablator-type thermal protection system (TPS) materials. This facility is the sole NASA-dedicated Space Shuttle Orbiter TPS test facility, providing Shuttle TPS certifications and life testing, flight-to-flight TPS testing support, and testing to resolve Shuttle TPS anomalies. Specifically, the ARMSEF provides simulation of the convective heating and pressure flow environment by employing electric heaters that heat air and expand it into a test chamber through supersonic or hypersonic nozzles to form a test stream. Test specimens of

TPS materials ranging in size from 3 inches in diameter to 2 feet in diameter by 2 feet in heighth can be inserted into the chamber.

THERMOCHEMICAL TEST AREA

The Thermochemical Test Area (TTA), located on 115 acres in the northwest corner of JSC, consists of four independent test facilities: the Fluid Systems Test Facility, the Power Systems Test Facility, the Propulsion Test Facility, and the Pyrotechnics Test Facility. In addition, the TTA facilities include laboratories which provide support for electrical and mechanical systems, equipment fabrication, chemical analysis, system cleaning and assembly, instrumentation calibration, and data acquisition and reduction. The TTA has been used since 1964 to provide component and subsystem test support for propulsion and power systems utilized in U.S. manned space programs. The dedicated facilities and support laboratories provide the capability for rapid response in the investigation of real-time problems and flight anomalies. A limited number of qualification programs have also been performed for components and subsystems for which contractors did not have adequate facilities.

WHITE SANDS TEST FACILITY (WSTF)

WSTF's propulsion test facilities consist of seven versatile test stands (four vacuum and three ambient) adaptable to almost any component, engine, system, or complete stage test up to 25,000 lbf, and a test article envelope up to 20 by 20 by 40 feet for vacuum tests. Hypergolic propellant storage, distribution, and conditioning capability is available at all test stands. A LOX/hydrogen system is under construction. An instant chemical steam generator provides space vacuum simulation (>100,000 feet) during engine firings (45-minute capability with the larger engines, 135-minute capability with smaller engines). Test stands are supported by modern data acquisition systems with computerized data processing and computer-controlled test operations. At the present time, Shuttle FRCS, ARCS, and OMS test articles are installed in three of the test stands, and a fourth is undergoing extensive modification to provide long-term test support for the Space Station Freedom Program. The remaining test capability is presently dedicated to a wide variety of short-duration testing for NASA and other Federal agencies.

Existing laboratory facilities encompass a wide variety of highly sophisticated and unique materials and components test capabilities. These include a full spectrum of standard materials testing in fuel, oxidizer, and simulated space flight environments; frictional heating, particle impact, and promoted combustion testing in high-pressure gaseous oxygen; and testing in environments unique to space such as thermal vacuum stability testing motion analysis.

JSC/NASA AIRCRAFT

Shuttle Training Aircraft

The Shuttle Training Aircraft (STA) is a twin-engine Grumman Gulfstream II aircraft modified to simulate Orbiter flight characteristics including realistic motion, visual, and handling qualities. It provides realistic training for astronaut pilots for the Orbiter final approach phase from 35,000 feet to simulated touchdown including simulated winds, turbulence, and navigation errors that they might experience in an actual landing. The STA can fly at altitudes up to 45,000 feet, at speeds up to 367 knots, and has a transcontinental range. The four STA's are based at Ellington Field with training flights in El Paso, Texas; Edwards AFB, California; and the Kennedy Space Center, Florida. The Orbiter descent profiles simulations are done primarily at White Sands.

T-38A

The T-38A is a two-seat, twin turbojet, swept-wing, supersonic aircraft. It is capable of speeds up to Mach 1.2 and has a nominal range of 800 nautical miles. The T-38A is very maneuverable and fully acrobatic. It is used for astronaut proficiency flying and to simulate Space Shuttle Orbiter low lift-to-drag landing approaches. JSC has 30 T-38A's based at Ellington Field.

KC-135A

The KC-135A, a military version of the four-engine Boeing 707, is the standard U.S. Air Force tanker aircraft used primarily to refuel the Strategic Air Command bomber fleet. JSC's KC-135A has been modified to permit operations in reduced gravity for NASA research and training. In this aircraft, astronauts and experimenters can experience up to 30 seconds of weightlessness. Astronauts also fly this aircraft to familiarize themselves with heavy aircraft operations in preparation for Space Shuttle flights. The KC-135A is based at Ellington Field.

WB-57F

The Martin WB-57F is a modified B-57 with larger wings, a bigger tail, and more powerful engines. It is a four-engine, two-seat, high-altitude weather research aircraft capable of flying at altitudes of 65,000 feet with a payload capacity of 4,000 pounds, a range of 2,500 nautical miles, and speeds of up to 345 knots. The WB-57F carries multiple sensors to measure the atmosphere plus whole air and particulate air samplers. The two WB-57F's still flying are based at Ellington Field.

G-159

The G-159 is a Grumman-Gulfstream twin turboprop administrative aircraft used to transport management personnel to other centers, contractor work sites, conferences, and NASA Headquarters to support managerial and technical meetings. It can carry 12 passengers and has a crew of 3. It has a cruising airspeed of 275 knots, a range of 1,200 nautical miles, and can fly at altitudes of up to 30,000 feet. NASA has five of these aircraft at various centers and one (NASA 2) is based at Ellington Field.

Super Guppy

The B377SG Aero Spacelines Super Guppy is a low-wing, four-engine turboprop designed for oversized cargo transport. It is an extensive modification of a Boeing C-97J transport. It was purchased by NASA in April 1979, and is based in El Paso. The Guppy cruises at approximately 190 knots, has a range of 450 nautical miles with maximum payloads, and normally operates at altitudes below 10,000 feet. The Super Guppy can carry payloads of up to 41,000 pounds and 21 feet in diameter, and has transported such items as the Hubble Space Telescope, Syncom satellites, and Shuttle Centaur components. During the Apollo program, the Guppy was used to transport the S-IVB third stage of the Saturn V launch vehicle. As of 1991, all replacement engines have been used, and additional ones are not available. As a result, the Guppy is no longer in service and will remain in storage at Demir Montham AFB in Arizona.

Shuttle Carrier Aircraft

The Shuttle Carrier Aircraft is a Boeing 747 modified with extra stabilizer-tip vertical tail surfaces and external hardpoints for attaching and transporting an Orbiter in a piggyback arrangement. It is used to transport Orbiters to the Kennedy Space Center (KSC) for launch after landings at sites other than KSC, and to move them to and from the Rockwell plant in Palmdale, California, where they are built or significantly modified. NASA has two SCAs; one stationed at Edwards AFB, California and one at El Paso, Texas. ☐

VIII. JSC Workforce

VIII. JSC Workforce

Civil Service Staff Profile (1991)

	JSC	NASA
Permanent employees	3674	24,416
Age, average	42.2	42.2
Grade, average	11.9	11.7
Annual salary, average	$48,747	$47,643
Supervisors, number	567	3777
%	15.4	15.5
Women, number	1216	7301
%	33.1	29.9
Minorities, number	634	4025
%	17.3	10.5
Received training, number	3036	21,380
%	82.6	82.4
Cash awards, number	2194	12,894
Retirements	90	667
Scientists and engineers	2399	13,694
Prof. administrative	649	4579
Clerical	430	2881
Technical support/wage grade	196	3262

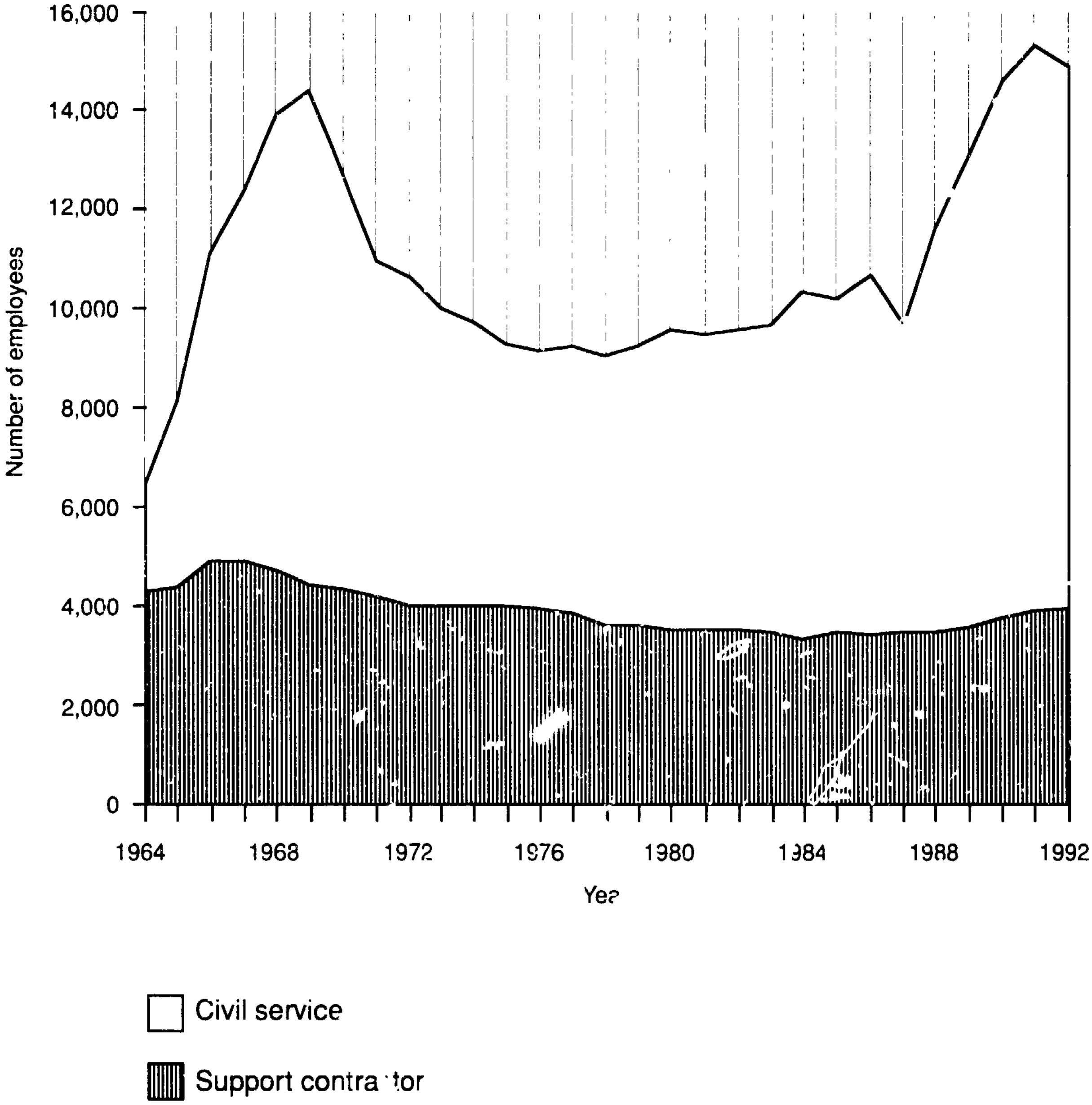
Source: JSC Workforce in Profile, FY91.
The Civil Service Workforce (As of September 30, 1991), NASA Headquarters, 1991.

JSC Workforce by Directorate (1991)

	Civil service	Support contractor
Director and Staff	134	59
Administration	405	112
Flight Crew Operations	166	386
Mission Operations	602	4204
Engineering	821	1711
Information Systems	129	587
NSTS Program Office	193	439
New Initiatives	83	256
Center Operations	335	1191
Space Station Projects Office	112	205
SR&QA	170	568
White Sands Test Facility	51	477
Space and Life Sciences	244	1015
STS Orbiter and GFE	130	522
Lunar/Mars Program Office	25	27
Space Station Projects Integration	14	0
Total	3674	10,863

Source: JSC/Central Budget Office
Note: Civil service are end of year actuals
Support contractors are equivalent people.

JSC Workforce History — Civil Service/Support Contractors

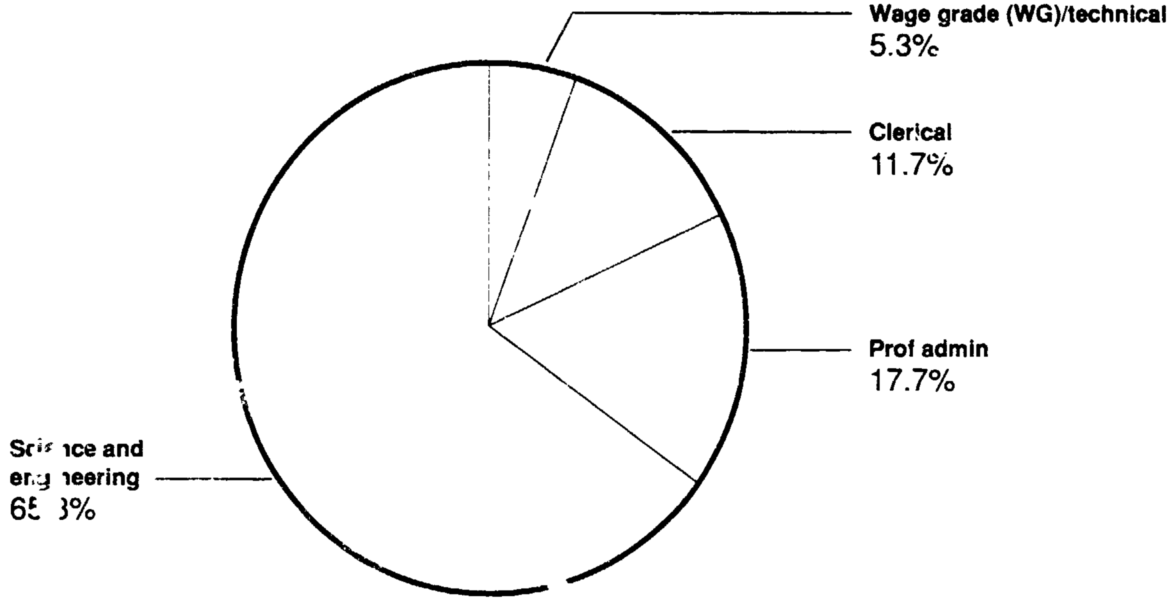


Expressed in equivalent people
Civil service = full-time permanent

Source JSC Comptroller

Composition of JSC Workforce by Occupation and Directorate

(As of September 30, 1991)



Directorate/ program office	WG/tech No.	WG/tech %	S&E No.	S&E %	Prof admin No.	Prof admin %	Clerical No.	Clerical %	Total	SES
Dir/Staff (A)	1	0.7	7	5.1	91	66.4	38	27.7	137	11
Admin. (B)	0	0.0	33	7.9	320	76.6	65	14.2	418	4
Flt. Crew Ops. (C)	34	20.0	101	58.0	10	5.7	29	16.7	174	2
Mission Ops. (D)	1	0.2	538	87.9	20	3.3	53	8.7	612	8
Engineering (E)	15	1.8	745	89.7	16	1.9	55	6.6	813	11
*Space Shuttle Prog. Office (G,M,T,W)	0	0.0	150	75.4	18	9.0	31	15.6	199	0
*Spa. Sta. Freedom Ofc. (H)	0	0.0	9	69.2	1	7.7	3	23.1	13	0
New Initiatives Ofc. (I)	0	0.0	67	81.7	4	4.9	11	13.4	82	2
Center Ops. (J)	108	32.0	71	21.0	111	32.8	48	14.2	338	2
Spa. Sta. Proj. Ofc. (K)	0	0.0	70	81.4	5	5.8	11	12.8	86	5
SR&QA (N)	26	14.5	131	73.2	5	2.8	17	9.5	179	2
Information Systems (P)	2	1.6	96	75.0	17	13.3	13	10.2	128	2
WSTF (R)	0	0.0	37	74.0	6	12.0	7	14.0	50	1
Spa. & Life Sci. (S)	7	2.9	210	86.1	7	2.9	20	8.2	244	4
Orb. & GFE Proj. Ofc. (V)	2	1.5	80	75.8	8	6.1	22	16.7	132	2
Exploration Prog. Ofc. (X)	0	0.0	21	77.8	2	7.4	4	14.8	27	1
Total	197	5.5	2357	65.3	609	16.9	446	12.4	3674	58

Source: JSC Workforce in Profile, FY91.

