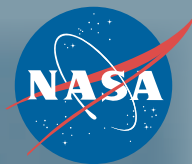


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Special Deliveries

NASA 747 ferries Discovery and Enterprise to new homes



NASA 747 SCA delivers history

By Alan Brown

Dryden Public Affairs

As the awe-inspiring 30-year Space Shuttle Program comes to a close, a set of flights added to its spectacular history.

These flights did not involve space travel, but were impressive nonetheless as NASA 747 Shuttle Carrier Aircraft No. 905, which is based at Dryden, delivered space shuttles Discovery and Enterprise in two flights that were 10 days apart. The flights offered breath-taking imagery as the host 747 and its piggybacked shuttle flew routes that included some of the nation's most iconic sights.

On April 17, the SCA ferried Space Shuttle Discovery from Kennedy Space Center in Florida to Dulles International Airport in suburban Washington, D.C. Before beginning the three-and-a-half hour journey the stack flew low-level flyovers of the center, the Florida Space Coast and the Orlando area before heading up the East Coast.

The modified Boeing 747 SCA carrier aircraft, which had served the shuttle program for more than 37 years, circled downtown Washington, D.C. three times before landing. Thousands gathered on the National Mall and other locations in the nation's capital to see the historic delivery.

Discovery was de-mated from the 747 and towed to the Smithsonian National Air and Space Museum's Stephen F. Udvar-Hazy Center in Chantilly, Va., where it will be

enshrined in a permanent public exhibit in tribute to the more than three-decade Space Shuttle Program.

NASA transferred Discovery to the museum during a ceremony April 19 at the Udvar-Hazy Center. Thousands of visitors gathered at the center during the festivities to see Discovery and the prototype shuttle it will replace in the center's exhibit, Enterprise, positioned nose to nose. Enterprise, which never flew in space, validated the shuttle's flightworthiness during the Approach and Landing Tests at Dryden on Edwards Air Force Base in 1977 and helped prove a number of shuttle systems.

NASA Administrator Charles Bolden and former Ohio Senator John Glenn were among the featured speakers at the ceremony. The former NASA astronauts both flew on Discovery during its 39 space flights over a 27-year span. In addition, museum director Gen. John "Jack" Dailey extolled the accomplishments of Discovery and the shuttle fleet.

Following the Discovery delivery ceremony, Enterprise, which has been on display at the Udvar-Hazy Center since 1985, was mounted on the SCA. On April 27, the SCA carried Enterprise to John F. Kennedy International Airport in New York City. The stack flew

over the city's metropolitan area including well-known landmarks such as the Statue of Liberty, the Manhattan skyline and Enterprises' final home – the Intrepid Sea, Air and Space Museum, which is located in New York Harbor.

Enterprise will be demated from the NASA 747 and placed on a barge in the coming weeks. The barge will be moved by tugboat up the Hudson River to the museum in June. The shuttle will be lifted by crane and placed on the flight deck of the Intrepid where it will be on exhibit beginning this summer in a temporary climate-controlled pavilion. The Intrepid permanent exhibit facility continues to be developed and will showcase Enterprise. The exhibit is intended to enhance the museum's space-related exhibits and education curriculum.

Preparations continue for the two remaining orbiters, Atlantis and Endeavour, to be transported to their final display locations. Atlantis will be located at the Kennedy Space Center's visitor center and Endeavour will be on display at the California Science Center in Los Angeles.

Jay Levine, X-Press editor, contributed to this report.

