HISTORIC AMERICAN BUILDINGS SURVEY

CAPE CANAVERAL AIR FORCE STATION, HANGAR M ANNEX

HABS No. FL-583-F

Location:	Northwest of Hangar Road, between NASA Parkway and Skid Strip Road Cape Canaveral Air Force Station (CCAFS) Cape Canaveral Brevard County Florida The Hangar M Annex, Building No. 55005, is located within the Industrial Area of CCAFS, at latitude: 28.491818, longitude: -80.582141. These coordinates were obtained on September 9, 2014, through Google Earth™. The coordinates datum are North American Datum 1983.
Present Owner/ Occupant:	National Aeronautics and Space Administration (NASA) Kennedy Space Center (KSC), FL 32899-0001
Present Use:	Vacant
Significance:	The Hangar M Annex is considered a contributing resource to a NASA-owned CCAFS Industrial Area Historic District, which is eligible for listing in the National Register of Historic Places under Criterion A, in the area of Space Exploration and under Criterion C, in the area of Architecture. It contributes to the district under Criterion A for its association with NASA's Space Shuttle Solid Rocket Booster (SRB) management and materials testing laboratories, and under Criterion C as a representative example of International-style military architecture at CCAFS. The building retains all seven aspects of historic integrity.[1]
Historian:	Patricia Slovinac, Architectural Historian Archaeological Consultants, Inc. (ACI) 8110 Blaikie Court, Suite A Sarasota, Florida 34240 January 2015
Project Information:	The documentation of Hangar M Annex was conducted in 2014-2015 for KSC by ACI, under contract to InoMedic Health Applications (IHA) and

[1] David Price, "Architectural Survey and Evaluation of NASA-owned Facilities on Cape Canaveral Air Force Station, Brevard County, Florida" (survey report, New South Associates, Stone Mountain, GA, 2013), 64.

in accordance with KSC's Programmatic Agreement Regarding Management of Historic Properties, dated May 18, 2009. The field team consisted of architectural historian, Patricia Slovinac (ACI), and independent photographer, Penny Rogo. Assistance in the field was provided by Barbara Naylor, KSC Historic Preservation Officer, and Nancy English, KSC Cultural Resource Specialist. The written narrative was prepared by Ms. Slovinac; it was edited by Joan Deming, ACI Project Manager; Elaine Liston, KSC Archivist; Ms. Naylor; Ms. English; and Jane Provancha, Environmental Projects-Manager, IHA. The photographs and negatives were processed by Zebra Color, Inc., an independent photography and processing studio.

The Scope of Services for the project, which was compiled based on the Programmatic Agreement, specified a documentation effort following HABS Level II Standards. Information for the written narrative was primarily gathered through informal interviews with current NASA and contractor personnel, the KSC Archives Department, the KSC Institutional Imaging Facility, the CCAFS Cultural Resources Department and Infrastructure Operations and Maintenance Service Engineering Documentation Center, and various NASA center websites. In addition, the Air Force Space and Missile History Center was contacted, although to no avail. Selected drawings were provided by KSC's Engineering Documentation Center, which serves as the repository for all facility drawings. For the Hangar M Annex, this included the original as-built drawings, as well as drawings depicting major additions and modifications to the facility. It should also be noted that KSC does not periodically produce drawings of their facilities to show current existing conditions.

LIST OF ACRONYMS

ACI	Archaeological Consultants, Inc.
ACOE	Army Corps of Engineers
AFB	Air Force Base
CCAFS	Cape Canaveral Air Force Station
DoD	Department of Defense
ICBM	Intercontinental Ballistic Missile
IHA	InoMedic Health Applications
IRBM	Intermediate Range Ballistic Missile
ISS	International Space Station
KSC	Kennedy Space Center
LC	Launch Complex
LiOH	Lithium Hydroxide
M&P	Materials and Processing
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
OV	Orbiter Vehicle
SRB	Solid Rocket Booster
STS	Space Transportation System
US	United States
USA	United Space Alliance
USSR	Union of Soviet Socialist Republics
TWX	Teletypewriter Exchange

Part I. Historical Information

A. Physical History:

1. **Date of erection:** The Hangar M Annex was completed in 1963.[2]

2. **Architect/Engineer:** The building was designed by Norman M. Giller & Associates, Architects and Engineers, of Miami Beach, Florida, and the US Army Corps of Engineers (ACOE), Jacksonville, Florida.[3]

3. **Original and subsequent owners, occupants, uses:** Hangar M Annex was originally owned by the US Air Force's Patrick Air Force Base (AFB). On July 12, 1965, ownership of the building was transferred to NASA. Circa 1986, the Lithium Hydroxide (LiOH) Laboratory moved into the south end of the first floor. In 2002, United Space Alliance (USA), one of NASA's Space Shuttle contractors, began to use the second floor as office space, and in 2005, USA moved its Materials and Processing (M&P) Laboratory into the north end of the first floor. NASA/USA vacated the building on November 1, 2012.[4]

4. **Builder:** The consulted sources were unable to provide information on the construction contractor for the Hangar M Annex.

