CAPE CANAVERAL AIR FORCE STATION, LAUNCH COMPLEX 39, ROTATION PROCESSING & SURGE FACILITY
(John F. Kennedy Space Center)
Launcher Road, north of the Vehicle Assembly Building
Cape Canaveral vicinity
Brevard County
Florida

HAER FL-8-11-G
HAER FL-8-11-G

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
SOUTHEAST REGIONAL OFFICE
National Park Service
U.S. Department of the Interior
100 Alabama St. NW
Atlanta, GA 30303

HISTORIC AMERICAN ENGINEERING RECORD

CAPE CANAVERAL AIR FORCE STATION,
LAUNCH COMPLEX 39,
ROTATION PROCESSING & SURGE FACILITY

HAER NO. FL-8-11-G

Location: John F. Kennedy Space Center, Cape Canaveral, Brevard County, Florida

USGS Orsino, Florida, Quadrangle, Universal Transverse Mercator Coordinates: E 533902 N 3162778 Zone 17, NAD 1983.

Date of Construction: 1982-84

Architect: Ernest Lautzenheiser, lead design engineer with NASA. Building plans by Milan Svabensky, Architect, California C-5859, with Daniel, Mann, Johnson and Mendenhall (DMJM), Los Angeles, California.

Builder: W & J Construction Company of Cocoa, Florida.

Present Owner: National Aeronautics and Space Administration (NASA)

Present Use: Rotation Processing and Surge Facility (RPSF)

Significance: Determined eligible for nomination to the National Register of Historic Places in a historical survey conducted in 2006-7 timeframe of the U.S. Space Shuttle Program facilities completed for NASA. The Rotation Processing & Surge Facility (RPSF) was one of twenty-six assets on the John F. Kennedy Space Center (KSC) that were determined individually eligible for the National Register for their role in the Space Shuttle Program (SSP). This building is where the booster rocket segments for the space shuttle are inspected and rotated to the vertical position, and where aft segments for the booster rockets are built-up with the addition of the aft skirts and exit cones. The segments are then stored in adjacent surge buildings for final assembly in the Vehicle Assembly Building (VAB) prior to launch. This building has served this function since its completion in 1984.

Report Prepared by: New South Associates, Stone Mountain, Georgia

Date: May 1, 2011

PART I. HISTORICAL INFORMATION

A. INTRODUCTION

The RPSF is one of many components of the U.S. Space Shuttle Program (SSP). That program, under the direction of the National Aeronautics and Space Administration (NASA), has defined the U.S. space effort since the 1970s. The main building of the RPSF, identified as K6-494, is located north of the Vehicle Assembly Building (VAB), a building that is a familiar site within Kennedy Space Center (KSC). KSC, located in Brevard County, Florida, is NASA's primary center for launch and landing operations, and the lift-off site for all of the space shuttle flights since the initial lift-off in April 1981.[1]

B. CONTEXT

NASA was created in 1958 in response to the Soviet launching of *Sputnik*. NASA's first series of missions were to send man into space, followed by manned orbits around the Earth, mastery of rendezvous and docking procedures, and finally landing man on the moon. These were the goals of the three main programs of the late 1950s and 1960s: Mercury, Gemini, and Apollo. This effort culminated in the first moon landing, which took place on July 20, 1969. Moon landings continued until 1972, after which the Apollo program ended. By this time, it was clear that the next major program would be based on re-usable space shuttles, designed to serve orbiting space stations and related missions.

President Nixon announced this new space program in 1972. Three years earlier, he had established the Space Task Group to recommend the future course of the U.S. space program. This led to the creation of the SSP, inaugurated in 1972. The shuttle

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[1] Deming, Joan, and Patricia Slovinac, *NASA-Wide Survey and Evaluation of Historic Facilities in the Context of the U.S. Space Shuttle Program: Roll-Up Report* (Prepared for National Aeronautics and Space Administration, Environmental Management Division, Office of Infrastructure and Administration, Headquarters; Prepared by Archaeological Consultants, Inc., Sarasota, Florida, February 2008, revised July 2008), 4.12.

program was based on the idea that a series of re-useable space flight vehicles would make orbital space flight "routine."[2]

The SSP got underway during the 1970s, as contracts were let, new space vehicles were designed, old facilities were retrofitted, and new facilities were built. After a decade of preparation, the first shuttle flight occurred on April 12, 1981. After almost three decades of operations, the SSP is scheduled to retire in 2011.[3]

Since 1981, there have been over 120 different flights, using a total of five space shuttles: *Columbia*, *Challenger*, *Discovery*, *Atlantis*, and *Endeavour* (the prototype, *Enterprise*, never flew into space). The SSP achieved a number of significant goals. In addition to serving a wide array of space facilities, such as Spacelab, the Hubble Space Telescope, the Mir Space Station, and the International Space Station, the shuttles contributed to many other space programs. Among these were various satellite systems (from the Communications Satellite Corporation or COMSAT, to the Advanced Communications Technology Satellite, or ACTS), and the un-manned probes that were sent to Jupiter (*Galileo*), Venus (*Magellan*), and the sun (*Ulysses*).[4]

Two significant accidents have been associated with the SSP. The *Challenger* exploded shortly after take-off on January 28, 1986, and the *Columbia* disintegrated on re-entry into the atmosphere, February 1, 2003. In both cases, the accidents killed all crewmembers on board.[5]

Most of the space shuttle system was in place by the time of the first shuttle launch in 1981. The RPSF was an exception. It was designed in 1981, and was constructed between 1982 and 1984. Its purpose was to remove a potentially hazardous operation from the VAB, which was constructed in the mid-1960s during the Apollo program and already hosted a large number of activities.

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[2] Deming and Slovinac, *Evaluation of Historic Facilities, Space Shuttle Program*, 2.1.
[3] Deming and Slovinac, *Evaluation of Historic Facilities, Space Shuttle Program*, 2.1.
[4] Deming and Slovinac, *Evaluation of Historic Facilities, Space Shuttle Program*, 2.22-24.
[5] Deming and Slovinac, *Evaluation of Historic Facilities, Space Shuttle Program*, 2.15.

The function of the RPSF is basically to receive the segments of the Solid Rocket Motor (SRM) booster from the ATK Launch Systems factory in Utah, rotate the segments from horizontal to vertical, and store them in "surge" buildings after a series of inspections. The aft segment, unlike the others, requires additional modification, and is built-up with the addition of an aft skirt and an exit cone. These built-up aft segments are then stored in the surge buildings with the other segments, until they are needed for finally assembly in the VAB prior to a shuttle flight.

To understand the function of the RPSF, it is necessary to first understand the various components that make up a typical space shuttle flight. These basic components have not changed since re-usable space shuttles were first designed in the 1970s. The basic shuttle flight process and its component parts are detailed below.

The final design for the space shuttle was chosen from twenty-nine different possibilities in 1972. After years of testing and preparation, the first shuttle vehicle, *Columbia*, arrived at KSC in 1979. *Columbia*, STS-1, lifted off on April 12, 1981, in the first launch of the shuttle program. Most of the work required to prepare the vehicle for launch was done in the VAB. The first operational flight occurred the following year, on November 11, 1982 (STS-5).[6]

These launches were conducted from KSC's Launch Complex 39, Pad A. By the mid-1980s, Pad B was also available for launch service. Since this beginning, there have been an average of five shuttle launches per year, with few or no launches for many months following each of the two major accidents.[7]

The space shuttle, a vehicle designed to be launched vertically, orbit the Earth, and then land horizontally, is comprised of three main components that are clearly visible at the time of

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[6] Deming and Slovinac, *Evaluation of Historic Facilities, Space Shuttle Program*, 2.13-15.

[7] Deming and Slovinac, *Evaluation of Historic Facilities, Space Shuttle Program*, 6.4; RPSF Manager Howard Christy, personal communication, February 24, 2010.

launch. These are: 1) the re-usable orbiter, the main shuttle vehicle; 2) an external tank (ET), the large orange tank in the middle of the shuttle assembly; and 3) the two re-usable solid rocket boosters (SRB) that flank either side of the ET. Of these, only the ET is expendable and is not recovered from each flight.[8] It is in the production and assembly of the SRBs that the RPSF plays its role in the space shuttle process.

The orbiter or space shuttle is the central component of any shuttle flight. Equipped with its own engines, it is versatile in space and capable of re-entry into Earth's atmosphere, after which it can land like a glider. It is not, however, capable of leaving the Earth's gravitational pull upon launch. For this it requires the ET and the two SRBs.

The ET is 154'-0" tall and 27'-0" in diameter. It serves as the structural backbone for the whole shuttle assembly. Both the orbiter and the two SRBs are attached to it. Designed in the 1970s by Martin Marietta Corporation, the ET contains liquid hydrogen and liquid oxygen, which serve as the fuel and oxidizer for the orbiter's three main engines. The fuel in the ET provides the shuttle with approximately 29 percent of the thrust needed to escape the Earth's gravitational pull. When expended, the ET is jettisoned over the Indian Ocean and is not recovered.[9]

The SRBs are the workhorses of the shuttle, providing 71 percent of the thrust for it to achieve orbit. Thiokol Chemical Company (later Morton-Thiokol and now Alliant Techsystems, or ATK), designed the SRBs in the 70s. The two SRBs are attached to each side of the ET and support the full weight of the ET and orbiter on the launch pad. Each booster is its own rocket, about 150'

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[8] Deming and Slovinac, *Evaluation of Historic Facilities, Space Shuttle Program*, 3.1.

[9] Deming and Slovinac, *Evaluation of Historic Facilities, Space Shuttle Program*, 3.15, 2.4-5; Presidential Commission, *Report of the Presidential Commission on the Space Shuttle Challenger Accident, June 6, 1986* (Washington, D.C. Updated August 5, 2004, Steven J. Dick, NASA Chief Historian, Steve Garber, NASA History Web Curator. National Aeronautics and Space Administration, NASA History Office, http://history.nasa.gov/rogersrep/51lcover.htm), Chapter IV.

tall, with an average diameter of 12'. When fully loaded with solid propellant, each booster weighs around 160 tons.[10]

Each booster is made up of four segments, often referred to as solid rocket motor (SRM) segments. The segments are also called motors. Here, the "motors" are chemical, not mechanical, and refer to the propellant. The four segments are the only parts of the booster that contain propellant, a solid mass of highly combustible material packed along the inside of the segments, with a hollow tube of air down the middle. In each segment, the propellant makes up most of the weight.

The SRM is comprised of the four segments that are stacked to form the bulk of the rocket. These four segments each have names. The uppermost segment (27.29′ tall) is called the forward segment. The two middle segments (each 26.67′ tall) are referred to as the forward mid (or center) segment and aft mid (or center) segment. The lowest segment is larger than the others (41.5′ tall), with the nozzle or exit cone, and is called the aft segment. The top and bottom of each segment is also identified by "forward end" and "aft end."

These four segments require additional parts to make up a complete booster, and these parts are found both above and below the motor segments. The parts above the forward segment, which comprise the apex of the rocket, are, from top to bottom, the nose cone (6.25′-0″ tall), the frustum (10′-0″ tall), and the forward skirt (10.75′ tall). It is the forward skirt that attaches to the forward end of the forward segment.[11]

At the lower end of the rocket, the aft segment connects with the aft skirt (7.54′ tall) and the exit cone, also referred to as a nozzle. The nose cone, frustum, and forward skirt are not assembled within the RPSF. The motor segments, the aft skirt,

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[10] Presidential Commission, *Report on Challenger Accident*, Chapter IV; Deming and Slovinac, *Evaluation of Historic Facilities, Space Shuttle Program*, 2.4-5; "SRB Complex Work Begins on Site North of VAB," *Spaceport News*, Volume 21, No. 17, August 19, 1982, p. 7; *NASA Facts: Solid Rocket Boosters and Post-Launch Processing* (National Aeronautics and Space Administration, John F. Kennedy Space Center, Florida; FS-2004-07-012-KSC, www.nasa.gov, Rev. 2006).
[11] Presidential Commission, *Report on Challenger Accident*, Chapter IV, Figure 8; *NASA Facts: Solid Rocket Boosters*.

and the exit cone are the only portions of the booster rockets that are examined and built up in the RPSF.

The four segments, when stacked together and ignited from the top of the uppermost segment, will burn like a gigantic Roman candle, beginning at the edge of the tube and working outward to the edge of the rocket casing, until the fuel is spent. The fuel is spent two minutes after launching, by which time the shuttle assembly has been driven 26.3 nautical miles above the Earth's surface. At that point, the spent booster rockets are jettisoned from the ET and the orbiter. Small booster separation motors, located on the aft skirt, help push the spent boosters away from the rest of the shuttle assembly.[12] Inertia keeps the boosters rising to a height of over 38 miles before they begin to fall back to Earth.[13]

On the fall back, at 2.5 miles above sea level, the nose cap separates from the rest of the booster. A pilot parachute deploys, followed by a drogue chute. This orients the boosters as they begin to slow down. At 6,000 feet above sea level, the frustum separates, allowing the three main parachutes to deploy and slow the booster from 230 miles per hour to the impact speed of around 51 miles per hour. The exit cone is jettisoned before impact to prevent any damage to the aft skirt and aft segment, which will be the first portions of the booster to hit the water. Upon impact, air is trapped inside the booster rocket, which will then float upright, about 30 feet above water.[14]

The *Liberty Star* and *Freedom Star*, two ships designed for this purpose, retrieve the two boosters floating in the Atlantic Ocean. Each ship handles a single booster, towing it back to Hangar AF at Cape Canaveral Air Force Station. The frustums and the parachutes are also retrieved. The nose cap and the exit cones are not usually recovered.