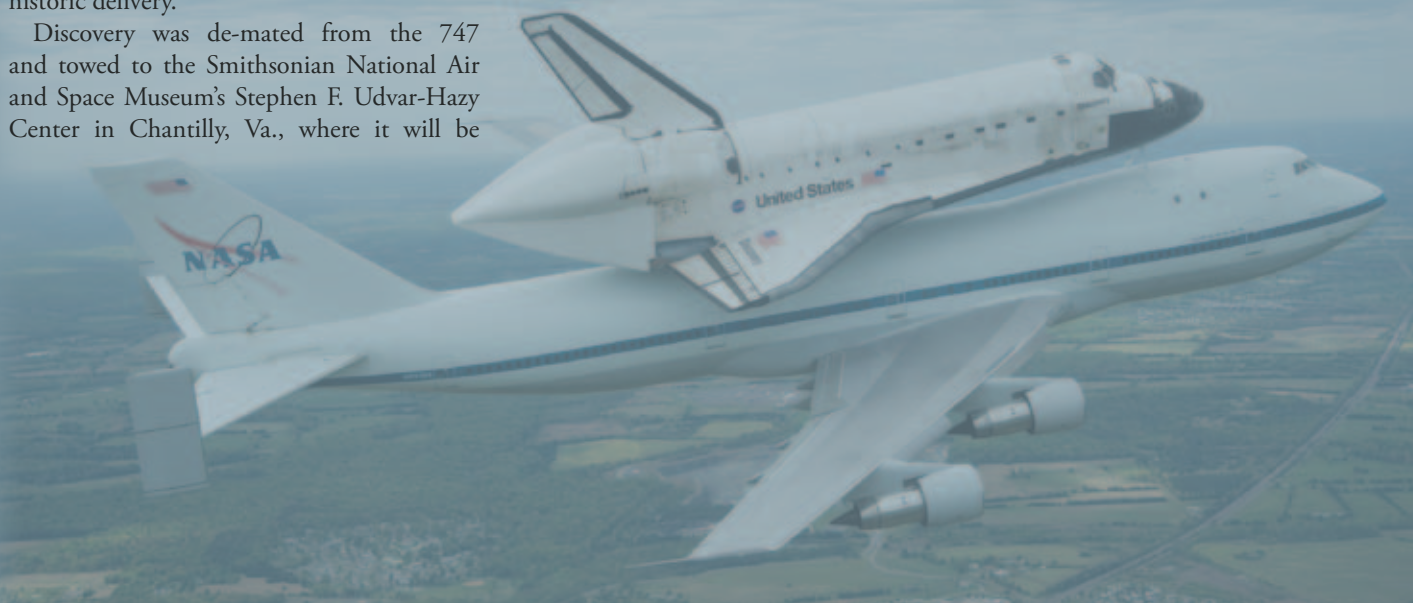




Photo courtesy of Kevin Rohrer

During ceremonies marking the arrival of Discovery to the Smithsonian National Air and Space Museum's Stephen F. Udvar-Hazy Center in Chantilly, Va., and Enterprise leaving the center, the shuttles were displayed facing.



Photo courtesy of Kimberlee Buter

From left, Kevin Rohrer, Mary Ann Harness, James Sokolik and Kimberlee Buter have a backdrop of the Discovery in its new location at the Smithsonian National Air and Space Museum's Stephen F. Udvar-Hazy Center in Chantilly, Va. Dryden managed the agency's air show exhibit during the ceremonies marking Discovery's arrival on top of the NASA 747 Shuttle Carrier Aircraft.



NASA photo by Bill Ingalls



NASA photo by Robert Markowitz

Above, the Enterprise and NASA 747 fly by the Manhattan skyline on its way to the Intrepid Sea, Air and Space Museum, which is located in New York Harbor. At left, the Enterprise and NASA 747 pass by the Statue of Liberty and the Empire State Building.



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NASA photo by Jim Ross

Discovery and the NASA 747 prepare to land at Dulles International Airport near Washington, D.C., but first fly by the Smithsonian National Air and Space Museum's Stephen F. Udvar-Hazy Center in Chantilly, Va., where it will be on display.

Work horse Discovery retired

By Alan Brown

Dryden Public Affairs

Discovery, the first shuttle to be retired, flew more missions than any of the other shuttles – 39 in all. Its first mission was STS-41D in August – September 1984 and concluded with STS-133 in February – March 2011. It flew more than 148 million miles in space on some of the most significant of the Space Shuttle Program's 135 missions.

Discovery missions included carrying the Hubble Space Telescope to orbit and later servicing it and sending the Ulysses robotic probe on its way to the sun. It was also the first shuttle to rendezvous with the Mir Space station and it delivered the Japanese Kibo laboratory to the ISS.

Discovery's 180 passengers included Air Force Col. Eileen Collins, who was the first woman pilot in 1995 on STS-63. On a separate mission, STS-93 in 1999, she became the shuttle's first woman commander. Collins also commanded the STS-114 return-to-flight mission, which marked the shuttle program's first mission since the loss of Columbia on Feb. 1, 2003.

Bernard Harris, also on STS-63, became the first African American spacewalker and Jake Garn became the first sitting member of Congress to fly in space, on STS-51D in April 1985. In 1998 Mercury 7 astronaut and former U.S. Senator John Glenn flew aboard the STS-95 mission. He was 77. The flight also marked the first time that a U.S. president – Bill Clinton – attended a shuttle launch, although President Ronald Reagan had attended the fourth landing of the shuttle Columbia at Dryden on July 4, 1982.