5. **Original plans and construction:** The original drawings for Hangar M Annex are dated September 1963. The roughly 20,510-square foot facility was rectangular in plan, two stories in height, and featured a recessed main entrance that opened into a lobby area. The south end of the first floor contained a laboratory area that included a general lab, a chemical lab, a mechanical lab, an airlock, a Teletypewriter Exchange (TWX) room, offices, and equipment and storage rooms. The north end of the first floor had offices, a blueprint room, and a reproduction lab. The second floor of the facility contained a data readout room in the north end; all other rooms were offices.[5]

6. **Alterations and additions:** The Hangar M Annex has received no additions; however, it has undergone a few alterations.[6] No changes were ever made to the south end of the first floor. A facility usage plan from 1975 shows that by this time, one office on the first floor and one on the second floor were enlarged, and two rooms on the first floor and seven

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[2] NASA KSC, "Real Property Record, Building 55005," on file, KSC Real Property Office.
[3] Norman M. Giller & Associates, "M/Research Laboratory & Engineering Bldg. (Hangar "M" Annex)," September 1962, on file, KSC Engineering Documentation Center.
[4] NASA KSC, "Building 55005."
[5] Norman M. Giller & Associates, "M/Research Laboratory & Engineering Bldg. (Hangar "M" Annex)."
[6] NASA KSC, "Building 55005;" Sweetsir Collection, Folder: 55005 Hangar M Annex, KSC Archives Department.

rooms on the second floor had been subdivided.[7] The next available space utilization plan, dated 1992, indicates that on both floors, some internal partitions were removed to create larger work areas, while other rooms were partitioned into smaller spaces.[8] A space utilization plan from 1996 also shows changes in the sizes of some of the rooms; either individual rooms were subdivided, or multiple rooms were combined into one large space.[9] By 2010, the only other changes that had occurred were a subdivision of one room and a joining of two rooms on the second floor of the building.[10]

B. Historical Context:

Circa 1958, the ACOE commissioned Norman M. Giller & Associates, an architecture-engineering firm from Miami, Florida, to design the Hangar M Annex, to be located along Hangar Road in the Industrial Area of CCAFS. At the time, the building was also referred to as the M/Research Laboratory & Engineering Building. Its original use was as a support building to the Hangar M missile assembly building, which was associated with the US Air Force's Thor intermediate-range ballistic missile.[11]

Ownership of the building was transferred to NASA on July 12, 1965.[12] Research did not reveal the function of the building from that date to circa 1986, when drawings indicate a LiOH Laboratory moved into the south end of the building.[13] This laboratory conducted processing and quality control for the LiOH canisters used in the Space Shuttle orbiter, the astronauts' extravehicular activity spacesuit, and later, the International Space Station (ISS).[14] Prior to the installation of the LiOH Laboratory, a facility usage plan indicates that by 1974, one office on the first floor (in the north half of the building) and one on the second floor were enlarged, and two rooms on the first floor (also at the north end) and seven rooms on the second floor had been subdivided.[15] One source indicated that United Space Boosters, Inc., one of the Space Shuttle SRB contractors, had program management and business management offices within the building. The source did not have the date the offices moved into the building, but gave a time frame of circa 2000-2002 for when the company vacated the building.[16]

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[7] NASA KSC, "Facilities Space Control Document-Cape Area," 1975, on file, KSC Archives Department.
[8] NASA KSC, "Building 55005."
[9] NASA KSC, "Building 55005."
[10] NASA KSC, "Building 55005."
[11] Price, "Cape Canaveral Air Force Station," 64.
[12] NASA KSC, "Building 55005."
[13] NASA, "LIOH Lab System Schematics," April 1986, on file, KSC Engineering Documentation Center.
[14] Frank Golan, personal communication (telephone interview) with Patricia Slovinac, November 12, 2014, notes on file at ACI, Sarasota; Karl Murray, personal communication (telephone interview) with Patricia Slovinac, December 16, 2014, notes on file at ACI, Sarasota. LiOH canisters helped maintain a breathable environment for the astronauts by pulling carbon dioxide out of the atmosphere and replacing it with oxygen.
[15] NASA KSC, "Facilities Space Control Document-Cape Area."
[16] David Mayo, personal communication (telephone interview) with Patricia Slovinac, December 16, 2014, notes on file at ACI, Sarasota.

A space utilization plan, dated 1992, shows that by this time, alterations had been made to both floors. Some included the removal of internal partitions to create larger work areas, while other rooms were subdivided into smaller spaces.[17] Another space utilization plan from 1996 also shows similar changes in the sizes of some of the rooms.[18]

Around 2002, personnel from USA's M&P Laboratory moved into the vacant offices on the second floor and those at the north end of the first floor; the lab itself was located within Hangar N along Hangar Road, north of NASA Parkway.[19] Circa 2005, USA decided to move the M&P Lab to the north end of the first floor in the Hangar M Annex, because they needed more space for newer equipment that had to be installed on the ground floor. Also, Hangar N was prone to shaking in high winds and certain equipment/tests needed a stable platform. A few modifications were needed, such as dividing rooms into two spaces; nearly all of the personnel offices were moved to the second floor.[20]

The M&P Laboratory performed several functions in support of the Space Shuttle Program, primarily in relation to the SRBs, but also for the orbiter and external tank. For example, it conducted post-flight assessments of the SRBs. If an anomaly was discovered in any of the booster's materials following recovery, a sample of the material was sent to the M&P Laboratory where tests were performed to try and determine why the anomaly occurred. Similarly, if there was a material failure, the laboratory would attempt to discover why the failure occurred and how such a failure could be prevented in the future. The laboratory also tested the SRBs' thermal protection system to verify the materials were performing properly. In addition, the M&P Laboratory tested other SRB materials to ensure there was no silicone located in any area that came in contact with the booster's thermal protection system, as silicone caused damage to the thermal protection materials.[21]

The LiOH Laboratory continued to operate in the building until the final Space Shuttle flight in July 2011. The M&P Laboratory continued to support NASA until the following year (2012). On November 1, 2012, the building was officially vacated.[22]

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[17] NASA KSC, "Building 55005."
[18] NASA KSC, "Building 55005."
[19] Originally, the lab was created at the United Space Boosters, Inc. facility in Huntsville, AL, to support return to flight activities following the *Challenger* accident. In 1996 and 1997, the majority of the company's employees were relocated to KSC. The M&P Lab and its associated personnel were moved into Hangar N, on the second floor of the north end. In 1999, USA took over United Space Boosters, Inc.'s contract, and with it, the M&P Lab and personnel. Mayo, personal communication.
[20] Mayo, personal communication; NASA KSC, "Building 55005."
[21] Mayo, personal communication.
[22] Golan, personal communication; Mayo, personal communication; NASA KSC, "Building 55005."