After being towed back to Hangar AF, the recovered boosters are washed at the SRB Disassembly Facility, after which they are separated into their individual segments. The segments are

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[12] RPSF Technician Keith Lawton, personal communication, February 22, 2010.
[13] *NASA Facts: Solid Rocket Boosters.*
[14] *NASA Facts: Solid Rocket Boosters.*

transported by rail back to Utah, where they are reloaded with propellant by ATK.

The aft skirts are removed from the boosters and transported back to the SRB Assembly and Refurbishment Facility (ARF), located south of the VAB. The ARF is where the aft and forward skirts, frustums, and recovery systems are all refurbished. Within the ARF, the Thrust Vector Control Deservicing Facility cleans and removes the aft skirt and booster separation motors. Then in the Robotic Hydrolase Facility, also within the ARF, the aft skirts are cleaned of any remaining foam. The aft skirts are then rebuilt at the ARF[15] and transported back to the RPSF for SRM reassembly.

The basic purpose of the RPSF is to help assemble the SRBs. Activities completed at the RPSF include receiving the SRB motor segments that arrive by rail from Utah; the rotation of segments from the horizontal position to the vertical; inspection and cleaning of the SRB segments; and then storage of the segments until they can be assembled in the VAB. In addition to this basic rotation process, the aft motor segment is mated to both the aft skirt and the exit cone.[16]

The upright segments, including the upright aft segment, now united with the aft skirt and exit cone, are stored in the two surge buildings, identified as Surge 1 and Surge 2. From the surge buildings, the motor segments will eventually be transported to the VAB for final assembly, prior to launching. At that time, the four motor segments are joined together at what is called the "field joints." The other joints, combined in Utah, are referred to as "factory joints."

Before 1984, all of the work done in the RPSF was performed in the VAB, which was constructed in 1966. The booster segment assembly was specifically done in High Bay 4.[17] Because of the inherently dangerous nature of the rotational work, and due to

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[15] Deming and Slovinac, *Evaluation of Historic Facilities, Space Shuttle Program*, 3.22; *NASA Facts: Solid Rocket Boosters*; "Inside SRB Refurbishment," *Spaceport News*, July 20, 2001, pp. 4-5.
[16] Deming and Slovinac, *Evaluation of Historic Facilities, Space Shuttle Program*, 3.22.
[17] RPSF Manager Howard Christy, personal communication, February 24, 2010.

the many other activities conducted in the VAB, NASA decided relatively early in the shuttle program to remove this function from the VAB to a new facility some distance away. The new facility was eventually named the Rotation Processing and Surge Facility (RPSF).

The RPSF was built to support the SSP by inspecting, rotating, and storing the SRB motor segments and building up the aft segment with the aft skirt and the exit cone. The RPSF was one of twenty-six properties on KSC that were determined to be individually eligible for listing on the National Register of Historic Places (NRHP) under Criterion A. This determination was made by KSC's Historic Preservation Officer and concurred by the KSC Center Director, identifying approximately seventy-four properties as either listed, determined eligible, or were potentially eligible to the NRHP. Out of twelve property types identified for NASA's SSP, the RPSF was identified as Type 2, Vehicle Processing Facilities, which included such buildings as the VAB, the ARF, and the RPSF, all of which are dedicated to the processing of shuttle vehicles and components.[18]

Building Design and Construction History, 1981-84

In the early 1980s, the decision was made to move the rotation and aft segment build-up operations from the VAB to a more isolated location. This was considered less hazardous to the overall operation of the VAB and would furthermore ease the VAB's already hectic assembly construction schedule. The NASA project engineer for the RPSF at that time was Alfredo Teran.[19]

The earliest known layout map of the RPSF dates to December 1981 and was part of a safety assessment done by Robert A. Gerron. At that time, the RPSF was known by its early name: Shuttle Rocket Motor (SRM) Processing and Storage Facility.[20] By the time formal plans were drawn up the following year, the name had been changed to the Rotation Processing & Surge Facility.

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[18] Deming and Slovinac, *Evaluation of Historic Facilities, Space Shuttle Program*, i, 1.7-8, 5.14-17.
[19] "SRB Complex Work Begins," *Spaceport News*, August 1982.
[20] Map, "Intraline Distances – SRM Processing and Storage Facility, S531A, Safety Assessment, A. Gerron, December 1981," in "RPSF Floor Plan," on file RPSF Support Building.

Safety was the primary concern in drawing up plans for the RPSF. From the beginning, the RPSF was considered an ordnance facility.[21] The fire suppression system required hook-ups to fire hydrants located outside the main building. In the case of an incident (or explosion), where one or more of the segments ignited, the only possible solution was isolation, which explains the location of the RPSF at the northern extremity of the VAB complex.

The lead design engineer for the RPSF project was Ernest Lautzenheiser, who worked with NASA.[22] Lautzenheiser appears to have worked at the George C. Marshall Space Flight Center earlier in his career.[23] The lead design engineer took the more general ideas of the project engineer and translated them into the specific building and project requirements that would be needed by the design firm.

The job of drawing up the building plans of the new facility was given to the firm of Daniel, Mann, Johnson, Mendenhall (DMJM) of Los Angeles.[24] DMJM prepared a total of 161 engineering plans pertinent to the RPSF. The earliest of these are seven sheets completed in November and December 1981. Designed by K. Jamison, they were designated "Design 1a." These plans included the basic layout of the ground level, the crane platforms, building cross-sections, and the control room.

The remaining sheets, almost all dated to January 1982, were designed by a number of different DMJM architects or engineers, presumably under the supervision of Ernest Lautzenheiser. One of these was William Weinstock, R.C.E. California License No. C-24114, who prepared the first twelve sheets showing the various maps of the RPSF area layout and the layout of the railroad. The plans of the RPSF building itself were prepared by Milan

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[21] RPSF Technician Keith Lawton, personal communication, February 22, 2010.
[22] "SRB Complex Work Begins," *Spaceport News*, August 1982.
[23] George C. Marshall Space Flight Center, Huntsville, Alabama, Telephone Directory, NASA, September 4, 1960. www.nasa.gov/centers/marshall/pdf/434151main_1960_phonebook.pdf. Accessed April 21, 2010.
[24] "SRB Complex Work Begins," *Spaceport News*, August 1982.
[26] California Architects Board, 2420 Del Paso Road, Suite 105, Sacramento, CA 95834.

Svabensky, Architect, California License No. C-5859. Sheets 13 through 67, illustrate the building plans, elevations, and the workstations. Karl J. Frank, California No. 18809, was responsible for the overall framing plans, details of the walls, and workstand sections.

Milan Svabensky, the main architect for the RPSF building, was registered with the California Architects Board from 1969 to 1989.[26] "Svabensky" is a Czech name, and information from the California Death Index, 1940-1997, shows that Milan Svabensky was born June 13, 1929, outside the United States, presumably in Czechoslovakia, and died in Los Angeles on August 27, 1989.[27]

The main characteristic of the RPSF area is a consideration for spacing and distance. The main RPSF building and the two surge buildings are situated as far from each other as possible, forming a triangle with smaller auxiliary buildings located in between. Each building within the complex has a number. The numbering system used at the KSC is based on a grid, with numbers along one axis and letters along the other. All buildings within the RPSF complex fall under the combination of K6. The main RPSF building is K6-494. Surge Building No. 1 is K6-497; Surge 2 is K6-345. The smaller buildings include the support and office building (K6-495); a storage building (K6-446); the POL/HAZ Waste building (K6-445); and the gate entrance building (K6-496).[28]

During the planning and construction of the RPSF, a second processing facility was considered, along with another set of two storage buildings. In the end, this duplication effort was not built.[29]

The final design by NASA and DMJM featured a rail track that entered the main building through the southernmost of the two large doors on the west side of K6-494. This would allow railcars to bring segments directly into the building, where

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[27] Information on "Milan Svabensky" at www.ancestry.com.
[28] Map of RPSF, May 21, 1981, from notebook of plans entitled "RPSF Floor Plan," on file RPSF Support Building.
[29] *Space Transportation System: Facilities and Operations, Kennedy Space Center, Florida* (National Aeronautics and Space Administration, John F. Kennedy Space Center, K-STSM-01, Appendix A, Revision A, April 1984).

they could be positioned under the two 200-ton bridge cranes. The segments could then be rotated to their vertical position, inspected, and loaded onto pallets for transport to the surge (storage) buildings. Transportation out of the main building to the surge buildings was done through the large door on the north side of the building.

The other major activity in the RPSF building was the build-up of the aft motor segments, each of which was mated to the aft skirt and the exit cone. This was completed in two build-up stands located in the northeast quadrant of the building. After build-up, these segments were also transported to the surge buildings.

The first maps and three-dimensional drawings completed of the RPSF depict a building and a process area that have not changed greatly since the early 1980s.[30] These drawings show the basic work area and build-up stands that still characterize the building. There are, however, some differences, especially in the southeast quadrant of the building. The early plans show no Fall Abatement Stand and no 400 Stand with a 386 Stand on top, features added to the operations at a later date.

The surge buildings were storage buildings for the motor segments after inspection and/or aft build-up.[31] Each surge building measured 6,000 square feet of floor space, large enough to hold eight SRM segments. These eight segments are the equivalent of the two rockets needed for a shuttle flight. Most of the building height is 43′, sufficient for the forward and center segments; the front portion of the building is 61′ high, to accommodate the built-up aft segment, with the added height of the aft skirt and the exit cone.[32]

The Support Building (K6-495), located just northeast of the main building, is divided into two parts, with offices on the east side and more general support facilities (restrooms,

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[30] *Space Transportation System: Facilities and Operations*, Fig. 2-11; Map, "Rotation/Processing Building – Evacuation Routes, SRM Processing and Storage Facility, Safety Assessment," from notebook of plans, "RPSF Floor Plan," on file RPSF Support Building.
[31] RPSF Technician Keith Lawton, personal communication, February 22, 2010.
[32] Information on official operational board, RPSF Support Building.

lunchroom, lockers) on the west.[33] The other buildings serve general functions or are for storage.

The area now occupied by the RPSF complex was first used as a storage area, beginning with the construction of the VAB in the 1960s. During the construction of the VAB, the entire area was built up with sand pumped onto the site.[34]

In 1966, immediately after the construction of the VAB, mobile service structures, with what looked like a series of mobile homes and trailers, occupied the location that would later be used for the main RPSF building. It was at this time that what appears to be the oldest building in the RPSF complex was first noted in any of the existing aerial photographs. Storage Building K6-446 appears to be over 40 years old. A building with the same size, with the same orientation, and with the same seven roof vents, appears to have been in that location since 1966.[35] This is corroborated in the "Demolition Plan" prepared prior to the RPSF construction, Sheet 5 of 154, dated to January of 1982, which shows that an existing "Roads and Grounds Warehouse, K6-446," measuring 140.6′ x 40.4′, was slated to be left standing. Another, much smaller building, K6-445, northwest of the Roads and Grounds Warehouse, also predates the RPSF construction project, and is currently the small structure located between the Support Building parking lot and Surge Building No. 2.

None of the other RPSF area buildings were constructed at such an early date. A 1979 aerial view shows what appears to be K6-446. Otherwise, the project area contained a series of mobile launcher platforms, clearly put there as storage.[36]

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[33] Map, "Support Building – Evacuation Routes, SRM Processing and Storage Facility, Safety Assessment," from notebook of plans, "RPSF Floor Plan," on file RPSF Support Building.
[34] Kennedy Space Center photograph negative number 100-KSC-64C-5536, dated November 9, 1964, from Kennedy Space Center Archives.
[35] Kennedy Space Center photograph negative number 100-KSC-66C-254, dated January 7, 1966, from IMCS Photo and Media Services, Mission Solutions Group, M6-0399 KSC Headquarters Building, Kennedy Space Center.
[36] Kennedy Space Center photograph negative number 116-KSC-379C-267-8, dated March 21, 1979, from Kennedy Space Center Archives.

Construction of the RPSF complex began in May 1982 and was not completed until 1984. An article that appeared in *Spaceport News*, dated to August 1982, supplied much of the data on the early construction of the RPSF. At that time, it was reported that the RPSF would be a $15.5 million complex for the processing and storage of the SRB segments for space shuttle missions. The main contractor was the W & J Construction Company of Cocoa, Florida, with the work supervised by company vice-president Nick Witek. W & J Construction had a $7.2 million-contract for labor, equipment and materials for the construction of the main RPSF building and the two storage (surge) buildings. Construction began on May 20, 1982. By the time of the article, the preliminary work had already been completed. Construction work was scheduled for completion eighteen months after commencement, or by November 20, 1983.[37] Formal completion of the project did not occur until 1984.

W & J Construction worked at the KSC prior to construction of the RPSF. Located in the Cocoa area for the previous seventeen years, it was estimated that this company obtained half of their work from NASA or the U.S. Air Force. Just before the RPSF work, the company completed modifications to the Launch Complex Pad 39B area for $6.7 million.[38]

In the months that followed, the progress of the RPSF construction can be documented by a series of aerial photographs taken by NASA of the VAB area, dating from early February 1983, to June 1984. The aerial from February 8, 1983 illustrates the early progress made on the surge buildings. Their steel frames were standing and the roofs were in place, although the walls had not been installed. At the site of the main building, construction of the foundation was underway. Building K6-446, constructed prior to 1966, is standing in the middle of the site complex.[39]

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[37] "SRB Complex Work Begins," *Spaceport News*, August 1982.
[38] "SRB Complex Work Begins," *Spaceport News*, August 1982.
[39] Kennedy Space Center photograph negative 108-KSC-383C-267, #20, dated February 8, 1983, from IMCS Photo and Media Services, Mission Solutions Group, M6-0399 KSC Headquarters Building, Kennedy Space Center.