*The Senior Executive Staff for the Space Shuttle Program Office and the Space Station Freedom Office are assigned to NASA Headquarters and are not reflected in these statistics.

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Composition of JSC Workforce by Occupation and Fiscal Year

(As of September 30, 1991)

End of FY	WG/tech No.	WG/tech %	S&E No.	S&E %	Prof admin No.	Prof admin %	Clerical No.	Clerical %	Total
1980	307	8.8	2211	63.2	454	13.0	529	15.1	3501
1981	297	8.8	2157	63.8	439	13.0	487	14.4	3380
1982	281	8.6	2084	63.8	452	13.8	449	13.7	3266
1983	264	8.2	2078	64.2	459	14.2	434	13.4	3235
1984	256	7.9	2012	62.4	468	14.5	488	15.1	3224
1985	243	7.3	2086	62.6	503	15.1	498	15.0	3330
1986	227	6.9	2069	63.3	490	15.0	481	14.7	3267
1987	212	6.3	2134	63.8	515	15.4	486	14.5	3347
1988	206	6.1	2204	65.0	524	15.4	458	13.5	3392
1989	210	5.9	2339	65.4	576	16.1	451	12.6	3576
1990	197	5.5	2357	65.3	609	16.9	446	12.4	3609
1991	196	5.3	2399	65.3	649	17.7	430	11.7	3674

Source: JSC Workforce in Profile, FY91.

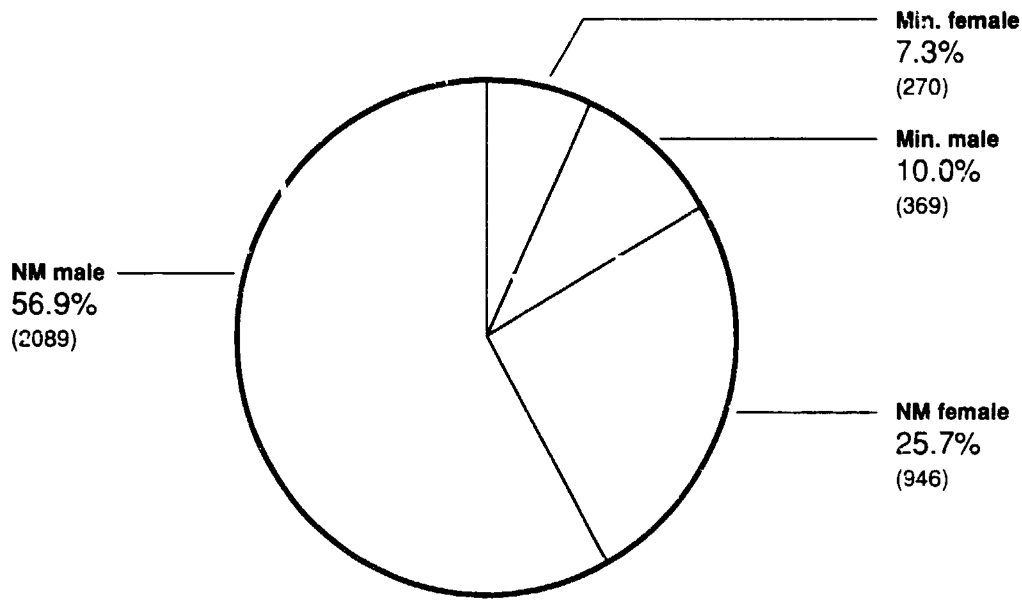
Composition of JSC Workforce by Sex and Occupation

(As of September 30, 1991)

Occupation	Female No.	Female %	Male No.	Male %	Total No.	Total %
WG/technician	22	11.2	174	88.8	196	5.3
Scientist & engr.	412	17.2	1987	84.0	2399	65.3
Prof. admin.	357	55.0	292	45.0	649	17.7
Clerical	425	98.8	5	1.2	430	11.7
Total	1216	33.1	2458	66.9	3674	100.0

Source JSC Workforce in Profile, FY91

Composition of JSC Workforce by Minority/Nonminority and Directorate
(As of September 30, 1991)



Directorate/ program office	Nonminority				Minority				Total
	Male		Female		Male		Female		
	No.	%	No.	%	No.	%	No.	%	
Dir/Staff (A)	53	38.7	59	43.1	7	5.1	18	13.1	137
Admin. (B)	161	38.5	181	43.3	25	6.0	51	12.2	418
Flt. Crew Ops. (C)	97	55.7	51	29.3	16	9.2	10	5.7	174
Mission Ops. (D)	373	60.9	155	25.3	43	7.0	44	6.7	612
Engineering (E)	537	64.6	137	16.5	111	13.4	46	5.5	831
Space Shuttle Prog. Ofc. (G,M,T,W)	117	58.8	52	26.1	16	8.0	14	7.0	199
Spa. Sta. Freedom Ofc. (H)	8	61.5	3	23.1	1	7.7	1	7.7	13
New Initiatives Ofc. (I)	58	67.4	20	23.3	5	5.8	3	3.5	86
Center Ops. (J)	153	45.3	105	31.1	47	13.9	33	9.8	338
Spa. Sta. Proj. Ofc. (K)	66	62.3	27	25.5	8	7.5	5	4.7	106
SR&QA (N)	113	57.5	27	15.1	36	20.1	13	7.3	179
Information Systems (P)	73	57.0	32	25.0	13	10.2	10	7.8	128
WSTF (R)	33	66.0	8	16.0	7	14.0	2	4.0	50
Spa. & Life Sci. (S)	158	64.8	53	21.7	19	7.8	14	5.7	244
Orb. & GFE Proj. Ofc. (V)	82	62.1	27	20.5	15	11.4	8	6.1	132
Exploration Prog. Ofc. (X)	17	63.0	9	33.3	0	0.0	1	3.7	27
Total	2089	56.9	946	25.7	369	10.0	270	7.3	3674

Source: JSC Workforce in Profile, FY91.

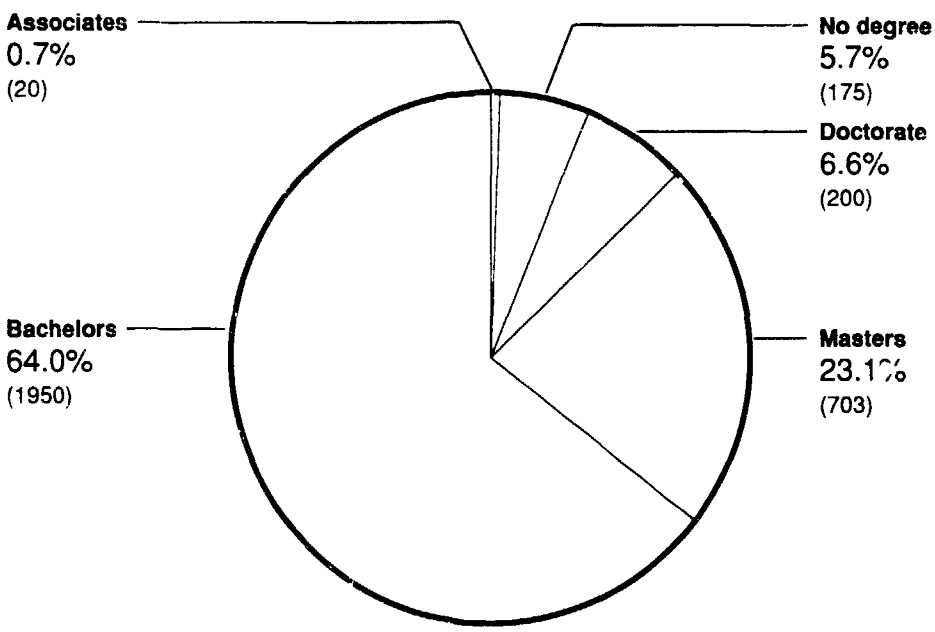
Composition of JSC Workforce by Minority/Nonminority and Fiscal Year

End of FY	Nonminority Male No.	Nonminority Male %	Nonminority Female No.	Nonminority Female %	Minority No.	Minority %	Total
1980	2475	70.7	563	16.1	463	13.2	3501
1981	2390	70.7	559	16.5	431	12.8	3380
1982	2299	70.4	549	16.8	418	12.8	3266
1983	2250	69.6	561	17.3	424	13.1	3235
1984	2133	66.2	634	19.7	457	14.2	3224
1985	2142	64.3	715	21.5	473	14.2	3330
1986	2061	63.1	731	22.4	475	14.5	3267
1987	2057	61.5	781	23.3	509	15.2	3347
1988	2052	60.5	808	23.8	532	15.7	3392
1989	2113	59.1	889	24.9	547	16.1	3576
1990	2089	57.9	917	25.4	603	16.7	3609
1991	2089	56.9	946	25.7	639	17.4	3674

Source: JSC Workforce in Profile, FY91.

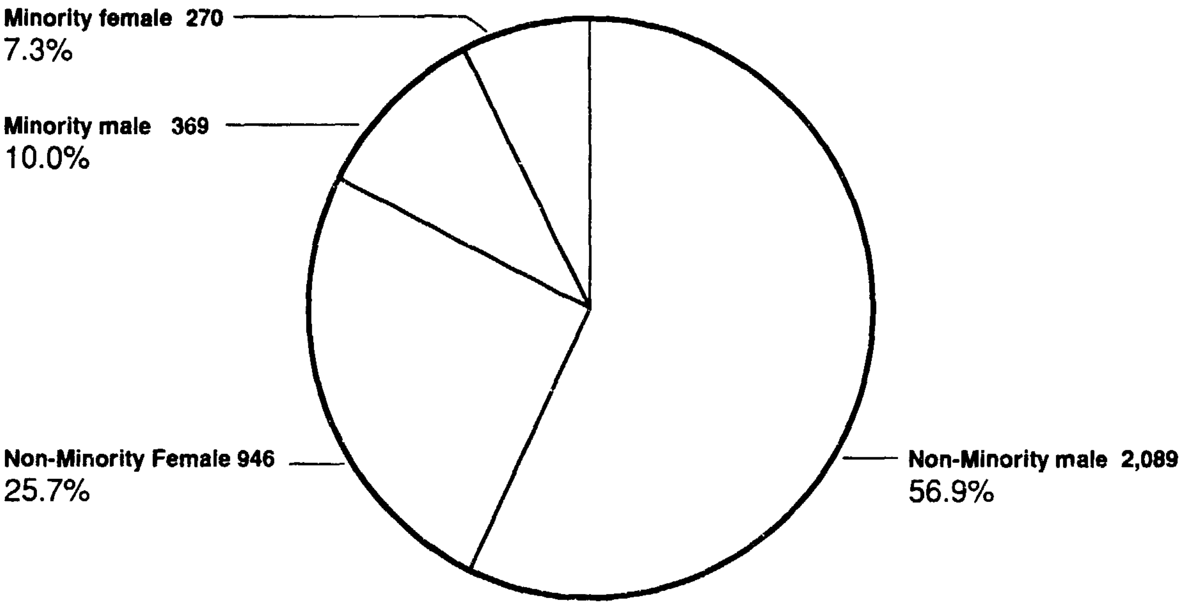
Education of Professional Civil Service Employees

(As of September 30, 1991)



Source: JSC Workforce in Profile, FY91.

Minorities and Women by Organization



	Nonminority				Minority				
	Male		Female		Male		Female		
	No.	%	No.	%	No.	%	No.	%	Total
Director/Staff (A)	53	38.7	59	43.1	7	5.1	18	13.1	137
Administratc ,B)	161	38.5	181	43.3	25	6.0	51	12.2	418
Center Operations (J)	153	45.3	105	31.1	47	13.9	33	9.8	338
Flight Crew Operations (C)	97	55.7	51	29.3	16	9.2	10	5.7	174
Mission Operations (D)	373	60.9	155	25.3	43	7.0	41	6.7	612
Engineering (E)	537	64.6	137	16.5	111	13.4	46	5.6	831
Safety, Relaibaility and Quality Assurance (N)	103	57.5	27	15.1	36	20.1	13	7.3	179
Information Systems (P)	73	57.0	32	25.0	13	10.2	10	7.8	128
WSTF (R)	33	66.0	8	16.0	7	14.0	2	4.0	50
Space and Life Sciences (S)	158	64.8	53	21.7	19	7.8	14	5.7	244
Space Shuttle Program Office (G,M,T,W)	117	58.8	52	26.1	16	8.0	14	7.0	199
Space Station Freedom Office (H)	8	61.5	3	23.1	1	7.7	1	7.7	13
New Initiatives Office (I)	58	67.4	20	23.3	5	5.8	3	3.5	86
Space Station Project Office (K)	66	62.3	27	25.5	8	7.5	5	4.7	106
Orbiter and GFE Project Office (V)	82	62.1	27	20.5	15	11.4	8	6.1	132
Lunar and Mars Exploration Office (X)	17	63 0	9	33.3	0	0.0	1	3.7	27
Total	2,089	56.9	946	25.7	369	10.0	270	7.3	3,674

Source: JSC Human Resources Office

Age of Professional Civil Service Employees by Occupation

(As of September 30, 1991)

Age	S&E		Prof admin		Total professional workforce	
	No.	%	No.	%	No.	%
20–24	74	3.1	15	2.3	89	2.9
25–29	388	16.2	64	9.9	452	14.8
30–34	410	17.1	97	14.9	507	16.6
35–39	292	12.2	87	13.4	379	12.4
40–44	190	7.9	94	14.5	284	9.3
45–49	326	13.6	95	14.6	421	13.8
50–54	408	17.0	95	14.6	503	16.5
55–59	214	8.9	57	8.8	271	8.9
60–above	97	4.0	45	6.9	142	4.7
Total	2399	100.0	649	100.0	3048	100.0

Source: JSC Workforce in Profile, FY91.

