CAPE CANAVERAL AIR FORCE STATION, LAUNCH COMPLEX 39, CANISTER ROTATION FACILITY
(John F. Kennedy Space Center)
Northwest corner of the D Avenue SE/4th Street SE intersection
Cape Canaveral
Brevard County
Florida

HAER No. FL-8-11-K

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
U.S. Department of the Interior
100 Alabama Street, SW
Atlanta, GA 30303

HISTORIC AMERICAN ENGINEERING RECORD

CAPE CANAVERAL AIR FORCE STATION, LAUNCH COMPLEX 39, CANISTER ROTATION FACILITY (John F. Kennedy Space Center)

HAER No. FL-8-11-K

Location: Northwest corner of the D Avenue SE/4th Street SE intersection
John F. Kennedy Space Center
Cape Canaveral
Brevard County
Florida

U.S.G.S. 7.5. minute Orsino, Florida, quadrangle,
Universal Transverse Mercator coordinates:
17.534333.3154661

Date of Construction: 1991-1992

Architect: Ivey's Construction, Inc., Merritt Island, Florida (with Stottler Stagg and Associates, Cape Canaveral, Florida, and Gardner, Griffith and Associates, Inc. of Cocoa, Florida)

Builder: Ivey's Construction, Inc., Merritt Island, Florida

Present Owner: National Aeronautics and Space Administration (NASA)
Kennedy Space Center, FL 32899-0001

Present Use: Aerospace Facility-rotation, processing, and maintenance of Space Shuttle payload canister

Significance: The Canister Rotation Facility (CRF) is considered eligible for listing in the National Register of Historic Places (NRHP) in the context of the U.S. Space Shuttle program (1969-2010) under Criteria A and C in the areas of Space Exploration and Engineering, respectively. Because it has achieved exceptional significance within the past 50 years, Criteria Consideration G applies. The CRF was specially designed to accommodate the rotation of the payload canister, from horizontal to vertical or from vertical to horizontal, in support of the Space Shuttle program. This building made possible a more efficient performance of this operation, which had previously been conducted in the Vehicle Assembly Building. Under Criterion C, it is distinguished by its uniquely designed equipment, rather than the building's exterior shell.

Project Information: The documentation of the Cape Canaveral Air Force Station, Launch Complex 39, Canister Rotation Facility was conducted in 2010 for the John F. Kennedy Space Center (KSC) by Archaeological Consultants, Inc. (ACI), under contract to Innovative Health Applications (IHA), and in accordance with KSC's Programmatic Agreement (PA) Regarding Management of Historic Properties, dated May 18, 2009. The field team consisted of architectural historian, Patricia Slovinac (ACI), photographer, Penny Rogo Bailes, and assistant photographer, Nigel Rudolph. Assistance in the field was provided by Shannah Trout, IHA's Cultural Resource Specialist. The written narrative was prepared by Ms. Slovinac; it was edited by Joan Deming, ACI Project Manager; Elaine Liston, KSC Archivist; Barbara Naylor, KSC Historic Preservation Officer; and Ms. Trout. The photographs and negatives were processed by Bob Baggett Photography, Inc.

The Scope of Services for the project, which was compiled based on the PA, specifies a documentation effort following HAER Level II Standards. Information for the written narrative was primarily gathered through informal interviews with current NASA and contractor personnel and research materials housed at the KSC Archives Department. Selected drawings were provided by KSC's Engineering Documentation Center, which serves as the repository for all facility drawings. The available drawings for the CRF included the "as-built" drawings, as well as those depicting major modification to the facility, or any small modifications that required a set of drawings (such as changes to the electrical or mechanical systems). KSC does not periodically produce drawings of their facilities to show current existing conditions.

Report Prepared by: Patricia Slovinac, Architectural Historian
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Sarasota, Florida 34240

Date: April 2011

LIST OF ACRONYMS

CCAFS	Cape Canaveral Air Force Station
CRF	Canister Rotation Facility
ET	External Tank
FOD	Foreign Object Debris
ISS	International Space Station
JSC	Johnson Space Center
KSC	Kennedy Space Center
LC	Launch Complex
MMSE	Multi-Mission Support Equipment
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NRHP	National Register of Historic Places
OPF	Orbiter Processing Facility
OV	Orbiter Vehicle
SRB	Solid Rocket Booster
SSME	Space Shuttle Main Engine
STS	Space Transportation System
TCF	Transporter/Canister Facility
U.S.	United States
VAB	Vehicle Assembly Building

HISTORICAL INFORMATION

NASA's John F. Kennedy Space Center

The John F. Kennedy Space Center (KSC) is the National Aeronautics and Space Administration's (NASA) primary Center for launch and landing operations, vehicle processing and assembly, and related programs in support of manned space missions. It is located on the east coast of Florida, about 150 miles south of Jacksonville, and to the north and west of Cape Canaveral, in Brevard and Volusia Counties, and encompasses almost 140,000 acres. The Atlantic Ocean and Cape Canaveral Air Force Station (CCAFS) are located to the east, and the Indian River is to the west.

Following the launch of Sputnik I and Sputnik II, which placed Soviet satellites into Earth's orbit in 1957, the attention of the American public turned to space exploration. President Dwight D. Eisenhower initially assigned responsibility for the U.S. Space Program to the Department of Defense. The Development Operations Division of the Army Ballistic Missile Agency, led by Dr. Wernher von Braun, began to focus on the use of missiles to propel payloads, or even a man, into space. The United States successfully entered the space race with the launch of the Army's scientific satellite Explorer I on January 31, 1958 using a modified Jupiter missile named Juno I.[1]

With the realization that the military's involvement in the space program could jeopardize the use of space for peaceful purposes, President Eisenhower established NASA on October 1, 1958 as a civilian agency with the mission of carrying out scientific aeronautical and space exploration, both manned and unmanned. Initially working with NASA as part of a cooperative agreement, President Eisenhower officially transferred to NASA a large portion of the Army's Development Operations Division, including the group of scientists led by von Braun, and the Saturn rocket program.[2]

NASA became a resident of Cape Canaveral in 1958 when the Army Missile Firing Laboratory, then working on the Saturn rocket project under the direction of Kurt Debus, was transferred to the agency. Several Army facilities at CCAFS were given to NASA, including various offices and hangars, as well as Launch Complexes (LC) 5, 6, 26, and 34. The Missile Firing Laboratory was renamed Launch Operations Directorate and became a branch office of Marshall Space Flight Center (MSFC). As the American space program evolved, the responsibilities of the Launch Operations Directorate grew, and NASA Headquarters separated the Directorate from

[1] Charles D. Benson and William B. Faherty. *Gateway to the Moon. Building the Kennedy Space Center Launch Complex* (Gainesville, University Press of Florida, 2001), 1-2.
[2] Benson and Faherty, *Gateway*, 15.

MSFC, officially designating it an independent field installation called the Launch Operations Center.[3]

In May 1961, President John F. Kennedy charged NASA and the associated industries to develop a space program that would surpass the Soviet program by landing a man on the Moon by the end of the decade. With the new, more powerful Saturn V rocket and the accelerated launch schedule, it was apparent that a new launch complex was required, and CCAFS, with twenty-two launch complexes, did not have the space for new rocket facilities. Merritt Island, an undeveloped area west and north of the Cape, was selected for acquisition, and in 1961 the Merritt Island Launch Area (which, with the Launch Operations Center, would become KSC) was born. In that year, NASA requested from Congress authority to purchase 80,000 acres of property, which was formally granted in 1962. The U.S. Army Corps of Engineers acted as agent for purchasing the land, which took place between 1962 and 1964. NASA began gaining title to the land in late 1962, taking over 83,903.9 acres by outright purchase, which included several small towns, such as Orsino, Wilson, Heath and Audubon, many farms, citrus groves, and several fish camps. Negotiations with the State of Florida provided submerged lands, resulting in the acquisition of property identified on the original Deed of Dedication. Much of the State-provided land was located south of the Old Haulover Canal and north of the Barge Canal.

The American program to put a man in space and land on the Moon proceeded rapidly with widespread support. In November 1963, the Launch Operations Center and Merritt Island Launch Area were renamed John F. Kennedy Space Center to honor the late President.[4] The 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, bridging the gap between the short-duration Mercury flights and the long-duration missions proposed for the Apollo Program.[5]

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.[6]

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[3] Benson and Faherty, *Gateway*, 136.
[4] Harry A Butowsky. *Reconnaissance Survey: Man in Space* (Washington, D.C.: National Park Service, 1981), 5; Benson and Faherty, *Gateway*, 146.
[5] Butowsky, 5.
[6] Butowsky, 5.

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 (only LC 39 is still active). Altogether, thirty-two Saturn flights occurred (seven from LC 34, eight from LC 37, and seventeen from LC 39, 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).[7]

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 at KSC. On July 20, 1969, the goal of landing a man on the Moon was achieved when Apollo 11 astronauts Armstrong, Aldrin, and 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, which was the final launch of the Apollo Program.[8]

Skylab, an application of 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 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.[9]

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. As the first meeting of two manned spacecraft of different nations in space, first docking, and first 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.[10]

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[7] NASA. *Facts: John F. Kennedy Space Center* (1994), 82.
[8] NASA. *Facts*, 86-90.
[9] NASA. *Facts*, 91.
[10] NASA. *Facts*, 96.

On January 5, 1972, President 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."[11] The Space Task Group, previously established by President Nixon in February 1969 to recommend a future course for the U.S. Space Program, presented three choices of long-range space plans. All included an Earth–orbiting space station, a space shuttle, and a manned Mars expedition.[12] 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.[13]

During this speech, President Nixon instructed NASA to proceed with the design and building of a partially reusable space shuttle consisting of a reusable orbiter, three reusable main engines, two reusable solid rocket boosters (SRBs), and one non-reusable external liquid fuel tank (ET). NASA's administrators vowed that the shuttle would fly at least fifty times a year, making space travel economical and safe. NASA gave responsibility for developing the shuttle orbiter vehicle and overall management of the Space Shuttle program to the Manned Spacecraft Center (now known as the Johnson Space Center [JSC]) in Houston, Texas, based on the Center's experience. MSFC in Huntsville, Alabama was responsible for development of the Space Shuttle Main Engine (SSME), the SRBs, the ET, and for all propulsion-related tasks. Engineering design support continued at JSC, MSFC and NASA's Langley Research Center, in Hampton, 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.[14] 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.[15]

On September 17, 1976, the full-scale Orbiter Vehicle (OV) prototype *Enterprise* (OV- 101) was completed. Designed for test purposes only and never intended for space flight, structural

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[11] Marcus Lindroos. "President Nixon's 1972 Announcement on the Space Shuttle." (NASA Office of Policy and Plans, NASA History Office, updated 14 April 2000).
[12] NASA, History Office, NASA Headquarters. "Report of the Space Task Group, 1969."
[13] Dennis R. Jenkins. *Space Shuttle, The History of the National Space Transportation System. The First 100 Missions* (Cape Canaveral, Florida: Specialty Press, 2001), 99.
[14] Jenkins, 122.
[15] Linda Neuman Ezell. *NASA Historical Databook Volume III Programs and Projects 1969-1978.* The NASA History Series, NASA SP-4012 (Washington, D.C.: NASA History Office, 1988), Table 2-57; Ray A. Williamson. "Developing the Space Shuttle." *Exploring the Unknown: Selected Documents in the History of the U.S. Civil Space Program, Volume IV: Accessing Space* (Edited by John M. Logsdon. Washington, D.C.: U.S. Printing Office, 1999), 172-174.

assembly of this orbiter 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 (SCA) 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 SSME components as well as the thermal protection system (TPS). *Columbia* spent 610 days in the Orbiter Processing Facility (OPF), another thirty-five days in the Vehicle Assembly Building (VAB) and 105 days on Launch Pad 39A before finally lifting off on April 12, 1981. Flight No. STS-1, the first orbital test flight and first Space Shuttle program mission, ended with a landing on April 14 at Edwards Air Force Base (EAFB) in California. This launch demonstrated *Columbia's* ability to fly into orbit, conduct on-orbit operations, and return safely.[16] *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 Reagan declared that with the next flight the Shuttle would be "fully operational."

By the end of the Space Shuttle program, a total of 135 missions will have been 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 seven or eight yearly missions. Since 1995, in addition to its unique responsibility as the shuttle launch site, KSC also became the preferred landing site.

Over the past two 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 rear of the space shuttle cargo bay. It was developed on a modular basis allowing assembly in a dozen arrangements depending on the specific mission requirements.[17] The first Spacelab mission, carried aboard *Columbia* (Flight No. 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

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[16] Jenkins, 268.
[17] NASA. *NASA Shuttle Reference Manual* (1988).

space shuttle missions carried Spacelab hardware before the program was decommissioned in 1998.[18] In addition to astronomical, atmospheric, microgravity, and life sciences missions, Spacelab was also used as a supply carrier to the Hubble Space Telescope and the Soviet space station *Mir*.

In 1995, a joint U.S./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.[19] The first approach and flyaround of *Mir* took place on February 3, 1995 (STS-63); the first *Mir* docking was in June 1995 (STS-71). During the three-year Shuttle-*Mir* Program (June 27, 1995 to June 2, 1998) the space shuttle docked with *Mir* nine times. All but the last two of these docking missions used the Orbiter *Atlantis*. In 1995, Dr. Norman Thagard was the first American to live aboard the Russian space station. Over the next three years, six more U.S. astronauts served tours on *Mir*. The 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 to Earth experiment results and unneeded equipment. 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.[20]

On December 4, 1999, *Endeavour* (STS-88) launched the first component of the ISS into orbit. This event marked, "at long last the start of the Shuttle's use for which it was primarily designed – transport to and from a permanently inhabited orbital space station."[21] STS-96, launched on May 27, 1999, marked the first mission to dock with the ISS. Since that time, most space shuttle missions have supported the continued assembly of the space station. As currently planned, ISS assembly missions will continue through the life of the Space Shuttle program.