By late April 1983, the surge buildings were covered with sheet metal walls. At the site of the main building (K6-494), the steel girder frame was partially in place. The east side of the main building was totally open.[40]

In July 1983, the surge buildings appeared to be largely in shape and the main building had a complete frame, with roof installed. There was still no solid wall on the east side of the main building.[41]

By early September 1983, the external construction of the three RPSF buildings was nearing completion. The surge buildings appeared complete except for the installation of the roll-up doors. There was possibly some roof work to be finished on the main building.[42] One month later, the buildings were completed, at least on the outside. Inside the main building, there was still construction at the build-up stands and in the stairwells. The Support Building (K6-495) was still under construction.[43]

By March 1984, it appeared that construction was basically completed, both inside and outside.[44] Photographic evidence corroborates the official completion date of the building's construction, given as 1984.[45]

Most of the main building was new construction, but not all. The build-up stands, located in the northeast quadrant of the

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[40] Kennedy Space Center photograph negative 108-KSC-383C-1085, #90, dated April 21, 1983, from IMCS Photo and Media Services, Mission Solutions Group, M6-0399 KSC Headquarters Building, Kennedy Space Center.
[41] Kennedy Space Center photograph negative 108-KSC-383C-2203, #40, dated July 5, 1983, from IMCS Photo and Media Services, Mission Solutions Group, M6-0399 KSC Headquarters Building, Kennedy Space Center.
[42] Kennedy Space Center photograph negative 116-KSC-383C-3090, #30, dated September 1, 1983, from IMCS Photo and Media Services, Mission Solutions Group, M6-0399 KSC Headquarters Building, Kennedy Space Center.
[43] Kennedy Space Center photograph negatives 108-KSC-383C-3674, #1 (October 3, 1983); 116-KSC-383C-3561, #100 (October 4, 1983); and 116-KSC-383C-3563, #20 (October 4, 1983), from IMCS Photo and Media Services, Mission Solutions Group, M6-0399 KSC Headquarters Building, Kennedy Space Center.
[44] Kennedy Space Center photograph negatives 108-KSC-384C-1134-7 (March 8, 1984) and 108-KSC-384C-1134-1 (March 9, 1984), from Kennedy Space Center Archives.
[45] Deming and Slovinac, *Evaluation of Historic Facilities, Space Shuttle Program*, 4.14.

building, were actually cut out of High Bay 2 in the VAB and transported over to the RPSF. This probably explains why the east wall of the main building was the last to be constructed, to allow the build-up stands to be brought into the building from outside. Even today, it is clear that the steel beams of the build-up stands are different from those used in the rest of the building.[46]

Operational History

The main purpose of the RPSF is the rotation and inspection of the booster rocket segments before final assembly, and the preparation of the aft segment with the aft skirt and the exit cone. As a result, the most important elements to be processed in the RPSF are the SRMs, the aft skirts, and the exit cones.

The booster rockets used in the SSP are the largest solid-propellant rocket motors ever launched into space. When completely assembled, each booster is almost 150′ long, with a 12′ diameter, not counting the aft skirt, which is wider. Fully assembled, the rocket is composed of nine main elements: four SRM segments, a nose cap, a frustum, a forward and an aft skirt, and an exit cone or nozzle. Only the four segments, the aft skirt, and the exit cone are assembled in the RPSF.

Each solid rocket booster weighs about 1.3 million pounds at the time of the launch, and 1.1 million pounds of that is the propellant. The propellant is mostly a mixture of ammonium pechlorate, 70 percent by weight, and aluminum powder, 16 percent. The aluminum powder is the fuel, while the ammonium pechlorate serves as the oxidizer. When burned, they create more than 70 percent of the thrust at the time of lift-off and during the first stage ascent.[47] The design and the fuel used in the rockets have changed very little since their inception in the 1970s.

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[46] Kennedy Space Center photograph negatives 116-KSC-66-13950, 116-KSC-66-13947, and 116-KSC-66-13949 (all dated July 6, 1966), from IMCS Photo and Media Services, Mission Solutions Group, M6-0399 KSC Headquarters Building, Kennedy Space Center.

[47] Deming and Slovinac, *Evaluation of Historic Facilities, Space Shuttle Program*, 3.14.

The booster program was managed by NASA's Marshall Space Flight Center, in Huntsville, Alabama, but the boosters themselves were designed and built by Morton Thiokol, which got the initial contract on November 20, 1973. Thiokol tested and improved the rockets during the mid-1970s.[48]

Other components used in the boosters were designed and built at the same time. Chemical Systems Division of United Technology Corporation made the SRB separation motors. McDonnell Douglas built the aft skirt, rings, struts, frustums, and nose caps. Martin Marietta and Pioneer Parachute Company designed and built the parachute system.[49]

Many of the other items, especially the large-scale tools used at RPSF, were designed and made by NASA or its contractors. These items, always painted yellow, are usually identified as "ground support equipment" or GSE.

These elements form the basic building blocks used in the RPSF process, and these building blocks have not changed greatly since the SSP began operational flights in 1982. Basic rocket technology has not changed greatly in the past fifty years, since the days of the Apollo missions. The biggest change has been the introduction of computers.[50]

In the thirty or so years of operation, the space shuttle technology has only been altered in the wake of obvious mistakes or disasters. The first mistake was the loss of two booster rockets after the fourth space shuttle launch, on June 27, 1982.[51]

A far greater disaster, and the one with the greatest impact on the RPSF process, was the *Challenger* explosion, which occurred on January 28, 1986. All the astronauts on board perished, and

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[48] Deming and Slovinac, *Evaluation of Historic Facilities, Space Shuttle Program*, 3.14-15; Presidential Commission, *Report on Challenger Accident*, Chapter VI.
[49] Deming and Slovinac, *Evaluation of Historic Facilities, Space Shuttle Program*, 3.14.
[50] RPSF Lead Technician Ed O'Neal, personal communication, February 22, 2010.
[51] "NASA Will Attempt Salvage of Boosters," *Spaceport News*, Volume 21, Number 17, August 19, 1982, p. 1; RPSF Manager Howard Christy, personal communication, February 25, 2010.

the disaster was subject of an investigation, which in turn resulted in an eight-volume Presidential commission accident report. This report concluded that the destruction of *Challenger*, STS 51-L, on January 28, 1986, was caused by the "failure in the joint between two lower segments of the right SRM. The specific failure was the destruction of the seals that are intended to prevent hot gases from leaking through the joint during the propellant burn of the rocket motor." It was further noted that the accident was caused not by improper assembly at the VAB, but by faulty design of the 0-ring seals, which made them too sensitive to a number of factors, such as temperature extremes and reactions to dynamic loading.[52]

As was noted in the report, the 0-rings that failed were located where the four segments are field-jointed together at the VAB just before launch. At those joints, the tang of the upper segment joins with the clevis of the lower segment, with two rubber 0-rings set in place between the tang and clevis to prevent the escape of any gases during the firing of the rocket. On this occasion, a gap was created due to 0-ring compression, compounded by icy conditions that prevented the rubber seals from functioning properly.[53]

As a result of this accident report, a "SRM joint redesign team" was created with personnel from the Marshall Space Flight Center and other NASA centers. This team evaluated design alternatives for the 0-rings, and came up with what was called the "J-seal."[54] The J-seal was added to the inside of the tang-clevis joint and was named because of its shape: a flange of material that in profile looks like a "J." On take-off, pressure from inside the rocket would automatically seal this J-shaped flap in such a way that it is unlikely that any pressure at all ever reached the 0-

[52] Presidential Commission, *Report on Challenger Accident*, Chapter IV.
[53] Presidential Commission, *Report on Challenger Accident*, Chapter IV and Figure 14.
[54] *Report to the President: Actions to Implement the Recommendations of the Presidential Commission on the Space Shuttle Challenger Accident, July 14, 1986* (Updated August 5, 2004, Steven J. Dick, NASA Chief Historian, Steve Garber, NASA History Web Curator. National Aeronautics and Space Administration, NASA History Office, http://history.nasa.gov/rogersrep/genindex.htm), 1, 11.

ring seals located closer to the outer edge of the field joint.[55] The new J-seal was used only between segments, and not at the joint between the aft segment and the aft skirt.[56]

The addition of the J-seal was the greatest of the changes made to the space shuttle process in the wake of the *Challenger* disaster, but there were others as well. There were eight changes made to the ET. Changes were also made to the ET aft attach ring structure, where the frame was improved, and a few structural improvements were added to the SRB forward structural assembly and aft skirt. Also, a heated nitrogen gas purge was added to the process, as was joint heater power.[57]

For a while, at least, SRM became RSRM, or "re-designed solid rocket motor." In the wake of *Challenger*, there were many more inspections, especially of the joints. Special equipment was required for these inspections, including new leak check devices. The great increase in inspections was the biggest change to the RPSF process. Many of these inspections were dropped in later years, after they were found to be redundant. Changes were also made to some of the equipment, but those changes took place at other locations. For example, the lifting beams were improved for the handling of the segments, but this did not apply to the ones used at the RPSF, but rather the ones used at the VAB.[58]

In the early 2000s, two changes were made to the RPSF process and the overhead crane, but these were not major alterations. The rain curtain installation, which involved a blue Herculite cover applied on Level 2, ceased about this time as an unnecessary operation. Around 2004, modifications were made to the large overhead crane by Ederer, LLC, out of Seattle,

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[55] *Report to the President, Implementation of the Recommendations of the Presidential Commission on the Space Shuttle Challenger Accident, June 1987* (Updated August 5, 2004, Steven J. Dick, NASA Chief Historian, Steve Garber, NASA History Web Curator. National Aeronautics and Space Administration, NASA History Office. http://history.nasa.gov/rogersrep/51lcover.htm), Part 1, Figure 3, Field Joint Redesign.
[56] RPSF Manager Howard Christy, personal communication, February 24, 2010.
[57] *Implementation of Recommendations*, Part 2.
[58] RPSF Manager Howard Christy, personal communication, February 24, 2010.

Washington. These changes enabled both sides of the bridge crane to move simultaneously.[59]

Few additional changes were made to the process until the *Columbia* accident of 2003. While there were no major repercussions to the RPSF process, more cameras were installed to monitor both the foam application process and the work associated with the ET attach ring.[60]

The biggest changes to the RPSF building occurred in 2009, although these were temporary changes done for the Ares 1-X rocket. The Ares 1-X was the first new space vehicle in more than twenty-five years. It was part of the Constellation program, announced by NASA in 2006 for the purpose of developing equipment and propulsion systems needed for travel to the moon and to the adjacent planets of our solar system.[61]

The total height of the Ares 1-X was around 330′. Like other boosters, it was made in segments, which had to be inspected and stored just like the shuttle rockets. These operations were done in the RPSF. The Ares aft skirt had to be mated to the Ares aft segment, although the aft skirt in this case was very different from that used in the SSP. In order to perform this work at the RPSF, it was necessary to remove the entire folding platform for Level 3 and replace it with a temporary wooden platform. In this manner, the Ares 1-X rocket was assembled for its single flight in October 2009.[62]

One of the very last pieces of equipment installed in the RPSF was a noise detector, a Sensor Highway II, placed on Level 4 in November 2009. It was installed to help identify a mysterious noise that had been noted earlier in 2009.

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[59] RPSF Manager Howard Christy, personal communication, March 17, 2010; Ed O'Neal, personal communication, Feb. 22, 2010.
[60] RPSF Manager Howard Christy, personal communication, February 25, 2010.
[61] Deming and Slovinac, *Evaluation of Historic Facilities, Space Shuttle Program*, ii, 2.25-26; Klaus Schmidt, "Stacking of New Space Vehicle Begins at Kennedy Space Center" (http://spacefellowship.com/news/art9934/stacking-of-new-space-vehicle…), Published by Klaus Schmidt, July 9, 2009. Accessed March 3, 2010.
[62] RPSF Manager Howard Christy, personal communication, February 24, 2010.

