



NASA's Orbiter Fleet

Discovery



Endeavour



Atlantis

NASAfacts

Original Fleet

Originally, NASA's fleet of working orbiters comprised five ships: Challenger, OV-099; Columbia, OV-102; Discovery, OV-103; Atlantis, OV-104; and Endeavour, OV-105.

Challenger was lost during launch in January 1986. Columbia, the flagship of the fleet, was lost during approach to landing in February 2003.

The first of NASA's orbiter fleet, Columbia was delivered to Kennedy Space Center in March 1979. Columbia initiated the space shuttle flight program April 12, 1981, when it lifted off Pad A in the Launch Complex 39 Area at KSC.

It proved the operational concept of a winged, reusable spaceship by completing the Orbital Flight Test Program, missions STS-1 to STS-4. STS refers to Space Transportation System.

Columbia was named after a Boston-based sloop that operated out of Boston in 1792 and explored the mouth of the Columbia River on the West Coast of North America. The same ship was the first American vessel to circumnavigate the globe.

Also sharing the name is the first U.S. Navy ship to circle the globe and the command module for the Apollo 11 lunar mission.

Discovery

Discovery, the third in NASA's fleet of reusable, winged spaceships, arrived at KSC in November 1983. It was launched on its first mission, flight 41-D, on Aug. 30, 1984, and carried three communications satellites aloft for deployment by its astronaut crew.

Other Discovery milestones include the deployment of the Hubble Space Telescope on mission STS-31 in April 1990, as well as the second Hubble servicing mission STS-82 in February 1997; the launching of the Ulysses spacecraft to explore the Sun's polar regions on mission STS-41 in October 1990; the deployment of the Upper Atmosphere Research Satellite in September 1991; and the second flight to the International Space Station on mission STS-96 in May 1999.

Discovery is named for two famous sailing ships: one sailed by Henry Hudson in 1610 and 1611 to explore Hudson Bay in Canada, as well as search for a northwest passage between the Atlantic and Pacific Oceans; and the other by James Cook in the 1770s on voyages in the South Pacific, during which he discovered the Hawaiian Islands.

The British Royal Geographical Society used two ships named Discovery: one to explore the North Pole in 1875 and one to explore the Antarctic in 1904.

The orbiter Discovery touches down Aug. 22, 2001, at KSC's Shuttle Landing Facility to conclude the 12-day STS-105 mission to the International Space Station. The mission was Discovery's 30th flight.



Atlantis

The fourth orbiter, Atlantis, was delivered to Kennedy Space Center in April 1985. It lifted off on its maiden voyage on Oct. 3, 1985, on mission 51-J, the second dedicated Department of Defense flight. Later missions included the launch of the Galileo interplanetary probe to Jupiter on STS-34 in October 1989, and launch of the Gamma Ray Observatory on STS-37 in April 1991.

Others were STS-71 and STS-74, the first and second MIR dockings; six SPACEHAB



The shuttle carrier aircraft, or SCA, and its piggyback passenger Atlantis taxi down the runway after landing at the KSC Shuttle Landing Facility. Atlantis landed at Edwards Air Force Base in California on June 22 to end mission STS-117. It returned to Kennedy on July 3.



Endeavour is settled into place behind the external tank and solid rocket boosters on the mobile launcher platform in high bay 3 of the Vehicle Assembly Building. Space Shuttle Endeavour launched on mission STS-118 on Aug. 8, 2007, carrying the S5 truss segment to the International Space Station.

missions from March 1996 through September 1997; and six flights to the International Space Station from May 2000 to October 2002.

Atlantis is named after a two-masted, 460-ton ketch that was operated for the Woods Hole Oceanographic Institute from 1930 to 1966. The ketch was the first U.S. vessel to be used for oceanographic research.

Endeavour

Authorization to construct the fifth space shuttle was granted by Congress on Aug. 1, 1987. Endeavour first arrived at KSC's Shuttle Landing Facility May 7, 1991, atop NASA's new shuttle carrier aircraft (NASA 911).