Support Contractor Workforce Equivalents (FY91)

Anchor	16	Lockheed	239
ASI Universal	17	Lockheed/WSTF	488
Barrios	129	Loral	63
Brown & Root	62	Loral MSC	318
CSC/MOSC	499	Loral SRQA	496
DMS-Custodial	151	Mason Hangar	101
DMS-Grounds	22	MDAC-AASC	252
Dual & Associates	15	Media	32
ESC/Lockheed	1914	MITRE	100
FEPC/Boeing	300	Northrop	352
Fluor Daniel	54	Pioneer	152
GHG	32	Rockwell/OSC	222
Hernandez Engineering	154	Rockwell/STSOC	3667
IBM	93	Rothe	23
Jefferson Assoc.	35	Stellacom	99
Johnson Engineering	147	Technicolor	84
Kelsey Seybold	69	Webb-Murray	36
KRUG, International	261	Others (<10)	79
Link/TSC	243		
		Total	11,759

Source: JSC/Central Budget Office.
Note: Excludes equivalents for reimbursable work.

Civil Service – Full-Time Equivalent Employees (FTE)

Center	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Johnson Space Center	805	1,620	3,345	4,277	4,431	4,737	4,704	4,604	4,384	4,24
Kennedy Space Center	0	333	1,181	1,625	2,491	2,589	2,720	2,917	2,877	2,779
Marshall Space Flight Center	5,355	6,194	7,332	7,679	7,754	7,271	7,086	6,440	6,149	6,002
Stennis Space Center	0	0	0	0	0	0	0	0	0	0
Goddard Space Flight Center	1,497	2,414	3,487	3,675	3,782	3,712	3,782	3,822	4,141	4,412
Wallops Station	305	407	493	530	555	518	518	494	484	488
Ames Research Center	1,487	1,674	2,116	2,204	2,270	2,223	2,173	2,083	1,992	1,972
Dryden Flight Research Center	441	524	616	619	669	603	590	566	539	535
Langley Research Center	3,287	3,770	4,220	4,330	4,374	4,233	4,161	4,037	3,912	3,872
Lewis Research Center	2,756	3,678	4,697	4,859	4,917	4,819	4,676	4,452	4,268	4,201
Electronics Research Center	0	0	0	25	250	510	700	794	802	600
Space Nuclear Propulsion Center	0	40	96	112	117	117	117	106	104	114
Pacific Launch Operations Center	0	6	17	22	22	0	0	0	0	0
Western Operations Center	60	136	308	376	405	0	0	0	0	0
North Eastern Office	0	0	25	33	0	0	0	0	0	0
NASA Headquarters	751	1,360	2,001	2,133	2,263	2,592	2,499	2,154	2,093	2,126
Totals	16,744	22,156	29,934	32,499	34,300	33,924	33,726	32,471	31,745	31,350

Center	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Johnson Space Center	4,120	3,817	3,727	3,652	3,632	3,613	3,585	3,532	3,504	3,469
Kennedy Space Center	2,631	2,467	2,409	2,309	2,259	2,259	2,230	2,179	2,193	2,191
Marshall Space Flight Center	5,804	5,341	5,214	4,500	4,113	4,115	3,910	3,760	3,636	3,561
Stennis Space Center	0	0	0	65	70	70	70	102	104	103
Goddard Space Flight Center	4,412	4,061	3,966	3,808	3.753	3,752	3,625	3,575	3,482	3,444
Wallops Station	488	448	437	420	416	415	410	407	398	395
Ames Research Center	1,922	1,771	1,730	1,701	1,678	1,676	1,613	1,669	1,666	1,658
Dryden Flight Research Center	535	493	483	484	490	498	515	490	480	461
Langley Research Center	3,790	3,495	3,411	3,375	3,309	3,321	3,135	3,071	3,005	2,980
Lewis Research Center	4,201	3,835	3,350	3,115	3,025	3,025	2,998	2,921	2,858	2,835
NASA Headquarters	1,897	1,772	1,741	1,591	1,571	1,572	1,545	1,531	1,505	1,516
Totals	29,850	27,500	26,468	25,020	24,316	24,316	23,636	23,237	22.831	22,613

Data reflects permanent FTEs
Source: NASA Congressional Budget Books

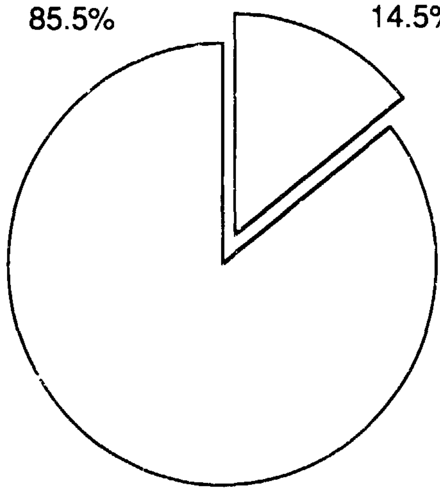
Civil Service – Full-Time Equivalent Employees (FTE) *(concluded)*

Center	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Johnson Space Center	3,380	3,346	3,255	3,196	3,247	3,337	3,254	3,302	3,437	3,587
Kennedy Space Center	2,156	2,133	2,093	2,074	2,064	2,097	2,056	2,167	2,316	2,425
Marshall Space Flight Center	3,385	3,351	3,338	3,270	3,263	3,303	3,290	3,251	3,442	3,594
Stennis Space Center	105	104	105	107	114	133	128	140	162	182
Goddard Space Flight Center	3,699	3,661	3,609	3,608	3,559	3,648	3,624	3,585	3,639	3,730
Ames Research Center	2,058	2,037	2,027	2,023	2,044	2,122	2,064	2,065	2,117	2,159
Langley Research Center	2,895	2,866	2,821	2,869	2,824	2,865	2,809	2,811	2,838	2,887
Lewis Research Center	2,690	2,663	2,520	2,634	2,647	2,704	2,652	2,640	2,662	2,725
NASA Headquarters	1,506	1,491	1,434	1,417	1,361	1,461	1,395	1,439	1,689	1,639
Totals	21,873	21,652	21,202	21,198	21,123	21,660	21,272	21,500	22,302	22,918

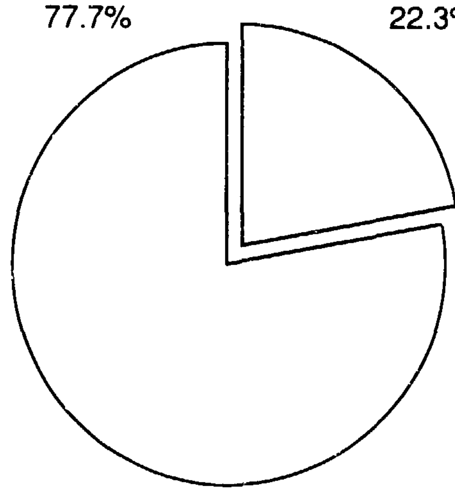
Center	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Johnson Space Center	3,665									
Kennedy Space Center	2,535									
Marshall Space Flight Center	3,661									
Stennis Space Center	222									
Goddard Space Flight Center	3,892									
Ames Research Center	2,265									
Langley Research Center	2,944									
Lewis Research Center	2,831									
NASA Headquarters	2,011									
Totals	24,026									

Data reflects permanent FTEs
Source: NASA Congressional Budget Books

Minorities in the Workforce — Permanent Personnel by Occupational Group
(As of September 30, 1991)



Professional



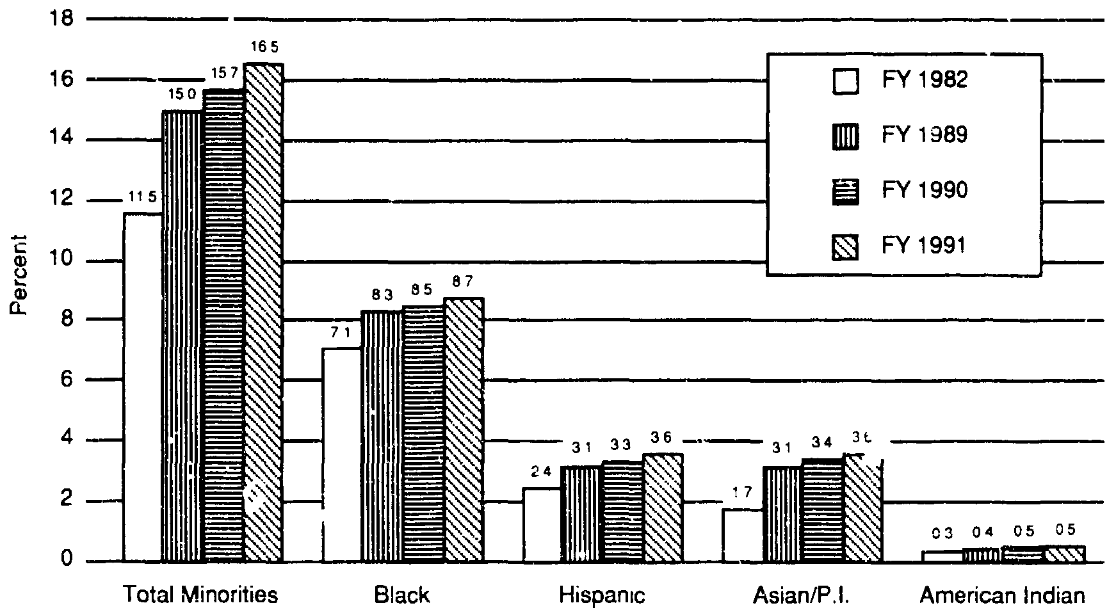
Non-Professional

Percent of Minorities in the Workforce

Occupation	Total NASA	HQ	OAST ARC	OAST LaRC	OAST LeRC	OSSA GSFC	OSF MSFC	OSF SSC	OSF JSC	OSF KSC
Science and Engineering	13.7	11.2	16.5	10.9	16.1	14.7	9.7	8.6	15.3	15.6
Professional Administrative	17.0	20.9	25.5	12.3	16.3	16.5	13.9	20.0	15.1	12.3
Clerical	29.3	53.9	41.6	28.7	19.4	26.4	16.6	8.1	30.5	17.9
Technical Support	13.4	66.7	18.0	15.1	6.4	13.6	15.2	100.0	21.3	5.1
Wage System	24.5	100.0	25.0	20.0	22.3	30.9	0.0	0.0	50.0	0.0

Source: The Civil Service Workforce, NASA Headquarters, 1991

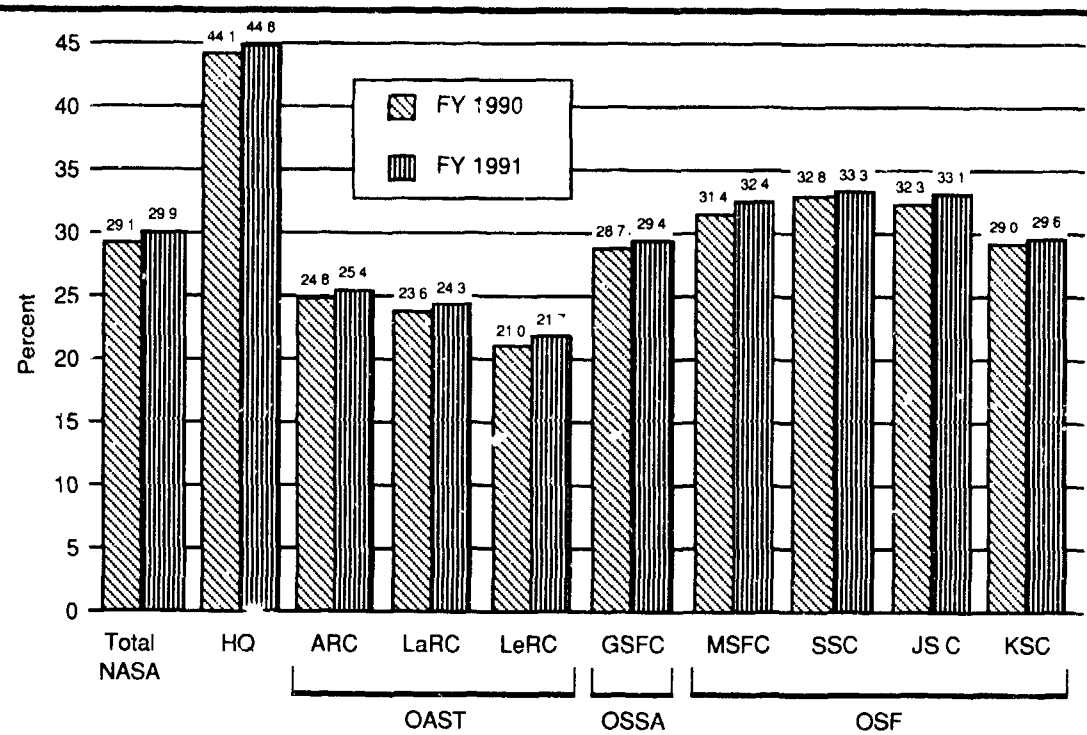
Minorities as Percent of Perman~nt Employees
By Minority Group (End FY82, FY89, FY90, FY91)



FY91	4,025	2,130	889	680	126
FY90	3,706	2,009	782	802	113
FY89	3,442	1,904	713	724	101
FY82	2,433	1,512	499	355	67

Source: The Civil Service Workforce, NASA Hdqtrs, 1991

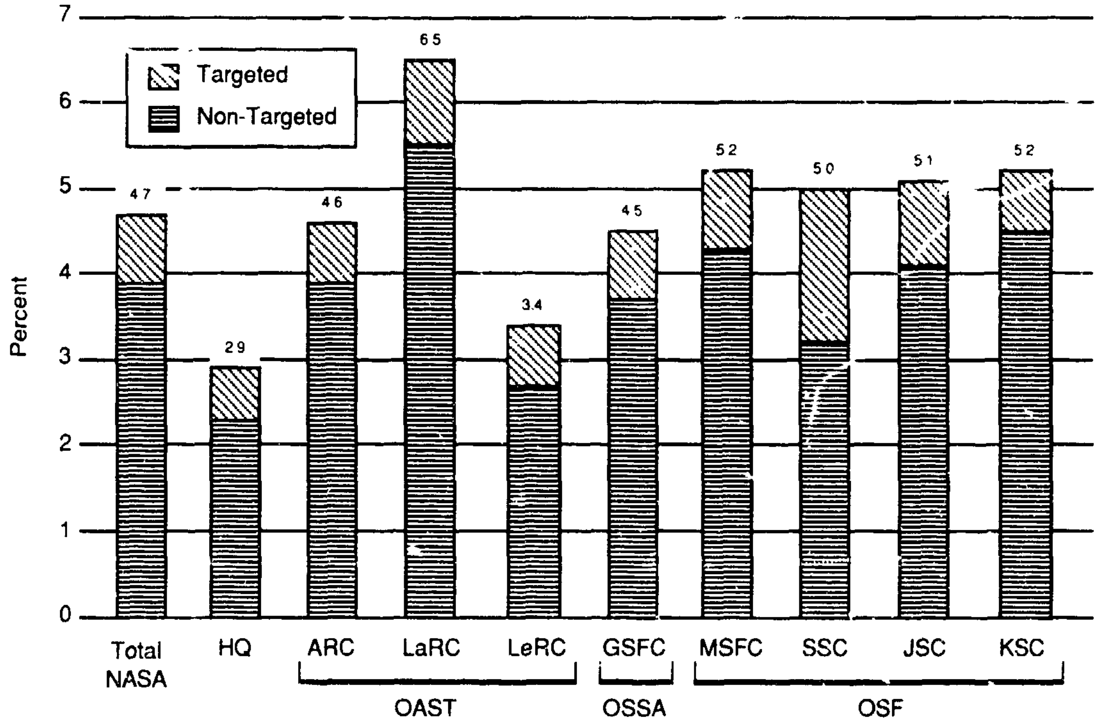
Women as Percent of Permanent Employees by Installation
End FY90 – FY91