Cape Canaveral Air Force Station

With the increasing concern over the Union of Soviet Socialist Republics' (USSR) missile and nuclear development after World War II, the US Department of Defense (DoD) created the Committee on Long Range Proving Grounds in October 1948. One of their first duties was to select a suitable missile test site. Four locations were examined, including an area near Washington State, with tracking stations in the Aleutian Islands of Alaska; the Naval Air Missile Test Center at Point Mugu, California; the Naval Air Station at El Centro, California; and Cape Canaveral, Florida, which was near the existing Banana River Naval Air Station (now Patrick AFB).[23] Cape Canaveral was eventually selected for several critical reasons. First, the Government already owned land at the Cape, and the undeveloped nature of the remaining land made it less expensive to acquire. In addition, its isolated location enhanced security for research and development. Furthermore, the launch area was accessible via water, easing the logistics of transporting heavy rockets and building supplies. Operationally, missiles could be launched over the Atlantic Ocean and tracked from islands, such as Bermuda. Also, Florida's temperate climate allowed year round operation of a missile site.[24]

In May 1949, President Harry S. Truman signed the legislation to officially establish the Joint Long Range Proving Ground at Cape Canaveral with Patrick AFB as the support base. Although the entire facility was initially under the cooperative use of the US Army, Navy, and Air Force, the US Air Force, by a directive of the DoD, ultimately assumed responsibility for the Range. Subsequently, on May 16, 1950, the Cape Canaveral Missile Range was redesignated as the Long Range Proving Ground, the first of many subsequent name changes.[25]

Construction at the southern tip of Cape Canaveral commenced in July 1950, under the direction of the Jacksonville District of the ACOE. These activities included the construction of Port Canaveral and launch complexes (LCs) 1, 2, 3, and 4. Although not fully completed, the Army conducted the first successful launch, a Bumper rocket from LC 3, on July 24, 1950. Construction of LC 3 was completed by 1951. By 1952, LC 4 was finished, followed closely by LC 1 and LC 2 in 1953.[26]

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[23] Harry A. Butowsky, *National Historic Landmark Federal Agency Nomination, Cape Canaveral Air Force Station* (Washington, D.C.: National Park Service, 1983), 8-2. For ease of discussion, the name Patrick AFB will be used throughout the context.

[24] David Barton and Richard S. Levy, *An Architectural and Engineering Survey and Evaluation of Facilities at Cape Canaveral Air Force Station, Brevard County, Florida* (Resource Analysts, Inc., March 16, 1984), 3-4; Charles D. Benson and William B. Faherty, *Gateway to the Moon: Building the Kennedy Space Center Launch Complex* (Gainesville, FL: University Press of Florida, 2001), 1; Butowsky, *Cape Canaveral Air Force Station*, 8-2; Cliff Lethbridge, "The History of Cape Canaveral," *Spaceline.org*, 2000.

[25] Lethbridge, "Cape Canaveral." For ease of reference, it will be referred to as CCAFS (Cape Canaveral Air Force Station) throughout the text.

[26] Butowsky, *Cape Canaveral Air Force Station*, 7-3 and 7-4; Lethbridge, "Cape Canaveral."

During the late 1940s and early 1950s, US Air Force activities at CCAFS focused on winged cruise missile research and development as a deterrent force in the weapons race between the US and the USSR. The earliest launch pads (LCs 1, 2, 3, 4, 9, 10, 21, and 22), located at the southern tip of the CCAFS, were used for firing experimental winged missiles including the Lark, Matador, Navaho, Snark, Bomarc, Bull Goose, and Mace. Support buildings, including a communications building, a water plant, a fire fighting unit, electrical substations, a skid strip for the landing and reuse of the missiles, and Hangars C and O, were constructed near these original launch pads.[27]

In 1952, the USSR detonated their first thermonuclear device. Additionally, intelligence reports indicated that they were also developing long-range missiles. Not to be outdone, the US began to advance their ballistic missile development and by 1955, US Air Force officials convinced President Eisenhower to assign the intercontinental ballistic missile (ICBM) development program the highest national priority. Subsequently, the DoD approved two intermediate range ballistic missile (IRBM) programs: the US Air Force's Thor Program and the Army/Navy's Jupiter Program. Both were developed simultaneously and were assigned an equal national priority.[28]

The drive to develop more accurate and powerful weapons led to the construction of numerous additional launch complexes along the CCAFS. Many of the earliest launch complexes were adapted to new uses, such as support structures, for these facilities. Since the Government maintained programs for both ICBMs and IRBMs, launch complexes for both types of missiles were constructed at CCAFS. Over time, the southern area of the CCAFS was developed for launching IRBMs (Redstone, Pershing, Polaris/Poseidon, and Thor) and included LCs 5, 6, 17, 18, 25, 26, 29, and 30; LCs 9 and 10 in this area were used for the Navaho winged intercontinental missile. The northern area of the CCAFS was developed for launching ICBMs and space launch vehicles (Atlas, Titan, Saturn) and included LCs 11, 12, 13, 14, 15, 16, 19, 20, 34, 36, and 37.[29]

In 1955, President Dwight D. Eisenhower announced that the US would launch an unmanned satellite as part of the nation's participation in the International Geophysical Year, which was planned for July 1957 through December 1958. Initially, the US Navy's Project Vanguard was chosen to complete this task. Although the Vanguard made use of the reliable Viking rocket, the

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[27] Barton and Levy, *Cape Canaveral Air Force Station,* 6, 25; E.R. Bramlitt, *History of Canaveral District 1950-1971* (South Atlantic Division, U.S. Army Corps of Engineers, 1971); Jacob Neufeld, *The Development of Ballistic Missiles in the United States Air Force, 1945-1960* (Washington, D.C.: United States Air Force, Office of Air Force History, 1990), 239.