Worker History

Worker history at RPSF has naturally coincided with the operational history of the facility itself. NASA has always used contractors in the day-to-day operation of the RPSF, as well as at most of its other facilities at the KSC. The first of these contractors was the United Space Boosters, Inc. (USBI). This group was merged with the United Space Alliance (USA) in 1999, and it is USA that currently operates RPSF.[63] USA is currently NASA's prime human spaceflight operations contractor.[64]

The rotation and processing of rocket motor segments has required the same number of workers since the beginning of the space shuttle operation. The only big difference has been in the number of shifts. In the early days, there were three shifts at the RPSF, with work continuing around the clock. Later, this was scaled back to two shifts, an adjustment made possible by increasing efficiency in the rotation and processing operation.[65]

The RPSF currently operates with two work shifts, a regular day shift and a night shift, working five days a week. On average, there are fifteen to twenty people working during the day, and fifteen at night. On each shift, there are about twelve technicians and two to three inspectors. There are no resident engineers at the RPSF, but that level of support can be obtained from the adjacent Operational Support Building (OSB).[66]

There are two major operations that occur at the RPSF, and each requires a different set of employees. The "off-load" operation, during which segments are taken off the railcars and rotated and inspected, requires five to six crane operators, five USA technicians, one USA quality inspector, and one NASA quality inspector, making a total of twelve to thirteen workers. The "build-up" operation, which occurs in the two workstands,

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[63] Deming and Slovinac, *Evaluation of Historic Facilities, Space Shuttle Program*, 3.14.
[64] Schmidt, "Stacking of New Space Vehicle."
[65] RPSF Manager Howard Christy, personal communication, February 24, 2010.
[66] RPSF Manager Howard Christy, personal communication, February 25, 2010.

requires ten technicians and two USA inspectors, and another two NASA inspectors.[67]

The build-up operation takes much longer to perform than the off-load. Normally, it requires thirty-five workdays to complete a typical build-up on the aft booster segments. In addition to the mating of the aft skirt and the exit cone with the aft segment, this build-up period also includes the addition of the cable, tunnel covers, ET attach rings and struts, and the foam.[68]

Work at the RPSF requires considerable training, and certification is required for all positions within the building. The testing for this certification is usually done by USA for NASA. The technicians are either mechanical or electrical technicians, and many workers in the facility have both certifications.[69]

Crane operators are a special category of workers within the RPSF. Like the other RPSF workers, they are USA employees, but unlike the other workers, crane operators are unionized. Their union is known as the CDPE, which stands for "cranes, doors, platforms, and elevators." When the crane is in operation, there might be five to six crane operators assigned to the crane control room. There are also crane spotters on the floor, with the power to make emergency stops.[70]

The RPSF Process

This portion of the documentation is an examination of the actual processes that occur in the RPSF. This work is basically divided into two general operations, the "off-load" process and the "build-up" process. The first occurs in the west half of the RPSF building, while the second occurs in the east half, more specifically in the build-up stands located in the northeast quadrant of the building.

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[67] RPSF Technician Keith Lawton, personal communication, February 22, 2010.
[68] RPSF Manager Howard Christy, personal communication, February 24, 2010; Ed O'Neal, personal communication, February 22, 2010.
[69] RPSF Manager Howard Christy, personal communication, February 25, 2010.
[70] RPSF Manager Howard Christy, personal communication, February 24, 2010; RPSF Technician Keith Lawton, personal communication, February 22, 2010.

Off-Load & Rotation Process

The off-load process relies on a number of different operations, which are discussed in chronological order: railroad car operations, crane operations, the spreader beam and the break-over beams, the rotational process, operations at the 400 stand, and operations associated with the inspection stands adjacent to the north door. Three of the four in-coming segments (the forward segment and two mid-segments) follow these steps. The fourth, the aft segment, is treated to most of these same processes, but is also subjected to much more work at the build-up stands, which will be explored in greater detail in the next section.

The railroad plays an essential role in the process that occurs in the RPSF. It brings the booster segments from the ATK plant in Utah, where solid propellant has been added to the inside of each segment. Each segment is protected by a "transportation cover" (or "railcar cover") in order to make the journey to KSC. Each cover has a small GPS unit attached to the front, which allows the segment to be tracked while in transit.

The railcars are first brought to the KSC railroad siding at Mims, in the vicinity of North Titusville. Here they are given their first inspection. The Environmental Data Recorder (EDR) is checked for any possible damage to the segment. The EDR is a magnetic instrument attached to the segment but with connections to the railcar cover. It is used to measure shock, temperature shifts, and humidity changes during transit.

After this first inspection, the railcar is turned over to the NASA railroad crew. Up to fifteen railcars might be kept in the siding area before being sent over to the RPSF for off-loading. Two railcars are sent over at a time. It is a two-day process to unload each car.[71]

In order to begin the process at the RPSF, the railroad locomotive backs the railcar carrying the segment into the building through the southernmost of the two west doors. For

[71] RPSF Manager Howard Christy, personal communication, February 24, 2010.

safety reasons, the locomotive itself never enters the building.[72]

Once in the building, the railcar is detached from the locomotive and is grounded. Instruments are again checked for any damage to the segment during transit, and then the railcar cover (transportation cover) is removed, using the spreader beam and the overhead bridge crane.[73] The spreader beam (also known as the lifting beam and the railcar cover lifting beam) is formally identified by GSE number H77-0304-00. After it has been opened and removed from the railcar, the railcar cover is then set onto a railcar cover dolly and wheeled out of the building into a storage area on the west side of the RPSF.

In the meantime, the first internal inspection is conducted on the segment while it is still in the horizontal position on the railcar. The yellow impact shipping cover, located at each end of the segment, is removed to inspect the propellant. This is a close inspection of the propellant grain and the segment's metal surfaces. Inspectors enter the segment to check for any imperfections in the composition of the solid fuel.[74] After this inspection, the yellow covers are placed back on the segment.

Before the segment can be removed from the railcar, the trunnion assembly at each of the four sides of the car must be released. When that is completed, the segment can be moved with the overhead crane, the break-over beam, and the handling rings. Also known as end rings, the handling rings are the metal rings at both ends of each segment. Each handling ring is fastened to the segment by approximately 132 shipping pins. These handling rings protect the solid propellant and the outer edge of the segment, and they provide handling points, called "ears," for the crane to grab the segment. These ears are holes situated in the two raised portions of the handling ring.

The railroad also brings the exit cones to the RPSF, which are brought in by a different kind of railcar. An exit cone, when put together with the aft segment, controls the exhaust and

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[72] RPSF Technician Keith Lawton, personal communication, February 22, 2010.
[73] RPSF Lead Technician Ed O'Neal, personal communication, February 22, 2010.
[74] RPSF Lead Technician Ed O'Neal, personal communication, February 22, 2010.

helps direct the thrust of the ignited propellant.[75] Exit cones or nozzles are stored on the west side of the building on exit cone dollies (or nozzle dollies) and are often protected by a "nozzle enclosure," a metal frame lined with plastic that serves to keep the exit cone clean during inspection and temporary storage. The exit cones, exit cone dollies, and the nozzle enclosures are usually located underneath the mezzanine. The exit cone dolly is a special piece of equipment, with air bearings and jacks. It is used to raise and support the exit cone during the assembly of the exit cone with the aft segment.

Before discussing the rotational process, there must be some discussion of the overhead cranes that actually move all of the heavy equipment within the RPSF. The building contains two bridge cranes, identified as the east and west cranes (also as Nos. 1 and 2). Each has a carrying capacity of 200 tons. These cranes are by far the largest motorized pieces of equipment in the RPSF. They are unique and were constructed for this building and purpose by the Fulton Crane Company of Portland, Oregon. As identified on the crane itself, the main hoist capacity is listed as 400,000 lbs., with an auxiliary hoist capacity of 30,000 lbs. Also listed on the crane is "NASA Contract No. NAS 10-10425; Serial No. 1274-A."

Even though this crane was constructed for this particular process, it has been modified. Around 2004, the two tracks of the bridge crane were synchronized so that both ends of the bridge would travel down the track at the same time.[76]

An essential piece of equipment closely associated with the crane is the "SRM lifting beam," often just referred to as the "lifting beam." This is formally identified by the GSE number H77-0388-00. The upper end of this beam hooks onto the overhead crane, while the lower arms of the beam attach to the ears of the handling ring.

The rotational process requires both cranes, one wielding the SRM lifting beam and the other the break-over beam. The break-over beam is a crucial piece of equipment and is formally identified by GSE number H77-0382-00. It is tested regularly to

[75] RPSF Lead Technician Ed O'Neal, personal communication, February 22, 2010.
[76] RPSF Manager Howard Christy, personal communication, February 24, 2010.

ensure that it works correctly and this is noted by proof-load "dog tags" placed on the beam to record the last inspection. The break-over beam, which is normally kept outside the building, consists of two parts: the sling beam, which attaches to the segment, and the dolly that supports the sling beam when not in use. When in use, the sling beam is normally just referred to as the break-over beam.

To lift the segment off the railcar and then rotate the segment, the east crane uses the SRM lifting beam to pick up the segment at the forward end (or east end), while the west crane uses the break-over beam at the aft end (west end) of the segment. Together they lift the segment off the railcar and place it in a cleared area just north of the railcar. There, between the track and the mezzanine, is where the rotation process takes place.

Even though the casual observer might not know which end of each segment is forward and which is aft, it is apparent to the RPSF work force. For one, all segments enter the RPSF forward end first. Also, the connections along each rim are different. The tangs, for instance, are located aft.

In order to get the segment from horizontal to vertical, the east crane then lifts its end of the segment, while the west crane remains stationary, allowing the sling beam to pivot as the east end of the segment is raised. When the segment is vertical, the break-over beam dolly is then manually rolled back under the sling beam. The segment is then lowered down onto the dolly, where the sling beam is disengaged from the handling ring ear. The break-over beam, now on its dolly, is then moved outside through the northern-most of the two west side doors. By this time, the railcar has also been removed. The upright segment is then ready for the 400 Stand.

The "400 Stand," known more formally as GSE number H77-0400-00, is a circular metal platform. Segments go to the 400 Stand after their rotation. The only exception is the aft segment, which has to go to the 400 Stand with the 386 Stand on top. This is required because of the extra size of the aft segment.

The upright segment rests on the 400 Stand so that the shipping pins can be removed from the handling ring on the aft or lower side. Once the shipping pins have been removed, the segment is lifted off by the crane, leaving the handling ring behind. The handling rings are then collected in an area west of the 400 Stand, where they are stacked awaiting shipment back to Hangar AF, where they will eventually be shipped back to Utah.

From the 400 Stand, the segment is then transported to the Fall Abatement Stand, located east of the 400 Stand and immediately northeast of the Crane Control Room. Formally identified as GSE number A-77-1617-00, the Fall Abatement Stand is not an original piece of equipment in the RPSF. Around 1998, OSHA determined that it was no longer safe to work on or under a segment suspended by the crane, without the added security of a support structure.[77] This led to the creation of the Fall Abatement Stand, an octagonal metal stand that can be wheeled into position underneath a segment.

At the Fall Abatement Stand, the upright segment is lowered into a position right above the stand, with about a half-inch to spare. The segment does not actually rest on the stand, which is there to prevent an accident in case the crane should fail. Workers underneath the stand use special cloths to remove the calcium grease that was coated on the underside of the segment prior to leaving Utah. After inspection for any signs of corrosion, a new layer of calcium grease is applied. In the early days of the RPSF, it was custom to use solvents to remove the old calcium grease, but in recent years, cloths have been used instead.

One of the areas carefully inspected at this point in the process is the tang at the aft end of the segment. Since the *Challenger* accident, this area contains the J-seal, the most important hot gas barrier formed when two segments are connected in a field joint.[78]

After calcium grease has been reapplied to the segment at the Fall Abatement Stand, the crane moves the upright segment to a pallet at the Vertical Inspection Stand area just south of the

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[77] RPSF Lead Technician Ed O'Neal, personal communication, February 22, 2010.
[78] RPSF Technician Keith Lawton, personal communication, February 22, 2010.

large north door of the RPSF. There are two inspection stands, north and south, and the pallets are situated at these two stands. These pallets are large platforms supported by four legs, which keeps them elevated some 9' above ground level.

After the crane places the segments onto the pallets, the SRM lifting beam is disconnected from the handling ring ears, and the crane and its SRM lifting beam are removed. While resting on these pallets, the segments are secured in place by four chocks that torque down to anchor the aft side. While the segment and the pallet are in the inspection stand, the segment's forward handling ring is removed. Old calcium grease from this end of the segment is then removed, the area inspected for corrosion, and new grease applied. After this operation, the segment and pallet are ready for transport to one of the two surge buildings.

Getting a pallet and segment to one of the surge buildings requires a special piece of machinery. Specifically, a huge flat-bed vehicle, referred to as a "crawler," "Mag unit," or "K-Mag," is used for this task. The KSC has approximately sixteen of these vehicles, and each has thirty-six wheels, with all-wheel drive. Capable of going under the pallet and picking it up several inches off the ground with a hydraulic lift, the vehicle then carries the pallet to one of the surge buildings or directly to the VAB, as required. If the destination is one of the surge buildings, the crawler follows the yellow line marking the center of the road, at a top speed of a half-mile per hour.[79]

Build-Up Process

Aside from rotation and inspection, little has to be completed to the forward segment and the two middle segments in the RPSF. This is not true of the aft segment, which has to follow most of the same processes described above, but then is transported to one of the two build-up stands in the northeast quadrant of the RPSF for additional work.

Before being moved to the build-up stand, the aft segment gets special attention. Since it is longer than the other segments

[79] RPSF Technician Keith Lawton, personal communication, February 22, 2010; RPSF Lead Technician Ed O'Neal, personal communication, February 22, 2010.

and has a basal dome, it will not fit onto a regular 400 Stand. The aft segment must be transported to the 400 Stand with a 386 Stand on top, located east of the Fall Abatement Stand, close to the large east door of the building. These stands have the GSE numbers H77-0400-00 and H77-0386-00. The extra elevation provided by the 386 Stand allows the aft segment to rest upright without damaging the basal dome.

After a stint at the Fall Abatement Stand, the crane moves the aft segment to either the east or west build-up stand, where it will be mated to the aft skirt and the exit cone, in addition to a number of other operations required to make the aft segment fully functional. It is the single most important segment of the SRB.