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 Ronald 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 Shuttle operational had put enormous pressures on the system and stretched its resources to the limit".[22] In addition to mechanical failure, the Commission noted a number of

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[18] STS-90, which landed on 3 May 1998, was the final Spacelab mission. NASA KSC. "Shuttle Payloads and Related Information." KSC Factoids. Revised 18 November 2002.
[19] Tony Reichhardt (editor). *Space Shuttle, The First 20 Year.* (Washington, D.C.: Smithsonian Institution, 2002), 85.
[20] Judy A. Rumerman, with Stephen J. Garber. *Chronology of Space Shuttle Flights 1981-2000.* HHR-70 (Washington, D.C.: NASA History Division, Office of Policy and Plans, October 2000), 3.
[21] Williamson, 191.
[22] Columbia Accident Investigation Board. *Report Volume I* (August 2003), 25.

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 JSC to NASA Headquarters, with the aim of preventing communication deficiencies.[23] 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.[24] 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.[25] The launch of *Discovery* (STS-26) from KSC Pad 39B on September 29, 1988 marked a Return to Flight after a thirty-two-month stand-down in manned spaceflight 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 TPS on the leading edge of the left wing, caused by a piece of insulating foam, which separated from the ET after launch and struck the wing.[26] NASA spent more than two years researching and implementing safety improvements for the orbiters, SRBs and ET. 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. . .*[27]

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[23] CAIB, 101.
[24] Cliff Lethbridge. "History of the Space Shuttle program." (2001), 4.
[25] Lethbridge, 5.
[26] CAIB, 9.
[27] The White House. "A Renewed Spirit of Discovery – The President's Vision for Space Exploration." (January 2004).

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.[28] As part of this initiative, NASA will continue to use the space shuttle to complete assembly of the ISS. The Shuttle will not be upgraded to serve beyond 2010 and, after completing the ISS, the Space Shuttle program will be retired.

[28] NASA Headquarters. "The Vision for Space Exploration." (February 2004).

Development of KSC's Industrial Area

Today, KSC maintains operational control over 3,800 acres, all located in Brevard County. The major facilities are situated within the LC 39 Area, the VAB Area, the Shuttle Landing Facility Area, and the Industrial Area. The LC 39 and VAB Areas were developed primarily to support launch vehicle operations and related launch processing activities. They contain two Launch Pads, A and B, the VAB, the Launch Control Center, the OPFs, and other support facilities. The Shuttle Landing Facility Area was established at the outset of the Space Shuttle program to provide runway facilities capable of handling the speed and weight of the orbiter. The Industrial Area was developed to support administrative and technical functions, spacecraft and payload processing, and also to provide areas in which hazardous operations could be performed on spacecraft components.[29]

The approximately 1,070-acre Industrial Area sits roughly 4 miles south of the VAB. Its site plan was largely developed by a joint Manned Lunar Landing Program Master Planning Board, which consisted of NASA and Air Force personnel, with help from smaller committees that had been established to focus on facilities, instrumentation, and communications. Their site layout was heavily derived from an overall master plan that had been produced by Pan American in December 1962, under contract to the Air Force, for the Merritt Island land acquisition (see page 5). The streets within the Industrial Area were arranged in a grid pattern. Those that run north to south were given alphabetic designations; those that extend west to east were given numeric designations. The Headquarters Building was positioned in a central location, while the spacecraft support facilities were placed to the east, and support, storage and maintenance facilities to the south. The hazardous operations facilities were placed at the southeast corner, to isolate them from the remainder of the Industrial Area.[30]

In January 1963, ground-breaking ceremonies for the Operations & Checkout Building marked the start of construction within the Industrial Area. Shortly afterwards, "the Corps of Engineers awarded a contract for the construction of primary utilities to provide for a water distribution system, sewer lines, an electrical system, a central heating plant, streets, and hydraulic fill from the Indian River causeway to connect the Industrial Area on Merritt Island with the Florida mainland."[31] This was followed by the awarding of numerous contracts to firms such as Azzarelli Construction Company of Tampa, Florida; the joint venture of Paul Hardeman of Stanton, California, and Morrison-Knudsen Construction Company of Boise, Idaho; Franchi

[29] Archaeological Consultants, Inc. (ACI). *Survey and Evaluation of NASA-owned Historic Facilities and Properties in the Context of the U.S. Space Shuttle Program, John F. Kennedy Space Center (KSC), Brevard County, Florida.* On file, NASA KSC, 2007, 1-4.
[30] Benson and Faherty, *Gateway*, 238-241.
[31] Benson and Faherty, *Gateway*, 252.

Construction Company of Newton, Massachusetts; and Blount Brothers Construction Company of Shreveport, Louisiana, for the construction of other buildings within the Industrial Area.[32]

The Operations & Checkout Building was the first facility at KSC to be occupied; the Florida Operations team of JSC (then the Manned Spacecraft Center) moved into the building in September and October 1964. Formal opening ceremonies for the Headquarters Building occurred on May 26, 1965.[33] Other major facilities within the area completed by 1966 included the Central Instrumentation Facility, the Central Supply Facility, the Engineering Development Laboratory, two Spacecraft Assembly/Encapsulation facilities, the High Pressure Gas Storage Facility, the Fluid Test Complex, and the Parachute Refurbishment Facility.[34]

Currently, the Industrial Area is comprised of roughly 178 buildings and structures. By the end of the 1960s, roughly 38 percent of these facilities was completed, which included the key structures listed above, as well as numerous support buildings, such as storage sheds, maintenance shops, site utility structures, fuel storage areas, and equipment shelters.[35] During the Apollo Program, these facilities supported the inspection, check-out, and integration of the spacecraft modules; ordnance storage; telemetry data analysis and transmission; testing of hazardous fluids; and testing the Lunar Module's rendezvous radar. The Operations & Checkout Building also provided pre-flight living quarters for the astronauts.[36] The Industrial Area facilities provided similar support for the Skylab missions and the Apollo-Soyuz Test Project of the mid-1970s. Only a few additional support structures (roughly 3 percent of the current total) were constructed during this time frame.[37] Likewise, roughly 95 percent of the facilities constructed from the mid-1970s to the present, are small support structures, such as maintenance shops, storage sheds, and utility buildings.

The Space Shuttle program brought the first major changes to the Industrial Area of KSC. Although many of the existing facilities were modified to meet the needs of this program, new structures were required to accommodate payload processing and launch procedure testing, as well as to provide storage and maintenance for new ground support equipment.[38] The first major facility designed for the Space Shuttle program, the Launch Equipment Test Facility, was completed in 1975. This was followed in the 1980s by the construction of a Proof Load Test Structure, a Cryogenics Test Laboratory, and a Multi-Mission Support Equipment Building

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[32] Benson and Faherty, *Gateway*, 252-268.
[33] Benson and Faherty, *Gateway*, 268-269.
[34] Kenneth Lipartito and Orville R. Butler. *A History of the Kennedy Space Center* (Gainesville: University Press of Florida, 2007), 222-223; Space Gateway Support. *CCAFS/KSC Basic Information Guide*. KSC-CCAFS-6747, Revision B, January 2006. On file, Kennedy Space Center, 3-28 to 3-31.
[35] *Basic Information Guide,* 3-28 to 3-31.
[36] Benson and Faherty, *Gateway*, 240-242; Lipartito and Butler, 105.
[37] *Basic Information Guide,* 3-28 to 3-31.
[38] Lipartito and Butler, 186, 201, 222-223; *Basic Information Guide,* 3-28 to 3-31.

within the spacecraft support area, and a Payload Hazardous Servicing Facility, a Multi-Operation Support Building, and an Operations Support Building within the hazardous operations area.[39] In 1992, the last major facility to be added to the Industrial Area for the Space Shuttle program, the Canister Rotation Facility, was completed. The introduction of the Space Station *Freedom*, which later became the ISS, program, spurred the construction of the last two major facilities of the Industrial Area: the Space Station Processing Facility, completed in 1992, and the Multi-Payload Processing Facility, finished in 1995.[40]

The Canister Rotation Facility

The Canister Rotation Facility (CRF) is a contributing resource to the Historic Cultural Resources of the John F. Kennedy Space Center multiple property submission in the context of the U.S. Space Shuttle Program (ca. 1969-2011). It is considered eligible for listing in the NRHP in the context of the U.S. Space Shuttle program (1969-2010) under Criteria A and C in the areas of Space Exploration and Engineering, respectively. Because it has achieved exceptional significance within the past 50 years, Criteria Consideration G applies. The period of significance for the CRF is from 1993, the date of its completed construction, through 2011, the designated end of the Space Shuttle program.

From the outset of the Space Shuttle program, NASA (and the U.S. Department of Defense) planned to use the Space Shuttle vehicle to carry various payloads, such as satellites, planetary probes, and experiments, into space. These payloads were processed separately from the vehicle, prior to being installed into the orbiter. For payloads installed at the launch pad, the canister needed to be rotated to the vertical position. During the early years of the Space Shuttle program, this operation was performed in the VAB, roughly 8 miles from the processing facilities. The construction of the CRF in the Industrial Area of KSC greatly improved this procedure by localizing all payload operations and housing all necessary equipment.

Historically, payloads fell into one of two categories. Some, such as Spacelab, were referred to as horizontal payloads, meaning they were built up, integrated, and installed into the orbiter horizontally. Other payloads, such as satellites, were referred to as vertical payloads, and were thus built up, integrated, and installed into the orbiter vertically. Typically, all of the payload components were fabricated at their sponsor's laboratories, before being delivered to one of several facilities at KSC or CCAFS for additional processing and build up for flight.[41] The

[39] *Basic Information Guide,* 3-28 to 3-31.
[40] *Basic Information Guide,* 3-28 to 3-31.
[41] At KSC, these facilities included the Vertical Processing Facility, the Operations & Checkout Building, and more recently, the Space Station Processing Facility. At CCAFS, facilities used for payload processing included Hangar AE, Hangar AO, Hangar AM, and Hangar S. Boggs and Beddingfield, 39; Bloom, G. and R. Baltes. "Space Shuttle Payload Processing, ELS vs. VLS." *Proceedings of 7th Aerospace Testing Seminar, Los Angeles, California.* October 13-15, 1982: 19.

components were then moved to one of four facilities for final integration and testing: either the Operations & Checkout Building (horizontal payloads) or the Vertical Processing Facility (vertical payloads) in the Industrial Area of KSC for non-Department of Defense payloads, the Space Station Processing Facility (beginning in 1997) for all ISS components, or the Shuttle Payload Integration Facility within the Solid Motor Assembly Building at CCAFS for Department of Defense payloads.[42] Afterwards, one of two payload canisters, carried by one of two canister transporters, picked up the payload at its processing facility for transport to either the OPF (horizontal payloads) or the launch pad (vertical payloads) for installation into the orbiter.[43]

Although there has always been two payload canisters available for use, scheduling constraints did not allow for the payload canisters to be devoted to either horizontal or vertical payloads. Thus, a means of rotating the canisters to the proper orientation was required. During the early years of the Space Shuttle program, payload canister rotation was performed in the VAB, and required the use of two cranes, additional heavy equipment, and much hands-on maneuvering, not to mention a lot of floor space. Due to the numerous other activities performed in the VAB, such as vehicle stacking, SRB segment processing, and ET preparations, scheduling the canister rotation proved to be tricky. In addition, the roughly 15-mile trip from the canister/transporter storage facility, known as the Multi-Mission Support Equipment (MMSE) Building, to the VAB for rotation, and back to any of the payload processing facilities, required a lot of time.[44]

By the late 1980s, managers at KSC decided to build a facility for canister rotation in the Industrial Area, where the majority of payload processing occurred, to alleviate scheduling issues and reduce travel time. In October 1990, Ivey's Construction Company of Merritt Island, Florida, was selected to design and build the Canister Rotation Facility (M7-777).[45] This new building would be located just to the north of the MMSE Building (M7-776).[46] Ivey's Construction Company completed the design of the facility in 1991, with the assistance of the architecture/engineering firm of Stottler Stagg and Associates of Cape Canaveral, Florida, and the engineering consulting firm of Gardner, Griffith and Associates, Inc. of Cocoa, Florida. The official ground-breaking ceremony for the new building occurred on the morning of May 24,

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[42] Bloom and Baltes, 19-20. After the final DoD payload in December 1992, the Shuttle Payload Integration Facility ceased to be used for processing payloads.

[43] Since ca. 1998, all payloads have been installed at the launch pad. Elizabeth (Liz) Boyd. Personal communication with Patricia Slovinac, via telephone, October 26, 2010.

[44] Elizabeth (Liz) Boyd. Personal communication with Patricia Slovinac, via email, October 22, 2010.

[45] At the time, it was referred to as the Canister Cleaning and Rotation Facility. Mitch Varnes. "KSC Release: 66-91, Groundbreaking for KSC Payload Canister Facility Set for May 24." May 23, 1991.

[46] The MMSE Building was designed and constructed from 1985 to 1986 as a storage and maintenance facility for the two payload canisters and the two canister transporters. It contains both a High Bay area and a Low Bay area.