Of those 39 missions, 24 landed at the Kennedy Space Center, Fla., from where it launched, while another 15 touched down at Edwards Air Force Base, necessitating ferry flights aboard one of NASA's two modified Boeing 747 Shuttle Carrier Aircraft to return it to its home base.

Discovery had a fast start after it was added to the shuttle fleet by flying six of the next nine missions of the orbiters during its first year of operation. Its early missions involved placing satellites into, or retrieving them from, orbit. The last of that series, mission STS-51-I in August – September 1985, saw the retrieval, repair and re-deployment of the LEASAT IV-F3 satellite during a dramatic two-hour spacewalk by Discovery's mission specialists.

Discovery was the go-to orbiter when the decision to resume shuttle flights after the Challenger disaster in early 1986 put the program on hold for more than two-and-a-half years. The four-day STS-26 mission placed a Tracking and Data Relay Satellite into space.

Although deployment of satellites continued to be a major function of Discovery's missions in the 1990s, many of its missions were devoted to a wide range of environmental and space science experiments conducted in both its mid-deck area and in special laboratories nestled in its payload bay.

The STS-82 mission in 1997 saw Discovery's crew upgrade the Hubble Space Telescope's capabilities by installing two new state-of-the-art instruments and perform maintenance to keep the telescope operating smoothly during four Extra-Vehicular Activity spacewalks.

Discovery's STS-96 mission in 1999 marked the first docking with the inaugural modules of the International Space Station, the construction and support of which would become the primary focus of most shuttle missions.



ED05 0166-30

NASA photo by Carla Thomas

NASA's specially modified 747 Shuttle Carrier Aircraft, or SCA, is positioned under Discovery to be attached for a ferry flight to the Kennedy Space Center.



ED09 0253-07

NASA photo by Tom Tschida

The setting sun provides a beautiful backdrop for Discovery and the Crew Transport Vehicle after Discovery's landing at Edwards Air Force Base on Sept. 11, 2009.

With the loss of Columbia and its crew in the STS-107 accident in early 2003, Discovery was again selected to be the Return-to-Flight vehicle when missions resumed on the STS-114 mission to the space station in July 2005. Much of that mission, along with the follow-up STS-121 mission a year later, was devoted to testing out new hardware and repair techniques for the Shuttles' Thermal Protection Systems while in orbit.

Discovery's roster of accomplishments during its missions concluded on STS-133 in early 2011 with a 13-day flight to attach a new module to the International Space Station and help the residents there outfit the orbiting laboratory for continued research. It returned from space for the last time at Kennedy on March 9, 2011.

Jay Levine, X-Press editor, contributed to this report.

Enterprise proved concepts

By Peter W. Merlin

Dryden History Office

The space shuttle orbiter was the first spacecraft designed with the aerodynamic characteristics and in-atmosphere handling qualities of a conventional airplane. To evaluate the orbiter's aerodynamic flight control systems and subsonic handling characteristics, Dryden undertook a series of flight tests, known as the Approach and Landing Test, or ALT, program, at Edwards Air Force Base in 1977.

A full-scale orbiter prototype, named Enterprise, was built for the program. Because the vehicle would not be subjected to reentry heating, Enterprise didn't have a thermal protection system. The flight deck had two crew stations for the commander and pilot.

Aerodynamic controls included a body flap at the aft end, elevons and a split rudder that doubled as a speed brake. For the captive flights and the first three free flights, an aerodynamic fairing covered the orbiter's aft end. Three dummy main engines were installed for the final two flights to simulate weight and aerodynamic characteristics of an operational orbiter.

The Enterprise was carried aloft by, and eventually released for flight from, a modified Boeing 747. This Shuttle Carrier Aircraft, as it came to be known, had a fuselage strengthened at key stress points, two vertical fins attached to the horizontal stabilizers, and three attach points on top of the fuselage to anchor the orbiter. All original seating except that of the first-class section of the main deck was removed.

NASA selected two two-man orbiter crews for the ALT: Fred W. Haise Jr. (commander) and C. Gordon Fullerton (pilot), and Joe H. Engle (commander) and Richard H. Truly (pilot). Crewmembers for the 747 SCA included pilots Fitzhugh L. Fulton Jr. and Thomas C. McMurtry and flight engineers Victor W. Horton, Thomas E. Guidry Jr., William R. Young and Vincent A. Alvarez.

