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National Park Service



Man in Space

Excerpts from a
National Historic Landmark Theme Study
Phases I and II



Composite photo from two Apollo 11 images
(Original photos courtesy of NASA)

Dr. Harry A. Butowsky

National Park Service
Department of the Interior
May 1984 (*Phase I*)
August 1984 (*Phase II*)

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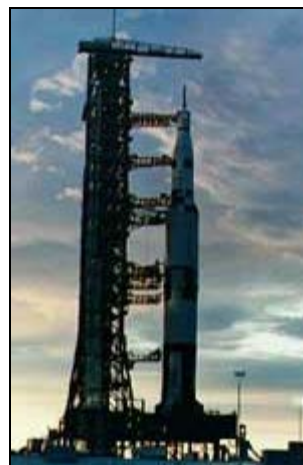


INTRODUCTORY ESSAY *(Phase I)*

The Man in Space National Historic Landmark Theme Study has been prepared for the Congress and the Secretary of the Interior's Advisory Board in partial fulfillment of the requirements of P.L. 96-344. The purpose of the Theme Study is to evaluate all resources which relate to the theme of Man in Space and to recommend certain of those resources for designation as National Historic Landmarks.

The Man in Space Theme Study considered resources relating to the following general subthemes:

- A. Technical Foundations before 1958
- B. The Effort to Land a Man on the Moon
- C. The Exploration of the Planets and Solar System
- D. The Role of Scientific and Communications Satellites



Apollo Saturn V on launch pad

The Theme Study considered the Space Program in an integrated fashion. In any given space mission thousands of scientists, technicians, and other support personnel were necessary to insure success. These support personnel performed vital work in a variety of ways using support facilities in many parts of the country. None of these personnel in all likelihood comprehended all aspects of each space mission, yet all were vital to the success of the program. Since individual missions lasted over many years and involved a wide variety of resources and people only a few managers at the National Aeronautics and Space Administration (NASA) were able to see all of the facets of the space program. It was this coordination, cooperation, and collaboration that enabled NASA to successfully manage the American Space Program. The theme study follows this same approach and attempts to identify, inasmuch as is possible, the surviving resources of those that were necessary to accomplish the goals of landing a man on the moon and exploring the earth, planets and solar system.

General Background

Other Support

Spacecraft



Seven original Mercury astronauts plus new members

NASA's origins can be traced to World War I and the realization that although America had invented the airplane we had fallen behind in the technology of aeronautical research. In 1915 President Woodrow Wilson signed into law a

Bill establishing the National Advisory Committee for Aeronautics (NACA) to remedy this situation. NACA began work in 1920 with the establishment of its first field office—the Langley Memorial Aeronautical Laboratory in Hampton, Virginia.

As the years passed and significant wind tunnel research was accomplished at Langley, NACA perceived the need for additional research facilities. In 1939 NACA established its second field center—the Moffett Field Laboratory, in California, later called the Ames Research Center. Like Langley, Ames was primarily devoted to wind tunnel testing needed to support the growing American aircraft industry.

In 1940 NACA established its third field center, in Cleveland, Ohio—the Lewis Research Center. The purpose of Lewis was also to support aeronautical research with special emphasis on the development of newer, more efficient engines.

By the late 1940s NACA also had established two flight test centers—the Auxiliary Flight Research Center at Wallops Island, Virginia and the NACA Muroc Flight Test Unit at Edwards, California, later renamed the Dryden Flight Research Center.

Also established during these early years were the U.S. Naval Research Laboratory in Washington, D.C., and the Guggenheim Aeronautical Laboratory at the California Institute of Technology, later called the Jet Propulsion Laboratory. Both of these centers were soon concerned with research involving rocket technology.



After the Second World War the interest of the Army in rockets as battlefield weapons led to the importation of many German scientists who had worked on the German V-2 program. This group, led by Dr. Werner von Braun, was first stationed at Fort Bliss, Texas and later reassigned to the U.S. Army Redstone Arsenal, in Huntsville, Alabama. The army group at the Redstone Arsenal eventually evolved into the George C. Marshall Space Flight Center.

After the launch of Sputnik 1 and the much publicized failure of the American Vanguard Rocket, Congress passed the National Aeronautics and Space Act of 1958 that brought into being the National Aeronautics

and Space Administration (NASA) and the modern American Space Program.