Total Women	Total NASA	HQ	ARC	LaRC	LeRC	GSFC	MSFC	SSC	JSC	KSC
FY91	7,301	938	547	721	615	1,176	1,226	74	1,216	761
FY90	6,881	867	547	699	572	1,112	1,138	63	1,167	716
FY82	4,620	568	402	515	384	834	695	31	705	486

Source: The Civil Service Workforce, NASA Hdqtrs, 1991

Employees with Disabilities as Percent of Permanent Personnel by Installation
September 30, 1991



	Total NASA	HQ	ARC	LaRC	LeRC	GSFC	MSFC	SSC	JSC	KSC
Non-targeted disability	956	49	88	163	76	146	162	7	149	116
Targeted disability	204	12	16	31	21	30	34	4	38	18
Total	1,160	61	104	194	97	176	196	11	187	134

Source The Civil Service Workforce, NASA Hdqtrs, 1991

Full-Time Equivalent of Federal Civilian Employment by Federal Agency

Agency	Fiscal year 1990 actual	1991 actual	1992 estimate
Agriculture	110,755	110,316	111,882
Commerce	87,756	38.988	35,594
Education	4,596	4,630	4,927
Energy	16,815	17,790	19,950
Health and Human Services	117,817	121,121	125,784
Housing and Urban Development	13,264	13,601	14,331
Interior	71,233	72,346	74,900
Justice	79,082	84,073	94,286
Labor	18,050	17,720	18,241
State	25,633	25,409	25,895
Transportation	64,863	66,010	70,134
Treasury	155,931	160,192	162,949
Veterans Affairs	214,040	217,665	220,641
Environmental Protection Agency	15,155	16,323	17,622
National Aeronautics and Space Administration	23,829	24,149	24,737
Other:			
Agency for International Development	4,526	4,347	4,562
General Services Administration	19,447	19,704	20,013
Nuclear Regulatory Commission	3,188	3,300	3,335
Office of Personnel Management	5,702	5,762	6,156
Panama Canal Commission	8,293	8,551	8,603
Small Business Administration	5,316	4,887	4,697
Tennessee Valley Authority	23,716	22,273	25,000
United States Information Agency	8,598	8,226	8,543
Miscellaneous	43,506	38,125	40,453
Civilian agency employment	1,169,370	1,132,749	1,170,960
Defense — military functions	1,021,163	969,059	938,669
Total	2,190,533	2,101,808	2,109,629

Source The Federal Budget, Office of Management and Budget, Executive Office of the President, FY1992

Installation Year-End Strength — Permanent Employees

End FY82 – FY91

Fiscal Year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
HQ	1,431	1492	1,396	1,383	1,362	1,532	1,653	1,727	1,966	2,092
ARC	2,041	2,033	2,043	2,052	2,072	2,079	2,101	2,151	2,205	2,263
LaRC	2,485	2,632	2,624	2,715	2,598	2,663	2,649	2,749	2,728	2,835
LeRC	2,801	2,904	2,821	2,827	2,814	2,851	2,840	2,864	2,961	2,969
Total OAST	7,327	7,569	7,488	7,594	7,484	7,593	7,590	7,764	7,894	8,067
GSFC/OSSA	3,621	3,668	3,541	3,629	3,679	3,648	3,626	3,735	3,873	3,999
MSFC	3,332	3,351	3,223	3,284	3,260	3,384	3,340	3,609	3,619	3,788
SSC	103	106	108	122	123	137	147	183	192	222
JSC	3,268	3,235	3,227	3,330	3,26[illegible]	3,349	3,399	3,578	3,615	3,677
KSC	2,104	2,084	2,067	2,081	2,0[illegible]	2,188	2,236	2,423	2,466	2,571
Total OSF	8,807	8,776	8,625	8,817	8,703	9,058	9,122	9,793	9,892	10,258
NASA Total	21,186	21,505	21,050	21,423	21 228	21,831	21,991	23,019	23,625	24,416

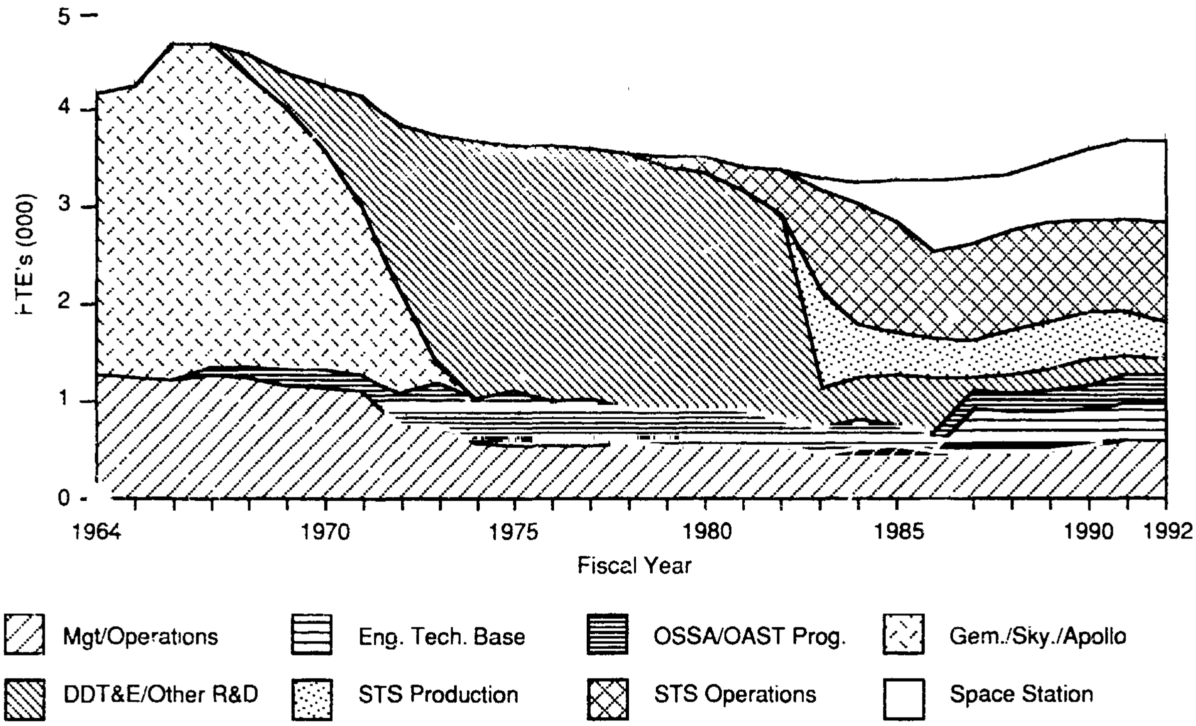
Source: The Civil Service Workforce, NASA Hdqtrs, FY1991

OAST – Office of Aeronautics and Space Technology

OSSA – Office of Space Science and Applications

OSF – Office of Space Flight

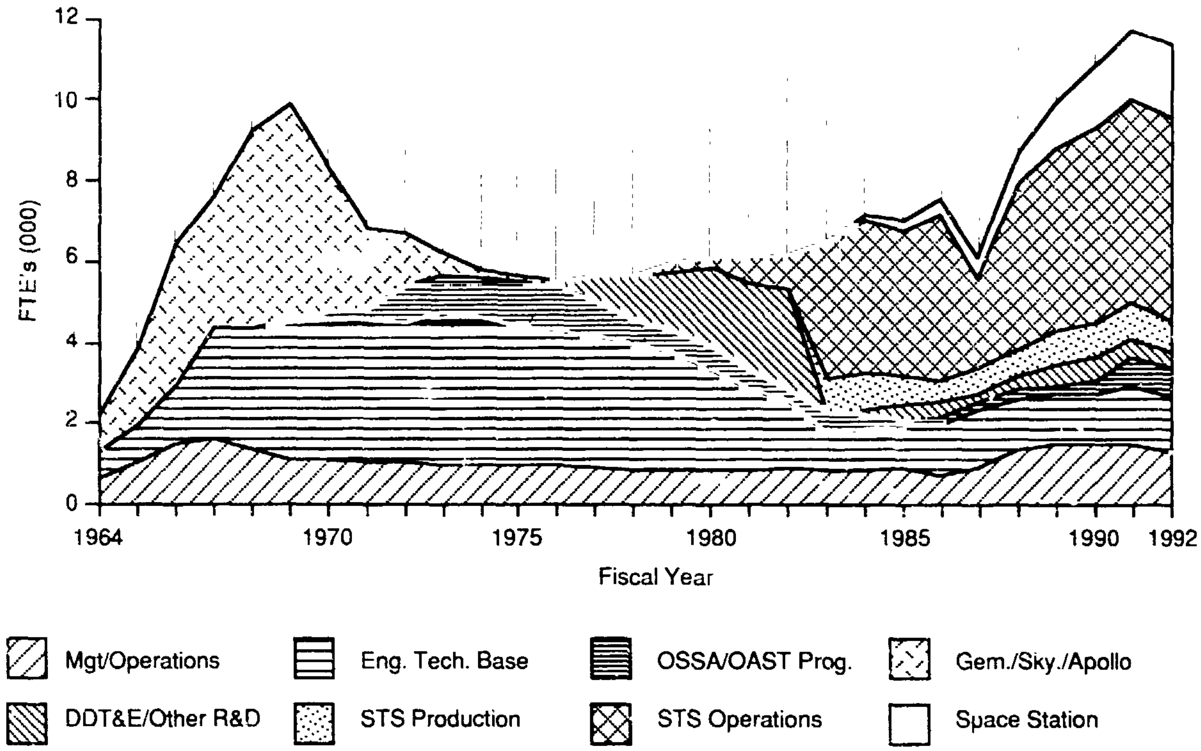
Work Force History – JSC Civil Service
By Major Programs



Expressed in equivalent people

Source: JSC Comptroller

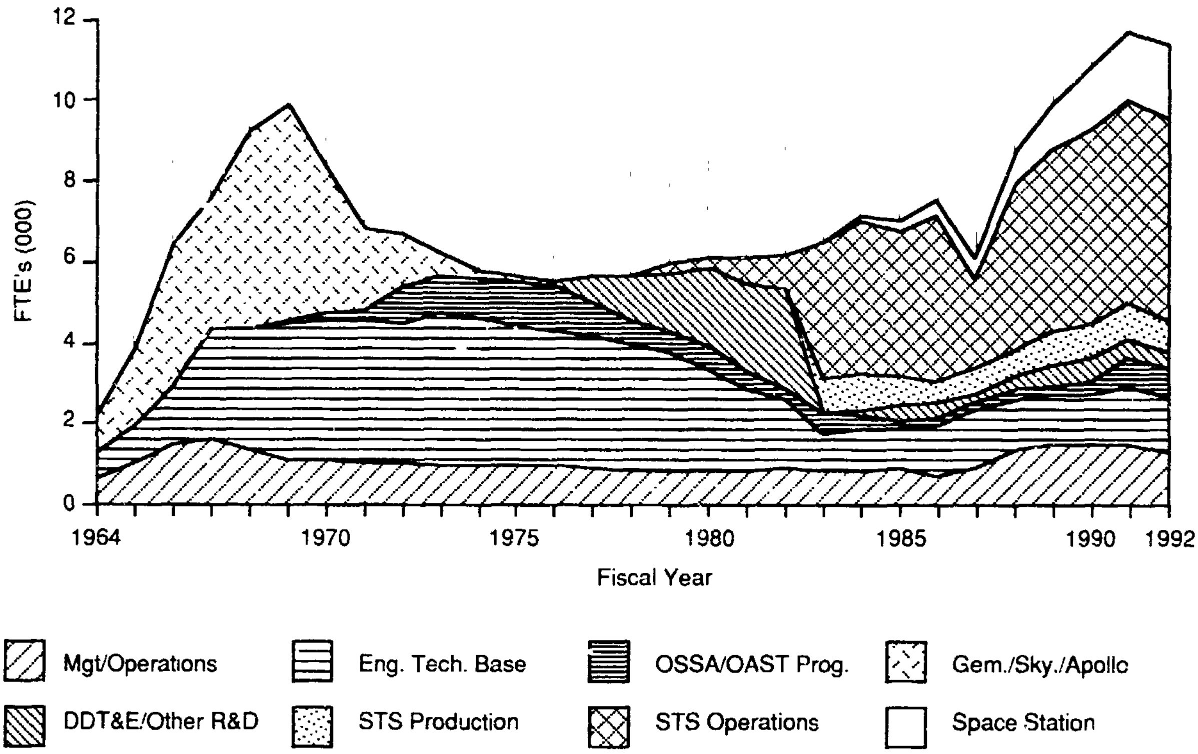
Work Force History – JSC Support Contractors
By Major Programs



Expressed in equivalent people

Source: JSC Comptroller

Work Force History – JSC Total Work Force
By Major Programs



Expressed in equivalent people

Source JSC Comptroller

IX. Procurement Activities

IX. Procurement Activities

DURING FISCAL YEAR 1992, procurement activity at JSC included contracts awarded totaling $2,113.1 million with a total of $2,690.7 million obligated. Of the total obligations, 95.9 percent was obligated to business firms, 2.3 percent was obligated to educational and other nonprofit institutions, 0.9 percent was obligated to other Federal agencies (primarily to the Air Force), and 0.9 percent was obligated to firms outside the United States. Educational and other nonprofit institutions received $63.1 million during fiscal year 1992; $29.4 million or 47 percent was obligated to educational institutions. More than 70 percent of the total dollars obligated to educational and other nonprofit institutions went to three states: Texas, Massachusetts, and Virginia. More than 93 percent of the total dollars obligated to business firms went to those in California and Texas.

Small business firms received $148.2 million or 5.8 percent of JSC's total dollars obligated to business. They received 68.0 percent of the total actions to business. Minority businesses received a total of $26.3 million.

The top ten educational and nonprofit institutions receiving the largest dollar value of individual actions, during fiscal year 1992 were the following.