[28] Neufeld, *Development of Ballistic Missiles,* 143-48, 242.

[29] Barton and Levy, *Cape Canaveral Air Force Station,* 4, 9; Denise P. Messick, Cynthia G. Rhodes, and Charles E. Cantley, *45th Space Wing Cultural Resource Management Plan*, Technical Report No. 386 (Stone Mountain, GA: New South Associates, 1996), 95; James N. Gibson, *Nuclear Weapons of the United States: An Illustrated History* (Atlglen, PA: Schiffer Publishing, Ltd., 2000).

first test flight did not occur until December 8, 1956, with the second test flight launching on May 5, 1957; both lifted off from CCAFS. After the successful Soviet launches of Sputnik I (October 4, 1957) and Sputnik II (November 3, 1957) and the failure of the third Vanguard test flight, President Eisenhower and the DoD approved the Army's Explorer Project, which was under its Development Operations Division led by Dr. Wernher von Braun.[30] The US successfully entered the space race with the launch of the Army's scientific satellite Explorer I from CCAFS on January 31, 1958, using a four stage Jupiter C missile named Juno I.[31]

Realizing the military's involvement in the space program would jeopardize the goal of using space for peaceful purposes, the President's Science Advisory Committee urged that a centralized agency be created to oversee the scientific exploration of space. Thus, NASA was established as a civilian agency with the mission of carrying out scientific aeronautical and space exploration, both manned and unmanned.[32] Forming the core of this new agency was the National Advisory Committee for Aeronautics, which had been a leader in flight research since 1915. NACA also had long working relationships with the different US military branches and the ability to take that research and apply it to civilian applications. Above all, the group had the advantage of a "peaceful, research-oriented image."[33]

Soon after the creation of NASA in 1958, Navy personnel and facilities associated with Project Vanguard, and over 400 scientists from the Naval Research Laboratory were reassigned to NASA, as was the Army-affiliated Jet Propulsion Laboratory of the California Institute of Technology. Initially working with NASA as part of a cooperative agreement, President Eisenhower officially transferred a large portion of the Army's Development Operations Division, including the team led by von Braun, to NASA in March 1960. At the same time, Eisenhower named the Huntsville NASA installation the George C. Marshall Space Flight Center (MSFC) and designated the Missile Firing Laboratory at CCAFS as its Launch Operations Directorate.

NASA's Early Manned Space Programs

Initially, NASA's space program was organized into three phases: Projects Mercury, Gemini, and Apollo. Project Mercury, initiated in 1958, was executed in less than five years. Begun in 1964, Project Gemini was the intermediate step toward achieving a manned lunar landing,

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[30] Benson and Faherty, *Gateway to the Moon*, 1-2.
[31] Roger D. Launius, *NASA: A History of the U.S. Civil Space Program* (Malabar, FL: Krieger Publishing Company, 2001), 21-8.
[32] R. Cargill Hall, "Civil-Military Relations in America's Early Space Program." In *The U.S. Air Force in Space: 1945 to the 21st Century, Proceedings of the Air Force Historical Foundation Symposium, Andrews AFB, Maryland, September 21-22, 1995*, ed. R. Cargill Hall and Jacob Neufeld (Washington, D.C.: U. S. Air Force, USAF History and Museums Program, 1998), 30; Barton and Levy, *Cape Canaveral Air Force Station,* 20.
[33] Roger E. Bilstein, *Testing Aircraft, Exploring Space: An Illustrated History of NACA and NASA* (Baltimore, MD: The Johns Hopkins University Press, 2003), 50-58.

bridging the gap between the short-duration Mercury flights and the long-duration missions proposed for the Apollo Program. Apollo, the largest and most ambitious of the manned space programs, had as its goal the landing of astronauts on the Moon and their safe return to Earth. Providing the muscle to launch the spacecraft was the Saturn family of heavy vehicles. Saturn IB rockets were used to launch the early unmanned Apollo test flights and the first manned flight, Apollo 7, which carried astronauts on a ten-day Earth orbital mission.[34]

Three different launch vehicles were used for Apollo: Saturn I, Saturn IB and Saturn V; and three different launch complexes were involved: LC 34 and LC 37 on CCAFS, and LC 39 on KSC.[35] Altogether, thirty-two Saturn flights occurred (seven from LC 34, eight from LC 37, and seventeen from LC 39 Pad A [twelve] and Pad B [five], including Skylab and the Apollo-Soyuz Test Project) during the Apollo era. Of the total thirty-two, fifteen were manned, and of the seven attempted lunar landing missions, six were successful. No major launch vehicle failures of either Saturn IB or Saturn V occurred. There were two major command/service module failures, one on the ground (Apollo 1) and one on the way to the Moon (Apollo 13).[36]

The unmanned Apollo 4 mission, which lifted off on November 9, 1967, was the first Saturn V launch and the first launch from LC 39 (Pad A) at KSC. The next launch from LC 39 (Pad A) was Apollo 6, on April 4, 1968. Beginning with the launch of Apollo 8 on December 21, 1968, all manned missions have launched from LC 39.[37] On July 20, 1969, the goal of landing a man on the Moon was achieved when Apollo 11 astronauts Neil A. Armstrong, Edwin E. “Buzz” Aldrin, Jr., and Michael Collins successfully executed history’s first lunar landing. Armstrong and Aldrin walked on the surface of the Moon for two hours and thirty-one minutes, and collected 21 kilograms of lunar material. Apollo 17 served as the first night launch in December 1972. An estimated 500,000 people viewed the liftoff from LC 39 Pad A, which was the final launch of the Apollo Program.[38]