When NASA began business on October 1, 1958, the process of consolidating the many pieces of the American Space Program was initiated. By 1963, when the process was completed, NASA consisted of the following field centers.

NASA Field Centers

Ames Research Center, Moffett Field, California: Ames continued its work in furthering aeronautical research using its fine wind tunnel complex. Its role in the Space Program was limited to the management of the Pioneer series of Spacecraft; space environmental physics; simulation techniques; gas dynamics at high speeds; configuration, stability, structures, and guidance and control of aeronautical and space vehicles; and biomedical and biophysical research.

Hugh L. Dryden Flight Research Center, Edwards, California: Dryden supported flight testing of general aviation and high performance aircraft and spacecraft; flight operations and flight systems; and structural characteristics of aeronautical and space vehicles.

Goddard Space Flight Center, Greenbelt, Maryland: Goddard developed from the Naval Research Laboratory after its transfer to NASA in 1958. The role of Goddard is in the scientific research of space with unmanned satellites; research and development of meteorological and communications satellites; and tracking and data acquisition operations. The Goddard Space Flight Center also manages the Goddard Institute for Space Studies in New York City which conducts research in astrophysics, planetary physics, and atmospheric physics.

George C. Marshall Space Flight Center, Huntsville, Alabama: Marshall developed from the U.S. Army Redstone Arsenal rocket program under Dr. Werner von Braun. After the transfer of Dr. von Braun and his group to NASA, Marshall continued to work in the research and development of launch vehicles and systems to launch manned and unmanned spacecraft; development and integration of payloads and experiments for assigned space flight activities; and application of space technology and supporting scientific and engineering research. Marshall is most famous for the development of the Saturn family of rockets Marshall also managed the Michoud Assembly Facility in New Orleans, Louisiana where the giant Saturn V rocket first stage was built and the Slidell Computer Facility in St. Tammany Parish, Louisiana, which handled computer data processing for both Michoud and the National Space Technology Laboratories.



Jet Propulsion Laboratory, Pasadena, California: The Jet Propulsion Laboratory was transferred to NASA from the U.S. Army in 1958 and developed into NASA's primary center for the exploration of the moon, planets, and solar system. JPL also manages the Goldstone Tracking Station which is responsible for the tracking and data acquisition systems necessary to communicate with spacecraft exploring deep space. JPL is operated for NASA under contract with the California Institute of Technology.

John F. Kennedy Space Center, Florida: The Kennedy Space Center in cooperation with Cape Canaveral Air Force Station supports major NASA launches. All moon flights originated from Launch Complex 39 at this site. The Kennedy Space Center also manages the NASA Western Test Range Operations Office at Vandenberg, California, which was responsible for the integration, test, checkout, and launch of unmanned light and medium vehicles and the White Sands Test Facility in Las Cruces, New Mexico, which supported developmental and operational tests of spacecraft propulsion and power generating systems.

Langley Research Center, Hampton, Virginia: Langley was the first NACA field installation and thus the oldest NASA center. Through the use of its fine complex of wind tunnels and other facilities Langley supports research in aeronautical and space structures and materials; advanced concepts and techniques for future aircraft; aerodynamics of re-entry vehicles; and space environmental physics, and improved supersonic flight capabilities. Langley has also provided major support for most aspects of the Space Program including Projects Mercury, Gemini, Apollo, the Space Shuttle, and the Viking Project.

Lewis Research Center, Cleveland, Ohio: Lewis is another of the original NACA field offices that was transferred to NASA in 1958. Lewis was responsible for power plants and propulsion; high energy propellents; electric propulsion; aircraft engine noise reduction; engine pollution reduction; and data bank research information in aerospace safety. The most significant achievement of Lewis was in pioneering research that led to the development of hydrogen as a rocket engine fuel and in the

development and testing of new materials for spacecraft and aircraft. Lewis also manages the Plum Brook Operations Division at Sandusky, Ohio, where many of its larger testing facilities are located.



Lyndon B. Johnson Space Center, Houston, Texas: The Johnson Space Center was created after the formation of NASA to manage the American Manned Space Program. Johnson pioneered in research and development of manned spacecraft systems; development of astronaut and crew life support systems; development and integration of experiments for space flight activities; and application of space technology, and supporting scientific, engineering, and medical research. Johnson was recently designated as the lead NASA center in the development of the manned space station.