Unlike the motor segments and the exit cones, the aft skirts are not brought into the RPSF by railcar. They arrive through the east door, hauled by small towing vehicles called "tugs." Aft skirts are transported to the RPSF from the Assembly Refurbishment Facility (ARF). After inspection, they are moved to one of the two build-up stands. There, the aft skirt is hauled onto an elevator platform lowered to ground level. It is then raised and secured onto the four hold-down posts, also known as aft skirt hold-down posts. These four posts are stationary and not only support the aft skirt, but later, the aft segment as well, after it has been mated with the aft skirt.[80]

To secure the aft skirt onto the four support posts, the elevator platform is raised to the second level, 9' above ground level. There, the elevator platform is secured at that height by the elevator platform stanchions, which are manually flipped into place with a special alignment tool. After the elevator platform has been secured, the crane moves the aft segment to the build-up area, where it is attached to the aft skirt.

Both build-up stands (also known as "cells") are duplicates of each other. Both were taken from the VAB's High Bay 2, which was a mirror image of High Bay 4 in the VAB. The stands were cut off at ground level from VAB and brought over to the RPSF

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[80] RPSF Technician Keith Lawton, personal communication, February 22, 2010.

during initial construction. The east build-up stand holds the left aft booster assembly, and the west build-up stand holds the right aft booster assembly.[81]

Both east and west build-up stands consist of a ground level, followed by Levels 2, 3, 4, 5, and 6. The elevator platform operates between ground level and Level 2. The other levels (3 through 6) have platforms that open and close on hinges located on the east and west sides of each build-up stand. Semi-circular cut-outs at the edges of these hinged platforms fit around the aft segment and the aft skirt. During build-up, the aft segment, aft skirt, and exit cone extend from Level 2 through the other levels, with the top of the aft segment extending a few feet above the platform on Level 6.

The two elevator platforms are powered by Wright motors. There are four Wright Overload Cut-off motors for each elevator platform, one located at each corner. As identified by tags located on the motors, these are "Wright Overload Cut-off, Patent No. 3,095,979, Part 30173, Setting 3600 lbs., American Chain and Cable Company, Inc., York, PA." Other tags found on the motors at Level 2 identify these as "Acco Wright motors, Electric Hoist Serial No. 533-03-2353, Product No. 3335300, Drum No. 2, Capacity 12,000 lbs.; 15 FPM; Lift 1 ft.; Acco Hoist and Crane Division, York, PA 17403; Model 4165; Wright Overload Cut-off; American Chain and Cable Company, Inc., York, PA." Associated with the Wright motors was a yellow tag "certificate of validation," which listed "model number AEmc5600; serial number BDFFG 0025; validation OMI number 900622.25; date of validation: 3-21-08; revalidation due date: 3-21-10; inspected by Ogram/Newton."

These motors are controlled by Hoist Distribution Panels, located on the ground level and on Level 2. At both of these locations, there are two such panels, one for the east cell and another for the west cell.

Cut-outs on each half of every hinged platform allow it to close around the aft segment and aft skirt when the platform is in position. Special (Wright) motors located at each level,

[81] RPSF Manager Howard Christy, personal communication, February 24, 2010; RPSF Technician Keith Lawton, personal communication, February 22, 2010.

working in conjunction with floor hoist hooks (or jib hoists), are used to lift up the platforms, which must be raised whenever the aft segment assembly is either being placed in the build-up stand or being taken out. These motors are controlled through Coffing panels that are found on each level.

Ground level in the build-up stands is the point of entry for the aft skirts and the exit cones, which have to be raised to Level 2 by the platform elevator in order to be mated with the aft segment. As a result, ground level is not a permanent work station, like the other levels, but it still contains important work equipment. In addition to the platform elevator basin, the platform elevator itself, and the stanchions that secure the platform elevator, there are two HVAC units that provide controlled air as needed, usually for the foaming process that occurs on Level 2. Hoses from these units extend to Level 2.

Along the east wall in this area is a portable Frothpak foam machine and a number of foam canisters. Just outside of the RPSF along the northeast corner, there is also a tube bank with compressed air for the foam machine.[82] The application of the foam is an important process in the whole booster build-up operation, and there are many types of foam.

Most foam applied to the booster assembly is designed to protect it from water impact, and this includes the foam applied at the top of the assembly, under the stiffener rings, and on the aft skirt. While four foams are used on the aft segment assembly, only two of these are applied at the RPSF.

The Frothpak foam is applied on the external attach ring and on the stiffener rings, equipment that will be further discussed with the operations on Levels 4, 5, and 6 at the RPSF. The other foam-like material applied at the RPSF is RT 455, which is a mixture that is two parts epoxy and one part cork material. Stored in the support buildings and combined in a Hobart mixer, RT 455 is mixed one gallon at a time, as needed. It is applied to the systems tunnel that runs along the outside of the aft segment when the assembly is mated together, and it cures in approximately one day. RT 455 is an ablative, which means that

[82] RPSF Manager Howard Christy, personal communication, February 24, 2010.

as the outer exposed surface heats up, it sheds the outer layer, removing heat in the process.[83]

The last two foam materials are not applied at the RPSF, but should be mentioned, if only because they are used on the aft segment assembly. MSA, or Marshall Sprayable Ablative, is applied at the ARF, where assembly line robots spray it on the aft skirt. This is also the case with BTA, or Booster Troweler Ablative.[84] All of this is part of the Thermal Protection System or TPS.[85] The final check for any foam or foam-like application is the pull test, where pressure is applied to the foam to determine its adhesive strength. If it fails this test, the defective foam is pulled off and the foam process begins again.[86]

In the build-up of the aft segment, more work is done at Level 2 than on any other single level. The joint connecting the aft skirt with the aft segment might be located on Level 3, but the exposed underside of the aft skirt is located on Level 2, and the underside of the aft skirt is where most of the booster's controlling instrumentation is located.[87] A sign on the wall beside the service elevator lists the four main operations performed on Level 2. They are as follows: 1) aft exit cone installation and closeouts; 2) thermal curtain installation; 3) rain curtain installation; and 4) aft skirt/internal ring foam application. The rain curtain installation, is no longer performed.

Work in the build-up stands begins with the union of the aft segment and the aft skirt. The aft skirt, after being placed on the holding posts, is joined with the aft segment, brought to the build-up area by the overhead crane. A total of 177 pins or bolts are used to secure the aft segment with the aft skirt, roughly one pin for every two degrees of the arc. These pins are then secured with a steel pin retainer strap and the joint is then sealed with a cork and RT-455 ablative compound. This

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83 RPSF Manager Howard Christy, personal communication, February 24, 2010.
84 RPSF Manager Howard Christy, personal communication, February 24, 2010.
85 *NASA Facts: Solid Rocket Boosters*.
86 RPSF Lead Technician Ed O'Neal, personal communication, February 22, 2010.
87 RPSF Technician Keith Lawton, personal communication, February 22, 2010.

begins the roughly thirty-five work days required to build-up the aft assembly.[88]

The next step in the process conducted on Level 2 is the installation of the exit cone, which goes underneath the aft skirt and is connected to the tail end of the aft segment. Using the exit cone dolly and the platform elevator, the exit cone is raised up and floated on an air bearing for mating. This joint is then bolted with ninety-six fasteners, and the joint gap is sealed with RTV silicon sealant.[89]

By this point, the "aft skirt work platform," also known as the "aft skirt internal access kit," has been installed along the lower rim of the aft skirt to provide easier access to the underside of the aft skirt. Formally identified as GSE number A77-0169-00, the aft skirt internal access kit is comprised of a series of yellow metal platforms that allows technicians to work inside and underneath the aft skirt.[90] When this access kit is not in use, it is stored in the corner of the build-up stand at this level.

During this process, it is common to erect a "tent build-up" around the work area on Level 2, enclosing the aft skirt in a large plastic enclosure to provide a clean work environment for the aft skirt and exit cone. This is often referred to as an "air purge unit." Ducts from the HVAC units on the ground level provide controlled air for the plastic enclosure.[91] Also located on this level are the GN2 nitrogen bottles, which provide air to check for blown seals associated with the aft segment or aft skirt.

Inside the aft skirt, now accessed by the aft skirt internal access kit, the most important elements to be worked on are the actuator arms. These metal struts, comprised of hydraulic cylinders, attach to the exit cone and act as steering arms, powered by hydrozene-propellant motors. By tilting the exit

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[88] RPSF Lead Technician Ed O'Neal, personal communication, February 22, 2010.
[89] "SRB-processing.ppt," power point presentation from www.nasa-klass.com/curriculum/Get…/RDG_SRB…/SRB-processing.ppt. Accessed March 3, 2010.
[90] RPSF Technician Keith Lawton, personal communication, February 22, 2010.
[91] RPSF Technician Keith Lawton, personal communication, February 22, 2010.

cone, these actuator arms help steer the booster rocket and are the crux of the steering system installed inside the aft skirt. All of this is part of the Thrust Vector Control System, or TVC.[92]

After the control system is put in place, foam is added to the exposed surfaces under the aft skirt. Most of the foam used on the aft skirt is not for thermal protection, but for the protection from landing impact and exposure to seawater.[93] Thermal protection is provided by a thermal curtain that extends between the aft skirt interior ring and the outer surface of the exit cone.

At Level 3, the following operations occur: 1) mate the aft segment to the aft skirt; 2) field joint closeout; 3) tunnel cable installation; 4) tunnel cover installation and closeout; and 5) foam application on stiffener rings. The first two are the joining of the aft skirt with the aft segment, and that is located on Level 3.

This is also the first level to have the folding platforms that open and close on hinges. It is also unique for another reason. Because the distance between levels 3 and 4 is not as great as the distance between the other levels, the folding platform for level 3 has a special feature. The outer edges of both sides of the platform, often referred to as flips, have to be pulled up before the main part of the platform can be raised. This outer edge or flip is drawn up manually, using a wire rope jib hoist.[94]

The Level 3 platform is unique in another way, too. The cut-out area is larger on this level than on the others to accommodate the aft skirt. There is also a special cut-out for the booster separation motors (BSMs) located near the top of the aft skirt. The BSMs, which looks like a series of small pipes attached to the outside of the aft skirt, allow the booster to separate from the rest of the shuttle assembly after the boosters have expended their fuel.

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[92] RPSF Technician Keith Lawton, personal communication, February 22, 2010; *NASA Facts: Solid Rocket Boosters*.
[93] RPSF Manager Howard Christy, personal communication, February 24, 2010.
[94] RPSF Technician Keith Lawton, personal communication, February 22, 2010.

The "tunnel cable installation" and "tunnel cover installation and closeout" relate to the series of cables that run along the exterior of the segment, connecting the various command elements at the top and bottom of the aft segment. These operations are among the last that are completed during the build-up process and are not unique to this level. Neither is the "foam application on the stiffener rings," which occurs on Level 3, but is more commonly associated with Level 4.

Levels 4 and 5 are the two levels most alike, both in size and in function. Level 4 operations include: 1) stiffener ring installation; 2) tunnel cable installation; 3) tunnel cover installation and closeouts; and 4) stiffener ring foam application.

Most of the stiffener ring work appears to be localized to Level 4. This is where the stiffener rings are most commonly stored when not in use, supported by wooden frames with rubber backing. The purpose of the stiffener rings is to keep the aft segment casing from deforming upon impact in the ocean. Since the final parachutes deploy from near the top of the spent booster, the rocket hits the water aft-end first, which means that the aft skirt and the aft segment take the brunt of the impact. For this reason, three stiffener rings, each comprised of a black metal band, are put onto the aft segment (none are used on the upper segments). These rings are installed at RPSF, rather than in Utah, simply because if they were installed in Utah, the segment would be too large for the railcar casing.[95]

Level 5 operations are similar to what is listed on Level 4 and include: 1) stiffener ring installation; 2) tunnel cable installation; and 3) tunnel cover installation and closeouts. Like Level 4, extra stiffener rings are also kept on this floor. As on the other levels, the tunnel cable is protected by a white tunnel cover that will eventually be foamed with RT 455.

Level 6, the upper-most level in the build-up stands, allows access to the top of the aft segment. Operations include: 1) tunnel cable installation; 2) tunnel cover installation and

[95] RPSF Lead Technician Ed O'Neal, personal communication, February 22, 2010.

closeouts; 3) ET attach ring installation and closeouts; 4) strut installation; and 5) IEA installation.

One of the first things performed on Level 6 is the placement of the "pies" across the exposed top of the aft segment. These are pie-shaped wedges comprised of fiberglass set in place to cover the circular top of the segment and protect it from falling debris. When not in use these pies are stored on this level.[96]

Aside from the tunnel cable and cover installation, which is also done on the lower levels, one of the main tasks on Level 6 is the attachment of the External Tank Attach Ring, more commonly known as the ET attach ring, or even the ETA ring. This metal ring goes around the upper portion of the aft segment. Struts are attached to this ring, and these struts, called ETA struts, hold the booster to the ET.[97]

Also installed on this level is the Integrated Electronics Assembly (IEA), a black box installed on the side of the aft segment, near the top and adjacent to the ET attach ring. Essential during the first two minutes of flight, the IEA contains an on-board computer that informs the booster when to ignite and when to separate from the ET.

After the various tasks outlined above have been completed on the different levels of the build-up stands, the hinged platforms are raised and the crane moves in to take the aft segment, with the aft skirt and the exit cone, to a pallet at one of the inspection stands. From there, the crawler takes the aft segment to one of the surge buildings, where it is placed in the front higher portion of the building, so that it can accommodate the aft segment. By then, the other segments are already in place behind it, and the booster segments are ready for final assemblage in the VAB, followed by launch on one of the pads. This has been the process followed by almost 120 manned space flights associated with the SSP since the inauguration of the RPSF in 1984.