Skylab, an Earth-orbiting mission that was a follow-on to the Apollo Program, served as an early type of space station. With 12,700 cubic feet of work and living space, it was the largest habitable structure ever placed in orbit at the time. The station achieved several objectives: scientific investigations in Earth orbit (astronomical, space physics, and biological experiments); applications in Earth orbit (Earth resources surveys); and long-duration spaceflight. Skylab 1 orbital workshop was inhabited in succession by three crews launched in modified Apollo command/service modules (Skylab 2, 3 and 4). Actively used until February 1974, Skylab 1

[34] Harry A Butowsky, *Reconnaissance Survey: Man in Space* (Washington, D.C.: National Park Service, 1981), 5; Benson and Faherty, *Gateway*, 5.
[35] LC 39 is comprised of two launch pads, Pad A and Pad B. Unless otherwise noted, the term LC 39 refers to both launch pads.
[36] NASA, *Facts: John F. Kennedy Space Center* (1994), 82.
[37] Apollo 5 launched from CCAFS’s LC 37B; Apollo 7 launched from LC 34 at CCAFS.
[38] NASA, *Facts*, 86-90.

remained in orbit until July 11, 1979, when it re-entered Earth's atmosphere over the Indian Ocean and Western Australia after completing 34,181 orbits.[39]

The Apollo-Soyuz Test Project of July 1975, the final application of the Apollo Program, marked the first international rendezvous and docking in space, and was the first major cooperation between the only two nations engaged in manned space flight, the US and Russia. As the first meeting of two manned spacecraft of different nations in space, and the first docking and visits by astronauts and cosmonauts into the others' spacecraft, the event was highly significant. The Apollo-Soyuz Test Project established workable joint docking mechanisms, taking the first steps toward mutual rescue capability of both Russian and American manned missions in space.[40]

The Space Shuttle Program

On January 5, 1972, President Richard M. Nixon delivered a speech in which he outlined the end of the Apollo era and the future of a reusable space flight vehicle, the Space Shuttle, which would provide "routine access to space." By commencing work at this time, Nixon added, "we can have the Shuttle in manned flight by 1978, and operational a short time after that."[41] The Space Task Group, previously established by President Nixon in February 1969, recommended three choices of long-range space plans. All included an Earth–orbiting space station, a space shuttle, and a manned Mars expedition.[42] Although none of the original programs presented was eventually selected, NASA implemented a program, shaped by the politics and economic realities of its time that served as a first step toward any future plans for implementing a space station.[43]

During this speech, President Nixon instructed NASA to proceed with the design and building of a partially reusable Space Transportation System (STS; commonly referred to as the Space Shuttle) consisting of a reusable orbiter, three reusable main engines, two reusable SRBs, and one non-reusable external tank. NASA's administrators vowed that the Space Shuttle would fly at least fifty times a year, making space travel economical and safe. NASA gave responsibility for developing the Space Shuttle's orbiter vehicle (OV) and overall management of the Space Shuttle Program to the Manned Spacecraft Center (now known as the Johnson Space Center) in Houston, Texas, based on the Center's experience. MSFC in Huntsville, Alabama, was responsible for development of the space shuttle main engine, the SRBs, the external tank, and for all propulsion-related tasks. Engineering design support continued at Johnson Space Center,

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[39] NASA, *Facts*, 91.
[40] NASA, *Facts*, 96.
[41] Marcus Lindroos, ed., "President Nixon's 1972 Announcement on the Space Shuttle," updated April 14, 2000, http://history.nasa.gov/stsnixon.htm.
[42] NASA, "Report of the Space Task Group, 1969," (Washington, D.C.: NASA Headquarters, 1969), http://www.hq.nasa.gov/office/pao/History/taskgrp.html.
[43] Dennis R. Jenkins, *Space Shuttle, The History of the National Space Transportation System. The First 100 Missions* (Cape Canaveral, Florida: Specialty Press, 2001), 99.

MSFC, and NASA's Langley Research Center in Virginia and engine tests were to be performed at NASA's National Space Technology Laboratories (later named Stennis Space Center) in south Mississippi and at the Air Force's Rocket Propulsion Laboratory in California, which later became the Santa Susana Field Laboratory.[44] NASA selected KSC as the primary launch and landing site for the Space Shuttle Program. KSC, responsible for designing the launch and recovery facilities, was to develop methods for shuttle assembly, checkout, and launch operations.[45]

On September 17, 1976, the full-scale OV prototype *Enterprise* (OV-101) was completed. Designed for test purposes only and never intended for space flight, structural assembly of OV-101 had started more than two years earlier in June 1974 at Air Force Plant 42 in Palmdale, California. Although the *Enterprise* was an aluminum shell prototype incapable of space flight, it reflected the overall design of the orbiter. As such, it served successfully in 1977 as the test article during the Approach and Landing Tests aimed at checking out both the mating with the Boeing 747 Shuttle Carrier Aircraft for ferry operations, as well as the orbiter's unpowered landing capabilities.