The space agency's newest orbiter began flight operations in 1992. Significant missions included the first SPACEHAB mission, STS-57, in June 1993; the first manned flight to the International Space Station, STS-88, in December 1998, carrying the Unity connecting module; and the Shuttle Radar Topography Mission, STS-99, in February 2000.

Endeavour is named after the first ship commanded by 18th century British explorer James Cook. On its maiden voyage in 1788, Cook sailed into the South Pacific and around Tahiti to observe the passage of



Columbia sits on Launch Pad 39A before its maiden flight on STS-1, April 12, 1981.

Venus between the Earth and the Sun. During another leg of the journey, Cook discovered New Zealand, surveyed Australia and navigated the Great Barrier Reef. A national competition in public schools produced the name of this fifth orbiter.

Orbiter Upgrades, Modifications

Columbia was the first online orbiter to undergo the first scheduled inspection and retrofit program. The ship was transported Aug. 10, 1991, after its completion of mission STS-40, to shuttle contractor Rockwell International's Palmdale, Calif., assembly plant, where the work was performed.

Columbia underwent approximately 50 modifications, including the addition of carbon brakes and a drag chute, improved nose wheel steering, removal of development flight instrumentation and an enhance-

ment of its Thermal Protection System.

The orbiter returned to KSC Feb. 9, 1992, to begin processing for mission STS-50 in June of that year. Columbia was sent to Palmdale in 1999 for a second round of upgrades, returning to KSC in 2001.

The orbiters' EDO changes allowed them to support missions up to 16 days long. The upgrades that made a longer stay in space possible included the EDO pallet, which holds a set of liquid hydrogen and liquid oxygen tanks to provide additional fuel for the orbiter's electrical power generation system. In addition are a regenerating system for removing carbon dioxide from the crew cabin atmosphere; two additional nitrogen tanks for cabin air; an improved waste collection system; and additional middeck lockers for storage.

Orbiter major modification, or OMM, periods are scheduled at regular intervals to enhance safety and performance, infuse new technology and allow for thorough inspections of the airframe and wiring of the vehicles. Many modifications have been made to the

orbiter fleet since the vehicles were first built, including improvements to the main engines, thermal protection system and propellant supply systems, and installation of a new crew escape system.

In 2002, OMMs were moved from Palmdale to KSC. Discovery was the first orbiter to go through OMM at KSC.

Main engine modifications included changes to the high-pressure turbo machinery, hydraulic actuators and main combustion chamber.

Some of the tiles that make up the orbiter thermal protection system were replaced to make the system lighter, stronger and more durable. Also, a Reinforced Carbon-Carbon panel was added to the orbiter chin between the nose cap and the nose wheel-well door to provide improved insulation against the searing heat experienced during reentry into the Earth's atmosphere.

Improvements to the orbiter propellant supply system included a redesigned, 17-inch quick-disconnect valve between the orbiter and the external tank. Additional modifications were made to the propellant systems of the orbiter reaction control system, orbital maneuvering system and the auxiliary power units.

A new crew escape system was added that allows the space shuttle crew to bail out if the orbiter has to make an emergency return descent and a safe runway cannot be reached. This system consists of an escape pole that can be extended from the opened crew hatch. The crew would then fasten a lanyard hook assembly that is a part of the pole to their parachute harnesses. Once attached to this hook, the crew would slide down the deployed pole, away from the orbiter. Once free of the pole, they would parachute to safety.



The "glass cockpit" provides easy-to-read, graphic portrayals of key flight indicators like attitude, altitude and speed.

Two more recent upgrades on the orbiters are installation of the "glass cockpit" and improved space shuttle main engines.

Both Discovery and Atlantis have received the new full-color, flat, 11-panel multifunction electronic display subsystem. The new system improves crew/orbiter interaction with easy-to-read, graphic portrayals of key flight indicators like attitude, altitude and speed.