1991; construction of the facility began that afternoon.[47] By August 1991, the foundation of the facility was nearly complete (Figure No. A-1), and by the end of October 1991, roughly 50 percent of the structural steel frame had been erected (Figure No. A-2). All of the exterior siding had been installed on the building before the end of January 1992 (Figure Nos. A-3, A-4), and work had begun on the mechanical building along the north wall. Throughout 1992, construction of the facility continued (Figure Nos. A-5, A-6), leading to the official ribbon-cutting ceremony on December 16, 1992.[48]

Between 1995 and 1996, Ivey's Construction Company designed and built an office and support building in between the CRF and the MMSE Building, to replace the office trailers to the west and south of the MMSE Building (Figure No. A-7). Upon completion, this new building provided a physical connection between the CRF and the MMSE Building, creating one large facility that was named the Transporter/Canister Facility (TCF; M7-777). However, the MMSE technicians, playfully called the "can crew," continue to refer to its smaller parts, either the High Bay or the Low Bay for the MMSE Building, the Operations Support Annex for the office/support areas, and the CRF for the rotation building.[49]

Functions

The TCF was established as a centralized location where the payload canisters, as well as the canister transporters, could be stored, maintained, and processed for mission support. A key task in mission support operations, which includes cleaning and preparing the canister for receiving payloads, is the rotation of the payload canister between the horizontal and vertical positions. The CRF was specially designed to accommodate payload canister rotation operations, but is also used for all mission support tasks, as well as storage and maintenance.[50] To assist with these functions, the facility contains a bridge crane, with a 100-ton main hook and a 10-ton auxiliary hook; a lifting beam; four support stanchions; wall-mounted canister access platforms; and powerful mechanical and electrical systems that are capable of maintaining the required environmental conditions for both the facility and the payload canister.

The simplest function of the CRF is to serve as a storage location for the payload canister, either on its own or mated to the canister transporter.[51] Typically, to complete this task, the canister is

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[47] "Construction to begin on new payload support facility." *Spaceport News* (30, 10), May 24, 1991: 2; "Kennedy Space Center breaks ground for two new facilities." *Spaceport News* (30, 11), June 7, 1991: 1.
[48] "Canister Cleaning and Rotation Facility Rises." *Spaceport News* (30, 21), October 25, 1991: 3; Ken Nail, Jr. "Chronology of KSC and KSC Related Events for 1992." KHR-17, March 1993. On file, KSC Archives, 50.
[49] Boyd, October 26, 2010; NASA. *NASAfacts: Canister Rotation Facility*. IS-2004-09-014-KSC. September 2004, revised 2006.
[50] Boyd, October 26, 2010; NASA, *Canister Rotation Facility*.
[51] The payload canister and canister transporter can also be stored in the TCF High or Low Bays, either mated together or separate; but the payload canister must be in a horizontal position. Boyd, October 26, 2010.

brought into the CRF by a transporter, which is then parked in the facility with the canister still mated to it in either the horizontal or vertical position. If there is a need to remove the canister transporter from the facility, the two are de-mated, and then the canister is either attached to the four CRF stanchions for support (if horizontal) or lifted by the crane and set on protective pads on the floor (if vertical).[52] In 2005, the CRF became a designated Clean Work Area, which allows storage of a canister that contains payloads.[53] If the canister contains one or more payloads, it is connected to the facility's electrical power and environmental control systems to maintain the proper temperature and humidity.[54]

The CRF is also used in support of maintenance activities on either the payload canister or the canister transporter. Historically, any form of maintenance could be done within the facility, from simple inspections to work on a transporter's hydraulic systems. Since the CRF became a Clean Work Area, only maintenance tasks that do not produce "foreign object debris" (generally referred to as FOD), such as visual inspections or equipment calibrations, can be performed within the facility; any FOD-producing maintenance procedures on the payload canister are conducted within the TCF High or Low Bay. Similarly, if the transporter requires work on its hydraulic systems, or even a simple oil change, it is de-mated from the canister and taken into the TCF High or Low Bays, where the work will occur. Afterwards, the transporter is returned to the CRF and mated to the canister.[55]

One task that is solely performed in the CRF is the preparation of the payload canister to retrieve the mission's payloads from the processing facilities. The procedure for this task is straightforward, and begins with the payload canister oriented in the horizontal position. At this point, the can crew will install a series of trunnions at designated locations within the canister, which will support the various payloads during transport procedures. Once this is finished, the canister is rotated to the vertical position to undergo its initial cleaning. First, a blow down of the canister interior pushes any FOD to the bottom, and then the entirety is vacuumed. Once these tasks are completed, the canister is rotated back to the horizontal position, where it is cleaned with alcohol-moistened wipes and then vacuumed again. The payload canister remains in the horizontal position until it has retrieved the payload(s).[56]

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[52] Elizabeth (Liz) Boyd. Personal communication with Patricia Slovinac, via email, November 19, 2010.

[53] It is rated as a Class 300,000 clean room, which means the airborne particle count is less than or equal to 300,000 particles per cubic foot. The average home is considered equal to a Class 300,000 clean room, while a hospital is considered a Class 100,000 clean room (except for the operating rooms, which are Class 10,000). Prior to this, if the canister contained a payload, it would typically be stored within the Operations & Checkout Building. Boyd, October 22, 2010.

[54] Boyd, October 26, 2010. Should the CRF systems fail, the canister can be connected to the Environmental Control System on the transporter.

[55] Boyd, October 26, 2010; Boyd, November 19, 2010.

[56] Boyd, October 22, 2010; Boyd, October 26, 2010; NASA, *Canister Rotation Facility*.

After the canister is cleaned, the instrumentation and communication subsystems for the transporter and canister are tested to ensure that they are working properly. Then, the environmental control system for the canister is checked to confirm the temperature and humidity levels are within the required parameters. Just before the payload canister is taken to the processing facilities to pick up the various payloads, the canister/transporter combination is moved to the apron outside of the CRF, where the fire suppression system and other alarm systems are checked. The transporter then carries the canister to the processing facility(ies) to retrieve the assigned payloads. The payload canister is then returned to the CRF, where it is rotated to the vertical position prior to carrying the payloads to the launch pad for installation into the orbiter.[57]

Payload Canister Rotation

The principal function of the CRF is to rotate the payload canister from either the horizontal to vertical positions, or from the vertical to horizontal positions. The process for one is essentially the opposite as that for the other, and usually takes one to two hours, and requires a crew of 15 to 20 technicians.[58] It is important to note that the payload canister is positioned inside the CRF so that its forward end sits to the west, while its aft end sits to the east.

For the rotation of the canister from horizontal to vertical, the following steps take place. First, the weight of the payload canister must be transferred from the canister transporter to the four CRF support stanchions, what is generally referred to as demating. To accomplish this, the transporter positions the payload canister so that each of its four lifting trunnions lines up with its matching CRF stanchion.[59] Then, each trunnion is fitted within a special holding fixture. The canister's forward trunnions are inserted into the bottom ring of a forward lug retainer (Figure No. A-8), which is held in place by a cover bolted to the face of the trunnion. At the aft end, U-saddles are slid out from the stanchion and positioned around each trunnion (Figure No. A-9). The completion of these connections indicates the official transfer of the canister's weight from the transporter to the stanchions. Afterwards, the transporter is lowered, and is either left there in place or moved out of the CRF.[60]

Once the demate has occurred, the bridge crane is moved to the west end of the facility, where the 100-ton hook is used to remove the access ladder attached to the forward end of the canister

[57] Boyd, October 22, 2010; Boyd, October 26, 2010; NASA, *Canister Rotation Facility*.
[58] Since the two operations are the exact opposite of one another, only the process for horizontal to vertical rotation will be described in detail.
[59] There are two lifting trunnions on each long side of the payload canister, one at the forward end and one at the aft end.
[60] Boyd, October 26, 2010.

(Figure No. A-10).[61] The crane is then moved to the east side of the facility, to retrieve the lifting beam. Once the crane reaches the east end, the 100-ton hook is lowered into a rectangular slot in the top of the lifting beam and a locking pin is inserted through the beam to hold the hook in place (Figure No. A-11). The crane then carries the lifting beam to the west side of the facility. The beam is lowered, and its two slings (one for each side of the payload canister) are each fitted around the top ring of one of the forward lug retainers; a locking pin holds the components together (Figure Nos. A-12, A-13).

After the lifting beam is securely attached, the crane begins to rotate the payload canister. This operation is completed in small steps that alternate between moving the crane to the east and lifting the hook, until the payload canister is vertical (Photo Nos. 22, 23; Figure Nos. A-14 to A-17). Once this is completed, the crane is used to adjust the canister's center of gravity, which requires the canister to be rotated forward to an approximate 3-degree tilt from true vertical (Figure No. A-18). The U-saddles are then retracted from the aft trunnions, while four hold-down posts are attached to the transporter's flatbed. Following these steps, the flatbed is tilted so that it is parallel to the aft face of the canister (Figure Nos. A-19, A-20).[62] The crane is then used to adjust the position of the canister before it is lowered onto the support pads on the transporter, and secured to the hold-down posts.[63]

Afterwards, the lifting beam slings are detached from the forward lug retainers. The crane then carries the beam back to the east end of the facility, where it is placed on its storage racks; the crane is also stored at the east end of the facility.[64] When the canister is set to leave the CRF, the vacuum seals on the eastern sliding doors are released, and the door is opened (Figure No. A-21). The transporter moves the canister to the parking apron, where both are subjected to a final round of inspections (Photo Nos. 24, 25; Figure Nos. A-22, A-23). The transporter then carries the canister to the launch pad, where the payloads are installed into the orbiter.[65]

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[61] The ladder is only removed if the payload canister will be exiting the facility. This is due to the fact that the door is only tall enough to accommodate the combined height of the transporter and canister. Boyd, October 26, 2010.
[62] The back of the transporter is raised, while the front is lowered (due to the canister tilt).
[63] Boyd, October 22, 2010; Boyd, October 26, 2010; NASA, *Canister Rotation Facility*.
[64] Elizabeth (Liz) Boyd. Personal communication with Patricia Slovinac, via email, November 22, 2010.
[65] Boyd, October 26, 2010.

Physical Description

The CRF is part of a larger complex known as the TCF. The TCF has approximate overall dimensions of 235’ in length (north-south), 123’ in width (east-west), and 144’ in height. Aside from the CRF, which gives the building its historic significance, the TCF also contains the MMSE Building, an Operations Support Annex, and a mechanical area.

The MMSE Building (Photo Nos. 1-4) sits at the south end of the facility and measures approximately 102’ in length (east-west) and 86’ in width (north-south). This area has a poured concrete slab foundation; its walls and roof are composed of a steel skeleton faced with corrugated metal siding. There are two metal rolling doors on the east elevation, and one metal rolling door on the north elevation. Both the west and south elevations have a one-light metal swing door. Other exterior features of the building include three ventilation louvers on both the east and west elevations. Internally, the MMSE Building is divided roughly in half lengthwise (Photo No. 26). The north half is called the High Bay, and has a height of 38’, while the south half, with a height of 20’, is referred to as the Low Bay.

To the north of the MMSE area is the Operations Support Annex (Photo Nos. 1 and 5). This portion of the facility has approximate dimensions of 75’ in length (east-west), 63’ in width (north-south), and 26’ in height. It has a poured concrete slab foundation, and its walls are composed of a steel skeleton faced with galvanized metal panels. The south elevation abuts the MMSE Building, while the north elevation abuts the CRF. The east elevation features the main entrance to the TCF, a glass swing door with sidelights, just to the north of the façade’s centerline; to the south of the centerline is a projecting stairwell. Additionally, this façade features both one-light fixed windows and pairs of sliding windows at both floor levels. On the west elevation of this area, there are three metal swing doors and one pair of metal swing doors at the first floor level, and one metal swing door and two pairs of sliding windows at the second floor level. An open metal staircase at the north end provides access to the second level door. Internally, this part of the building contains two floor levels. The first floor has a conference room, a break room, locker rooms, and some offices, while the second floor contains a large open office area with four small, enclosed offices along the east wall.

To the north of the Operations Support Annex is the CRF (see below for description). Along the north wall of the CRF is a two-story mechanical area (Photo Nos. 6-8), which roughly measures 90’ in length (east-west) and 30’ in width (north-south). This area has a shed roof, which slopes from a peak height of 32’ to a height of 24’-5”, south to north. Its foundation is comprised of a 5”-thick poured concrete slab, and the walls are composed of a steel skeleton faced with prefabricated galvanized metal wall panels. The exterior of this maintenance building features a metal swing door and three ventilation louvers on the east elevation, two hooded ventilation louvers on the north elevation, and a metal rolling door on the west elevation. Internally, it is divided into an east half and a west half. The east half contains the mechanical room on the ground floor, with a mezzanine level above. The west half is a full-height storage space, and has an "L"-shaped metal stairwell in its southeast corner that provides access to the east half's mezzanine level (see Photo Nos. 29 and 30).

Canister Rotation Facility

Exterior

The CRF has approximate overall dimensions of 123' in length (east-west), 54' in width (north-south), and 144' in height. The facility is constructed of a steel skeleton clad with prefabricated galvanized metal siding, and has a poured concrete slab foundation and a flat, built-up roof. The east elevation (Photo Nos. 1, 2, 8) is considered the principal façade of the CRF. It features a 32'-wide x 73'-6"-high, bi-part sliding door (Photo No. 9), designed to accommodate the payload canister in either the horizontal or vertical position (see Photo No. 25). Along the top of the doorway is a galvalume door head that extends past the north and south edges, providing a track for the door sections to move along when opening and closing. Each half of the door has a width of 16' and is equipped with a vacuum seal that is controlled by a motor on its inner face (Photo No. 13).