Part II. Building Description

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[96] RPSF Manager Howard Cristy, personal communication, February 24, 2010.
[97] RPSF Lead Technician Ed O'Neal, personal communication, February 22, 2010.

The RPSF, K6-494, is a tall rectangular structure located approximately 2,048 feet northwest of the VAB. The RPSF area is separated from the VAB by a railroad line, Launcher Road, various secondary roads, and parking/construction areas. The RPSF site is roughly triangular, and is bounded on the south by the railroad and Launcher Road, on the northwest by an inlet of Clark Slough, and on the northeast by forest and wetlands. The RPSF site is fenced, and entry is from the south through a guard gate. Within the RPSF compound, K6-494 is located in the southwest corner, while the surge buildings are located in the southeast corner and the northern apex of the triangle. Support buildings are found adjacent to K6-494, the RPSF. Parking areas are found in front of the RPSF, while the entry-road through the guard gate forks near that center of the triangular tract and runs to the two surge buildings.

The only building described in detail in this report is the main building within the RPSF complex. Formally identified as K6-494, it is normally referred to simply as the "RPSF." This building is a tall, rectangular structure located immediately inside the area fence. The front façade of the building features a large roll-up door on the left-hand side, which forms a corridor through the building with another roll-up door on the opposite, western end. This corridor supports railroad tracks that connect to the adjoining railroad line south of the RPSF. Rocket components are brought into the RPSF area on a spur from this rail line and then into the RPSF for assembly. Facing the building, the rail corridor with cranes above is located on the left. Along the right are the build-up cells as well as a tall roll-up door in the north wall and storage space beyond this door. As constructed, the RPSF is 98.6' tall and covers an area of 18,800 square feet.[98] According to the building plans, the rectangular structure covers an area 198'-8" x 89'-9", with the long axis oriented east-west.

The building shell is supported by steel girder construction with extensive cross-bracing. This frame is sheathed with beige-colored ribbed metal sheet wall panels that form the skin

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[98] Solid Rocket Booster Processing (http://tital04.ksc.uasa.gov/shuttle/technology/sts-newsref/centers.html, Information content from NSTS Shuttle Reference Manual, 1988, last hyper-texted, August 32, 2000, Accessed March 25, 2010).

of the outer wall. These ribbed wall panels are separated by two horizontal bands that extend around the building. The first band is found at 20′-3″ above ground level, and the second at 30′-3″. The walls do not appear to be insulated; the steel frame structure is clearly visible from inside of the building.

There are no windows in the RPSF. The east side of the building has one large industrial-sized, roll-up-type door, 28′ wide and 20′ high. The west side has two such doors, although both are slightly smaller, 20′ high and 20′ wide. The north side has a very large vertical-lift door, 55′ high. In addition to these large industrial doors, there are a number of smaller-scale service doors, such as the one to the crane control room, accessed on the south side of the building.

There is no artificial air conditioning or heat for the entire building. For ventilation there are louvered panels near the base of the building to draw in cooler air from ground level. Hot interior air is released through vents in the roof. In addition to vents, the roof also has blow-out panels, in case of an industrial accident.[99] The roof is flat and covered with corrugated aluminum.

The basic parts of the building's interior are based on the functional needs of this part of the Shuttle preparation. The components of the RPSF enter the building through the east and west doors, and exit the building through the north door after assembly. Railcars transport motor segments and exit cones through the southern-most west door, while aft skirts are transported through the east door by means of tugs. On the west side of the building, the railcar casings protecting the segments are removed using the large overhead cranes, which are also essential in rotating the segment to its vertical position. Some of the equipment used to remove the casing is stored in the mezzanine, located in the northwest quadrant of the building. After the rotation process, located in the west half of the building, the segment is then examined at the 400 Stand before being placed on a pallet at the inspection stands immediately adjacent to the north door. After clearing final inspection,

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[99] RPSF Manager Howard Christy, personal communication, February 25, 2010.

these segments are transported to one of the surge buildings for storage.

The process is different for the aft segment. While the other three segments go directly to the surge buildings, the aft segment is transported to one of the two build-up stands located in the northeast quadrant of the building. There, they are mated to the aft skirt and the exit cones. After this process is complete, they too are moved to the inspection stands and finally the surge buildings.

The two stands now located in the southeast quadrant of the building, the Fall Abatement Stand and the 400 Stand with the 386 Stand on top of it, do not appear in any of the original building plans, and were clearly added to the building's interior at a later date.

The two most important pieces of equipment in the RPSF are the overhead bridge cranes. Owing to their positions on two sets of tracks, they can move north and south, east and west, and can access almost everything inside the building, except for an area 14′ closest to the walls known as the "crane hook limit." The cranes have an available lift of 74′-6″ from the ground, which is effectively the top of the rail on which it runs. The crane chassis itself is located between this level and the bottom of the roof truss, located at 90′. The cranes can be accessed from the level of the crane catwalk, located all around the building at the level of 64′.

The cranes are operated from the Crane Control Room, which projects out of the middle of the south wall. The floor of this room is 12′ above ground level, with roof height 21′-3″ above ground level. The room consists of two adjacent chambers or modules, each covering an area 9′-6″ x 8′-0″, and referred to as the east and west crane control room modules. The modules are accessed from the outside by means of a door and stairwell on the south side of the building.

The mezzanine, located in the northwest quadrant of the building, is located 21′-3″ above ground level and measures 22′ x 73′, with the long axis oriented east-west. Stairwells provide access to the mezzanine on the east and west sides, and are included in the overall 73-foot length. The mezzanine is also accessed by the overhead cranes, and is used to store some of the equipment needed to remove the railcar casings.

Just east of the mezzanine and immediately south of the large north door is the inspection stand area. There are no permanent fixtures in this area, which is where elevated pallets hold upright segments for final inspection before being moved to the surge buildings for storage.

The northeast quadrant contains what is probably the core function of the building. This contains the two build-up stands where aft segments are mated with aft skirts and exit cones. This is a critical step in the construction of the booster rocket. These two build-up areas lie between the east door and the large north door, and are accessed by smaller service doors at ground level along the north wall on the east side. Elevators and small lobby areas are found at each floor of the build-up stands.

The entire build-up area covers roughly 70′ x 36′ (including stairwells), with the long axis oriented east-west. The two stands are identified as the east and west build-up stands. In addition to ground level, Levels 2 through 6 provide access to every inch of the aft segment, aft skirt, and exit cone. Both build-up stands and the steel frames that support them were originally part of the VAB, and were cut out of that facility and transported to the RPSF during initial construction in the early 1980s.[100]

The elevator platform at each stand operates between ground level and Level 2. The elevator platform and the four support posts hold up the aft skirt and the aft segment during the build-up process. At that point, the elevator platform is at Level 2. Otherwise, the elevator platform is retracted to the ground level, where it fits into a shallow cross-shaped basin roughly 18′ wide.

The levels of the build-up stands, also referred to as workstand levels, are as follows:

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[100] RPSF Manager Howard Christy, personal communication, February 25, 2010.

Level 2 (9'-10" above ground level)
Level 3 (21'-3" above ground level)
Level 4 (29'-4" above ground level)
Level 5 (39'-4" above ground level)
Level 6 (49'-2" above ground level)

Each build-up stand at Levels 3 through 6 has a movable wing platform that opens from the center. Each level has to be open before the overhead crane can transport the aft segment into the built-up area and onto the elevator platform. Each platform, at Levels 3 through 6, has two wings, each with a semi-circular cut-out area to fit around the aft segment and the aft skirt. The Level 3 platform has extra cut-outs to accommodate the booster separator motors located at that level. Level 3 is unique in another way. Since this level is not as high as the others, the outer edge of both wings has to be pulled up manually before the whole wing can be raised mechanically.

This is the basic lay-out of the RPSF as it was established in the early 1980s. There have been few changes to the entire process, and very few indeed to the building itself. The biggest change to the building exterior occurred about two years ago, when the bottom 18" of the sheet metal skin around the building was replaced due to corrosion. At that same time, all original metal exterior personnel doors were replaced by fiberglass doors.

Another change is the addition of a series of small panels that jut out from the sides of the walls at various intervals inside the building. The most obvious of these are the ones located just above and to the side of the crane control room. These are antenna for wireless access for the computer system used in the whole building.

PART III. SOURCES OF INFORMATION

A. Engineering Drawings and Plans:

The construction plans for the RPSF come from KSC, Florida, administered by NASA. While Ernest G. Lautzenheiser of NASA oversaw the development of the plans, they were prepared by Daniel, Mann, Johnson, Mendenhall (DMJM), a prominent architectural firm in Los Angeles, California. In creating the plans for the RPSF, a total of 154 separate plans were prepared, detailing everything from project location maps to details of the stairwells. In addition to these 154 plans, another seven were prepared as part of Design-1a, covering the procurement of the two 200/15-ton bridge cranes for the RPSF.

These 161 plans are the only plans available for the RPSF. The 161 plans, prepared by DMJM, were dated to November and December 1981 and January 1982. They are as-built plans.

As part of this study, four drawings were selected for reproduction in this documentation. The drawings show the RPSF general pavement plan and east, west, north, and south elevations.

B. Early Views and Historical Data:

The KSC maintains a large and rich collection of historic aerial views that depict the RPSF during its construction period. Some of these views are included in the Appendix along with an isometric drawing that illustrates the basic areas of the RPSF. All views are dated and captioned. The other historical data comes from a variety of sources cited in the Bibliography below.

The historic photographs and most of the historical data used in this documentation came from sources within the KSC. Most of the historic photographs and other recorded historic data were provided by KSC Archivist Elaine E. Liston, whose office and data files are in the Headquarters Building (M6-399), and by Photograph Archivist Vera Van Hooser, of IMCS Photo and Media Services, also located in the KSC Headquarters Building.

Most of the RPSF building-specific information was obtained from a series of walking tours and personal interviews with the manager and the lead technicians working in the facility.

C. Interviews:

The following knowledgeable USA employees working within the RPSF complex provided walking tours of the RPSF or were interviewed for this documentation. Each provided a tremendous amount of information about the operation and history of the RPSF building and process.

Christy, Howard, Manager I, RPSF Operations, First Shift, Personal Interview, February 2010.

Lawton, Keith E., Technician, RPSF Operations, Walking Tour and Personal Interview, February 2010.

O'Neal, Ed, Lead Technician, RPSF Operations, Walking Tour and Personal Interview, February 2010.

Wright, Kenny, Lead Technician, RPSF Operations, Walking Tour, February 2010.

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Deming, Joan, and Patricia Slovinac. February 2008, revised July 2008. *NASA-Wide Survey and Evaluation of Historic Facilities in the Context of the U.S. Space Shuttle Program: Roll-Up Report*. Archaeological Consultants, Inc. Submitted to the National Aeronautics and Space Administration, Environmental Management Division.

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Schmidt, Klaus. "Stacking of New Space Vehicle Begins at Kennedy Space Center." http://spacefellowship.com/news/art9934/stacking-of-new-space-vehicle… Published by Klaus Schmidt, July 9, 2009. Accessed March 3, 2010.

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Space Transportation System: Facilities and Operations, Kennedy Space Center, Florida. National Aeronautics and Space Administration, John F. Kennedy Space Center. K-STSM-01, Appendix A, April 1984, Revision A. On file, Kennedy Space Center Archives.

"SRB Complex Work Begins on Site North of VAB," *Spaceport News*, Volume 21, No. 17, August 19, 1982, p. 7. On file, Kennedy Space Center Archives.

"SRB-processing.ppt," Power point presentation from www.nasa-klass.com/curriculum/Get…/RDG_SRB…/SRB-processing.ppt. Accessed March 3, 2010.

E. Likely Sources Not Yet Investigated

Research was conducted at KSC, using secondary sources. Sources that were not yet investigated that may contain information include NASA Headquarters and the offices of DMJM Architects, the firm that designed the RPSF.

Part IV. PROJECT INFORMATION

The RPSF, built to support the Space Shuttle Program by inspecting, rotating, and storing the SRB motor segments and building up the aft segment with the aft skirt and the exit cone, has been found to be eligible to the NRHP under Criterion A. This determination was made by KSC's Historic Preservation Officer and concurred by the KSC Center Director, which identified approximately seventy-four historic properties as either listed, determined eligible, or were potentially eligible to the NRHP. Out of twelve property types identified for NASA's Shuttle program, the RPSF was identified as Type 2, Vehicle Processing Facilities, which included such buildings as the VAB, the ARF, and the RPSF. All of these were dedicated to the processing of shuttle vehicles and components. This evaluation was completed due to the retirement of the U.S. SSP scheduled for termination in 2011.

