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# The First Reusable Spaceship

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## Introduction

Ask the typical space enthusiast to name the first reusable piloted spaceship and the most likely answer would be the Space Shuttle. While the Space Shuttle's external tank is discarded on each mission, its pair of solid rocket boosters as well as the highly complex and expensive orbiter (the actual "spaceship") are certainly reusable. But the Space Shuttle was not the first piloted spacecraft that could be flown over and over. Nor was some little known piece of Soviet engineering genius. The honor belongs to the grandfather of all modern aerospace planes, the X-15.

While the X-15 is certainly the most famous of all the X-series aircraft, the fact that it flew into space on no less than 13 occasions while the Mercury and Gemini programs came and went is frequently overlooked. Even in NASA's "official" count of American manned space missions, the suborbital X-15 flights are notably absent. This despite the fact that three NASA pilots (not to mention five USAF pilots) earned their astronaut wings during the program including Joe Engle who went on to fly NASA's Space Shuttle in the 1980s.

There are several possible reasons the X-15 spaceflight accomplishments are often forgotten: First the majority of the X-15's 199 flights were never meant to fly high enough to qualify as an "official" spaceflight. Extremely high altitude flights were only one of this long running program's many objectives. Combined with the almost routine nature of what was really a test program, X-15 flights did not generate the media coverage afforded to the far less "routine" space missions of the Mercury and Gemini programs. Finally, when the X-15 passed the threshold into space, it barely did so and only briefly - hardly newsworthy to some when men are spending days or weeks in orbit in preparation for a manned lunar mission. But exactly where is this threshold where one "officially" passes into space?

## The Edge of Space

There really is not a clearly defined altitude where one passes out of the sensible atmosphere and into the vacuum of space. In the late 1950's the USAF decided to award astronaut wings to pilots who flew over 50 statute miles (80.45 kilometers) above sea level. Besides being a nice round number (at least in English measurement units), 50 miles is higher than any balloon or conventional aircraft has ever flown (about 30 miles or 50 kilometers) yet lower than the lowest perigee of a marginally stable satellite orbit (about 55 miles or 90 kilometers). Eventually flying as high as about 108 kilometers (67 miles), the X-15 was the first craft capable of flying in the transition region between the sensible atmosphere and space.

The need to explore this region as well as the effects of hypersonic flight (i.e. at speeds exceeding five times the speed of sound or Mach 5), had been recognized in the early 1950s. In the years after the last World War, rocket-powered aircraft such as the USAF's X-1 series and the X-2 as well as the US Navy sponsored D-558 series of test aircraft first broke the sound barrier and proceeded to set a string of speed records up to Mach 3. In addition, these aircraft also flew at increasingly greater altitudes eventually reaching as high as 38 kilometers (24 miles) above sea level. But military planners anticipated the need for future aircraft to fly faster and higher still. In addition, since the prevailing view of manned spaceflight at the time called for a pilot to fly his rocket powered aircraft into orbit and back, there was an obvious need to explore the issues associated with high altitude hypersonic flight.

After meeting held by the Executive Committee of NACA (NASA's pre-Space Age predecessor, the National Advisory Committee for Aeronautics) it was

recommended that NACA start research into the problems of flight at speeds of Mach 4 to 10 and at altitudes from 12 to 50 miles (19 to 80 kilometers). What would become the X-15 was designed to meet this goal. A further resolution on July 14, 1952 extended NACA goals to speeds from Mach 10 to escape velocity and altitudes from 50 miles (80 kilometers) to infinity. Meeting this latter goal lead to the USAF X-20 "Dyna Soar" and NASA's Mercury program (see **The Beginnings of America's Man in Space Program** in the October 1998 issue of *SpaceViews*).

During the coming months NACA engineers performed numerous studies on hypersonic aircraft designs and soon the USAF took an interest. They had been performing similar studies and, along with NACA officials, knew that such a research program would be best carried out by pooling the resources of several agencies. By July 9, 1954 a joint NACA/USAF/US Navy committee started meeting to discuss the need for such a vehicle and its basic design. By late 1954 the base design criteria were determined and on January 17, 1955 the USAF officially assigned the new aircraft the "X-15" designation.