The west elevation of the CRF (Photo Nos. 4-6) contains a 12'-wide, 14'-high metal rolling door with a metal swing door for personnel to its south. The north elevation (Photo Nos. 6-8) features three downspouts, and a central, full-height projection that measures 28' in width and 8' in depth, and contains four, 32"-diameter air ducts. In addition, there is a metal swing door for personnel to the east of the mechanical building. The south elevation (Photo Nos. 2-4) has a metal swing door at 91.5' above grade, with a 9' x 7' metal platform, that provides access to a caged vertical ladder that extends to the roof.

Interior

Internally, the CRF is comprised of one large open space (Photo Nos. 10, 11), with wall and ceiling surfaces formed by painted gypsum board panels. The key features of the facility are the overhead bridge crane and the four floor-mounted payload canister support stanchions. The bridge crane (Photo No. 16), which has rough dimensions of 49' in length (north-south) and 28' in width (east-west), sits 120'-6" above the finished floor. It is fitted with a 100-ton main hook and a 10-ton auxiliary hook (Photo No. 17), which are connected to a trolley that rolls along the tops of main support beams of the crane, allowing the hooks to be positioned as necessary within the north-south direction. Likewise, the main support beams of the crane are fitted with rollers, which move the crane in the east-west direction, along rails mounted to the north and south walls.

In order to support the crane rails, the north and south walls of the CRF were designed to have a thickness of roughly 3'-6" from the finished floor to a height of roughly 118', where the wall thickness changes to 1'. This change in thickness creates a sloped surface, to which five mounting brackets for the crane's rails are attached (see Photo No. 16). Similarly, the floor of the CRF was designed to accommodate the static and dynamic loads resulting from the bridge crane and payload canister. While the entire floor is composed of reinforced poured concrete, for wide bands underneath the outer walls and the support stanchions, the floor is 3' in depth, as opposed to the remainder of the floor, which is only 9"-deep (Photo No. 33).

The four payload canister support stanchions are arranged in a rectangle that is roughly centered within the floor area of the CRF (Photo No. 35). When the payload canister is within the facility, it is oriented so that the forward end is to the west, while its aft end is to the east. Likewise, the starboard side is located to the north, and the port side is to the south. The distance between the forward and aft stanchions is roughly 62'-6" on center, while the distance between the starboard and port sides is 31'. The two stanchions that correspond to the forward end of the canister are different from the stanchions for the canister's aft end, due to the different roles they play in the rotation process. There are no differences between the starboard and port stanchions of each type.

The two forward stanchions take the form of an upside-down letter "L," and have approximate overall dimensions of 6' in length (north-south), 3' in width (east-west), and 11'-6" in height (Photo No. 14). On the inner face[66] of each forward stanchion, are connection points for the forward lug retainer, used to support the payload canister and assist in rotation activities. The forward lug retainer is a component that is comprised of two rings, one on top of the other and turned 90 degrees. Near the top of the west face of each stanchion is a small (6' x 3') work platform with railings around its perimeter; a vertical ladder provides personnel access to the platform.

The aft stanchions are a bit larger than the forward stanchions, with rough measurements of 9'-8" in length (north-south), 3' in depth (east-west), and 17'-3" in height (Photo No. 15). The inner face of each aft stanchion contains a "U"-saddle, which cradles a support trunnion on the canister, allowing it to rotate as the forward end is lifted. The "U"-saddle is connected to a steel bar that slides in and out of the stanchion, providing flexibility in the positioning of the canister. Similar to the forward stanchions, each aft stanchion is fitted with a work platform (9' x 3') near the top of its east face. A vertical ladder provides personnel access to the platform.

Mounted within the top half of the east wall of the CRF are two triangular support braces, which hold the payload canister lifting beam when it is not in use (Photo No. 19). Each brace projects roughly 16' from the inner wall surface, and has a vertical height of roughly 16'. The lifting

[66] The "inner face" is the side of the stanchion that abuts the payload canister.

beam is approximately 20' in length and 3'-6" in height. In the top center of the beam is a rectangular crevice, in which the crane hook sits; it is secured with a large pin. At each end of the lifting beam is a roughly 11' long steel sling with a hole at the bottom that fits onto a support trunnion at the forward end of the payload canister.

Both the north and south walls of the CRF contain a work platform that provides personnel access to the forward end of the payload canister when it is in the vertical position. Each platform has approximate dimensions of 9' in length (north-south) and 3' in width (east-west), and is reached by a catwalk mounted at 65'-4" above the finished floor. The platforms (Photo No. 20) are connected to the catwalk by a hinge that allows the platform to be rotated between its storage and use positions. An electrically-powered winch mounted to the wall next to each platform performs the rotation, and also helps support the platform when in its use position.

Other features of the CRF interior include a set of metal half-turn stairs (see Photo No. 11) within the southeast corner of the facility. These stairs provide direct access to both catwalks on the south wall (at 65'-4" and 108'-6" above the finished floor); the catwalk on the east wall (75'-10" above the finished floor); and the catwalk on the north wall (with portions 65'-4" and 74'-1" above the finished floor). All of the catwalks have a width of 4' and are fitted with metal railings. The catwalk on the north wall is also accessible from a three-section caged vertical ladder located at the wall's centerline. The lower of the two catwalks on the south wall can also be reached from a caged vertical ladder, which is located at the southwest corner of the facility. At the floor level, there are niches in the north and south walls, which serve as doorways to the mechanical room, exterior, or Operations Support Annex, and provide storage areas for small pieces of equipment. Different utility pipes are also mounted to west, north and south walls.

Bibliography

Archaeological Consultants, Inc. (ACI). *Survey and Evaluation of NASA-owned Historic Facilities and Properties in the Context of the U.S. Space Shuttle Program, John F. Kennedy Space Center (KSC), Brevard County, Florida.* On file, NASA KSC, 2007.

Benson, Charles D. and William Barnaby Faherty. *Gateway to the Moon. Building the Kennedy Space Center Launch Complex.* Gainesville, University Press of Florida, 2001 (first paperback printing).

________. *Moon Launch! A History of the Saturn-Apollo Launch Operations.* Gainesville, University Press of Florida, 2001 (first paperback printing).

Bloom, G. and R. Baltes. "Space Shuttle Payload Processing, ELS vs. VLS." *Proceedings of 7th Aerospace Testing Seminar, Los Angeles, California.* October 13-15, 1982: 19-29.

Boggs, Wallace H. and Samuel T. Beddingfield. "Moonport to Spaceport. The Changing Face at KSC." *Astronautics & Aeronautics,* July-August 1982: 28-41.

Boyd, Elizabeth (Liz). Personal communication with Patricia Slovinac, via email, October 22, 2010.

________. Personal communication with Patricia Slovinac, via telephone, October 26, 2010.

________. Personal communication with Patricia Slovinac, via email, November 19, 2010.

________. Personal communication with Patricia Slovinac, via email, November 22, 2010.

Bromberg, Joan Lisa. *NASA and the Space Industry.* Baltimore: Johns Hopkins University Press, 1999.

Butowsky, Harry A. *Reconnaissance Survey: Man in Space.* Washington, D.C.: National Park Service, 1981.

"Canister Cleaning and Rotation Facility Rises." *Spaceport News* (30, 21), October 25, 1991: 3.

"Canister Rotation Facility improves Space Shuttle payload processing." *Spaceport News* (32, 1), January 15, 1993: 3.

Columbia Accident Investigation Board. *Report Volume I,* August 2003. http://spaceflight.nasa.gov/shuttle/archives/sts-107/investigation/CAIB_lowres_ full.pdf.

"Construction to begin on new payload support facility." *Spaceport News* (30, 10), May 24, 1991: 2.

Dethloff, Henry C. "The Space Shuttle's First Flight: STS-1." *From Engineering Science to Big Science: The NASA and NASA Collier Trophy Research Project Winners.* NASA SP-4219, Edited by Pamela E. Mack, Washington, D.C.: Government Printing Office, 1998.

Ezell, Linda Neuman. *NASA Historical Databook Volume III Programs and Projects 1969-1978.* The NASA History Series, NASA SP-4012, Washington, D.C.: NASA History Office, 1988.

"Inside the Canister Rotation Facility." *Spaceport News* (41, 1), January 11, 2002: 4 and 5.

Jarrett, Frank E. "Chronology of KSC and KSC Related Events for 1979." KHR-4, September 22, 1980.

Jenkins, Dennis R. *Space Shuttle, The History of the National Space Transportation System. The First 100 Missions.* Cape Canaveral, Florida: Specialty Press, 2001.

"Kennedy Space Center breaks ground for two new facilities." *Spaceport News* (30, 11), June 7, 1991: 1.

Launius, Roger D. and Aaron K. Gillette. *Toward a History of the Space Shuttle: An Annotated Bibliography.* Washington, D.C.: NASA History Office, Studies in Aerospace History Number 1, 1992.

Lethbridge, Cliff. "History of the Space Shuttle program." 2001. http://spaceline.org/rocketsum/shuttle-program.html.

Lindroos, Marcus. "President Nixon's 1972 Announcement on the Space Shuttle." NASA Office of Policy and Plans, NASA History Office, updated April 14, 2000. http://history.nasa.gov/stsnixon.htm.

Lipartito, Kenneth and Orville R. Butler. *A History of the Kennedy Space Center.* Gainesville: University Press of Florida, 2007.

Nail, Ken, Jr.. "Chronology of KSC and KSC Related Events for 1990." KHR-15, March 1991. On file, KSC Archives.

________. "Chronology of KSC and KSC Related Events for 1991." KHR-16, March 1992. On file, KSC Archives.

________. "Chronology of KSC and KSC Related Events for 1992." KHR-17, March 1993. On file, KSC Archives.

National Aeronautics and Space Administration, *NASA Shuttle Reference Manual*. 1988. http://spaceflight.nasa.gov/shuttle/reference/shutref/index.html.

________. *Facts: John F. Kennedy Space Center*. 1994.

________. "NASA Centers and Responsibilities." *NSTS 1988 News Reference Manual*. 1988. http://science.ksc.nasa.gov/shuttle/technology/sts-newsref/centers.html.

________. *NASAfacts: Canister Rotation Facility*. IS-2004-09-014-KSC. September 2004, revised 2006.

National Aeronautics and Space Administration, Headquarters. "The Vision for Space Exploration." February 2004. http://history.nasa.gov/Vision_for_Space_Exploration.pdf.

National Aeronautics and Space Administration, History Office, NASA Headquarters. "Report of the Space Task Group, 1969." http://www.hq.nasa.gov/office/pao/History/taskgrp.html.

National Aeronautics and Space Administration, Kennedy Space Center. *Building KSC's Launch Complex 39*. NASA Facts FS-2002-08-010-KSC, (KSC), October 2002, rev. 2006.

________. *Countdown! NASA Space Shuttles and Facilities*. Information Summary IS-2007-04-010-KSC (KSC), April 2007.

________. *Kennedy Space Center Story*. (KSC), 1972, On file, UCF Libraries, Special Collections.

________. *Space Shuttle Launch Support Equipment Data Handbook*. Engineering Development Directorate, KSC-DD-186 Revision A, March 30, 1993.

National Aeronautics and Space Administration, Kennedy Space Center. "Shuttle Payloads and Related Information." KSC Factoids. Revised November 18, 2002. Accessed at http://www-pao.ksc.nasa.gov/kscpao/factoids/relinfo1.htm.

Reichhardt, Tony (editor). *Space Shuttle, The First 20 Years.* Washington, D.C.: Smithsonian Institution, 2002.

Rumerman, Judy A., with Stephen J. Garber. *Chronology of Space Shuttle Flights 1981-2000.* HHR-70. Washington, D.C.: NASA History Division, Office of Policy and Plans, October 2000.

Siceloff, Steven. "Changes planned in progress for Kennedy's future in Constellation Program." *Spaceport News* (47, 21), October 5, 2007: 4 and 5.

Slovinac, Trish and Joan Deming. National Register of Historic Places Multiple Property Documentation Form, *Historic Cultural Resources of the John F. Kennedy Space Center, Florida.* October 2007.

Stottler Stagg & Associates. "Canister Rotation Facility." January 6, 1993. On file, Engineering Documentation Center, Kennedy Space Center.

The White House. "A Renewed Spirit of Discovery – The President's Vision for Space Exploration." January 2004.
http://www.whitehouse.gov/space/renewed_spirit.html.

Varnes, Mitch. "KSC Release: 66-91, Groundbreaking for KSC Payload Canister Facility Set for May 24." May 23, 1991. On file, KSC Archives.

Williamson, Ray A. "Developing the Space Shuttle." *Exploring the Unknown: Selected Documents in the History of the U.S. Civil Space Program, Volume IV: Accessing Space.* Edited by John M. Logsdon. Washington, D.C.: U.S. Printing Office, 1999.

Figure A-1. View of CRF under construction, showing foundations, camera facing south, August 6, 1991.
Source: John F. Kennedy Space Center Archives, KSC-391C-5022_28.