Wallops Flight Center, Wallops Island, Virginia: Wallops was another of the original NACA field installations that transferred to NASA in 1958. Wallops was responsible for launch facilities and services to other NASA installations which conduct suborbital, orbital, and space probe experiments with vehicles ranging from small rockets to the Scout four-stage solid fuel rocket.

National Space Technology Laboratories, Bay St. Louis, Mississippi: The National Space Technology Laboratories (Mississippi Test Facility) was responsible for static test firing of large space and launch vehicles such as the Saturn V rocket.

Former NASA Installations

In addition to the above existing NASA installations there were two facilities that no longer exist:

Electronics Research Center, Cambridge, Massachusetts: The Electronics Research Center was responsible for conducting research and developing advanced technology in the area of space and aeronautical electronic

components. It was closed in 1970.

Nuclear Rocket Development Station, Jackass Flats, Nevada: The Nuclear Rocket Development Station was responsible for conducting full-scale ground tests of nuclear reactors, engines, and flight stages for the nuclear rocket program. It was closed in 1974.

United States Air Force Facilities

Cape Canaveral Air Force Station, Brevard County, Florida: Cape Canaveral Air Force Station contains some of the earliest facilities associated with rocket experimentation and space exploration as well as active space-age installations for current military and NASA programs. Cape Canaveral is best known for its association with Projects Mercury, Gemini, and Apollo as well as the launch site for most satellites and deep space probes during the early years of the American space program.

Edwards Air Force Base, Edwards, California: Edwards Air Force Base is the site of the Air Force Flight Test Center which conducts new and follow-on testing of aircraft and related avionics and weapons systems. Edwards is also the home of the Air Force Rocket Propulsion Laboratory and the Air Force Test Pilot School. Edwards is presently the primary landing site for the Space Shuttle.

Vandenberg Air Force Base, Lompoc, California: Vandenberg Air Force Base is the site of the 1st Strategic Aerospace Division, Western Space and Missile Test Center Space and Missile Test Organization, and the Shuttle Activation Task Force. Vandenberg conducts missile crew training, and operates testing and launch facilities for the Strategic Air Command.

Contractor Sites

In addition to the above NASA and USAF installations there were many contractor facilities that were important in the space program. These facilities were not visited during the course of this theme study. It is not known what contractor facilities associated with the early years of the American Space Program survive. Additional facilities associated with Robert Goddard, the U.S Army White Sands Test Sites, and space hardware now in the collection of the Smithsonian Institution will be visited and assessed during [Phase II](#) of the Man in Space Theme Study.

Recommendations

See list in the [Table of Contents](#)

Previously Designated Sites

Cape Canaveral Air Force Station was designated a National Historic Landmark on April 16, 1984. Launch Complex 39 at the Kennedy Space Center was listed on the National Register of Historic Places on May 24, 1973.

Summary



Apollo 17 astronaut Cernan on lunar surface

The 24 recommended resources contained in this phase of the Man in Space Theme Study represent only a small fraction of the technological resources that were necessary to support the American space program. They are recommended for designation as National Historic Landmarks because they represent the best and most important surviving

examples of this technology. Due to the rapid change of the space program and evolving technologies, support facilities simply do not survive or survive in a greatly altered state. The efforts to land a man on the moon, investigate the near Earth environment, and explore the planets and solar system were supported from a technological base that reflected a depth and variety of support facilities that were unprecedented in American history. Many of these resources have long since been destroyed, abandoned or altered to meet the changing demands of the space program. The 24 facilities reflected in this theme study are but a fraction of this resource base. They are the best, most intact, and most important resources that have survived. Their variety and range reflect the much larger technological base that provided the foundation of the space program. It is hoped that this selection will survive to interpret for future generations the early years of the American space program.

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INTRODUCTORY ESSAY *(Phase II)*

Phase II of the Man in Space National Historic Landmark Theme Study has been prepared for the Congress and the National Park System Advisory Board in partial fulfillment of the requirements of P.L. 96-344. The purpose of the Theme Study is to evaluate all resources which relate to the theme of Man in Space and to recommend certain of those resources for designation as National Historic Landmarks.