Institution	Obligations	Percent of total obligations
Charles Stark Draper Laboratories	$15,062,346	25.82
Mitre Corporation	13,022,265	22.32
University of Houston — Clear Lake	6,858,318	11.76
Universities Space Research Assoc.	3,657,651	6.27
California Institute of Technology	1,669,118	2.86
Massachusetts Institute of Technology	1,475,373	2.53
Washington University	1,283,999	2.20
University of California — La Jolla	1,210,677	2.08
University of Texas Health Sciences (Dallas)	961,861	1.65
University of Chicago	911,118	1.56

Source: JSC Annual Procurement Report (FY1992)

Top 15 Contractors in Terms of Obligations During FY1992

Contractor	Percent of total obligations to all business ($2,579,350,000)	Tasks
McDonnell Douglas	28.25	Space Station work package (WP-2) DDT&E
Rockwell International Corporation	20.02	Space Shuttle Orbiter design, development, test, evaluation, and integration; replacement Orbiter (OV-105)
Rockwell Space Operations	13.41	Space Shuttle operations
Lockheed Engineering and Sciences Company, Inc.	8.34	Engineering support services
Loral Aerospace	4.79	Mission system contract/SRM&QA
IBM	2.65	Space Shuttle Orbiter primary avionics software
CAE Link Corporation	2.39	Mission Support Directorate operations and support contract
Computer Sciences Corp.	2.19	Space Station SSE
United Technologies, Inc.	1.72	Mission Support Directorate training
General Electric Co.	1.64	Science payloads, development, engineering, and operations
Spacehab Corp.	1.47	Flight equipment processing
Lockheed Missiles and Space Co., Inc.	1.40	Space Shuttle extravehicular mobility unit
Boeing Company	1.40	Medical operations and laboratory support services
KRUG International Corp.	.96	Plant maintenance and operations support services
Canadian Commercial Corp.	.91	Space Shuttle Remote Manipulator Ststem

Source: Annual JSC Procurement Report (FY1992)

Distribution of JSC Procurements
Net Value of Obligations *(Millions of Dollars)*

Fiscal year	Business*	Educational/ nonprofit*	Government agencies*	Outside U.S.*	Total
1992	2,212.7 (96.0)	63.1 (2.3)	24.7 (0.9)	23.5 (0.9)	2,690.7
1991	2,540.2 (96.1)	62.7 (2.3)	23.4 (0.9)	18.0 (0.7)	2,644.3
1990	2,667.5 (96.5)	57.0 (2.1)	20.9 (0.8)	17.6 (0.6)	2,763.0
1989	2,212.7 (96.0)	51.4 (2.2)	22.4 (1.0)	19.3 (0.8)	2,305.8
1988	1,708.2 (94.5)	34.2 (1.9)	41.7 (2.3)	23.7 (1.3)	1,807.8
1987	1,540.3 (94.6)	34.2 (2.1)	42.4 (2.6)	11.8 (0.7)	1,628.7
1986	1,296.4 (95.0)	30.4 (2.2)	33.6 (2.5)	4.2 (0.3)	1,364.6
1985	1,651.1 (96.0)	30.8 (1.8)	28.9 (1.7)	9.2 (0.5)	1,720.0
1984	1,561.1 (96.0)	23.1 (1.4)	28.1 (1.7)	13.7 (0.9)	1,626.0
1983	1,664.0 (95.7)	23.9 (1.4)	32.8 (1.9)	17.7 (1.0)	1,738.4
1982	1,627.6 (96.3)	18.7 (1.1)	26.7 (1.6)	17.6 (1.0)	1,690.6
1981	1,567.7 (96.4)	20.0 (1.3)	21.8 (1.3)	16.7 (1.0)	1,626.2
1980	1,380.4 (96.6)	19.0 (1.3)	20.8 (1.4)	9.5 (0.7)	1,429.7
1979	1,154.9 (96.4)	16.2 (1.3)	22.4 (1.9)	4.6 (0.4)	1,198.1
1978	980.9 (96.6)	17.6 (1.7)	17.4 (1.7)	.2 (<.1)	1,016.1
1977	1,083.4 (97.1)	16.8 (1.5)	15.4 (1.4)	<.1 (<.1)	1,115.6
1976	991.7 (96.7)	16.9 (1.7)	16.3 (1.6)	<.1 (<.1)	1,024.9
1975	801.1 (96.3)	17.5 (2.1)	13.3 (1.6)		831.9
1974	633.3 (93.6)	24.1 (3.5)	19.4 (2.9)		676.8
1973	449.9 (91.4)	24.9 (5.0)	17.6 (3.6)		492.4
1972	391.6 (87.1)	35.4 (7.9)	22.4 (5.0)		449.4
1971	542.0 (89.0)	45.1 (7.4)	21.9 (3.6)		609.0
1970	995.5 (94.0)	36.6 (3.5)	26.8 (2.5)		1,058.9
1969	1,101.4 (95.3)	28.9 (2.5)	25.8 (2.2)		1,156.1
1968	1,174.1 (95.2)	31.6 (2.6)	26.8 (2.2)		1,232.5
1967	1,408.4 (94.7)	26.6 (1.8)	51.9 (3.5)		1,486.9
1966	1,396.9 (90.3)	22.0 (1.4)	127.8 (8.3)		1,546.7
1965	1,280.5 (86.1)	21.5 (1.4)	185.4 (12.5)		1,487.4
1964	1,234.6 (85.2)	18.9 (1.3)	195.1 (13.5)		1,448.6
1963	560.8 (76)	15.4 (2)	161.0 (22)		737.2
1962	169.2 (83)	3.1 (1)	32.2 (16)		204.8

*Numbers in parentheses are percentages.

Source: JSC Annual Procurement Reports (FY1963-1992).

Small Business and Minority Business Participation in JSC Procurement Activity
(Millions of Dollars)

Fiscal year	Total value of obligations	Small business value of obligations*	Minority business value of obligations*
1992	2,579.4	148.2 (5.75)	26.3 (1.0)
1991	2,540.2	123.6 (4.87)	32.3 (1.3)
1990	2,667.5	128.4 (4.81)	37.8 (1.4)
1989	2,212.7	117.3 (5.30)	35.4 (1.6)
1988	1,708.2	92.1 (5.4)	24.1 (1.41)
1987	1,540.3	89.3 (5.8)	27.5 (1.79)
1986	1,296.4	79.3 (6.1)	23.7 (1.83)
1985	1,651.1	74.4 (4.5)	20.4 (1.24)
1984	1,561.1	58.9 (3.8)	15.3 (0.98)
1983	1,664.0	57.1 (3.43)	13.5 (0.81)
1982	1,627.6	49.5 (3.04)	16.4 (1.01)
1981	1,567.7	40.7 (2.6)	10.0 (0.64)
1980	1,380.4	33.4 (2.4)	2.1 (0.15)
1979	1,154.9	28.2 (2.4)	2.4 (0.21)
1978	980.9	25.3 (2.6)	2.4 (0.25)
1977	1,083.4	25.1 (2.3)	2.7 (0.25)
1976	991.7	19.6 (2.0	2.3 (0.23)
1975	801.1	22.1 (2.8)	1.78 (0.22)
1974	633.3	20.8 (3.3)	1.4 (0.22)
1973	449.9	19.8 (4.4)	0.431 (0.09)
1972	391.6	21.3 (5.4)	0.611 (0.16)
1971	542.0	29.3 (5.4)	
1970	995.5	27.8 (2.8)	
1969	1,101.4	22.8 (2.1)	
1968	1,174.1	27.3 (2.3)	
1967	1,408.4	28.9 (2.1)	
1966	1,396.9	17.2 (1.2)	
1965	1,280.5	23.3 (2.0)	
1964	1,234.6	21.5 (2.0)	
1963	560.8	11.6 (2.1)	

*Numbers in parentheses are percentages.

Source: JSC Annual Procurement Reports (FY1963-1992).

Obligations to Educational and Other Nonprofit Institutions
(Millions of Dollars)

Fiscal year	Contracts		Grants		Total
	Educational	Nonprofit	Educational	Nonprofit	
1992	5.8	32.6	23.6	1.1	63.1
1991	5.5	33.8	21.8	1.6	62.7
1990	4.9	28.8	22.0	1.3	57.0
1989	5.2	25.3	18.9	2.0	51.4
1988	4.9	10.1	17.8	1.4	34.2
1987	7.2	11.3	14.9	0.8	34.2
1986	7.4	10.5	11.9	0.6	30.4
1985	9.8	7.0	13.4	0.6	30.8
1984	7.3	9.2	6.1	0.5	23.1
1983	8.8	9.9	4.9	0.3	23.9
1982	7.1	7.5	3.9	0.2	18.7
1981	6.9	8.9	4.0	0.2	20.0
1980	6.3	8.6	4.0	0.1	19.0
1979	5.7	7.9	2.5	0.1	16.2
1978	6.3	6.3	4.9	0.1	17.6
1977	6.5	5.0	5.0	0.3	16.8
1976	6.0	5.6	5.1	0.2	16.9
1975	8.2	4.4	4.6	0.3	17.5
1974	7.3	10.5	6.0	0.3	24.1
1973	14.8	3.2	6.6	0.3	24.9
1972	25.7	7.0	2.3	0.4	35.4
1971	35.9	0.7	8.0	0.5	45.1
1970	31.9	2.8	1.8	0.1	36.6
1969	25.8	1.2	1.8	0.1	28.9
1968	29.3	1.0	1.1	0.2	31.6
1967	24.3	0.84	1.44	0.06	26.6
1966	19.5	1.5	1.0	0.0	22.0
1965	19.5	1.6	0.3	0.1	21.5
1964	18.1	0.4	0.2	0.2	18.9
1963					15.4

Source: JSC Annual Procurement Reports (FY1963-1992).

Geographical Distribution of JSC Procurement Excluding Intragovernmental Actions

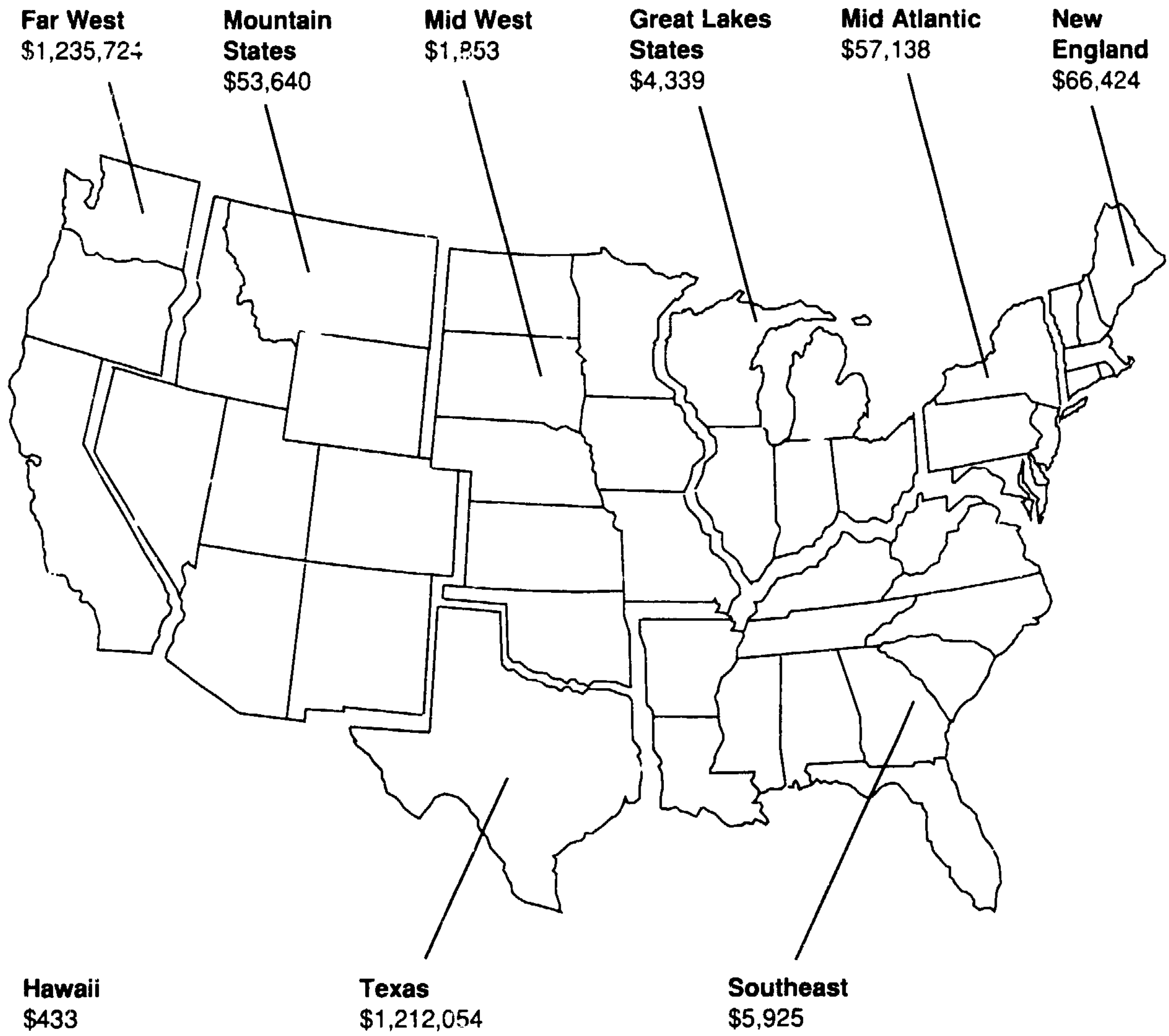
(Thousands of Dollars)

Fiscal year	Far West	Mountain states	Mid West	Texas	Great Lakes states	Southeast	Mid-Atlantic	New England	Alaska	Hawaii	Outside U.S.
1992	1,235,724	58,603	1,853	1,212,054	4,339	5,925	57,138	66,424	—	433	23,471
1991	1,300,769	53,640	3,337	1,147,920	3,290	6,491	35,869	51,425	—	283	18,023
1990	1,393,858	50,179	12,800	1,168,379	8,893	11,144	31,859	47,234	—	204	17,575
1989	1,100,352	40,864	27,217	1,011,218	12,305	5,311	3,543	43,250	2	—	19,310
1988	817,100	22,586	21,453	746,552	5,726	55,154	35,305	38,479	3	—	23,705
1987	758,582	21,941	5,410	608,252	8,313	82,698	50,730	38,561	1	—	11,767
1986	1,572,304	18,396	3,585	562,902	7,759	72,151	38,002	51,627	30	39	4,179
1985	928,363	15,671	4,148	513,797	5,330	68,433	72,647	73,444	3	—	9,199
1984	922,942	23,681	2,074	453,315	3,508	54,418	65,799	58,952	—	1	13,289
1983	1,060,422	30,553	2,785	407,972	7,861	58,131	52,704	67,446	1	—	17,715
1982	1,146,372	12,390	1,955	344,822	5,603	46,892	43,722	44,572	3	—	17,624
1981	1,144,176	23,471	2,220	266,274	7,726	35,159	68,204	40,443	—	10	16,663
1980	978,514	33,594	2,536	246,268	4,634	30,166	65,573	37,973	75	9	9,543
1979	810,162	4,341	1,568	218,901	5,002	23,631	56,719	50,852	<1	9	4,568
1978	679,861	21,226	7,948	197,161	4,959	8,932	51,602	26,807	10	36	211
1977	827,093	14,857	4,350	182,124	4,944	10,978	41,866	13,971	-(23)	7	47
1976	770,773	8,766	2,267	141,394	5,500	10,958	61,527	7,451	-(3)	<1	-(18)
1975	607,405	7,252	7,849	128,873	6,001	11,661	42,328	7,068	108	2	80
1974	433,411	15,945	13,041	109,159	5,450	9,101	58,218	12,971	30	1	132
1973	257,618	22,657	9,682	103,945	10,370	5,189	44,578	20,617	45	2	119
1972	140,366	28,971	17,495	116,605	26,357	3,697	57,394	35,991	145	<1	12
1971	153,588	20,717	14,233	118,974	60,967	3,717	154,992	59,420	192	33	287
1970	403,248	55,258	18,919	139,283	42,688	13,723	304,118	54,529	21	—	275
1969	494,057	14,411	17,801	83,403	49,790	53,330	375,966	40,613	422	—	443
1968	503,871	8,143	27,395	84,240	71,204	40.309	433,867	35,265	103	—	278
1967	591,218	7,666	16,714	74,681	98,342	27,832	578,907	39,367	—	—	348
1966	694,966	7,368	58,795	50,566	134,649	24,862	405,612	41,785	89	—	—
1965	654,503	7,261	177,478	30,360	76.624	23,998	295,892	38,375	—	—	—
1964	991,226	3,046.6	654,659.3	19,158.5	55,810	53,648.7	209,133.3	79,535.9	—	—	—

Source: JSC Annual Procurement Reports (FY1963-19912).