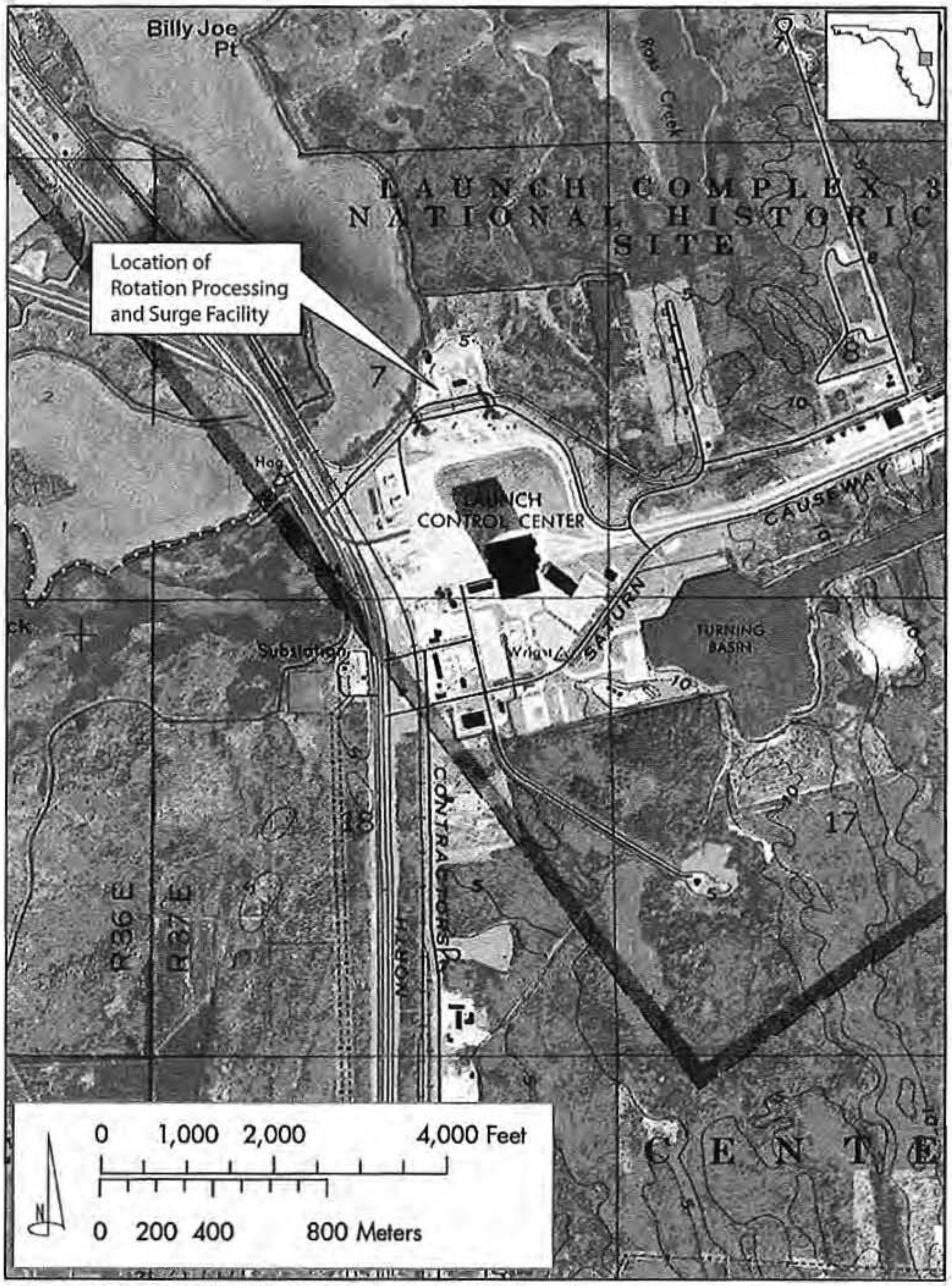
A Programmatic Agreement (PA) was developed to document the identified eligible resources and streamline the Section 106 consultation process. Per Section V.A of the PA between NASA, the Advisory Council on Historic Preservation, and the Florida State Historic Preservation Officer, dated May 2009, and the Statement of Work provided to New south Associates by KSC/Innovative Health Applications (IHA) as part of the Task Order Contract dated February 2010, the documentation package for the RPSF includes the following items: a written narrative; a series of photographs showing both exterior and interior views using large format negatives; and a selection of existing drawings, which were photographed with large format negatives. This HAER documentation fulfills the recordation requirements of the PA for the RPSF.

New South Associates, under contract with Innovative Health Applications (IHA), a subcontractor to NASA, conducted the HAER documentation and historic research for this project in February 2010. With the end of the SSP, the RPSF will be adapted and modified for future space missions. Therefore, NASA is completing HAER documentation of the RPSF and other KSC properties to record these as they appear and as they existed during the SSP. David Diener served as the project photographer. He was assisted by Cindy Thomas, who kept the photograph log. J. W. Joseph supported the coordination efforts of the photographic and historic documentation.

In order to complete the project, New South Associates personnel were allowed full access to the facility, under the supervision of an escort who was required to be with New South at all times. This individual was Shannah Trout, an Environmental Engineer and Cultural Resource Specialist with Innovative Health Applications. Photographs were taken around the building and throughout the ground level, as well as the various levels found within the build-up stands.

Mark Swanson was the project historian, and he conducted a limited number of oral interviews and otherwise compiled the historic documentation required for the project. Among the people interviewed for this project, were: Bill Carmody, Technician, RPSF Operations; Howard Christy, Manager I, RPSF Operations; Keith Lawton, Technician; Ed O'Neal, Lead Technician; and Kenny Wright, Lead Technician, RPSF Operations. These individuals provided much of the historical information used in this project. Elaine Liston and Vera Van Hooser also provided much information through their offices in the KSC Headquarters building. Shannah Trout identified and coordinated the oral interviews and research work.

Appendix- Location Map and Historical Views



Source: USGS Orsino, Florida Topographic Quadrangle

Location Map for RPSF

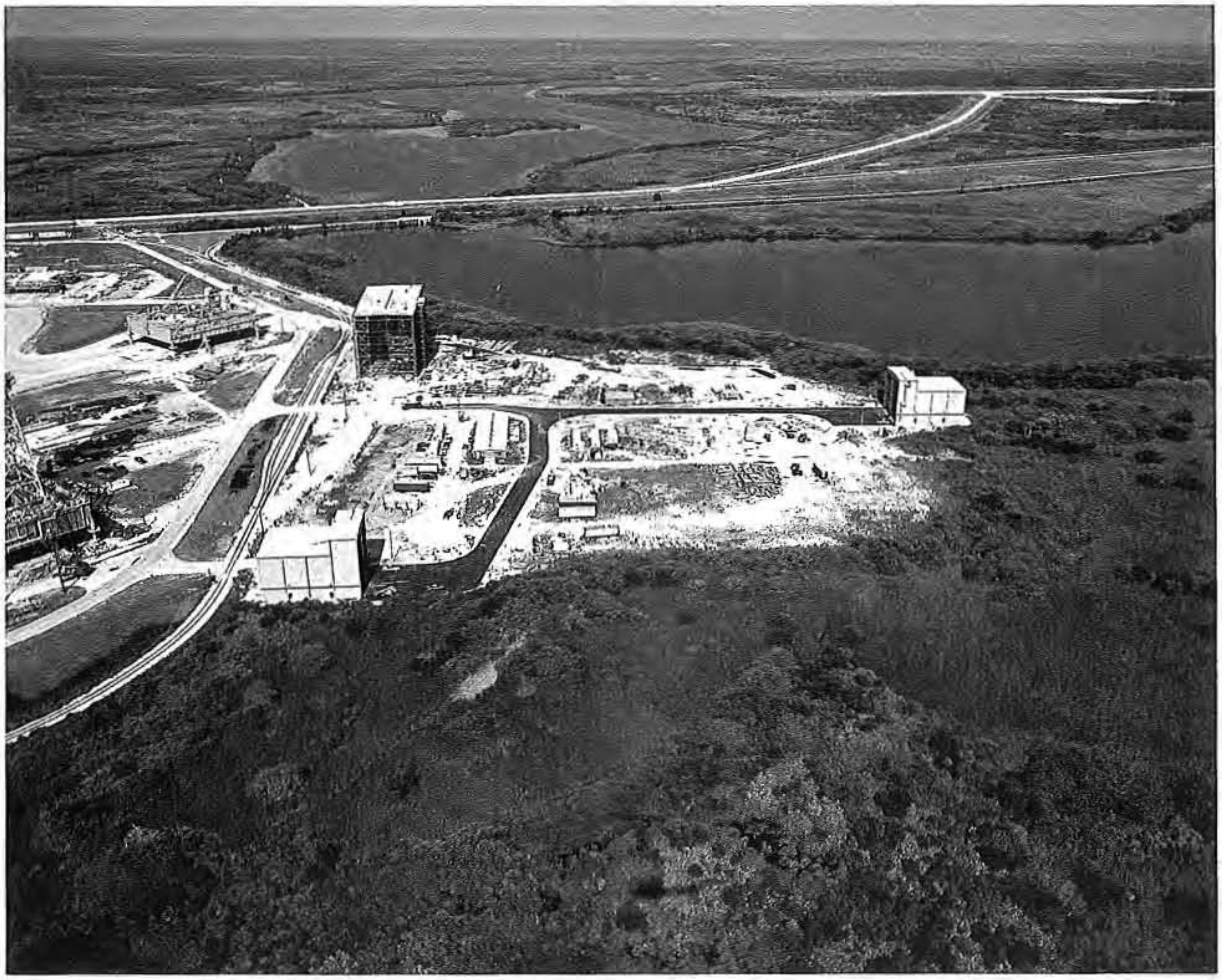
Aerial View of Proposed RPSF Area, Behind and to Right of Mobile Launcher Platforms and Towers, View to Northwest, November 9, 1964 (Courtesy of Kennedy Space Center, Negative 100-KSC-64C-5536).

Aerial View of Proposed RPSF Area, Foreground, with VAB in Background, View to South, January 7, 1966 (Courtesy of Kennedy Space Center, Negative 100-KSC-66C-254).

Aerial View of VAB Complex, with Proposed RPSF Area at Top of Photograph, View to North, March 21, 1979 (Courtesy of Kennedy Space Center, Negative 116-KSC-379C-267-8).

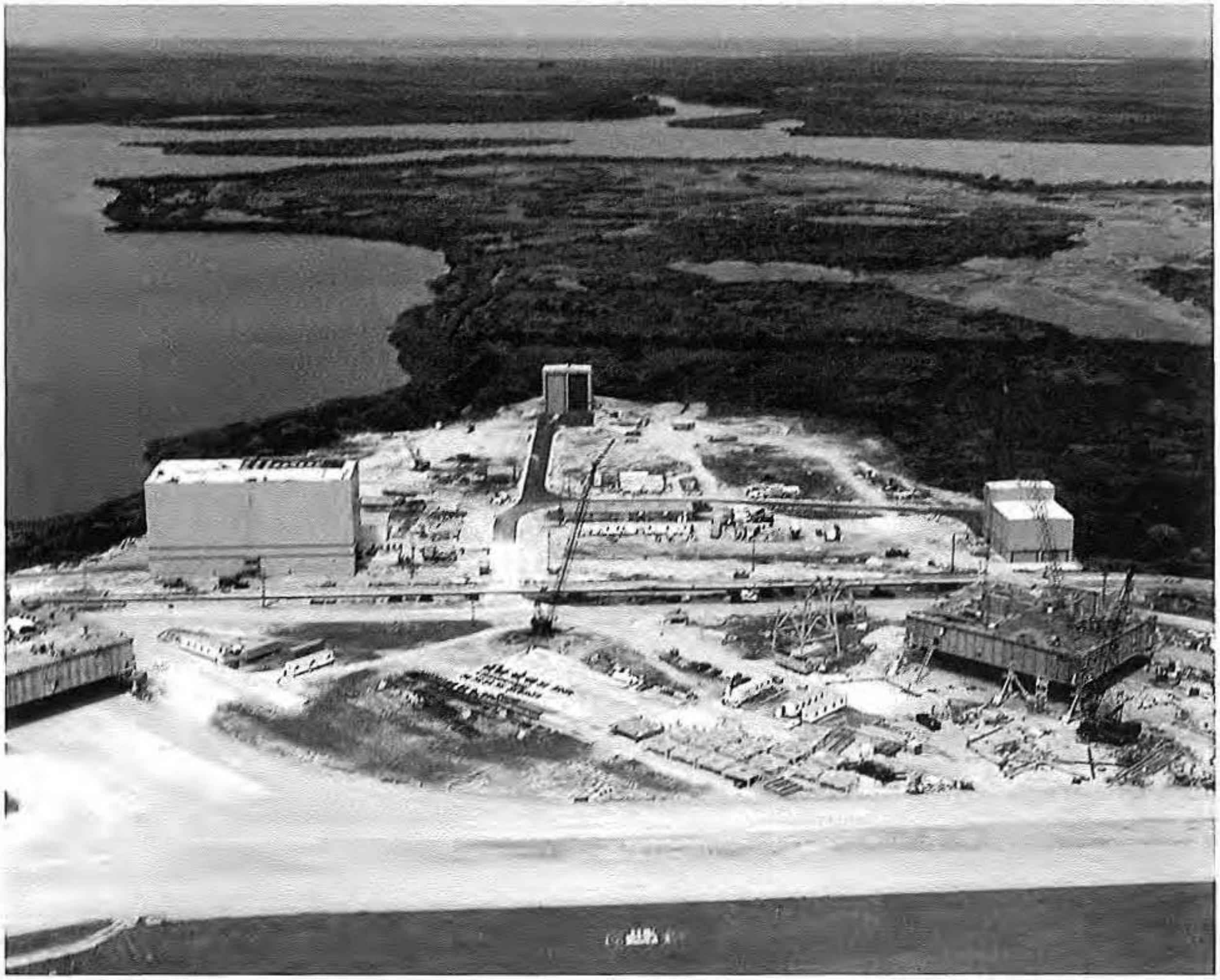
Aerial View of RPSF Complex Under Construction at Bottom of Photograph, View to South, February 8, 1983 (Courtesy of Kennedy Space Center, Negative 108-KSC-383C-267-20).