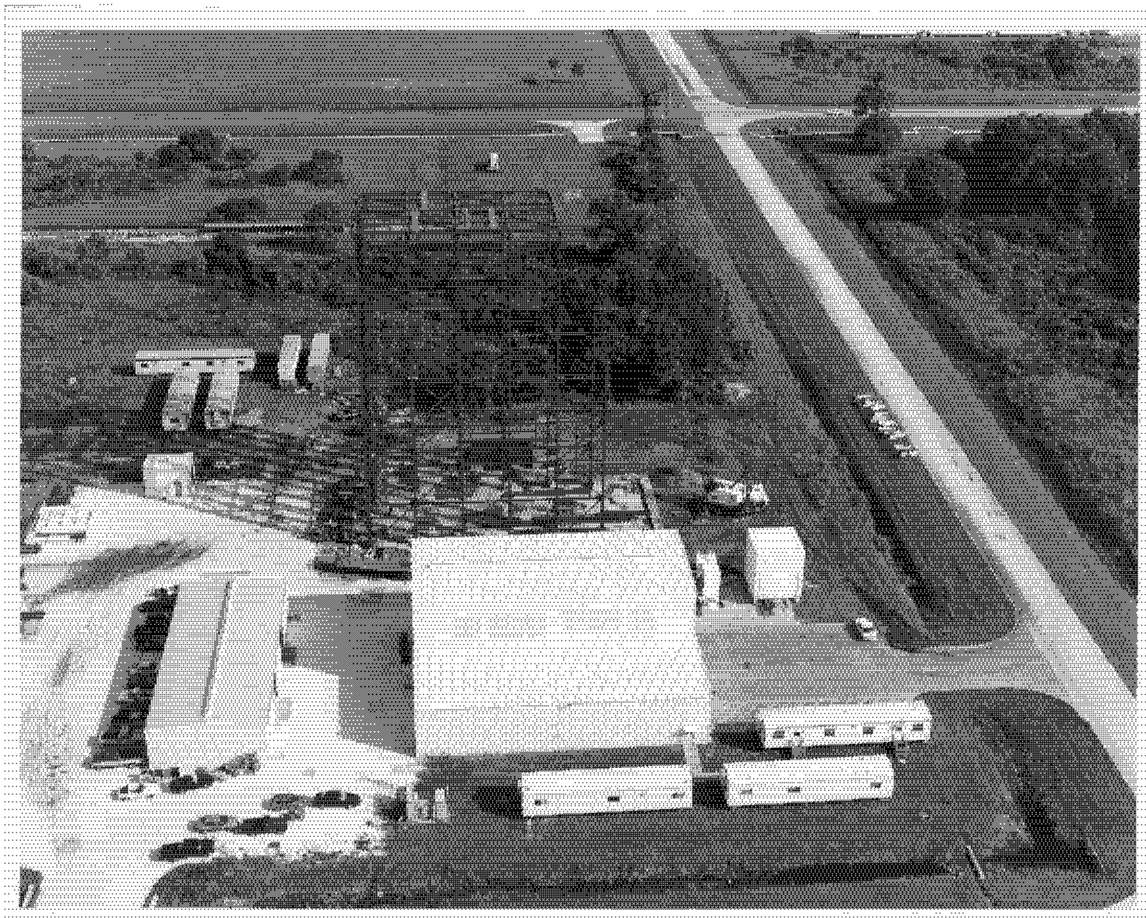

Figure A-2. View of CRF, showing the assembly of the steel skeleton, camera facing north, October 4, 1991.
Source: John F. Kennedy Space Center Archives, KSC-391C-6144_24.

Figure A-3. View of CRF, showing completed exterior walls and steel skeleton of the mechanical building to the north, camera facing southeast, January 24, 1992.
Source: John F. Kennedy Space Center Archives, KSC-392C-341_13.

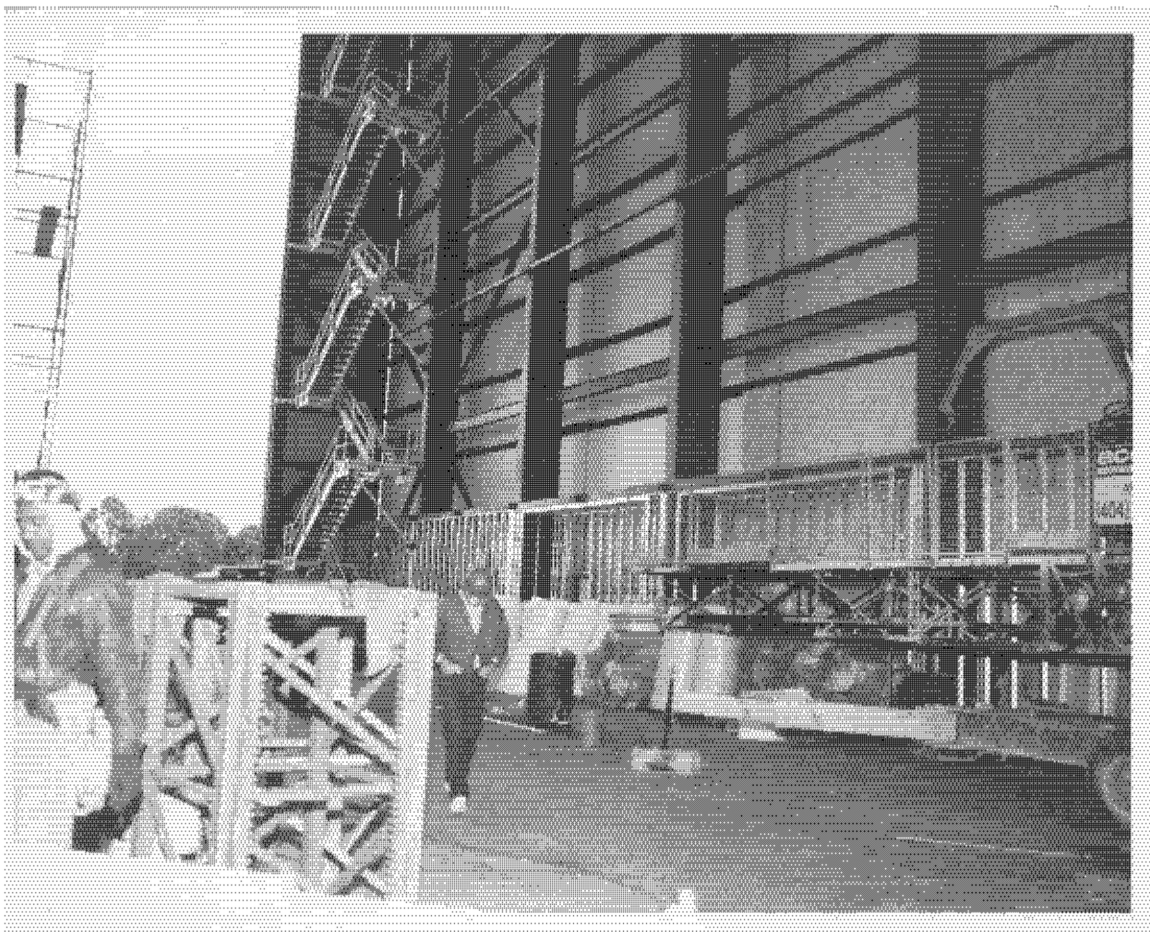

Figure A-4. Interior view of CRF during construction, camera facing southeast, January 24, 1992.
Source: John F. Kennedy Space Center Archives, KSC-392C-342_02.

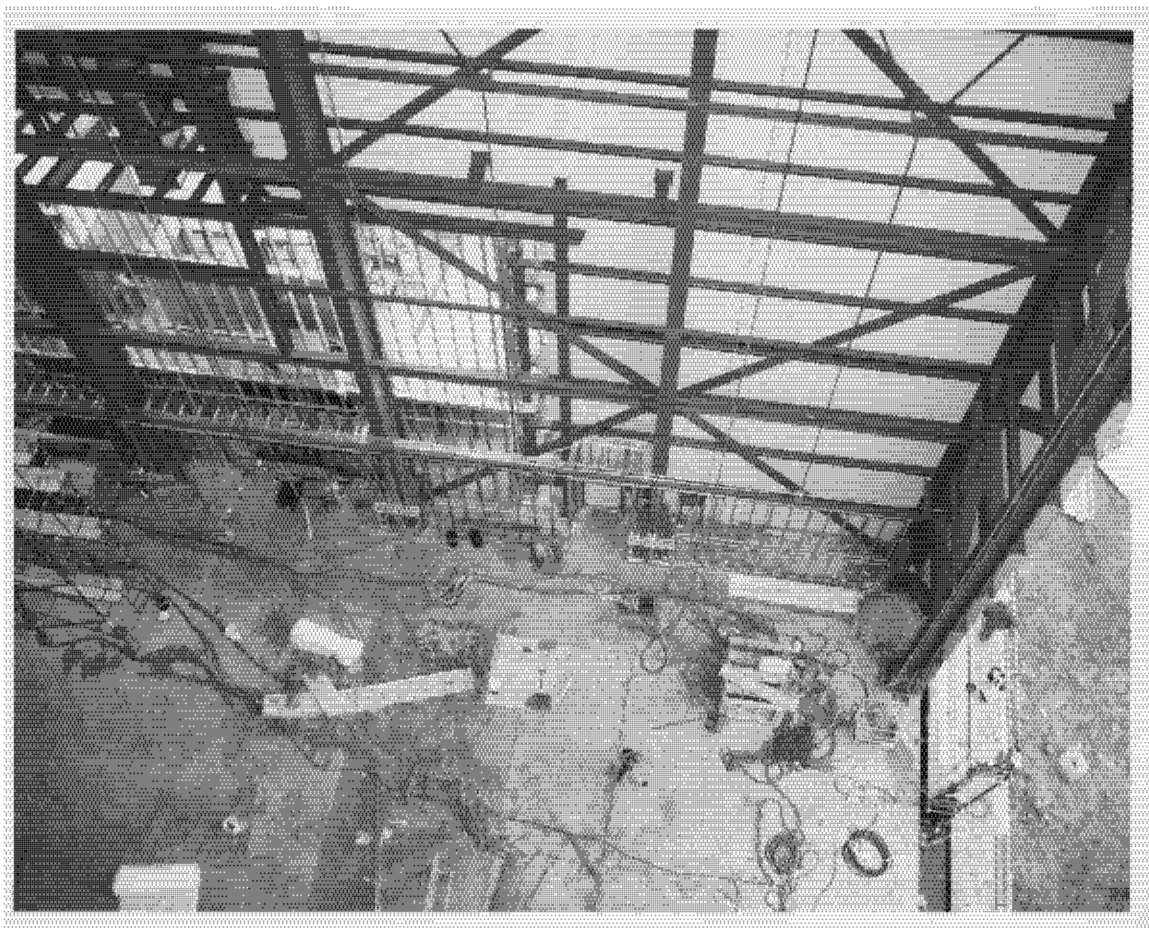

Figure A-5. Interior view of CRF during construction, camera facing north, January 24, 1992.
Source: John F. Kennedy Space Center Archives, KSC-392C-342_08.

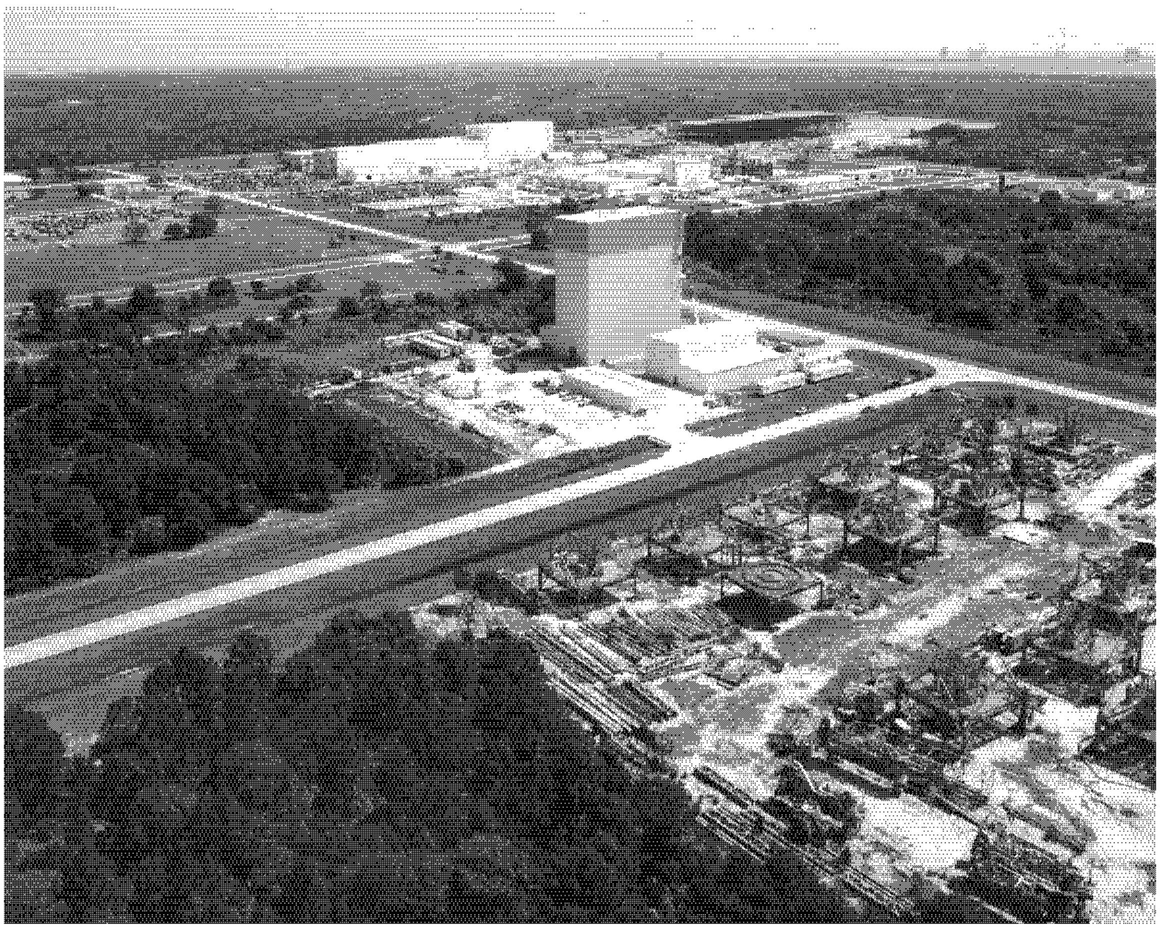

Figure A-6. Aerial view of CRF, camera facing northeast, April 28, 1992.
Source: John F. Kennedy Space Center Archives, KSC-392C-2230-70.