Mission Control during Soyuz mission

In Phase I of the Man in Space Theme Study 24 resources were discussed and recommended for designation as National Historic Landmarks. A discussion of these resources and their significance and role in the American Space Program can be found in [Phase I](#) of the Man in Space Theme Study. The role and function of resources contained in Phase II fit into the integrated outline of types of resources contained in Phase I. In addition to the 24 resources discussed previously, the following resources are believed to be nationally significant and are recommended for designation as National Historic Landmarks or recognition as nationally significant objects.

Recommendations

See list in the [Table of Contents](#)

Additional Comments

Additional objects at the Air and Space Museum were examined for inclusion in this study. Some, such as

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Skylab

Mercury Spacecraft Freedom 7, Gemini 7, and the Skylab 4 Command Module were rejected because more significant examples were found in the museum. Other objects, such as the V-2 Missile, the Vanguard Rocket, the Bell X-1 Plane, and the Pioneer 10 Planetary Probe were rejected because

they lacked integrity and, therefore, did not meet the criteria for designation as National Historic Landmarks and ought not to be recognized as a nationally significant historic objects. Additional objects such as the Jupiter-C Rocket, Lunar Module, Lunar Roving Vehicle, M2-F3 Lifting Body, X-15 Plane, Viking Mars Lander and the Voyager 1 Planetary Probe were rejected because either they did not meet the criteria for significance of the National Historic Landmark Program or there was insufficient information on the particular object in the collection to determine its integrity.

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A. NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS WIND TUNNELS

1. [Variable Density Tunnel](#) (Langley Research Center)
2. [Full Scale Tunnel](#) (Langley)
3. [Eight-Foot High Speed Tunnel](#) (Langley)
4. [Unitary Plan Wind Tunnel](#) (Ames Research Center)

These sites are recommended for designation as National Historic Landmarks because they represent the fine technological base of aeronautical research facilities created by the National Advisory Committee for Aeronautics. It was on this base that the National Aeronautics and Space Administration would build to create the success of the American Space Program. The **Variable Density Tunnel** was the first wind tunnel in the world to use the principle of variable density air pressure to test scale model aircraft. The **Full Scale Tunnel** was the first full scale tunnel in NACA's inventory and contributed mightily to the design of an entire new generation of aircraft in the 1930s and 1940s. The versatility of the Full Scale Tunnel is demonstrated by the fact that today, 53 years after its construction, it is still a major research tool in NASA's inventory and is being used to design a new generation of aircraft. The **Eight-Foot High Speed Tunnel** is important because it was the first tunnel to employ a slotted throat design which gave aircraft designers accurate data on airframe performance in the transonic range. The **Unitary Plan Wind Tunnel** is significant because it represents the continuing effort of NACA to update its wind tunnel inventory to provide the American aircraft and aerospace industry with the most advanced testing facilities in existence in the world. The Unitary Plan Wind Tunnel was extensively used in designing new generations of aircraft that eventually led to the Space Shuttle of today. These wind tunnels represent only a small fraction of the more than 65 wind tunnels currently in NASA's inventory.

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B. Rocket Engine Development Facilities

5. [Rocket Engine Test Facility](#) (Lewis Research Center)
6. [Zero-Gravity Research Facility](#) (Lewis)
7. [Spacecraft Propulsion Research Facility](#) (LeRC Plum Brook Operations Division)

These sites are recommended for designation as National Historic Landmarks because they represent the important role of the Lewis Research Center in developing hydrogen as a fuel for the Centaur and Saturn V rockets. The **Rocket Engine Test Facility** pioneered in the technology necessary to handle hydrogen as a rocket fuel, the **Zero-Gravity Research Facility** investigated the physics of handling liquids in a zero-gravity environment, and the **Spacecraft Propulsion Research Facility** enabled engineers at Lewis to hot fire full scale Centaur engines in simulated space conditions. The development of the Centaur and Saturn Rockets was crucial to both the manned and unmanned space programs of the United States.