The first orbiter intended for spaceflight, *Columbia* (OV-102), arrived at KSC from Air Force Plant 42 in March 1979. Originally scheduled for liftoff in late 1979, the launch date was delayed by problems with both the main engine components as well as the thermal protection system. *Columbia* spent 610 days in the Orbiter Processing Facility, another thirty-five days in the Vehicle Assembly Building and 105 days on LC 39A before lifting off on April 12, 1981. STS-1, the first orbital test flight and first Space Shuttle Program mission, ended with a landing on April 14, 1981, at Edwards Air Force Base in California. This launch demonstrated *Columbia's* ability to fly into orbit, conduct on-orbit operations, and return safely.[46] *Columbia* flew three additional test flights in 1981 and 1982, all with a crew of two. The Orbital Test Flight Program ended in July 1982 with 95 percent of its objectives accomplished. After the end of the fourth mission, President Ronald W. Reagan declared that with the next flight the Shuttle would be "fully operational."

During the Space Shuttle Program, a total of 135 missions were launched from KSC. From April 1981 until the *Challenger* accident in January 1986, between two and nine missions were flown yearly, with an average of four to five per year. The milestone year was 1985, when nine flights were successfully completed. The years between 1992 and 1997 were the most productive, with

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[44] Jenkins, *Space Shuttle*, 122.
[45] Linda Neuman Ezell, *NASA Historical Databook Volume III Programs and Projects 1969-1978*, The NASA History Series (Washington, D.C.: NASA History Office, 1988), 121-24, table 2-57; Ray A. Williamson, "Developing the Space Shuttle," in *Exploring the Unknown: Selected Documents in the History of the U.S. Civil Space Program, Volume IV: Accessing Space*, ed. John M. Logsdon (Washington, D.C.: U.S. Printing Office, 1999), 172-174.
[46] Jenkins, *Space Shuttle,* 268.

seven or eight yearly missions. Since 1995, in addition to its unique responsibility as the Space Shuttle launch site, KSC also became the preferred landing site.

Over the past three decades, the Space Shuttle Program has launched a number of planetary and astronomy missions including the Hubble Space Telescope, the Galileo probe to Jupiter, Magellan to Venus, and the Upper Atmospheric Research Satellite. In addition to astronomy and military satellites, a series of Spacelab research missions were flown, which carried dozens of international experiments in disciplines ranging from materials science to plant biology. Spacelab was a manned, reusable, microgravity laboratory flown into space in the Space Shuttle cargo bay. It was developed on a modular basis allowing assembly in a dozen arrangements depending on the specific mission requirements.[47] The first Spacelab mission, carried aboard *Columbia* (STS-9), began on November 28, 1983. Four Spacelab missions were flown between 1983 and 1985. Following a stand-down in the aftermath of the *Challenger* disaster, the next Spacelab mission was not launched until 1990. In total, twenty-four Space Shuttle missions carried Spacelab hardware before the program was decommissioned in 1998.[48]

In 1995, a joint US/Russian Shuttle-*Mir* Program was initiated as a precursor to construction of the International Space Station (ISS). *Mir* was launched in February 1986 and remained in orbit until March 2001.[49] The first approach and fly around of *Mir* (STS-63) took place on February 3, 1995, and the first *Mir* docking (STS-71) was in June 1995. During the three-year Shuttle-*Mir* Program (June 27, 1995 to June 2, 1998), the Space Shuttle docked with *Mir* nine times. The Orbiter *Atlantis* flew all but the last two of these docking missions. In 1995, Dr. Norman Thagard was the first American to live aboard the Russian space station. Over the next three years, six more US astronauts served tours on *Mir*. The Space Shuttle served as a means of transporting supplies, equipment, and water to the space station in addition to performing a variety of other mission tasks, many of which involved Earth science experiments. It returned experiment results and unneeded equipment to Earth. The Shuttle-*Mir* Program served to acclimate the astronauts to living and working in space. Many of the activities carried out were types they would perform on the ISS.[50]

On December 4, 1998, *Endeavour* (STS-88) launched the first US component of the ISS into orbit. This event marked, "at long last the start of the Space Shuttle's use for which it was primarily designed – transport to and from a permanently inhabited orbital space station."[51] STS-

[47] NASA, *NSTS 1988 News Reference Manual* (Florida: Kennedy Space Center, 1988), http://science.ksc.nasa.gov/shuttle/technology/sts-newsref/.
[48] STS-90, which landed on May 3, 1998, was the final Spacelab mission. NASA KSC, "Shuttle Payloads and Related Information," *KSC Factoids* (Florida: Kennedy Space Center, 2002), http://www-pao.ksc.nasa.gov/kscpao/factoids/relinfo2.htm.
[49] Tony Reichhardt, ed., *Space Shuttle, The First 20 Years* (Washington, D.C.: Smithsonian Institution, 2002), 85.
[50] Judy A. Rumerman, with Stephen J. Garber, *Chronology of Space Shuttle Flights 1981-2000* (Washington, D.C.: NASA History Division, 2000), 3.
[51] Williamson, "Developing," 191.

96, *Discovery*, launched on May 27, 1999, marked the first mission to dock with the ISS. Since that time, most Space Shuttle missions supported the assembly of the space station. The last major component of the ISS was delivered in May 2011, during the final flight of *Endeavour* (STS-134).

