

# Hypersonic Flight to the Edge of Space

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Paths to the Present  
**FLASHBACK**

## The X-15 Program

While most of the country was focused on the race to space, a unique test program was just getting underway at Edwards AFB in the high desert of California. This vehicle was like no other, built to withstand the temperatures of hypersonic flight as well as flight to the edge of space, the X-15 paved the way for many future of manned, winged, space vehicles such as the X-20 Dyna-Soar and the NASA Space Shuttle.

Built by North American Aviation (NAA), the joint Air Force/NASA X-15 program got underway when the first vehicle was rolled out in October 1958, just a year after Sputnik 1 was launched. Built primarily of Inconel X, in order to withstand the high temperatures of hypersonic flight, the X-15 was designed to be air-launched from a modified Boeing B-52 bomber which carried the X-15 to launch altitude before being released. Initially powered by two XLR11 rocket engines which limited the X-15 to Mach 3 for the first year of the program, the aircraft eventually received its XLR99 engine which allowed it to reach its full potential.

After some delays, the first, unpowered flight occurred on June 8, 1959, flown by NAA's chief test pilot A. Scott Crossfield. The first powered flight occurred on flight number 2 in September when Crossfield flew the X-15 to a speed of Mach 2 and 52,341 ft. The program suffered a minor setback when the fuselage of ship 2 was broken in the center during landing at the end of the fourth flight but was quickly repaired and returned to flight in just three months. NASA pilot Joe Walker surpassed Mach 3 (2,111 mph) on flight 15 in May of 1960 and as a prelude of things to come, Air Force Major Robert White took the X-15 to an altitude of 108,997 feet on the very next flight and set the first of many records just three months later when he flew to a record altitude of 136,500 feet, all while still powered by the interim XLR11 engines.

These early flights of the X-15 were used mostly for envelope expansion and systems check-out, experiment package flights would occur once the XLR99 was installed. The interim XLR11 engines (the same type of engines used on the Bell Aircraft X-1) were successful in checking out systems up to Mach 3 but the vehicle was built for so much more. Pilot checkout and stability & control flights were done using the smaller engine package. With the XLR99 now ready, the higher performance flights could now begin. Unlike the XLR11, the XLR99 was completely throttleable and was the largest man-rated rocket engine yet developed producing over 57,000 pounds of thrust at sea level.



The sleek lines of the North American Aviation X-15 are prevalent in this view taken during the rollout on 15 October 1958.

The first X-15 flight with the XLR99 engine occurred on November 15, 1960 when Crossfield took the second X-15 to a speed of Mach 2.97 using only 50% thrust on his 8 ½ minute flight. Just three flights later, Maj White took this same aircraft to a speed of Mach 4.43 (2,905 mph), a first for any aircraft, just a month before Alan Shepard made the first US manned space flight. Maj White topped this achievement just four flights later on Jun 23, 1961 when he made the



first hypersonic flight of any aircraft by taking the X-15 to a speed of Mach 5.27 (3,603 mph) in a flight lasting just over 10 minutes.

Maj White wasn't done achieving new 'firsts', making the first flight above 200,000 ft on October 11, 1961 and making the first flight above Mach 6 by flying to 4,093 mph on November 9. The following April, a young NASA test pilot named Neil Armstrong made the longest flight of the X-15 program with a flight of nearly 12 ½ minutes when he 'skipped' off the upper atmosphere and despite being in a 90 degree left bank, the aircraft would not turn. By the time the X-15 returned into the atmosphere, Armstrong was 45 miles past Edwards, roughly over Pasadena, utilizing his expert flying skills, he brought the X-15 back for a safe landing at Edwards.

X-15 Ship 2 is launched on an early contractor flight using the interim XLR11 engines (North American Aviation photo)

The program moved at a very rapid pace, setting new speed and altitude milestones

along the way. On July 17, 1962 Maj White set an FAI world altitude record when he took the aircraft to 314,750 ft, becoming the first active duty officer to receive Astronaut Wings for a flight above 50 miles altitude which the military recognizes as the edge of space, others recognized the Kármán line of 62 miles as the altitude for space and Joe Walker became the first to hit that mark when he took the third X-15 to an altitude of 347,800 ft on July 19, 1963 and then surpassed it the following month by setting an unofficial altitude record of 354,000 ft.

The next flight provided an exciting moment for the test engineers monitoring it on the ground when Air Force Captain Joe Engle performed an unauthorized 360 degree roll towards the end of his first flight in the X-15. The program suffered its first major setback on November 9, 1962 when the second X-15 with NASA pilot John McKay at the controls experienced an engine malfunction and was forced to make an emergency landing at Mud Lake, Nevada. McKay couldn't jettison all of his fuel load causing the X-15 to land heavy. The left landing skid collapsed and the X-15 slid sideways and then rolled on its back. McKay experienced crushed vertebrae but later returned to fly again. The X-15 was severely damaged in the rollover and was returned to North American Aviation and rebuilt into the more



Major Robert White drops away from the NB-52B mothership on 9 November 1961 on what would become the first Mach 6 flight by any aircraft. (NASA Photo)



The beginning of X-15 flight 2-28-48 on 29 August 1962 took Maj Rushworth to a speed of Mach 5.12 (3,447 mph) and an altitude of 97,200 feet (AFFTC/HO photo)

capable X-15A-2. The fuselage stretched an additional 29 inches and with the added capability of using external propellant tanks, which allowed for an addition 60 seconds of engine burn time.