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C. Rocket Engine Test Stands

8. [Redstone Test Stand](#) (George C. Marshall Space Flight Center)
9. [Propulsion and Structural Test Facility](#) (Marshall)
10. [Rocket Propulsion Test Complex](#) (National Space Technology Laboratories)

These facilities are recommended for designation as National Historic Landmarks because they represent the role of the Marshall Space Flight Center in the building and testing of actual space flight rockets. Before any rocket is allowed to fly and be used on a manned mission it is first tested by firing in a static test stand to verify its flight status. The Redstone Test Stand was the first facility of this type built at Marshall by Dr. Werner von Braun. The Redstone test stand tested the Mercury/Redstone missiles used to launch Alan B. Shepard and Gus Grissom on their first space launches. The Propulsion and Structural Test Facility was important in the testing of the Saturn 1B vehicle and represents the evolution of test stand technology from the days of the Army Redstone Missile to the Solid Rocket Boosters used on the Space Shuttle today. The Rocket Propulsion Test Complex was used by Marshall to test and man-rate all Saturn V rockets used in the Apollo Program.

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D. Rocket Test Facility

11. [Saturn V Dynamic Test Stand](#) (Marshall)

This facility illustrates another facet of the building and testing and man-rating of the Saturn V Rocket. After every Saturn V was tested on the firing stand it was brought to the **Dynamic Test Stand** for mechanical and vibrational tests to determine its structural integrity. This process was part of the extensive ground testing program for the Saturn V Rocket and it is a primary reason for the success of the American manned space program. Tests conducted here gave NASA and industry engineers their last chance to detect and correct any flaws in the fully assembled Saturn V.

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E. Rockets

12. [Saturn V Space Vehicle](#) (Alabama Space and Rocket Center)

At this time the only rocket recommended for designation as a National Historic Landmark is the **Saturn V** at the Alabama Space and Rocket Museum. This vehicle is one of only three remaining Saturn Vs in the country. It was selected to represent the class of Saturn V rockets because of its integrity and association with its site—the George C. Marshall Space Flight Center. All three stages of the vehicle and the instrument ring are intact. The vehicle is well maintained and in a good state of preservation. This Saturn V was the original test vehicle used in dynamic testing of the Saturn support facilities at the Marshall Space Flight Center. While not intended to fly itself, this Saturn V was a working vehicle with all of its parts intact, and prepared the way for all the Saturn Vs that did fly and were lost after having completed their missions.

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F. Launch Pads

13. [Space Launch Complex 2](#) (Vandenberg AFB)
25. [Launch Complex 33](#) (White Sands) — *Phase II addition*

Space Launch Complex 2W at Vandenberg Air Force Base is recommended for designation as a National Historic Landmark because it is the finest remaining example of a 1950s-era launch complex in the country. All facilities associated with the site are intact. The blockhouse retains the original electronic equipment. The only modifications to the site over the years involved changing from the Thor to the Delta Rockets. Since the Delta is descended from the Thor Rocket, modifications were minor.

Launch Complex 33 at the U.S. Army White Sands Missile Test Range is recommended for designation as a National Historic Landmark because of its close association with the testing of the V-2 rocket and the origins of the American rocket program. Launch Complex 33 was developed specifically to accommodate V-2 rocket tests at White Sands. The V-2 Gantry Crane and Blockhouse represent the first generation of large scale rocket testing facilities that would eventually lead to the American exploration of space and the first manned landing on the moon. The V-2 provided the technological base upon which the United States would build the Saturn family of rockets that eventually carried Americans to the moon. Launch Complex 33 also provided the facilities at which scores of Americans learned the techniques of launching large rockets.

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G. Apollo Training Facilities

14. [Lunar Landing Research Facility](#) (Langley)
15. [Rendezvous Docking Simulator](#) (Langley)
16. [Lunar Landing Training Vehicle](#) (Alabama Space and Rocket Center)
17. [Neutral Buoyancy Space Simulator](#) (Marshall)

These facilities are recommended for designation as National Historic Landmarks because of their association with training programs necessary to prepare American astronauts to land on the moon. The **Lunar Landing Research Facility** and the **Lunar Landing Training Vehicle** represent two different philosophies within NASA on how to fly the last 150 feet to the lunar surface. The Lunar Landing Research Facility employed a mock Lunar Excursion Module attached to a fixed facility while the Lunar Landing Training Vehicle was a free flying vehicle used to replicate Lunar Excursion Module flight dynamics here on Earth. Both methods were used to train Apollo Astronauts. The **Rendezvous Docking Simulator** is the only surviving trainer that Gemini and Apollo Astronauts used to practice rendezvous and docking techniques needed to link the Lunar Excursion Module and the Command and Service Module in Space. The ability to link these two vehicles in space was critical to the success of the Lunar Orbit Rendezvous technique for landing on the moon. The **Neutral Buoyancy Space Simulator** was used to familiarize Apollo astronauts with the dynamics of zero gravity while operating outside of the Apollo Spacecraft.