Another improvement to the space shuttle's propulsion system is the Block II main engine configuration that includes a new Pratt & Whitney high-pressure fuel turbopump. The new turbopump made its debut flight on Atlantis in July 2001 on mission STS-104. The Block II configuration results in a more reliable and safer engine due to increased pump robustness.

The primary modifications to the engine are the elimination of welds by implementing a casting process for the housing, an integral shaft/disk with thin wall blades and ceramic bearings. The unique casting makes the pump stronger and will increase the number of flights between major overhauls.

Other significant improvements in the shuttle's main engines are the high-pressure liquid oxygen turbopump, the two-duct power-head, the large throat main combustion chamber and the single-coil heat exchanger.

In response to the Columbia accident and recommendations of the Columbia Accident Investigation Board, there were 41 modifications for return to flight in 2005. Eight of these were significant.



A United Space Alliance technician installs BRI-18 tile.

When built, Endeavour featured new hardware designed to improve and expand orbiter capabilities. Most of this equipment was later incorporated into the other three orbiters during out-of-service major inspection and modification programs. The upgrades include:

- a 40-foot-diameter drag chute that reduces the orbiter's rollout distance by 1,000 to 2,000 feet.
- plumbing and electrical connections needed for Extended Duration Orbiter (EDO) modifications to allow up to 28-day missions.
- updated avionics systems that include advanced general purpose computers, improved inertial measurement units and tactical air navigation systems, enhanced master events controllers and multiplexer-demultiplexers, a solid-state star tracker and improved nose wheel steering mechanisms.
- an improved version of the auxiliary power units that provide power to operate the shuttle's hydraulic systems.

In 2003, Endeavour was taken out of the launch processing flow to go into a major modification period. This was the second of these modification periods performed entirely at Kennedy Space Center. Endeavour's previous modification was completed in March 1997.

For the latest period, engineers and technicians spent 900,000 hours performing 194 modifications to the vehicle, including more than 13,000 operations and maintenance tasks. These included all recommended return-to-flight safety modifications, bonding 2,045 thermal protection system tiles and inspecting more than 150 miles of wiring throughout Endeavour.

Rudder speed brake actuators were replaced as part of the life-cycle maintenance procedures. The forward reaction control system and orbital maneuvering system pods were removed and refurbished.

Seventy-two Boeing replacement insulation, or BRI-18, tiles were installed in critical locations. The BRI tiles, more rigid than previous tile materials, are gradually replacing tile around main landing gear doors, external tank doors and nose landing gear doors. Replacing the existing tiles with the BRI-18 tiles in strategic areas is one of the Columbia Accident Investigation Board's recommendations to strengthen the orbiters.

Two of the more extensive modifications included the addition of the multi-functional electronic display system, or "glass cockpit," and the three-string global positioning system that improves the shuttle's landing capability.

The new cockpit electronics provide better displays, increased capabilities, decreased weight and power consumption, and improved crew situational awareness.

The three-string global positioning system will allow Endeavour to make an emergency landing at any runway, provided it is long enough to accept a space shuttle. The previous system, TACAN, or Tactical Air Navigation System, only allowed for a landing at a military base.

Another major modification is the station-to-shuttle power transfer system. This allows the International Space Station to transfer power from its solar arrays to the orbiter while it is docked, thus allowing the mission to be extended up to four days if needed. The power transfer preserves the orbiter's liquid hydrogen and oxygen supplies that are used by the three fuel cells to produce electricity.

Endeavour returned to service Aug. 8, 2007, with the launch of mission STS-118 to continue assembly of the International Space Station.

To read more about NASA's Space Shuttle Program and other topics, go to
http://www.nasa.gov/centers/kennedy/news/facts/nasa_facts_toc.html.

Atlantis launches Oct. 7, 2002,
on mission STS-112.





Space Shuttle Endeavour launches on mission STS-118 on Aug. 8, 2007, after a nearly three-year hiatus for modifications. The shuttle carried the S5 truss for installation on the International Space Station.

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