Aerial View of RPSF Complex Under Construction, Showing RPSF Steel Frame, View to South, April 21, 1983 (Courtesy of Kennedy Space Center, Negative 108-KSC-383C-1085-90).



Aerial View of RPSF Complex Under Construction, View to West, July 5, 1983 (Courtesy of Kennedy Space Center, Negative 108-KSC-383C-2203-40).

Aerial View of RPSF Complex Under Construction, View to West-Southwest, September 1, 1983 (Courtesy of Kennedy Space Center, Negative 116-KSC-383C-3090-30).



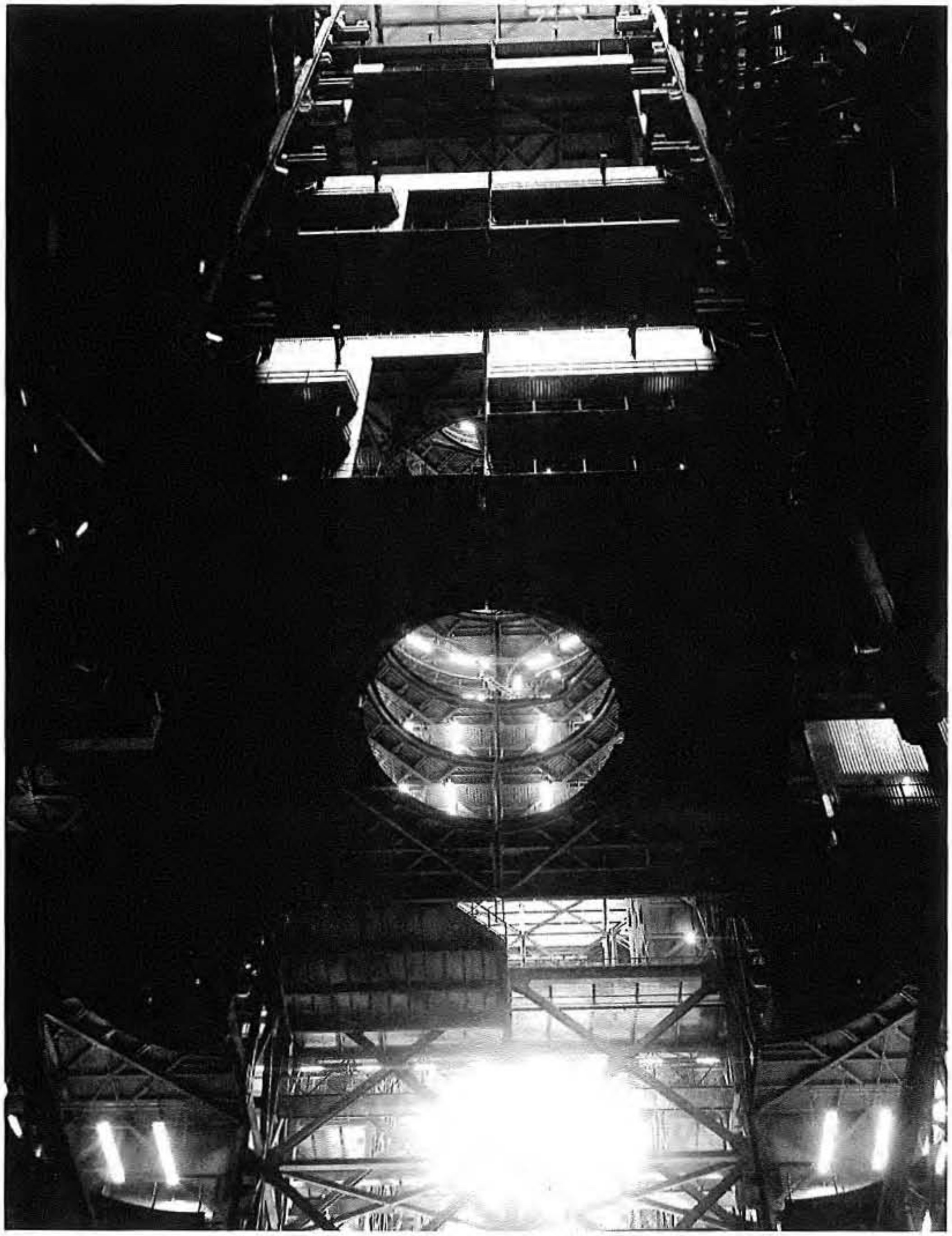
Aerial View of RPSF Complex Under Construction, View to North, October 3, 1983 (Courtesy of Kennedy Space Center, Negative 108-KSC-383C-3674-1).

Aerial View of RPSF Complex Under Construction, View to East, October 4, 1983 (Courtesy of Kennedy Space Center, Negative 116-KSC-383C-3561-100).

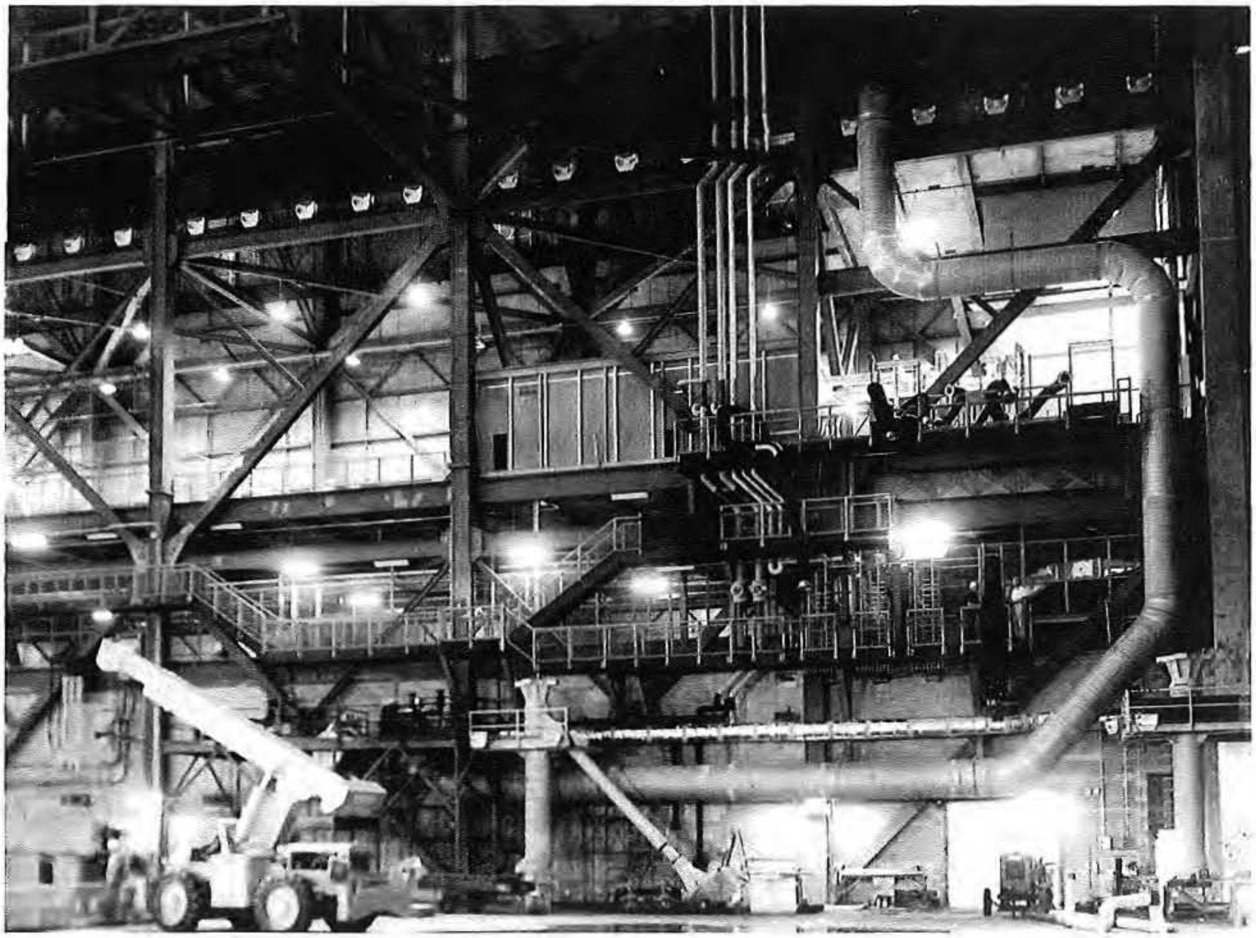
Aerial View of RPSF Complex Under Construction, View to North, October 4, 1983 (Courtesy of Kennedy Space Center, Negative 116-KSC-383C-3563-20).

Aerial View of RPSF Complex, View to West, March 8, 1984 (Courtesy of Kennedy Space Center, Negative 108-KSC-384C-1134-7).

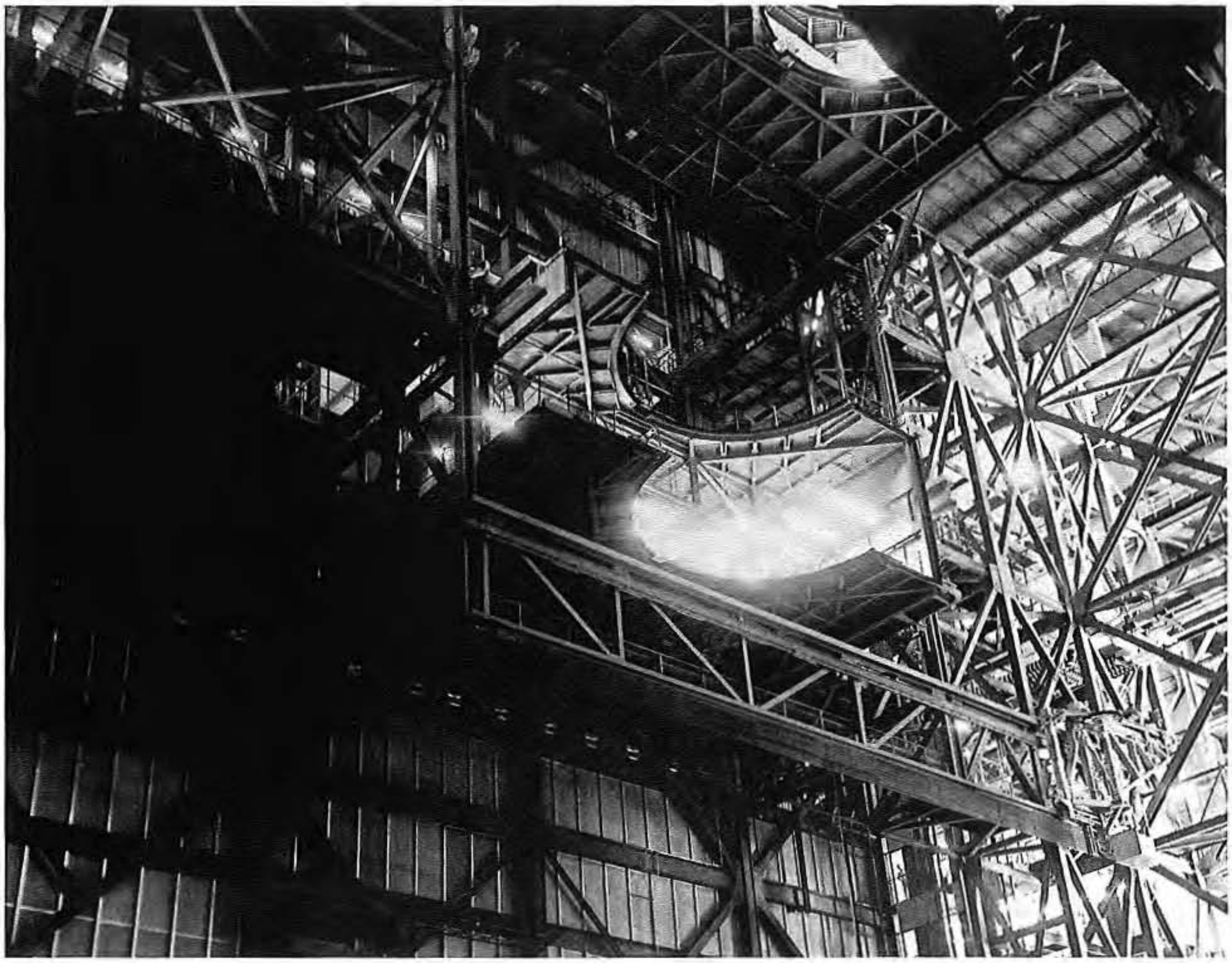
Aerial View of RPSF Complex, View to South with VAB in Background, March 9, 1984 (Courtesy of Kennedy Space Center, Negative 108-KSC-384C-1134-1).



View of VAB Work Platforms in Assembly Area, July 7, 1966 (Courtesy of Kennedy Space Center, Negative 116-KSC-66-13950).



View of VAB North Wall in Assembly Area, July 6, 1966 (Courtesy of Kennedy Space Center, Negative 116-KSC-66-13947).



View of VAB Southwest Wall in Assembly Area, July 6, 1966
(Courtesy of Kennedy Space Center, Negative 116-KSC-66-13949).