The Space Shuttle Program suffered two major setbacks with the tragic losses of the *Challenger* and *Columbia* on January 28, 1986, and February 1, 2003, respectively. Following the *Challenger* accident, the program was suspended, and President Reagan formed a thirteen-member commission to identify the cause of the disaster. The Rogers Commission report, issued on June 6, 1986, which also included a review of the Space Shuttle Program, concluded "that the drive to declare the Space Shuttle operational had put enormous pressures on the system and stretched its resources to the limit."[52] In addition to mechanical failure, the Commission noted a number of NASA management failures that contributed to the catastrophe. As a result, among the tangible actions taken were extensive redesign of the SRBs; upgrading of the Space Shuttle tires, brakes, and nose wheel steering mechanisms; the addition of a drag chute to help reduce speed upon landing; the addition of a crew escape system; and the requirement for astronauts to wear pressurized flight safety suits during launch and landing operations. Other changes involved reorganization and decentralization of the Space Shuttle Program. NASA moved the management of the program from Johnson Space Center to NASA Headquarters (Washington, D.C.), with the aim of preventing communication deficiencies.[53] Experienced astronauts were placed in key NASA management positions, all documented waivers to existing flight safety criteria were revoked and forbidden, and a policy of open reviews was implemented.[54] In addition, NASA adopted a Space Shuttle flight schedule with a reduced average number of launches and discontinued the long-term practice of launching commercial and military payloads.[55] The launch of *Discovery* (STS-26) from LC 39B on September 29, 1988, marked a Return-to-Flight after a thirty-two-month stand-down in manned space flight following the *Challenger* accident.

In the aftermath of the 2003 *Columbia* accident, a seven-month investigation ensued, concluding with the findings of the Columbia Accident Investigation Board, which determined that both technical and management conditions accounted for the loss of the orbiter and crew. According to the Board's Report, the physical cause of the accident was a breach in the thermal protection system on the leading edge of the left wing, caused by a piece of insulating foam, which separated from the external tank after launch and struck the wing.[56] NASA spent more than two years researching and implementing safety improvements for the orbiters, SRBs and external

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[52] Columbia Accident Investigation Board, *Report, Volume I*, (Washington, D.C.: U.S. Government Printing Office, 2003), 25, http://history.nasa.gov/columbia/CAIB_reportindex.html.
[53] Columbia Accident Investigation Board, *Report, Volume I*, 101.
[54] Cliff Lethbridge, "History of the Space Shuttle Program," 2001, http://spaceline.org/rocketsum/shuttle-program.html.
[55] Lethbridge, "History."
[56] Columbia Accident Investigation Board, *Report, Volume I*, 9.

tank. Following a two-year stand-down, the launch of STS-114 on July 26, 2005, marked the first Return-to-Flight since the loss of *Columbia*.

On January 14, 2004, President George W. Bush outlined a new space exploration initiative in a speech given at NASA Headquarters.

> *Today I announce a new plan to explore space and extend a human presence across our solar system . . . Our first goal is to complete the International Space Station by 2010 . . . The Shuttle's chief purpose over the next several years will be to help finish assembly of the International Space Station. In 2010, the Space Shuttle – after nearly 30 years of duty – will be retired from service. . .*[57]

Following the President's speech, NASA released *The Vision for Space Exploration*, which outlined the Agency's approach to the new direction in space exploration.[58] As part of this initiative, NASA decided that the Space Shuttle would not be upgraded to serve beyond the completion of the ISS; in 2011, after the last Space Shuttle Mission, STS-135, the Space Shuttle Program was officially retired.

[57] Weekly Comp. Pres. Docs., Remarks at the National Aeronautics and Space Administration, Vol. 40, Issue 3 (January 19, 2004), http://www.gpo.gov/fdsys/pkg/WCPD-2004-01-19/content-detail.html.
[58] NASA, *The Vision for Space Exploration* (Washington, D.C.: NASA Headquarters, 2004), http://www.nasa.gov/pdf/55583main_vision_space_exploration2.pdf.

Part II. Structural/Design Information

A. General Statement:

1. Architectural Character: The Hangar M Annex is a two-story masonry structure with approximately 20,510 square feet of space. Its longitudinal axis is oriented about 35 degrees east of due north; for ease of reference, the description will assume the longitudinal axis follows true north. The walls are comprised of concrete block and are topped with a flat, built-up roof. It is rectangular in plan and the interior room arrangement is based on a double-loaded corridor layout.

2. Condition of fabric: At the time of documentation, the Hangar M Annex was vacant, although the fabric remained in good condition due to previous periodic maintenance.

B. Description of Exterior:

1. **Overall dimensions:** The Hangar M Annex (Photo Nos. 1-10) has approximate overall measurements of 222’ in length (north-south), 46’-4” in width (east-west), and 25’ in height. The structure is rectangular in plan.

2. **Foundation:** The foundations of the Hangar M Annex are comprised of a 4”-thick steel reinforced poured concrete slab on compacted fill with steel reinforced poured concrete footers.

3. **Walls:** The exterior walls of the Hangar M Annex are comprised of reinforced concrete columns and beams with concrete block infill. In general, the east and west elevations (Photo Nos. 1 and 5, respectively) of the building are divided into fifteen 14’-8”-wide bays by 1”-wide/1’-deep, beige-painted concrete pilasters. The south and north elevations (Photo Nos. 3 and 7, respectively) are divided into two 21’-4”-wide bays by 1”-wide/1’-deep pilasters.

4. **Structural system, framing:** The structural framing system of the Hangar M Annex is comprised of concrete blocks and joists and steel beams.

5. **Porches, patios, stoops:** There is a 30’-8”-wide by 8’-deep inset porch with two concrete steps on the east elevation, which contains the main entrance (Photo No. 11). The first floor entrance on the north elevation also has a small concrete porch with two steps; the other first floor entrances to the Hangar M Annex feature either a small concrete stoop or an access ramp.