Despite all of the speed and altitude achievements, the X-15 was designed as a research tool to study the aerodynamic and thermodynamic effects at hypersonic speeds. Hundreds of thermocouples and pressure orifices were located on the surface of the aircraft to acquire the data and instrumentation compartments were built into the structure which could hold up to 1,300 pounds of instrumentation. A single large bay was located just behind the cockpit and smaller tail box was located just behind the upper speed brake. Wing pods were added later for smaller experiments. Biomedical research was conducted exclusively by the Air Force into physiological responses of the pilot to the demanding flight profiles required in high-performing aircraft. The X-15 was also used to test a variety of insulation and ablative materials used on the Apollo Saturn launch vehicle.

Repairs on the second aircraft were completed and the modified X-15A-2 made its first flight on June 25, 1964 by Major Robert Rushworth to a speed of Mach 4.59 (3,104 mph) and 83,300 ft and the first flight with external tanks occurred on November 3, 1965. The three X-15's were now flying 2 to 3 missions a month providing a wealth of data to be used in future applications to hypersonic flight. In June 1965, Capt Engle became the second active duty officer to receive Astronaut Wings when he flew X-15 ship 3 to an altitude of 280,600 ft. The X-15A-2 was now being prepared for even faster flights. A new ablative material made by Martin Marietta known as MA-25S would be applied to the aircraft in an attempt to protect the airframe from the thermodynamic effects above Mach 6. Pink in color, the MA-25S required a white sealer coat to protect it from the liquid oxygen used by the X-15.

On October 3, 1967, Air Force Major William J. 'Pete' Knight released from the NB-52B mothership and began to accelerate. With their propellants expended, the external tanks were released at Mach 2.4 and Knight really began to move. Among the experiments being carried by the X-15A-2 was a dummy ramjet attached to the lower ventral fin. The excessive heat caused by the shockwave from the ramjet burned a hole through the Inconel X skin as Knight achieved a top speed of Mach 6.7 (4,520 mph), an unofficial speed record for manned flight which still stands today. Though rebuilt, the X-15A-2 never flew again. Knight's next flight in the X-15 was to an altitude of 280,500 ft becoming the third Air Force pilot to be awarded Astronaut Wings.



Six of the twelve men to fly the X-15 pose in their David Clark pressure suits, L-R are: Maj William 'Pete' Knight, Maj Robert Rushworth, Capt Joe Engle, Milton Thompson, Bill Dana and Jack McKay (NASA photo)



The X-15A-2 with external propellant tanks installed prepares for launch at the beginning of flight 2-45-81 on 1 July 1966 (AFFTC/HO photo)

The celebration of the X-15's achievements would be short lived though as tragedy struck the program just over a month later when Major Mike Adams was killed as the X-15 went out of control during reentry from a flight above 260,000 ft. Adams would be awarded astronaut wing posthumously. With two vehicles out of service and funding running low, the decision was made to end the program after flight number 200. After 11 attempts to get flight 200 off the ground, the final one was aborted due to a rare snow storm in the high desert on December 20, 1968. The aircraft was demated from the B-52 mother-ship and placed in storage.

The X-15 program is recognized as one of the most successful X-plane programs undertaken. The joint Air Force/NASA program is still used as a grand example of what can be achieved through teamwork and cooperation. Data from this program has been used in the design of many follow-on vehicles such as the X-20 Dyna-Soar, NASA Space Shuttle, NASA's X-43 Hyper-X hypersonic test vehicle and the Air Force X-51A Waverider which holds the record for the longest air-breathing hypersonic flight.

As a tribute to the program, the two surviving X-15's hold a place of honor in their respective museums. X-15 ship one hangs in the entrance to the Smithsonian's National Air and Space Museum in Washington D.C. and the X-15A-2 is preserved in the research & development (R&D) gallery of the National Museum of the United States Air Force in Dayton, Ohio.



The North American X-15A-2(front) and the Lockheed Martin Titan IVB Rocket(rear) on display in the Space Gallery at the National Museum of the U.S. Air Force. (U.S. Air Force photo by Ken LaRock)



The Martin Marietta MA-25S ablative applied to the X-15A-2 was pink in color and utilized a white sealer coat to protect it from the liquid oxygen propellant (NASA photo).

For further reading, see: Dennis R. Jenkins & Tony R. Landis, *HYPERSONIC: The Story of the North American X-15*, Specialty Press, October 2003.

Dennis R. Jenkins, *X-15: Extending the Frontiers of Flight*, NASA Publications, 2008; [https://www.nasa.gov/connect/ebooks/aero\\_x15\\_detail.html](https://www.nasa.gov/connect/ebooks/aero_x15_detail.html)



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