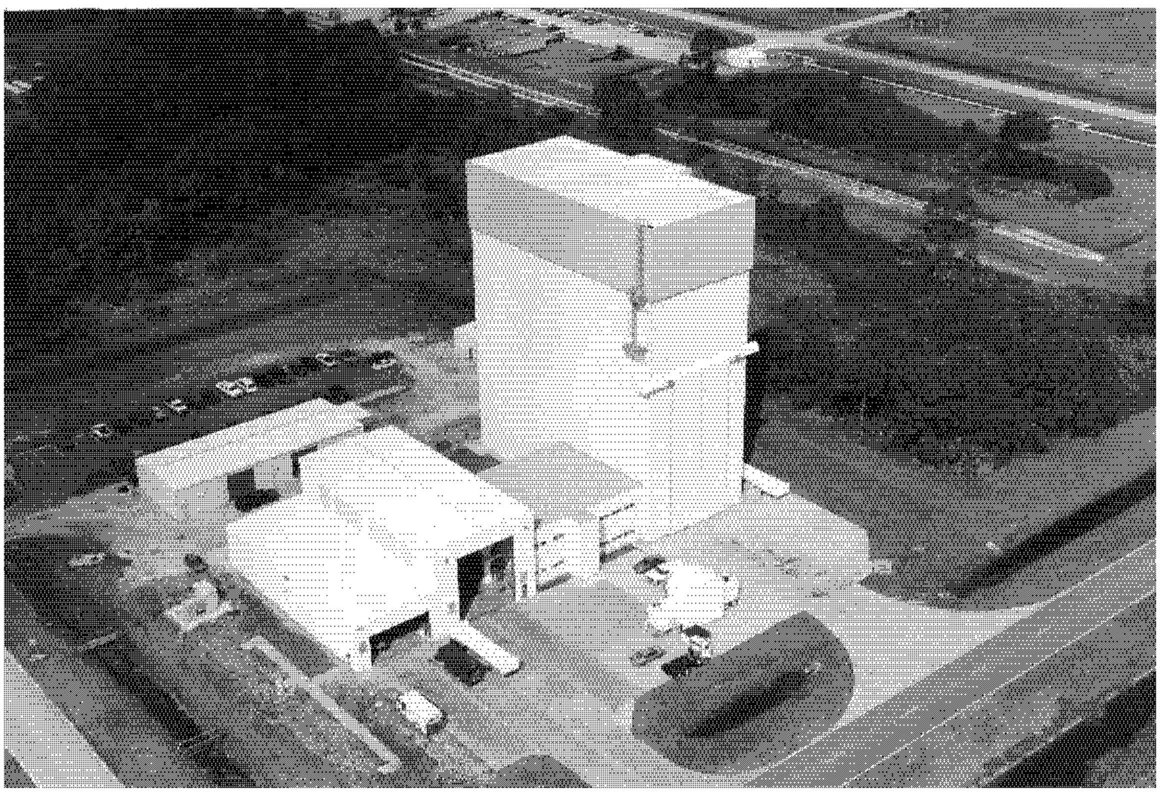

Figure A-7. Aerial view of CRF (note office annex in the center), camera facing northwest, February 27, 1996.
Source: John F. Kennedy Space Center Archives, KSC-396C-0949-11.

Figure A-8. Detail view showing a forward lug retainer (at left of photo), April 13, 2010.
Source: Penny Rogo Bailes.

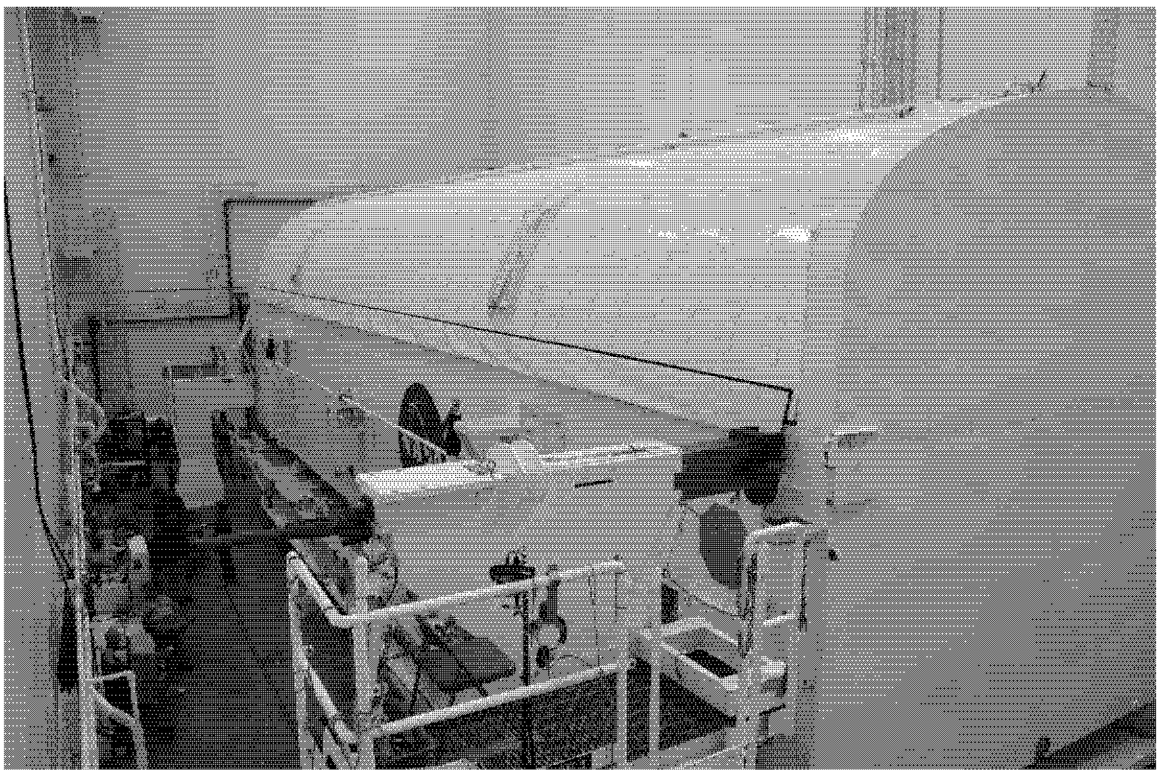

Figure A-9. Detail view showing a U-saddle (near right of photo), April 13, 2010.
Source: Penny Rogo Bailes.

Figure A-10. View showing the removal of the access ladder from the forward end of the payload canister, April 13, 2010.
Source: Penny Rogo Bailes.

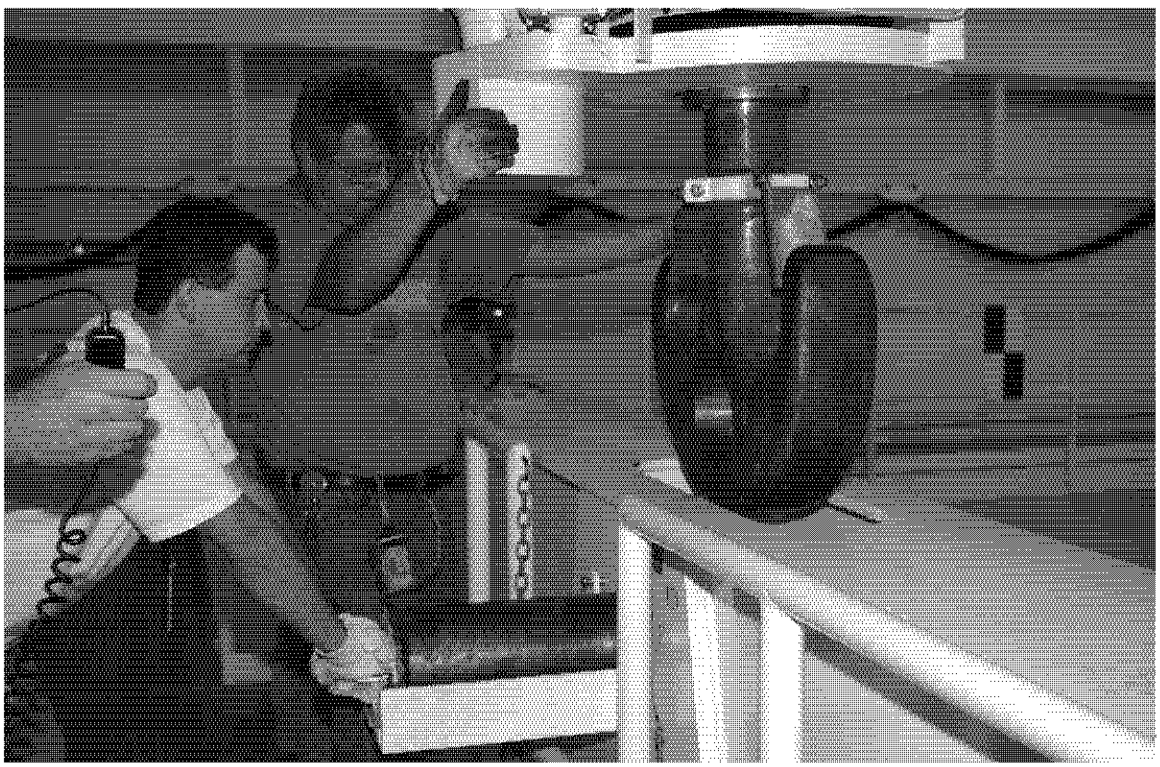

Figure A-11. Detail view showing crane hook being lowered into the slot on the lifting beam; the technician at the left is maneuvering the locking pin.
Source: "Inside the Canister Rotation Facility." *Spaceport News* (41, 1), January 11, 2002: 4.

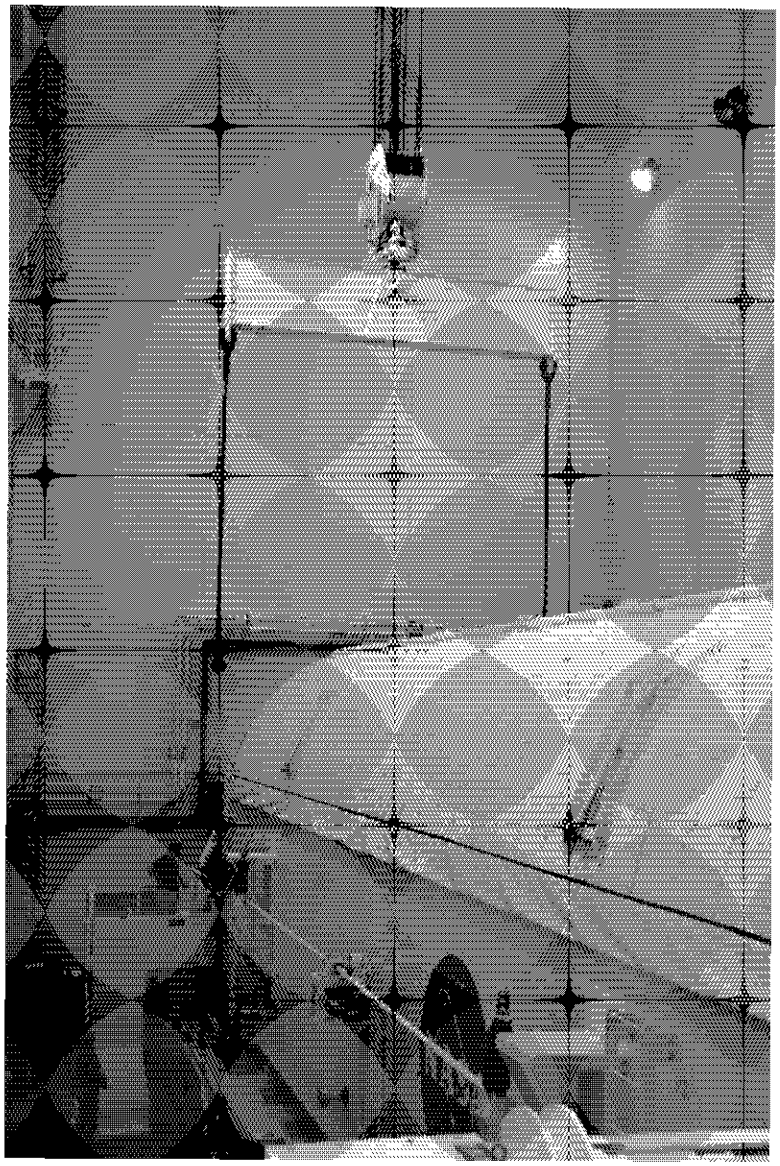

Figure A-12. Detail view showing a lifting beam and slings being lowered for attachment to forward lug retainers, April 13, 2010.
Source: Penny Rogo Bailes.