7. **Openings:**

   a. **Doorways and doors:** The main entrance to the Hangar M Annex is located on the east elevation (Photo Nos. 1, 9). It features a pair of one-light metal swing doors, with a two-light transom and plate glass windows to the south. There are no additional doorways on the east elevation. The north elevation contains one entrance at the first floor level and one entrance at the second floor level. The first floor entrance is comprised of a pair of one-light metal swing doors; the second floor entrance is a single one-light metal swing door reached by a set of concrete steps with a metal handrail. The south elevation features two sets of double one-light metal swing doors, one at the first floor level and one at the second floor level. The doorway on the second floor is accessed by a set of concrete steps. There are five doorways on the west elevation, all at the first floor level. They include two sets of double metal swing doors, one single metal swing door, and two sets of double louvered metal swing doors.

   b. **Windows:** With the exception of those around the main entrance, the majority of windows on the east and west elevations of the building are comprised of 7-3/4"-square glass blocks arranged in three rows with six to eighteen columns. The west elevation also features a few two-light windows, with a fixed top pane and an awning lower pane. All of the windows have precast concrete sills.

8. **Roof:**

   a. **Shape, covering:** Hangar M Annex has a flat roof faced with five-ply built-up roofing over lightweight concrete insulation. The entirety is supported by steel beams and concrete joists.

C. **Description of Interior:**

1. **Floor plans:** Hangar M Annex is comprised of two floors, both of which feature a double-loaded corridor room arrangement (Figure Nos. B-2, B-3). With the exception of the laboratory area at the south end of the first floor, most of the rooms have undergone some type of modification, typically in the form of new room finishes, partitioning into smaller spaces, or combining with others to form large spaces.

   On the first floor (Figure No. B-2), nearly centered on the east elevation, is the roughly 8' x 16' entrance lobby (Photo No. 11). This space features an asphalt tile floor, a gypsum board ceiling, and gypsum board/wood partition walls; the north wall contains fire alarm equipment and the south wall contains display boards. An 8' x 15' office sits in the south half of the original lobby. Across the corridor from the lobby is the main staircase. To the south of the lobby is the LiOH Laboratory area (Figure No. B-5), which has been minimally altered since its original construction. The main corridor leads to an 11’ x 7’ reception room, to the south of which is a 10’ x 7’ air shower (Photo No. 14), a 9’ x 7’ vestibule, and a 5’ x 7’ restroom. To the east of these rooms are (from south to north) a 9’ x 9’ airlock and a 9’ x 12’ storage room, a 38’ x 21’ laboratory (Photo No. 12), a 10’ x 22’ laboratory, a 20’ x 22’ office, and an 18’ x 22’ office. Carved out of the east side of the latter two rooms is a 27’ x 9’ space (Photo No. 16) that originally was used as a TWX room. On the other side of the corridor, from south to north, are a 9’ x 7’ airlock and a 9’ x 8’ storage room, a 22’ x 15’ laboratory (Photo No. 13), a 10’ x 15’ laboratory, a 14’ x 15’ mechanical equipment room, a 22’ x 15’ office (Photo No. 15), and a 14’ x 15’ mechanical equipment room. To the north of the lobby was USA’s M&P Laboratory (Figure No. B-9), installed circa 2005. To the east of the corridor, from south to north, are a 16’ x 17’ office, a 16’ x 12’ office (Photo No. 17) and a 16’ x 11’ office, a 16’ x 21’ thermal protection system laboratory, a 15’ x 21’ thermal protection system laboratory, a 32’ x 22’ thermal/spectroscopy laboratory (Photo No. 18), and a 15’ x 11’ office and 15’ x 12’ scanning electron microscope laboratory. On the west side of the corridor, from south to north, is a janitor’s closet, restrooms, a 16’ x 15’ electrostatic discharge laboratory, a 27’ x 15’ mechanical test laboratory, a 29’ x 15’ metals preparation laboratory, and a 6’ x 15’ communications room.

Almost the entirety of the second floor (Figure No. B-3) is comprised of small, medium, and large office areas. The majority of the offices were for single occupants (Photo No. 20), although a few had multiple occupants (Photo No. 19). To the east of the corridor, at the north end, is a 16’ x 22’ conference room (Photo No. 21). Also, near the center of the building to the west of the corridor are a mechanical equipment room, a janitor’s closet, and two restrooms.

3. **Flooring:** The flooring throughout the building is a combination of different materials applied to the concrete slab. In general, the offices have carpeting, the laboratories and corridors have vinyl or asphalt tile flooring, and the restrooms and equipment rooms have hardened concrete floors.

4. **Wall and ceiling finishes:** The laboratories at the south end typically feature painted gypsum board walls with plastic laminate wainscoting. In the office areas, the outer walls are exposed concrete block and painted gypsum board; the second floor conference room also features a wood panel wall. The service rooms (e.g., janitor’s closets) have exposed concrete block walls. The ceiling finishes throughout the Hangar M Annex include acoustic ceiling tile and painted gypsum board.

5. **Openings:**

   a. **Doorways and doors:** According to the various drawings, there are roughly eighty-seven interior doors in the Hangar M Annex; seventy-six are single swing doors and eleven are double swing doors. Most of the doors are constructed of wood and have a louver at the bottom; nearly all feature metal surrounds.

b. Windows: Most of the windows in the Hangar M Annex are comprised of glass block and are flush with the internal wall surface. The few non-glass block windows have a 4" sill.

8. Mechanical equipment:

a. Heating, air conditioning, ventilation: Hangar M Annex contains a central heating, ventilating, and air conditioning system.

b. Lighting: It contains surface-mounted and recessed fluorescent light fixtures throughout all rooms and corridors.

c. Plumbing: It features an indoor plumbing system with separate pumps for hot and cold water.

d. Electrical: It has an electrical system that powers all of the lighting, power outlets, communications systems, and plumbing/mechanical equipment.

D. Site:

1. Historic landscape design: Hangar M Annex has always featured grassed areas along the east and north elevations, but has never had any trees or shrubs around the building. To the east of the building are a one-way entrance drive (south to north) and a directional parking lot (Figure Nos. A-2, A-3). At the time of documentation, the historic landscaping and parking lot remained intact.

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