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H. Apollo Hardware Test Facility

18. [Space Environmental Simulation Laboratory](#) (Lyndon B. Johnson Space Center)

The **Space Environment Simulation Laboratory** is important because it was used to man-rate and test the integrity of the Apollo Command and Service Module, Lunar Module, and spacesuits under simulated space conditions here on Earth. This testing was essential to the safety and well being of the Apollo astronauts.

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I. Unmanned Spacecraft Test Facilities

19. [Spacecraft Magnetic Test Facility](#) (Goddard Space Flight Center)

20. [Twenty-Five-Foot Space Simulator](#) (Jet Propulsion Laboratory)

These facilities are recommended for designation as National Historic Landmarks because they illustrate the extensive ground support testing facilities needed to accomplish the American unmanned space program—the exploration of the near and deep space environment. The **Spacecraft Magnetic Test Facility** represents the role of the Goddard Space Flight Center in the American space program. This facility, the only one of its type in NASA's inventory, enables NASA to determine and minimize the magnetic movement of even the largest unmanned spacecraft and thereby eliminate unwanted torques due to the interaction of the spacecraft with the Earth's magnetic field. The **Twenty-Five-Foot Space Simulator** is the only NASA facility capable of producing the true interplanetary conditions of cold, high vacuum, and intense solar radiation coupled with a large test chamber that can accommodate large space vehicles. Both of these facilities have contributed to the success of the American unmanned space program and represent the technological sophistication of the support facilities necessary to accomplish that program.

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J. Tracking Stations

21. [Pioneer Deep Space Station](#) (Goldstone Tracking Station)

The **Pioneer Deep Space Tracking Station** is recommended for designation as a National Historic Landmark because it was the first antenna to support NASA's unmanned exploration of deep space. The technological achievements necessary to track deep space vehicles were first demonstrated and put into use at this site. The Pioneer Station was later joined by dozens of additional tracking stations around the world. This site illustrates the role of Goldstone and the NASA tracking system in the American Space Program.

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K. Mission Control Centers

22. [Space Flight Operations Facility](#) (JPL)

23. [Apollo Mission Control Center](#) (Johnson)

These sites are recommended for designation as National Historic Landmarks because they are the very heart and soul of both the American Manned and Unmanned Space Programs. The **Space Flight Operations Facility** at the Jet Propulsion Laboratory represents the role and achievement of JPL in the American effort to explore the moon, planets, and solar system. Projects Viking, Voyager, Pioneer, Ranger, and Mariner opened new worlds for exploration and human understanding. The Space Flight Operations facility is the symbol of this effort and the facility at the Jet Propulsion Laboratory is the one most closely associated with this effort. **Apollo Mission Control** at the Lyndon B. Johnson Space Flight Center represents the role and achievement of Johnson in the American manned spaceflight program. It was to Apollo Mission Control that Neil Armstrong reported his famous words that man had first landed on the moon in July 1969.

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L. Other Support Facilities

24. [Rogers Dry Lake](#) (Edwards AFB)

Although a natural resource the **Rogers Dry Lake** is recommended for designation as a National Historic Landmark because of its association with flight testing of advanced aircraft that opened the way to space. The natural attributes of clean air, isolated location, ideal weather, proximity to variable terrain, and the large surface of the dry lakebed provided a natural laboratory in which to flight test aircraft that were on the cutting edge in aviation and aerospace technology. As a resource the Rogers Dry Lake has contributed as much to the American aircraft and aerospace effort as any manmade facility. Starting in 1947 with the flight of the Bell X-1, the first plane to break the sound barrier, to the landing of the Space Shuttle Columbia in 1981, the Rogers Dry Lake has been the scene of some of the most important developments in the history of aviation.

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