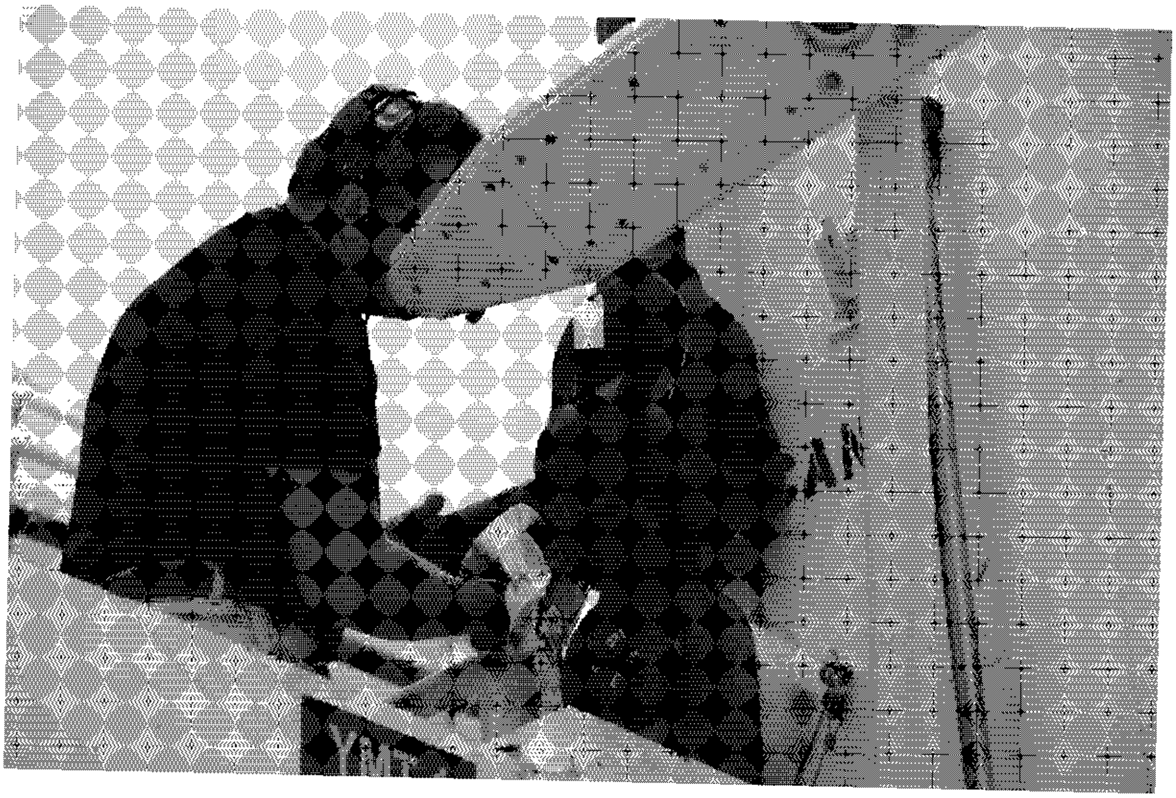

Figure A-13. Detail view showing a sling being fitted around a forward lug retainer, April 13, 2010.
Source: Penny Rogo Bailes.

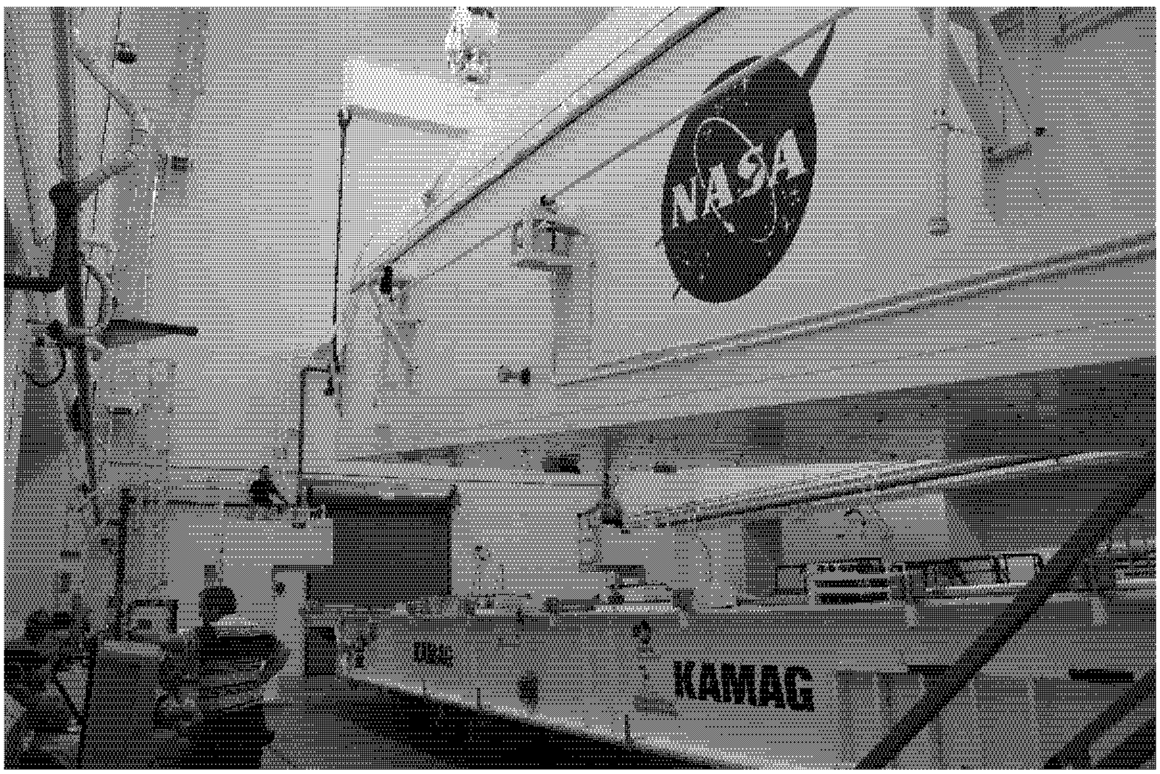

Figure A-14. View showing the beginning of the rotation process, April 13, 2010.
Source: Penny Rogo Bailes.

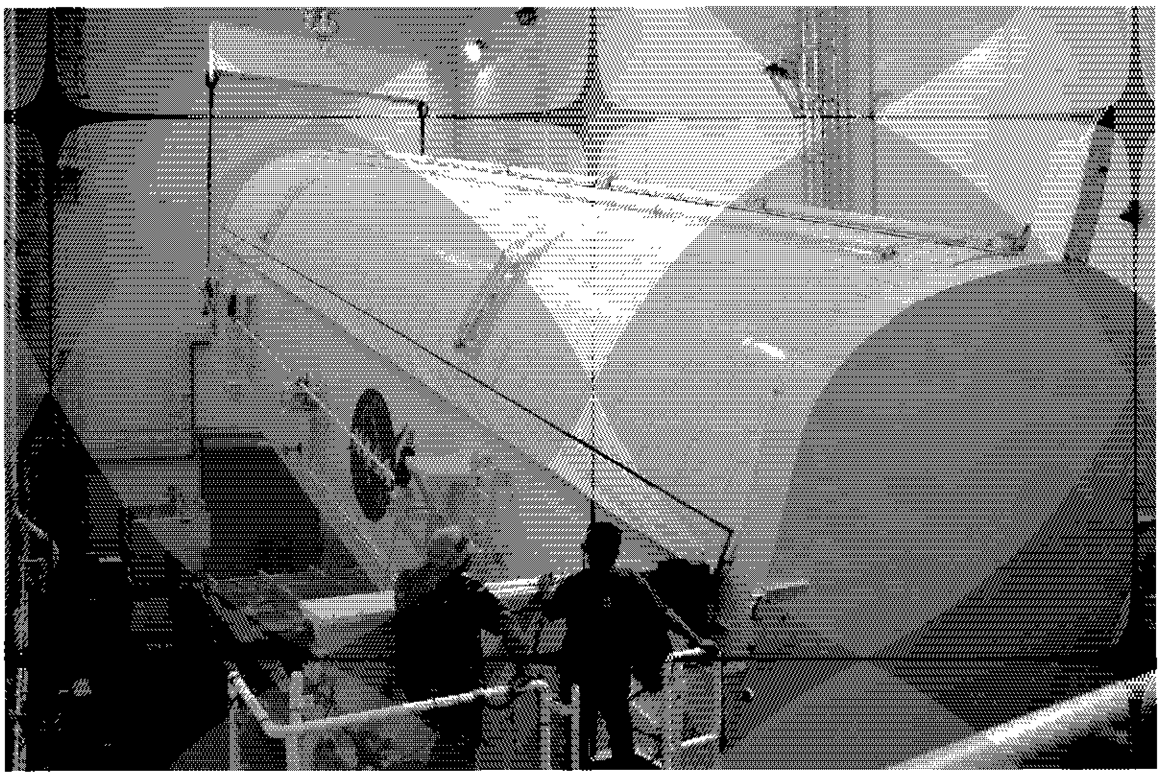

Figure A-15. View showing the rotation process of the payload canister approximately one-third complete, April 13, 2010.
Source: Penny Rogo Bailes.

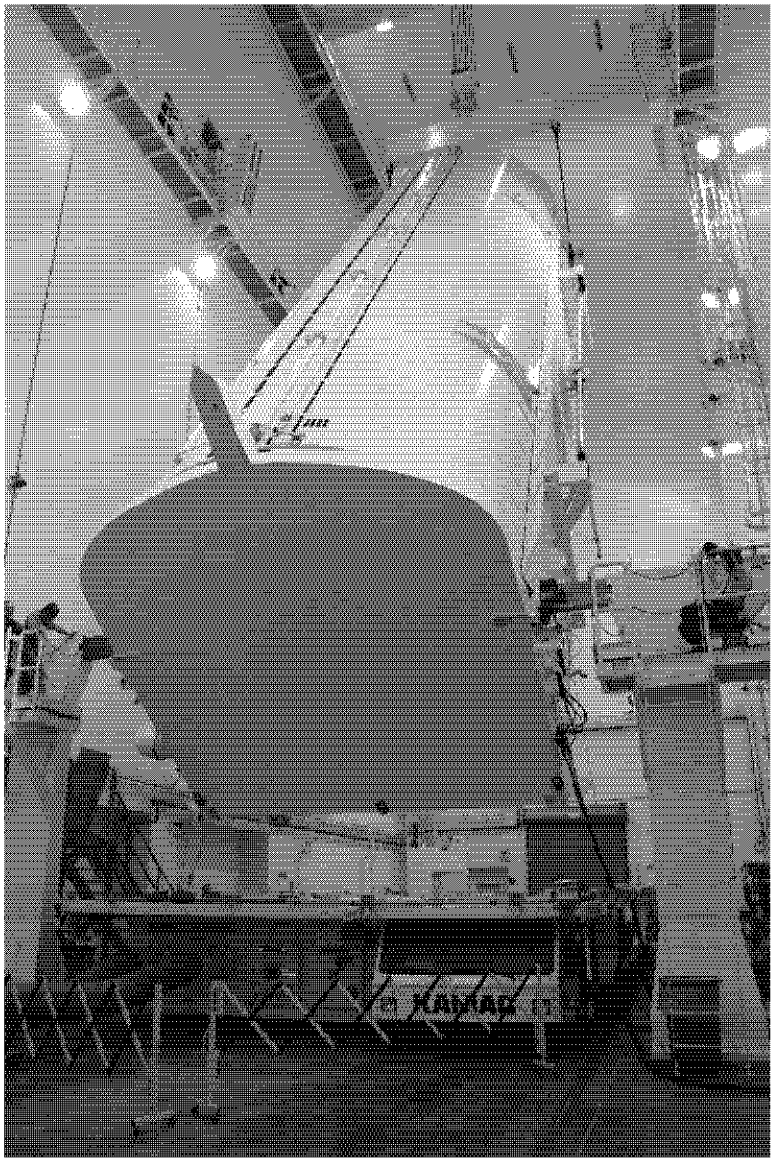

Figure A-16. View showing the rotation process of the payload canister approximately two-thirds complete, April 13, 2010.
Source: Penny Rogo Bailes.

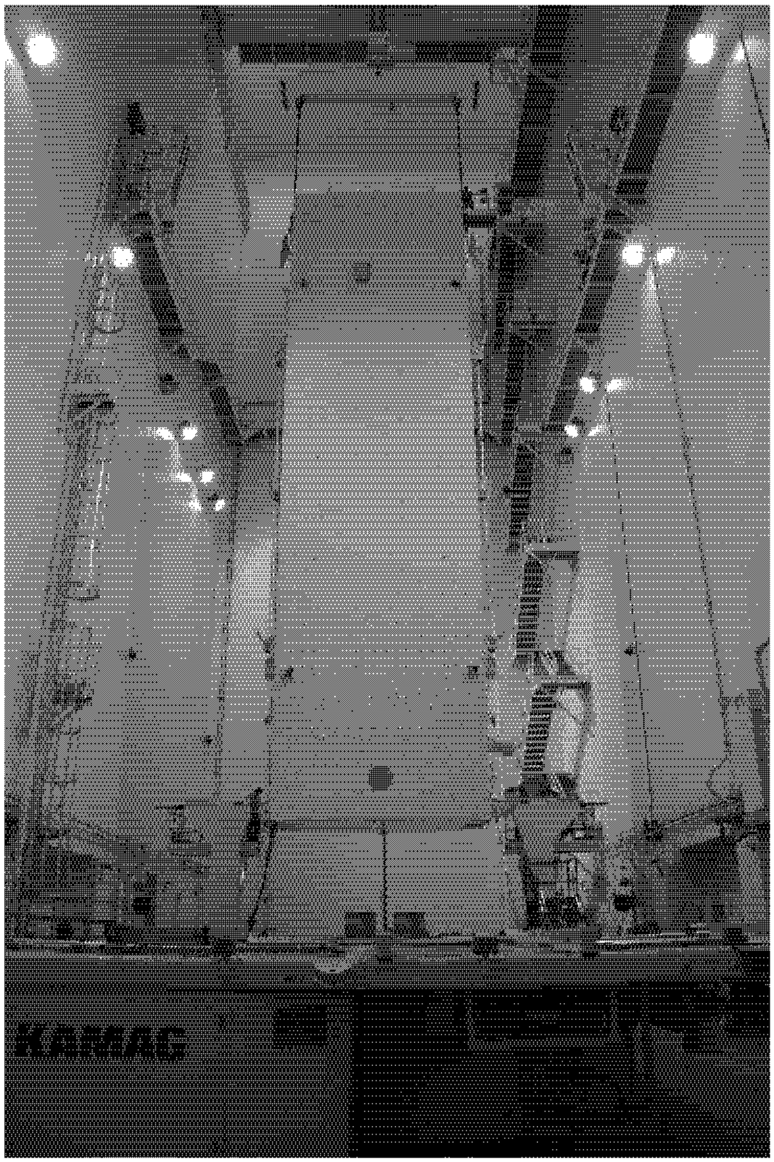

Figure A-17. View showing the payload canister at true vertical, April 13, 2010.
Source: Penny Rogo Bailes.

