National Aeronautics and Space Administration

NASA**facts**

Launch Complex 39, Pads A and B

Since the late 1960s, Pads A and B at Kennedy Space Center's Launch Complex 39 have served as backdrops for America's most significant manned space flight endeavors — Apollo, Skylab, Apollo-Soyuz and space shuttle.

Located on Merritt Island, Fla., just north of Cape Canaveral, the pads were originally built for the huge Apollo/Saturn V rockets that launched American astronauts on their historic journeys to the moon and back. Following the joint U.S.-Soviet Apollo-Soyuz Test Project mission of July 1975, the pads were modified to support space shuttle operations.

Both pads were designed to support the concept of mobile launch operations, in which space vehicles are assembled and checked out in the protected environment of the Vehicle Assembly Building, then transported by large tracked vehicles to the launch pad for final processing and launch.

During the Apollo era, key pad service structures were mobile. For the space shuttle, two permanent service towers were installed at each pad for the first time, the fixed service structure and the rotating service structure.

On April 12, 1981, shuttle operations commenced at Pad A with the launch of Columbia on STS-1. After 23 more successful launches from A, the first space shuttle to lift off from Pad B was the ill-fated Challenger in January 1986. Pad B was designated for the resumption of shuttle flights in September 1988, followed by the reactivation of Pad A in January 1990.

Major Features

Both pads are octagonally shaped and share identical features. Each pad covers about a quarter-square mile of land. Launches are conducted from atop a concrete hardstand 390 feet by 325 feet, located at the center of the pad area. The Pad A and Pad B hardstands are 48 feet and 55 feet above sea level, respectively.

Fixed Service Structure

The fixed service structure, or FSS, is each pad's most prominent feature, standing 347 feet from ground level to the tip of the lightning mast. The 80-foot-tall fiberglass mast supports a one-inch stainless steel cable that starts from an anchor south of the FSS, angles up and over the mast, and then extends back down to a second anchor to the north. Below the lightning mast is a hammerhead crane used for pad hoisting operations.

With the shuttle on the pad, the orbiter access arm and White Room is extended to the cockpit entry. Above the orange external tank is the "beanie cap" or vent hood.

The FSS is equipped with three swing arms that provide services or access to a shuttle on the pad. They are retracted when not in use. There are 12 floors on the FSS, positioned at 20-foot intervals. The first is located 27 feet above the pad surface. The FSS also provides an emergency egress system for astronauts.

Orbiter Access Arm

This is the lowermost arm (shown extended in photo at left), located 147 feet above the pad surface. It allows personnel to enter the orbiter crew compartment. The outer end of the access arm features an environmental chamber or "White Room" that mates with the orbiter and holds six persons. The arm remains in the extended position until seven minutes, 24 seconds before launch to serve as an emergency escape route for the flight crew. It is 65 feet long, 5 feet wide, and 8 feet high, and can be mechanically or manually repositioned in about 15 seconds in the event of a contingency.

External Tank Hydrogen Vent Umbilical and Intertank Access Arm

Also called the external tank (ET) gaseous hydrogen vent arm system, at the 167-foot level, the 48-foot-long arm allows mating of the external tank umbilicals as well as contingency access to the external tank intertank compartment.

The arm rotates 210 degrees to its extended position. The arm is retracted after umbilical/vent line mating, typically at T minus five days, leaving the umbilical vent line connected to the external tank to support tanking and launch. The umbilical vent line provides continuous venting of the external tank during and after loading of the volatile liquid hydrogen.

The vent line is disconnected from the vehicle at first motion and retracts vertically downward to a stored position.

ET Gaseous Oxygen Vent Arm

Attached between the 207- and 227-foot levels is a retractable arm and vent hood assembly. The arm truss section measures 65-feet long from tower hinge to vent hood hinge. The 13-foot wide vent hood also is known as the "beanie cap" (seen at top in photo on page 2). Heated gaseous nitrogen is pumped into the hood to warm the liquid oxygen vent system at the top of the external tank. This prevents oxygen vapors that are exiting the vent louvers from condensing water vapor in the surrounding air into potentially damaging ice.

About two and a half minutes before launch, the vent hood is raised to clear the external tank, a 25-second procedure. The arm is retracted against the FSS at about one minute, 45 seconds before liftoff. It is not latched in the event there is a hold, in which case the arm can be re-extended and the beanie cap again lowered onto the external tank.

The arm is latched when the solid rocket booster ignition signal is given at T minus 0 minutes.

Emergency Egress System

Located 195 feet above the ground at the same level on the FSS as the orbiter access arm is the emergency exit, or egress, system. It provides an escape route for personnel inside the orbiter or on the orbiter access arm.

The system includes seven baskets suspended from seven slidewires that extend from the FSS to a landing zone 1,200 feet to the west. Each basket can hold up to three people (see photo below). A braking system catch net and drag chain slow and then halt the baskets sliding down the wire approximately 55 miles per hour in about half a minute. Also located in the landing zone is a bunker, with an M-113 armored personnel carrier stationed nearby.