Wind-tunnel-model tests allayed concerns about the separation characteristics of the two vehicles in flight. Because of the orbiter's positive angle of attack while mated, the Enterprise tended to climb relative to the SCA. Meanwhile, the 747 tended to descend mildly as the crew idled the engines and deployed spoilers, allowing the orbiter to clear the SCA's tail in about 1.5 seconds.

Five captive flights with the inert, unmanned orbiter verified the airworthiness of the 747 as an orbiter transport vehicle and established parameters for ALT operations. Three captive-active flights followed, with Enterprise powered up and crew in its cockpit to test controls and other functions.

The final phase of the ALT program included five free flights during which the orbiter was released from the SCA and glided to a landing at Edwards.

Except on the last free flight, Enterprise landed on Rogers Dry Lake. The final flight ended on the 15,000-foot concrete runway at Edwards, an important demonstration of precision landing capabilities necessary for later



ECN77 8608

NASA photo

The first of Enterprise's five free flights from the NASA 747 Shuttle Carrier Aircraft at Dryden in 1977 were part of the shuttle program approach and landing tests. The tests verified the shuttle's aerodynamics and handling characteristics in preparation for orbital flights with Columbia.



E77 8142

NASA photo

Flight crewmembers of Enterprise and the host NASA 747 SCA included, from left, Fitz Fulton, Gordon Fullerton, Vic Horton, Fred Haise, Vincent Alvarez and Tom McMurtry.

operational missions.

At touchdown, the orbiter experienced a pilot-induced oscillation, or PIO, in which the vehicle skipped and bounced down the runway several times before safely coming to a stop. Prior to the start of the shuttle's orbital flight-test program, the PIO issue was corrected through additional research with Dryden's F-8 Digital Fly-By-Wire test aircraft, which was equipped with a flight control computer identical to that used on the orbiter. Dryden engineers recreated the PIO with the F-8 and developed a software filter to correct it.

The ALT program demonstrated the orbiter's capability for safe approach and landing after an orbital flight from space. It also validated crucial onboard control systems necessary for the shuttle program's launch of Columbia on April 12, 1981.



ED12 0096-06

NASA photo by Tony Landis

Eight of the nine pilots and flight engineers from the Johnson Space Center, Houston, and Dryden who have flown NASA's Shuttle Carrier Aircraft in recent years along with the SCA maintenance crew from Dryden were photographed prior to a pilot proficiency flight in NASA 747 SCA No. 905 March 29. The ground crew in the front row include, from left, Randy Isaac,

Eugene Smith, Robert Hackaday, Leroy Marsh and Rick Brewer, all employees of CSC Applied Technologies. Flight crew members in the back row are, from left, Henry Taylor, Larry LaRose, Frank Batteas, Bill Brockett, Arthur "Ace" Beall, Tim Sandon, Jeff Moultrie and Bill Rieke. Pilot Bob Zimmermann is not in the image.

Coast-to-coast: Orbiters traveled in style on top of the NASA 747 SCAs

Two NASA 747 Shuttle Carrier Aircraft have ferried the space shuttle fleet from coast to coast for more than three decades.

Built in 1970, NASA 747 SCA No. 905 was acquired by NASA in 1974 from American Airlines and modified for its shuttle-carrying role by The Boeing Company.

NASA 905 will conclude its mission as a shuttle carrier aircraft when it delivers Endeavour for the California Science Center in Los Angeles later this year.

NASA 905 carried Columbia aloft 60 times, Challenger 20 and Atlantis 35. Including the deliveries to museums in Washington, New York and Los Angeles, it will have carried Discovery 38 times, Endeavour



ED12-0096-34

NASA photo by Tony Landis

Batteas, Brockett and Sandon prepare for a pilot proficiency flight.

12 and Enterprise 57 times on ferry flights. NASA 905 also was used for five missions when it released the prototype orbiter for steep descents for the Approach and Landing Tests at Dryden in 1977.

The NASA 747 No. 905 also logged two ferry flights of Boeing's Phantom Ray technology demonstrator in late 2010 and 2011, for a total of 229 piggyback missions.

NASA 747 SCA No. 911 was built in 1973 and acquired by NASA from Japan Air Lines in 1989. After modifications, it carried shuttles on ferry flights 66 times over 21 years until it was retired in February. Johnson Space Center's Aircraft Operations Directorate owns and operates the aircraft, which are based at Dryden.

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