Geographical Distribution of Procurements*

Lyndon B. Johnson Space Center — FY1992



Outside U.S.
$23,471

(thousands of dollars)

*Excludes intragovernmental actions
Source. Fiscal Year 1992 Annual Procurement Report, October 1992.

NASA Expenditures by State

(Geographic Distribution of FY199 NASA Budget)

Alabama	$1.2B	Montana	$1.2M
Alaska	8.6M	Nebraska	1.4M
Arizona	43.7M	Nevada	1.6M
Arkansas	407k	New Hampshire	14.5M
California	3.1B	New Jersey	120.7M
Colorado	196.0M	New Mexico	57.3M
Connecticut	73.6M	New York	58.4M
Delaware	3.2M	North Carolina	11.9M
District of Columbia	130.8M	North Dakota	4[illegible]
Florida	1.5B	Ohio	291
Georgia	13.4M	Oklahoma	7.3M
Hawaii	8.4M	Oregon	8.0M
Idaho	2.8M	Pennsylvania	190.2M
Illinois	17.7M	Rhode Island	3.5M
Indiana	12.1M	South Carolina	1.6M
Iowa	11.5M	South Dakota	882k
Kansas	2.1M	Tennessee	33M
Kentucky	1.2M	Texas	1.3B
Louisiana	373.1M	Utah	528.6M
Maine	1.3M	Vermont	515k
Maryland	953M	Virginia	504.9M
Massachusetts	137.7M	Washington	39.0M
Michigan	44.1M	West Virginia	11M
Minnesota	5.9M	Wisconsin	39.6M
Mississippi	324.1M	Wyoming	640k
Missouri	10.5M		

Source: JSC Procurement Office Support Division/BD.

Total NASA Procurement by Installation *(FY1992)*

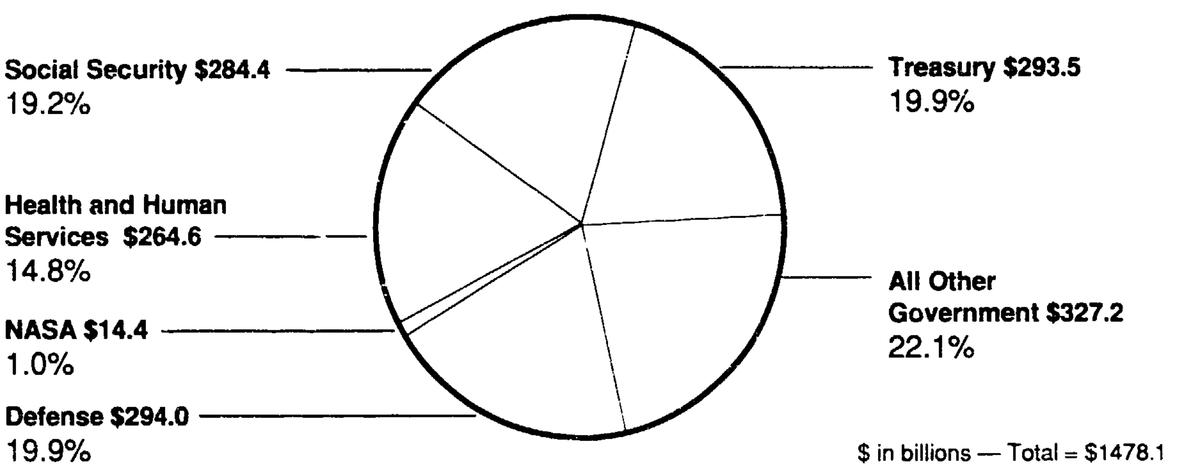
Installation		Awards (millions of dollars)	Percent
Marshall Space Flight Center		3,234.1	24.0
Johnson Space Center		2,686.9	19.9
Goddard Space Flight Center		2,044.3	15.2
Kennedy Space Center		1,484.6	11.0
NASA Resident Office / JPL		1,263.7	9.4
Headquarters		808.6	6.0
Lewis Research Center		831.6	6.2
Ames Research Center		568.0	4.2
Langley Research Center		436.0	3.2
Stennis Space Center		120.4	.9
	Total	13,478.2	100.0

Source. JSC Procurement Support Division/BD

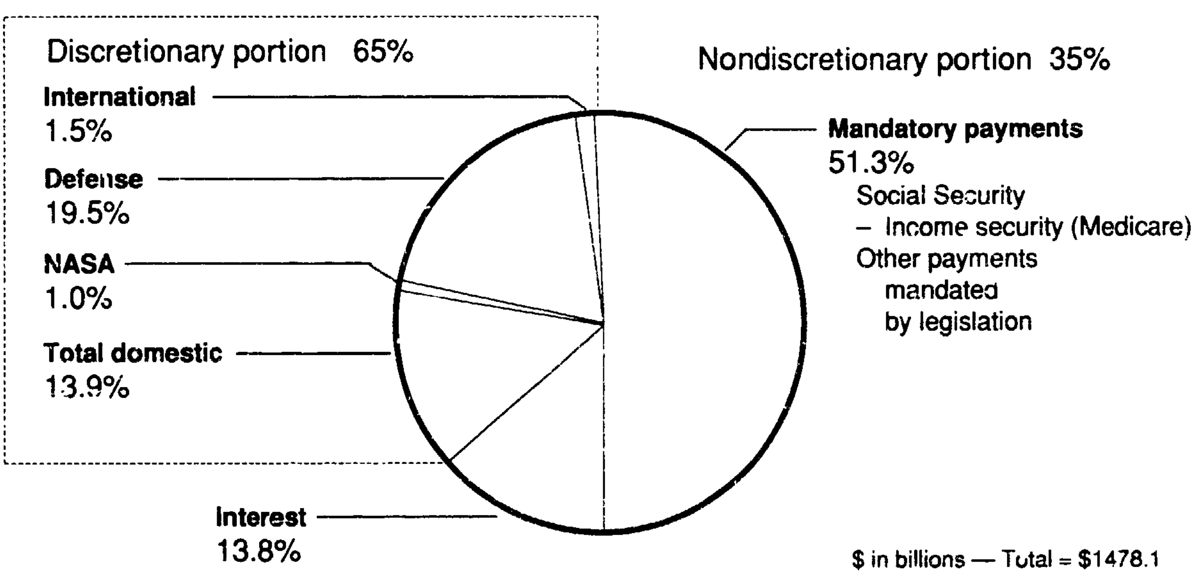
X. NASA/JSC Budget Activities

X. NASA and JSC Budget Activities

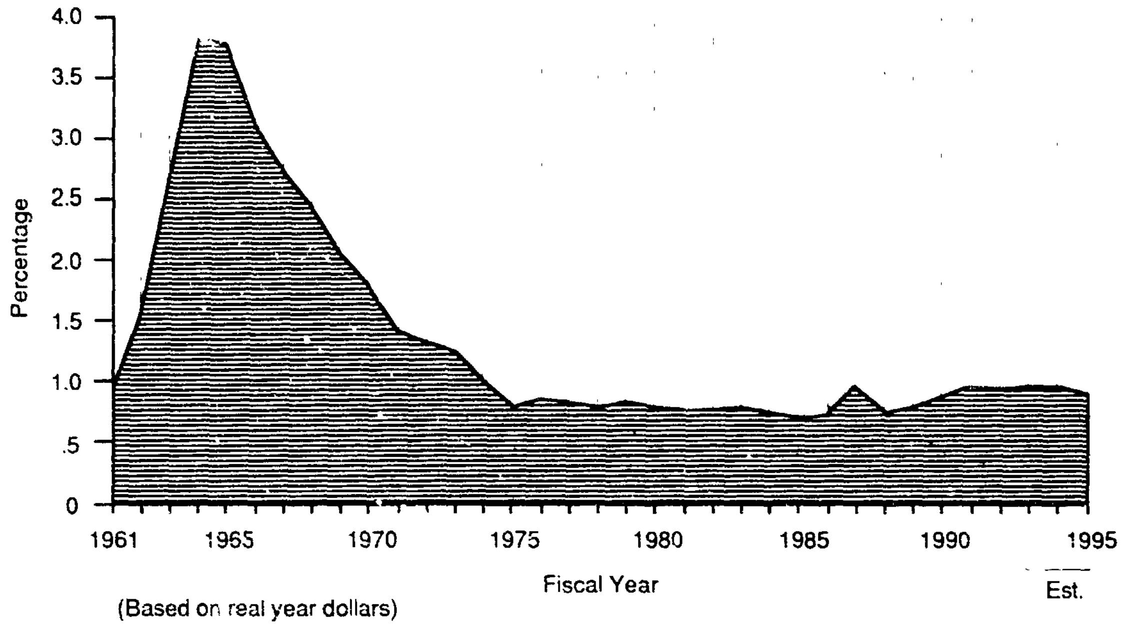
NASA as a Part of the Federal Budget
By Major Segments – FY92 Budget Authority



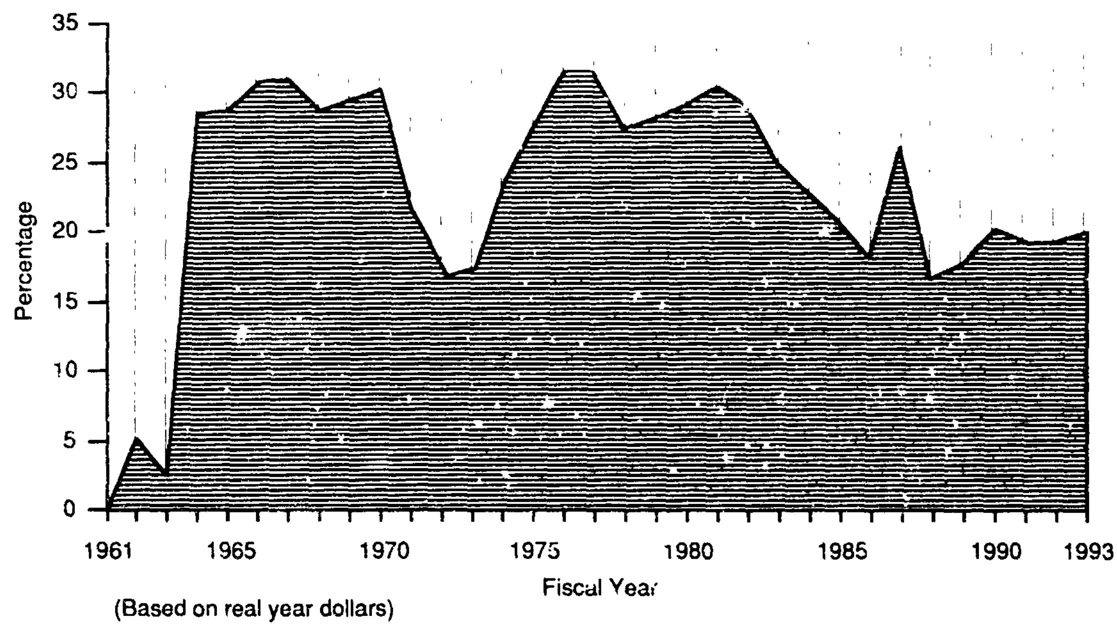
NASA as a Part of the Federal Budget
By Control Categories – FY92 Budget Authority



Percent of NASA to Total Federal Budget
Budget Authority



Percent of JSC to NASA Budget
Budget Authority



Source: Office of the Comptroller, JSC

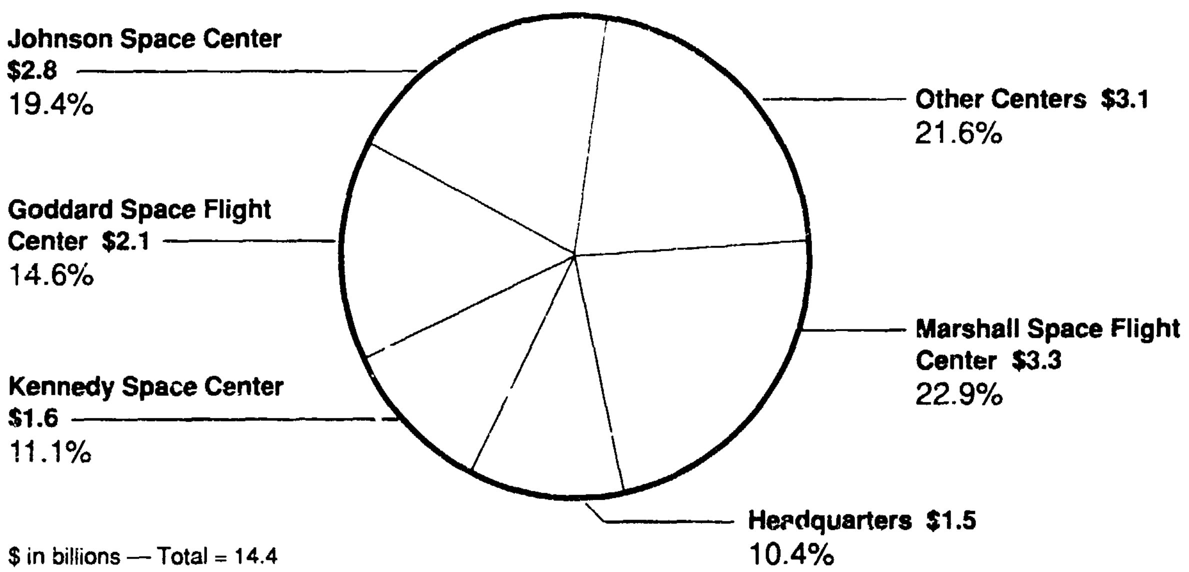
Johnson Space Center Budget by Program Office

Program Office *(Obligations in millions)*	PY1991 actual	PY1992 appropriation	PY1993 request
Office of Space Flight — Program	$2,078.6	$2,134.2	$2,357.4
• Space Shuttle	1,156.7	1,112.4	1,222.1
• Space Station	838.3	908.9	994.5
• Other space flight research and development	83.6	112.9	140.8
Office of Space Flight — Institution	496.6	510.3	537.8
• Personnel compensation	221.9	237.3	248.1
• Travel	7.1	6.8	7.3
• Operation of installation	109.4		
• Engineering technical base	112.7	114 6	120.0
• Program mission support *(OSF funded)*	45.5	50.6	55.0
• Research Operations Support		101.0	107.4
Office of Space Science and Application	79.8	83.5	102.9
Office of Aeronautics, Exploration and Technology *(PMS included)*	16.6	17.9 (1.1)	14.1 (3.5)
Office of Commercial Programs		44.2	55.5
Other NASA Programs/Program Office *(Includes exploration, SMQ external relations)*	4.2	4.8	19.8
Construction of facilities	53.9	30.9	16.5
Total	$2,729.9	$2,825.8	$3,104.0