Astronauts climb into the slidewire basket on the fixed service structure. The basket is part of the emergency egress system.

Rotating Service Structure

The rotating service structure, or RSS, provides protected access to the orbiter for installation and servicing of payloads at the pad, as well as servicing access to certain systems on the orbiter. The majority of payloads are installed in the vertical position at the pad, partly because of their design and partly because payload processing can thus take place further along in the launch processing schedule.

Spacelab and other large horizontal payloads are loaded while the orbiter is in an Orbiter Processing Facility high bay.

The RSS is 102 feet long, 50 feet wide, and 130 feet high. It is supported by a rotating bridge that pivots about a vertical axis on the west side of the pad's flame trench. The RSS rotates through 120 degrees —1/3 of a circle — on a radius of 160 feet. Its hinged column rests on the pad surface and is braced against the FSS.

The RSS is retracted before launch.

The major feature of the RSS is the Payload Changeout Room, an enclosed, environmentally controlled area that supports payload delivery and servicing at the pad and mates to the orbiter cargo bay for vertical payload installation. Clean-air purges help ensure that payloads being transferred from the payload canister into the Payload Changeout Room are not exposed to the open air.

The payload is removed from the canister and later installed inside the orbiter cargo bay using the payload ground handling mechanism (PGHM). Five platforms are positioned at five levels to provide

The rotating service structure (left) is rolled open for launch. Entry to the Payload Changeout Room is exposed.

access to the payload when it is installed on the PGHM. Each platform has extendible planks that can be configured to accommodate a particular payload.

Another feature of the RSS is the orbiter midbody umbilical unit, which provides access and services to the midfuselage portion of the orbiter. The unit is 22 feet long, 13 feet wide, and 20 feet high. It extends from the RSS at levels ranging from 158 feet to 176 feet above the pad surface and includes a sliding extension platform and a horizontally moving line-handling mechanism. The unit provides access to the midbody umbilical door. It is used to supply fluids to the orbiter's power reactant storage and distribution system and payloads. Liquid oxygen and liquid hydrogen for the fuel cells are funneled through here, as are gases such as nitrogen and helium.

Also found on the RSS is the hypergolic umbilical system. Hypergolic fuel and oxidizer lines, as well as helium and nitrogen service lines, are carried from the FSS to the space shuttle orbital maneuvering system (OMS) pods via this umbilical system. It includes six manually operated and locally controlled umbilical handling units that are structurally attached to the RSS. The hypergolic umbilical system lines can be mated and demated from the vehicle very rapidly.

The shuttle and MPLM sit above the flame trench.

Flame Trench-Deflector System

The flame trench, built with concrete and refractory brick, bisects the pad at ground level. (See photo at right.) It is 490 feet long, 58 feet wide and 42 feet deep. The flame deflector system includes an inverted, V-shaped steel structure covered with a high-temperature concrete material five inches thick that extends across the center of the flame trench. One side of the "V" receives and deflects the flames from the orbiter main engines; the opposite side deflects the flames from the solid rocket boosters. There are also two movable deflectors at the top of the trench to provide additional protection to shuttle hardware from the solid rocket booster flames.

LOX and LH2 Storage

Liquid oxygen (LOX) used as an oxidizer by the orbiter main engines is stored in a 900,000-gallon tank on the pad's northwest corner, while the liquid hydrogen (LH2) used as a fuel is kept in an 850,000-gallon tank on the northeast corner. The propellants are transferred from the storage tanks in vacuum-jacketed lines that feed into the orbiter and external tank via the tail service masts on the mobile launcher platform.

The liquid oxygen tank functions as a huge vacuum bottle designed to store the cryogenic fluid at a very low temperature — less than -297 degrees Fahrenheit. It is transferred to the pad by one of two main pumps capable of pumping 1,300 gallons per minute.

The lighter liquid hydrogen is stored in a vacuum bottle located at the northeast corner of each pad. It must be kept at an even lower temperature than the LOX: minus 423 degrees F. To move the LH2 to the pad, a small amount of the liquid hydrogen is allowed to vaporize, and the gas pressure exerted from the top of the tank pushes the LH2 into the transfer lines.

Hypergolic Storage

The orbiter's orbital maneuvering system and reaction control system burn monomethyl hydrazine as a fuel and nitrogen tetroxide as an oxidizer. These hypergolic fluids are stored in well-separated areas on the southwest and southeast corners of the pads, respectively. Transfer lines convey the fluids through the FSS to the hypergolic umbilical system located on the RSS, with its three pairs of umbilicals attaching to the orbiter.

Pad Terminal Connection Room

The Pad Terminal Connection Room is located on the west side of the flame trench, underneath the elevated hardstand. It is covered with as much as 20 feet of dirt fill. Housed here in a reinforced concrete room is the equipment that links elements of the shuttle, mobile launcher platform and the pad with the launch processing system headquartered in the Launch Control Center. Checkout, countdown and launch of the shuttle are performed and controlled through the launch processing system.