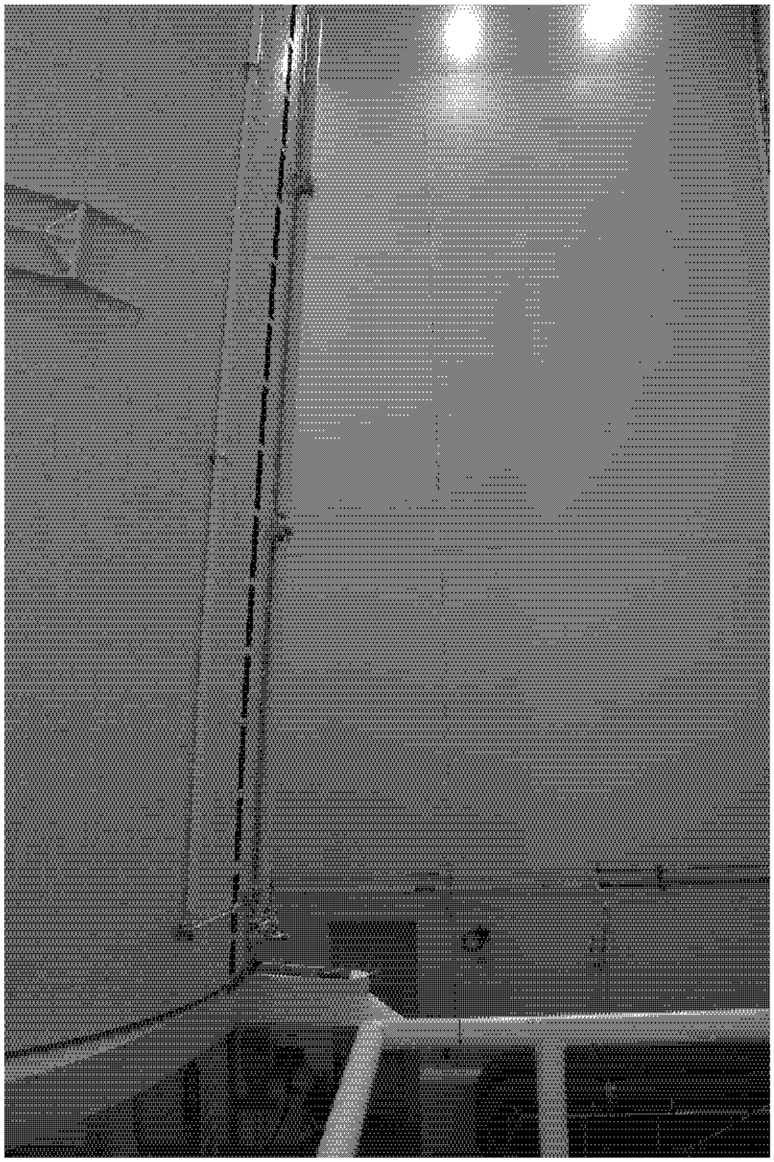

Figure A-18. Detail view showing the payload canister at the approximate 3 degree forward tilt, April 13, 2010.
Source: Penny Rogo Bailes.

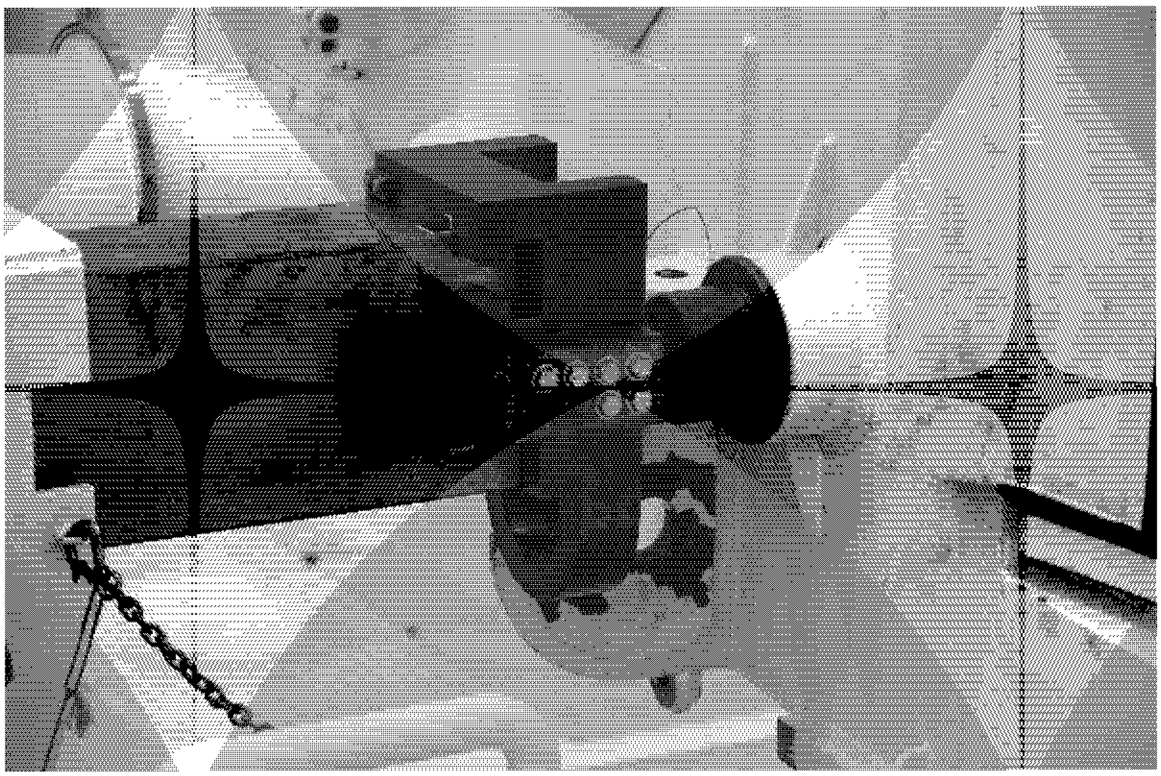

Figure A-19. Detail view showing a U-saddle being retracted, April 13, 2010.
Source: Penny Rogo Bailes.

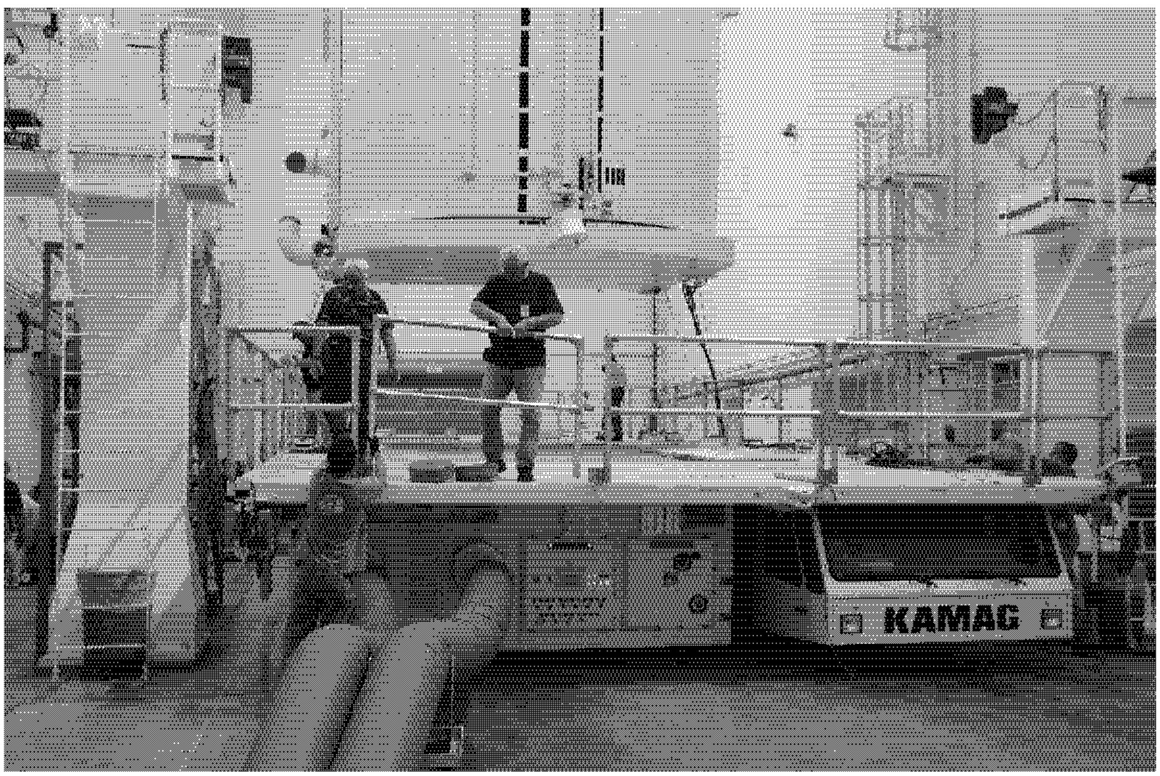

Figure A-20. Detail view showing the tilt of the canister transporter, April 13, 2010.
Source: Penny Rogo Bailes.

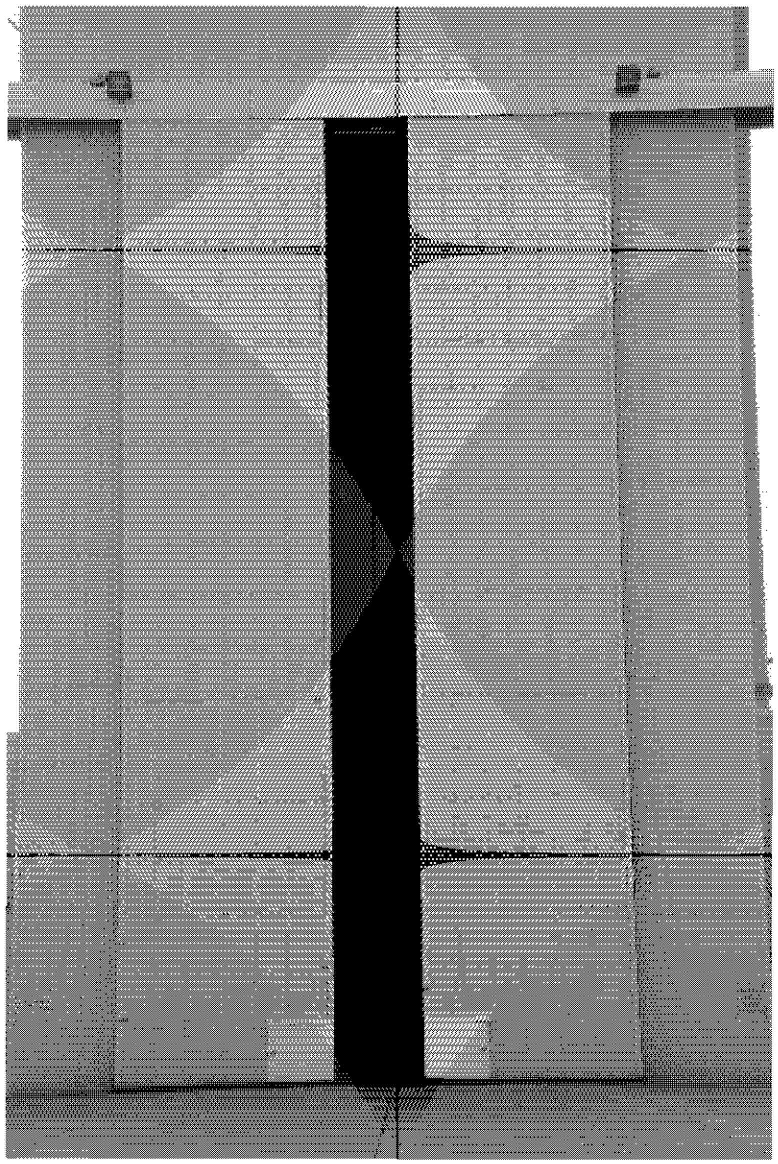

Figure A-21. Detail view showing the CRF doors opening, April 15, 2010.
Source: Penny Rogo Bailes.

Figure A-22. Detail view showing the payload canister being moved to the parking apron, April 15, 2010.
Source: Penny Rogo Bailes.

Figure A-23. View showing the payload canister on the parking apron with CRF doors closed, April 15, 2010.
Source: Penny Rogo Bailes.