SMQ – (Office of) Safety and Mission Quality
PMS – Program Mission Support
OSF – Office of Space Flight

PY – program year
Source: JSC Office of the Comptroller

NASA Budget by Center
FY1992 Budget Authority



FY92 Appropriations by Congressional Budget Line Items

(Dollars in millions)

Appropriation/budget line item	NASA	JSC	JSC Percentage
Research and development	**$6,850.8**	**$1,353.8**	**19.8**
Space Station	2,028.9	941.0	46.4
Space transportation capability development	719.5	262.4	36.5
Physics and Astronomy	1,047.3	14.7	1.4
Life sciences	148.9	53.6	36.0
Planetary exploration	534.5	12.9	2.4
Space applications	998.1	2.3	0.2
Technology utilization	32.5	4.0	12.3
Commercial use of space	115.1	40.2	34.9
Aeronautical research and technology	784.3	0.0	0.0
Space research and technology	314.3	17.9	5.7
Space exploration	0.0	0.0	0.0
Transatmospheric research and technology	5.0	0.0	0.0
Safety, reliability, and quality assurance	33.6	2.8	[illegible]
Academic programs	66.8	2.0	3.0
Tracking and data advanced systems	22.0	0.0	0.0
Space flight control, and data communications	**5,384.8**	**1,197.0**	**22.2**
Shuttle production and operations capability	1,327.8	380.7	28.7
Space Shuttle operations	2,943.4	816.3	27.7
Expendable launch vehicles	195.3	0.0	0.0
Space and ground networks, communications and data systems	918.3	0.0	0.0
Research and program management	**1,577.6**	**244.0**	**15.5**
Construction of facilities	**525.0**	**30.9**	**5.9**
Inspector general	**14.6**	**0.0**	**0.0**
Total NASA budget	$14,352.8	$2,825.7	19.7

Source: JSC Office of the Comptroller

History of NASA/JSC Resources

Fiscal year	Total Fed. BA (RY$M)	NASA NOA (RY$M)	NASA/ Fed. percent	JSC NOA (RY$M)	JSC/ NASA percent (RY$M)	JSC R&D (RY$M)	JSC SFCDC (RY$M)	JSC R&PM (RY$M)	JSC CofF (RY$M)	NASA NOA (CY$M)	JSC NOA (CY$M)
1961	110,428	964	0 87	0	0.00		N/A			6,078	0
1962	118,814	1,825	1.54	91	4 99	N/A	N/A	24	67	11,065	552
1963	130,685	3,674	2.81	76	2.07	N/A	N/A	51	25	21,519	445
1964	132,636	5,100	3.85	1,467	28.76	1,363	N/A	68	36	28,586	8,223
1965	138,610	5,250	[illegible]	1,538	29.30	1,423	N/A	91	24	28,460	8,337
1966	163,127	5,175	3 17	1,601	30.94	1,510	N/A	87	4	26,465	8,188
1967	182,562	4,968	2.72	1 554	31.28	1,448	N/A	96	10	24,219	7,576
1968	190.649	4,589	2.41	1,327	28.92	1,230	N/A	96	1	21,244	6,137
1969	196,167	3,995	2.04	1,191	29.81	1,091	N/A	99	1	17,482	5,212
1970	212,873	3,749	1.76	1,146	30.57	1,037	N/A	107	2	15,348	4,692
1971	236,406	3.312	1.40	719	21.71	607	N/A	111	1	12,755	2,769
1972	248,097	3,310	1.33	559	16.89	446	N/A	113	0	12,058	2,036
1973	276,417	3,408	1.23	601	17.63	490	N/A	110	1	11,747	2,072
1974	313,861	3,040	0.97	743	24.44	614	N/A	118	11	9,774	2,389
1975	412,099	3,231	0.78	918	28.41	793	N/A	121	4	9,376	2,664
1976	415,336	3,550	0.85	1,131	31.86	997	N/A	129	5	9,450	3,011
76TQ	91,409	932	1.02	283	30.36	244	N/A	38	1	2,431	738
1977	465,231	3,819	0.82	1,229	32.18	1,084	N/A	140	5	9,177	2,953
1978	501,500	4,063	0.81	1,121	27.59	969	N/A	147	5	9,056	2,499
1979	556.732	4,559	0.82	1,306	28.65	1,151	N/A	153	2	9,282	2,659
1980	658,790	5,243	0.80	1,558	29.72	1,388	N/A	165	5	9,642	2,865
1981	[illegible]	5,523	0 77	1,703	30.83	1,524	N/A	176	3	9,152	2,822
1982	779,926	6,053	0 78	1,789	29.56	1,598	N/A	187	4	9,237	2,730
1983	866,745	6,875	0.79	1,745	25 38	151	1,399	195	0	9,831	2,495
1984	949,751	7,243	0.76	1,682	23.22	[illegible]	1,303	201	2	9,793	2,274
1985	1,074,063	7,552	0.70	1,618	21.42	240	1,160	215	3	9,825	2,105
1986	1,072,773	7,764	0.72	1,445	18.61	245	988	206	6	9,775	1,819
1987	1,099,893	10,775	0.98	2,909	27.00	325	2,338	228	18	13,070	3,529
1988	1,185,526	9,001	0.76	1,528	16.96	327	908	282	11	10,378	1,762
1989	1,309,913	10,897	0.83	1,935	17 76	562	1,049	299	25	11,954	2,123
1990	1,368,500	12,295	0.90	2,547	20 72	1,037	1,129	321	60	12,787	2,649
1991	1,398,243	12,868	0.99	2,740	19.76	1,186	1,162	338	54	12,868	2,740
*1992	1,456,925	14,353	0.99	2,826	19.69	1,354	1,197	244	31	13,721	2,702
**1993	1,501,999	14,993	1.00	3,104	20.70	1,507	1,325	255	17	13.674	2,831
***1994	1,532,210	14,993	0.96	0	0 00					13,014	0
***1995	1,608,298	14,993	0.93	0	0 00					12,339	0

BA – budget authority
CofF – Construction of Facilities
CY$M – current year dollars in millions
FFB – Federal Financing Bank
NOA – new obligational authority
RY$M – real year dollars in millions
SFCDC – Space Flight Control and Data Communications
SSF – Space Station Freedom

[redacted] (SM)

Actual SSF portion of R&D – JSC

FY83–85	73.6
FY1986	83.7
FY1987	154.4
FY1988	135.2
FY1989	336.6
FY1990	786.8
FY1991	853.8
FY1992	941.0

JSC Federal Funding Since Inception in 1962

	$, billions
Total Appropriations received through FY1991:	44.8
Direct space-related programs	39.6
Institutional operations	4.7
Construction of facilities	.5

Sources of data: Budget of the United States Government, "Budget by Agency and Account" (Excludes FFB transfers, includes DOD transfers) – Data assembled by HQ-Comptroller
JSC data from actual columns of annual NASA congressional budget submits
(CY$) are indexed using 1991 NASA New Start Inflation Index prepared by HQ Code B
* Current year appropriation
** President's budget request
*** President's Budget Outyear Planning Estimates

Source: Office of the Comptroller, JSC

XI. Economic Impact

XI. Economic Impact on Clear Lake/Houston Economy

IN FISCAL YEAR 1992, NASA's Johnson Space Center (JSC) continued its 30 year history of providing a major economic stimulus to Houston, the State of Texas, and the nation through contract and grant awards. JSC also provides a major source of high-tech scientific and engineering, professional, and administrative jobs related to one of America's most exciting and challenging endeavors, the manned space flight program.

NASA is unique among Federal agencies in that over 80 percent of its funding goes to contractors, compared with 11 percent government-wide. This is a major stimulant for the private aerospace sector of our economy where our nation enjoys a technological competitive edge in the world economy.

The Johnson Space Center in fiscal year 1992 directly contributed nearly $1.45 billion to the Houston area economy, or 51 percent of JSC's total budget of $2.8 billion. Ten percent of the total NASA budget directly benefitted the Houston economy. This spending was for federal salaries, contractor salaries and services, utilities, materials and equipment, and other needed services.

In reality, the economic impact is even higher than the published numbers would indicate. For example, not estimated is the economic value of tourism to the Center and multiple secondary effects of JSC spending.

Since its inception in 1962, the Johnson Space Center has received over $47.4 billion in Federal appropriations, which translates to over $128 billion in 1992 dollars. For 1991, JSC spent $1.2 billion in California, $1.2 billion in Texas, and $300 million for contracts and grants in 39 other states. JSC received 20 percent of NASA's total budget of $14.3 billion in 1992. Over 45 percent of NASA's budget for Space Station Freedom resides at JSC, along with 28 percent of NASA's space shuttle budget. In addition to Texas, California is a major beneficiary of JSC's spending because most of the aerospace production facilities for shuttle and station are located there.

As an indication of the quality of federal jobs created by JSC, the average federal salary at the Center is $51,100. The average age of JSC employees is 43. Of the 3,641 full time permanent JSC employees, 2,869 or 78.7 percent hold bachelor degrees, 922 or 25.3 percent hold masters degrees, and 205 or 5.6 percent hold doctorate or equivalent post graduate degrees.

Of the nearly $1.45 billion spent in the Houston area in 1992, $186 million went for federal salaries; $133 million for 1,328 prime contractors located on or near site; $905 million for 11,600 support contractors; $17 million for utilities and communications; $32 million for construction of facilities; and the balance for other goods, services and non-federal salaries. Around $11.8 million was spent for grants and contracts with 17 different colleges and universities within the state of Texas during 1992.

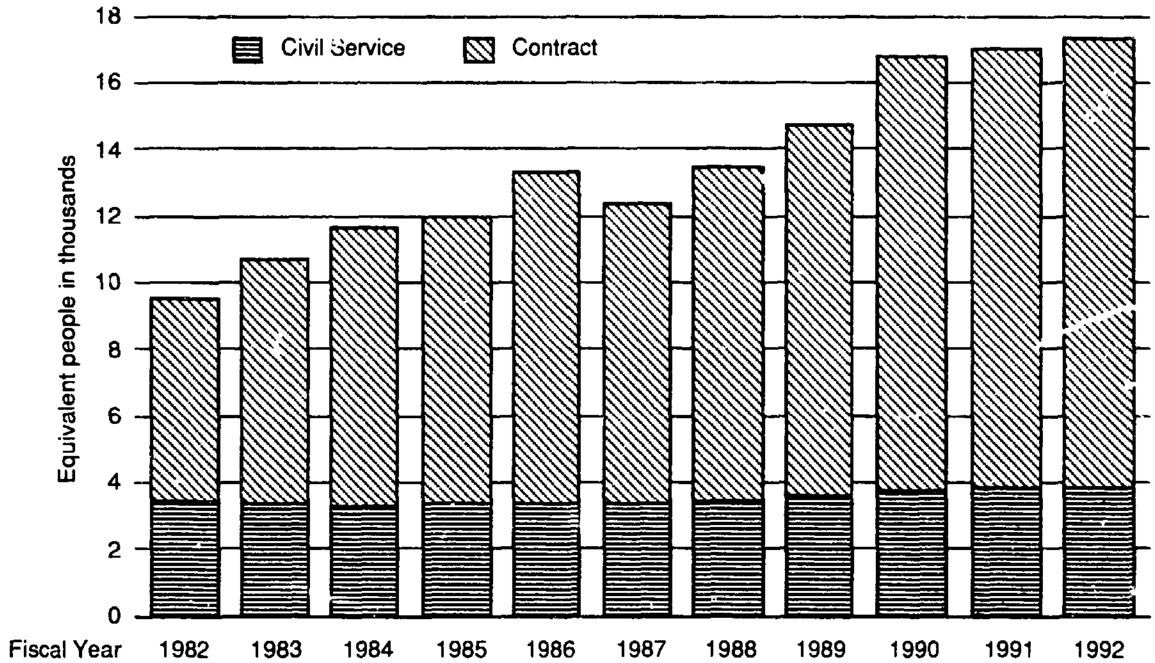
Overall, NASA's FY1992 budget is less than 1 percent of the total federal budget. JSC's budget is 1/5 of 1 percent. The total 1992 NASA budget for space station is less than 1/5 of 1 percent. This very small national investment supports high tech jobs, education, and critical environmental research; produces medical and life sciences breakthroughs; advances science and technology; enhances our national competitiveness; and stretches the limits of knowledge about our universe. ❑

JSC Economic Impact Overview — FY1992

Total NASA Funding Received at JSC	**$2,840.0**
Space Shuttle Program Related	1,287.2
Space Station Program Related	999.3
Other Space R&D Related	333.2
Institution Related	220.3
NASA Dollars Fed into Local Economy	**$1,410.8**
Space Shuttle Program Related	684.0
Space Station Program Related	312.3
Other Space R&D Related	251.2
Institution Related	163.3
Percent of NASA Dollars which stay in local economy	**49.7%**
Space Shuttle Program Related	53.1%
Space Station Program Related	31.3%
Other Space R&D Related	75.4%
Institution Related	74.1%
Total JSC-Related Economic Contribution *(Includes Direct and Indirect)*	**$1,454.1**
Number of Equivalent People	**20,913**
NASA Civil Service	3,763
Support Contractors (Excludes Subcontractors)	11,600
Prime Contractors in Houston Area	1,328
Other JSC-related	314
Percentage of Total Work Force by Program	
Space Shuttle Program Related	51.4%
Space Station Program Related	22.0%
Other Space R&D Related	17.0%
Institution Related	9.6%
Number of Visitors to JSC	**982,000**

Source: JSC Office of the Comptroller

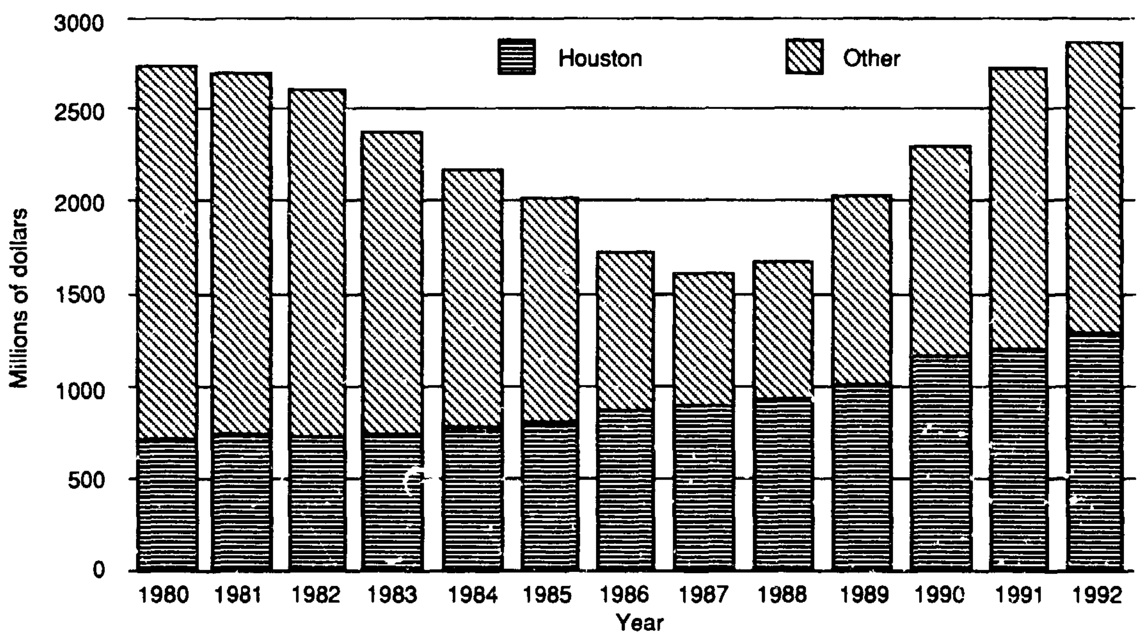
JSC Workforce in the Houston Area



Contract/Other	7.061	7.298	8.378	8.555	9.969	8.937	10.035	11.121	12.999	13.207	13.242
Civil Service	3.459	3.399	3.315	3.404	3.354	3.395	3.457	3.608	3.751	3.800	3.763