Launch Pad/MLP Interfaces

The space shuttle is brought to the pad atop the mobile launcher platform (MLP) and crawler-transporter. The MLP is parked on pedestals permanently located at the pad and is the platform from which the Shuttle is launched. Several MLP systems interface with pad systems. These include the sound suppression system and the propellant transfer lines for the external tank. Helium and nitrogen, as well as ground electrical power and connections for vehicle data and communications, also are established through the tail service masts of the MLP.

The space shuttle main engine hydrogen burnoff system, located inside the tail service masts, eliminates free hydrogen present prior to main engine ignition. Hydrogen vapors are exhausted into the main engine nozzles during the start sequence; if ignited when the main engines ignite, a small explosion could ensue, which might damage the engine bells. The six hydrogen burnoff pre-igniters are initiated just before main engine start. They throw off thousands of hot, luminescent balls into the area below the engine bells, igniting the free hydrogen and precluding a rough combustion when the main engines start.

Sound Suppression System

A sound suppression system was installed on the pads and MLP to protect the orbiter and its payloads from being damaged by acoustical energy reflected from the MLP during liftoff. Water stored in a 290-foot-high, 300,000-gallon tank on the northeast side of the pad is released just prior to main engine ignition and flows by gravity to special MLP outlets, including six 12-foot-high quench nozzles, or "rainbirds." Nine seconds after liftoff, peak flow rate is 900,000 gallons per minute.

A water spray system provides a cushion of water which is directed into the flame hole directly beneath each booster. A series of water bags stretched across the flame holes, providing a water mass to dampen the reflected pressure pulse, supplements this effort. Used together, this water barrier blocks the path of the reflected pressure wave from the boosters, greatly decreasing its intensity.

The system reduces acoustical levels within the orbiter payload bay to about 142 decibels, below the design requirement of 145 decibels.

(Below Left) Water is released onto the mobile launcher platform on Launch Pad 39A at the start of a water sound suppression test.

Shuttle-Era Pad Modifications

The launch pads are taken out of service every three to five years for maintenance and modifications. This "Mod Period" lasts six to nine months, during which several contractors are tasked with specific modifications.

One task completed in 2003 on Pad 39A was adding a computer-automating the payload ground handling mechanism (PGHM).

The PGHM is used in the Payload Changeout Room on the rotating service structure to remove payloads from a transportation canister and install them into the orbiter.

Essentially NASA's largest forklift, the PGHM is now controlled by a single operator, compared to the previous method of two or three working hand controls. It has greater tolerance for accuracy.

Other work included upgrading Apollo-era electrical power systems, adding new safety tie-off points and performing corrosion control.

Another upgrade was completed on Launch Pad 39A in 2006 that included more than 70 significant improvements .

Corrosion of metal structures are endemic to the waterside environment. One of the launch pad refurbishments included correcting the damage caused from years of exposure. Workers sandblasted the entire structure down to the bare metal and applied two layers of protective coating.

To enhance communications, the analog system was replaced with a digital communication system known as the "integrated network control system." Pad workers use the system to talk to each other, and it allows communication between the firing room and the pad.

The rotating service structure's wheels were upgraded and the structure received additional reinforcement to withstand the increased load. The structure provides protected access to the orbiter for installing and servicing payloads and some systems at the pad.

The modifications also addressed lightning, another major weather concern at the spaceport. A new lightning protection system, including a lightning mast, was manufactured and installed to protect the work force and equipment during lightning storms.

Furthermore, outdated and unused hardware was removed, the entire structure was rewired, and the sterile orbiter access White Room was cleaned, painted and outfitted with new light fixtures and phones. A special heat-resistant coating was also applied to the flame trench. The trench protects space shuttle hardware from main engine and solid rocket booster flames.

"Launch Pad 39A is in better shape than ever, and we are on track to provide one of the cleanest, safest launch platforms ever for the next mission and through space shuttle completion," said Mike Orr, director of Launch Operations for United Space Alliance, which coordinated the pad refurbishment effort for NASA.

Pad 39B was closed in 2006 for maintenance and upcoming changes to accommodate the Aries launches as part of the Constellation Program. The life of the launch pads may well continue into the midst of the 21st century.

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The rotating service structure on Launch Pad 39A is being moved for the first time in more than a year due to maintenance and upgrades on the pad. Some of the work included sandblasting the structure to remove rust and repainting. In addition, the RSS was jacked up and a new upper-bearing race assembly installed where the RSS pivots against the fixed service structure and a half-inch steel plate added. Pad 39A is being made ready for its first launch in four years, STS-117.

Space Shuttle Discovery (left) and Space Shuttle Atlantis (right) both stand ready on their launch pads (39A and 39B respectively). Atlantis launched first, July 12, 2001, on mission STS-104. Discovery launched Aug.10, 2001, on mission STS-105. Towering above each shuttle at left is an 80-foot-tall lightning rod, part of the lightning protection system at the pads.

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