JSC Dollars Spent in Houston Area

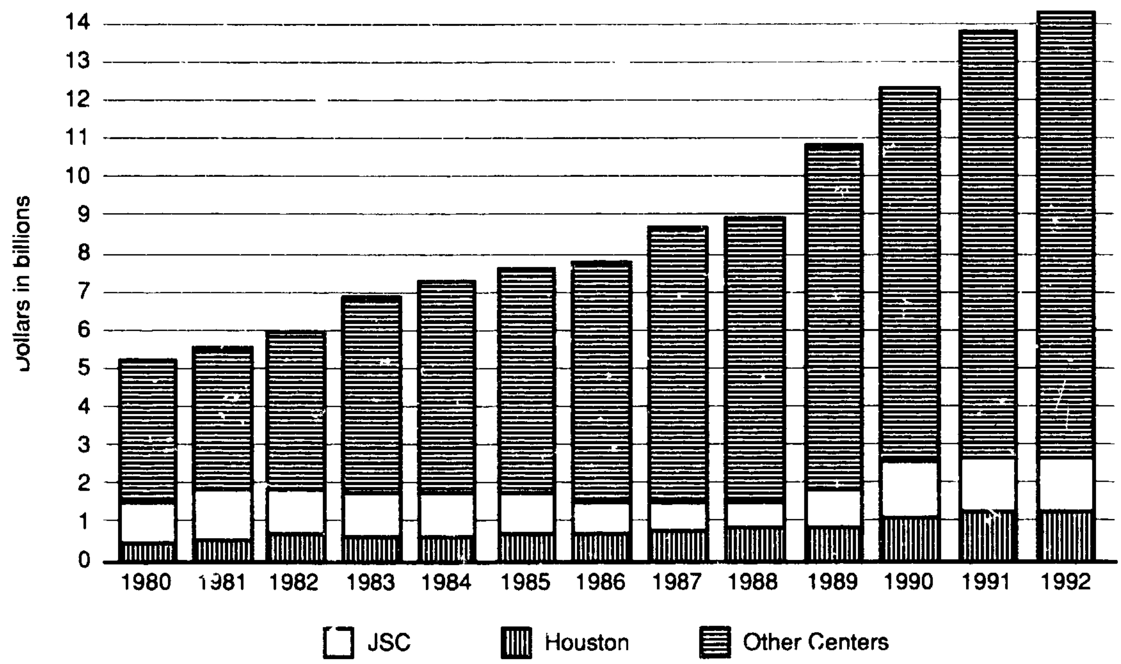
Expressed in Current Year (1991/1992) Dollars



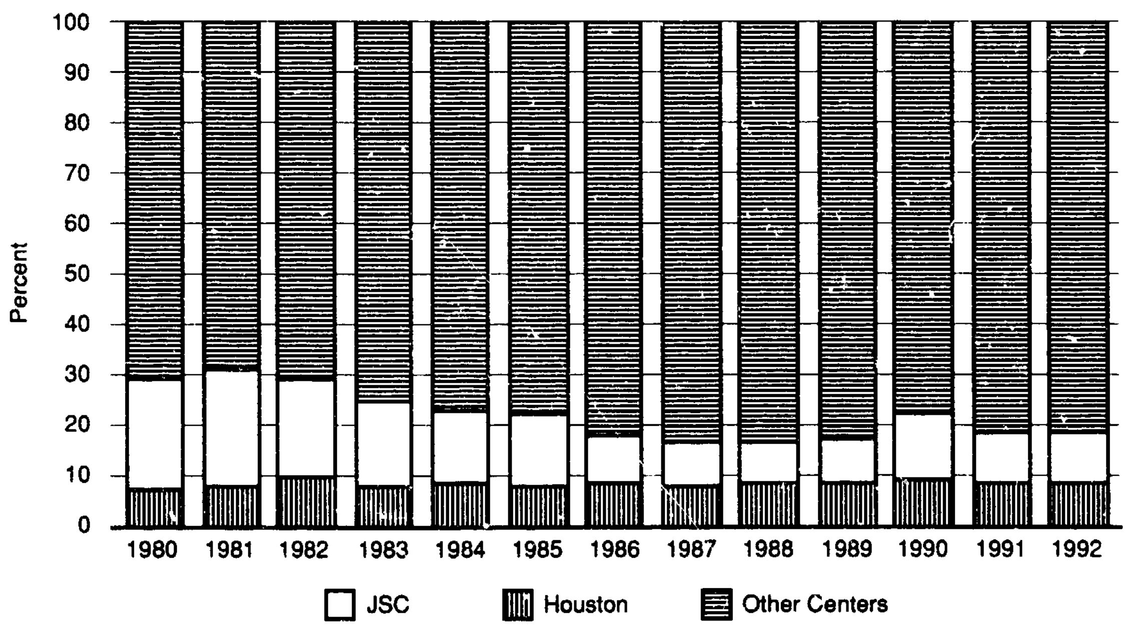
Source: JSC Central Budget Office.

JSC and Houston Share of the NASA Budget

(Expressed in Real Year Dollars)

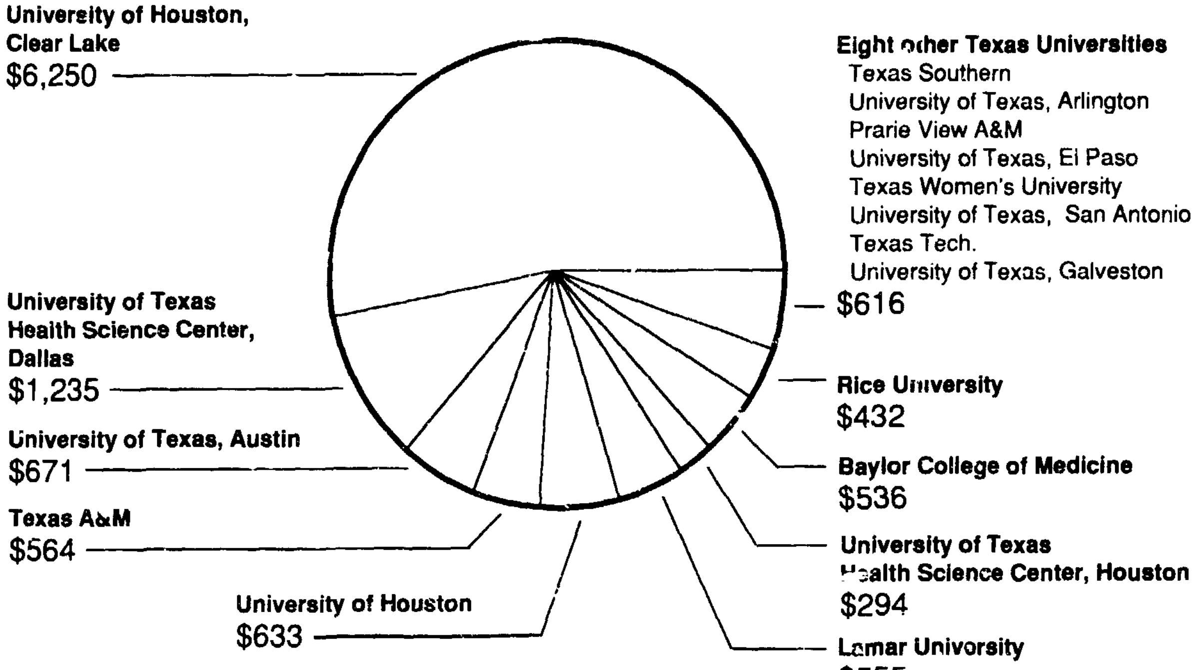


(Expressed in Percentage)



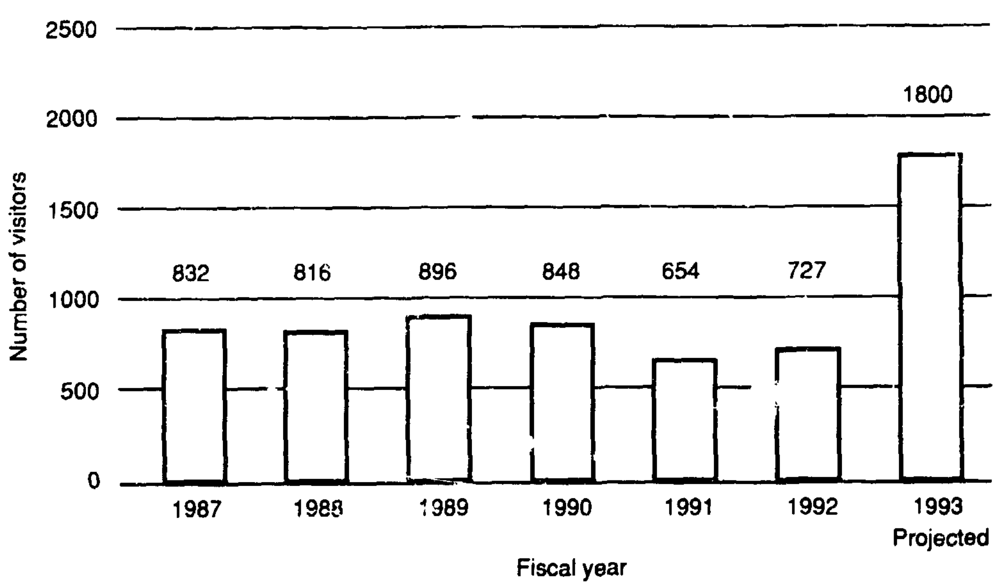
Source: JSC Central Budget Office.

JSC Spending in Texas – FY1992
Colleges and Universities



Obligations in thousands

Annual Visitors to JSC
(In thousands)

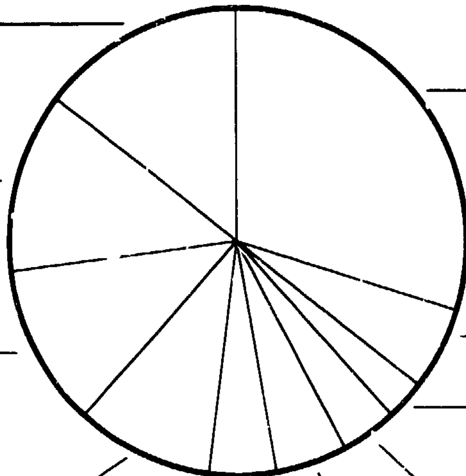


FY1993 Projects Space Center Houston
Actuals = fiscal year conservative estimate based on vehicle count.
FY1991 was affected by visitor constraints (Jan.–Mar.) imposed by "Desert Storm".

Source: Office of the Comptroller

NASA Contracts and Grants

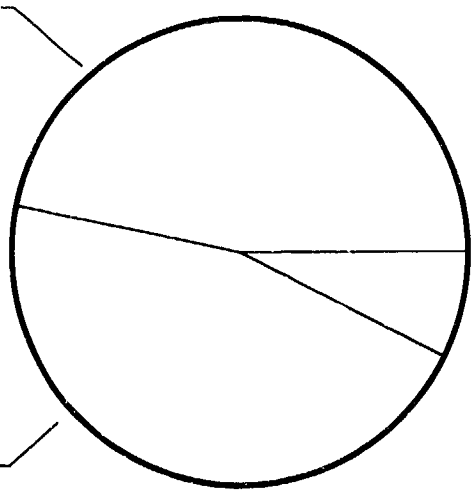
Distribution by State – FY1992



Dollars in billions (rounded)

JSC Contracts and Grants

Distribution by State – FY1992



Dollars in millions

Source: JSC Central Budget Office

XII. Bibliography

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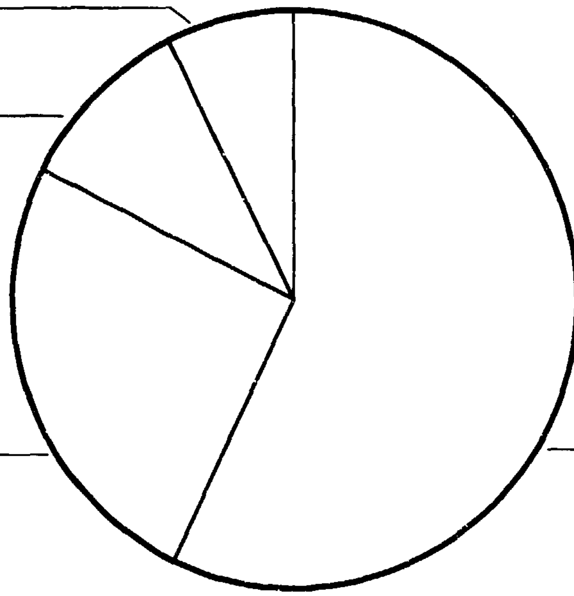
Minorities and Women by Organization



	Nonminority				Minority				
	Male		Female		Male		Female		
	No.	%	No.	%	No.	%	No.	%	Total
Director/Staff (A)	53	38.7	59	43.1	7	5.1	18	13.1	137
Administratc (B)	161	38.5	181	43.3	25	6.0	51	12.2	418
Center Operations (J)	153	45.3	105	31.1	47	13.9	33	9.8	336
Flight Crew Operations (C)	97	55.7	51	29.3	16	9.2	10	5.7	174
Mission Operations (D)	373	60.9	155	25.3	43	7.0	41	6.7	612
Engineering (E)	537	64.6	137	16.5	111	13.4	46	5.6	831
Safety, Relaibaility and Quality Assurance (N)	103	57.5	27	15.1	36	20 1	13	7.3	179
Information Systems (P)	73	57.0	32	25.0	13	10.2	10	7.8	128
WSTF (R)	33	66.0	8	16.0	7	14.0	2	4.0	50
Space and Life Sciences (S)	158	64.8	53	21.7	19	7.8	14	5.7	244
Space Shuttle Program Office (G,M,T,W)	117	58.8	52	26.1	16	8.0	14	7.0	199
Space Station Freedom Office (H)	8	61.5	3	23.1	1	7.7	1	7.7	13
New Initiatives Office (I)	58	67.4	20	23.3	5	5.8	3	3.5	86
Space Station Project Office (K)	66	62.3	27	25.5	8	7.5	5	4.7	106
Orbiter and GFE Project Office (V)	82	62.1	27	20.5	15	11.4	8	6.1	132
Lunar and Mars Exploration Office (X)	17	63.0	9	33.3	0	0.0	1	3.7	27
Total	2,089	56.9	946	25.7	369	10.0	270	7.3	3,674

Source: JSC Human Resources Office