**The Design**

Four aircraft manufacturers responded to the joint NACA/USAF/US Navy call for proposals. Bell (the builder of the X-1 series) submitted its D-171 design, Douglas its Model 684 D-558-3, and Republic its Model AP-76. While every agency involved had its favorite design, ultimately they agreed on the North American NA-240 proposal and a contract for three aircraft was signed on September 30, 1955. This design was chosen because of its simplicity and ease to modify to meet the agencies' various specifications. The final design that emerged from this long process became an aerospace classic.

The X-15 was designed to attain speeds of Mach 6 and altitudes in excess of 250,000 feet (76 kilometers). It was 15.2 meters (50 feet) long and weighed 15,100 kilograms (33,300 pounds) at launch. Midway down its fuselage were a pair of low aspect ratio, trapezoidal shaped wings with a span of 6.7 meters (22 feet). Based on NACA research, the X-15 used a pair of thick, wedge shaped vertical stabilizers and thin, down sloping horizontal stabilizers to provide directional control during flight. These also gave the aircraft its classic arrow-like profile. A set of a dozen small hydrogen peroxide-fueled jets located in the nose and wingtips with thrusts of 180 and 450 Newtons (40 and 100 pounds) provided attitude control when the X-15 was too high and the air too rarefied for its aerodynamic control surfaces to work. A similar system was later used by NASA's Mercury space capsule.


*The first XLR-11 powered X-15 as seen shortly before its rollout on October 15, 1958. (NASA)*

The bulk of the X-15 airframe was made from titanium while most of the outer skin was composed of the heat resistant and then exotic nickel-based alloy, Iconel X. Such materials were needed to withstand the anticipated 650 C (1,200 F) temperatures generated during hypersonic flight. The air conditioned, climate controlled cockpit provided enough room for a single pressure suit clad pilot. It was equipped with an advanced ejection seat that would work safely at speeds up to Mach 4 and an altitude 36.6 kilometers (120,000 feet or 22.7 miles). It provided an extra safety margin for what was recognized as a risky test program.

Most of the X-15 fuselage housed a set of tanks holding 8,540 kilograms (18,800 pounds) of propellant for the X-15's single rocket engine. Ultimately the XLR-99 engine built by Reaction Motors, Inc. (which later became a division of Thiokol) was chosen based on a bid the company submitted in December of 1955. This engine produced 223 kilonewtons (50,000 pounds) of thrust at sea level and was intended to be restartable and throttlable in flight. Initially the engine was to be throttled from 30% to 100% of its maximum thrust. Early versions of the engine would only throttle between 50% and 100% but even later versions were limited to a minimum 40% rating to avoid running problems found during test flights at low thrust settings.

The turbopump fed XLR-99 ran on an unusual combination of liquid anhydrous ammonia and liquid oxygen (LOX). While there are certainly rocket fuels more powerful than liquid ammonia available,

Reaction Motors did have much experience with this propellant combination and knew that engines burning it were very forgiving during restarts - a very important safety factor. This powerful engine would easily allow the X-15 to exceed its speed and altitude design goals. Ultimately the performance of the X-15 would be limited by the heat generated during high speed flight or reentry and not by its engine.

But as development of the X-15 and its XLR-99 engine proceeded it became increasingly clear that the first X-15 airframes would be available long before their innovative powerplants. By February 1958 it was decided that the first two X-15 aircraft would initially be equipped with a pair of less powerful XLR-11 engines similar to the ones that powered the Bell X-1 series and the Douglas D-558-II aircraft. Each XLR-11 engine consisted of four thrust chambers that could be fired independently allowing for an eight-step throttle capability. With all eight chambers running, the pair of alcohol/LOX fueled XLR-11 rocket engines produced a total of 71 kilonewtons (16,000 pounds) of thrust. While this was only a third of the maximum thrust generated by the XLR-99, it did allow the X-15 test program to proceed with the previously planned low speed trials that would be flown initially.

*An XLR-11 equipped X-15 being dropped from a NB-52 at the beginning of a test flight. (NASA)*

But even with the powerful XLR-99, the X-15 would waste far too much propellant taking off directly from the ground. Like many other rocket powered test aircraft, the X-15 would be carried by a large carrier aircraft to altitude before being dropped for the beginning of a test flight. But the B-29 and its sibling, the B-50, bombers used by earlier X-series aircraft were too small to handle the much larger X-15. After much debate a modified B-52 bomber, which was just entering service, was selected to be the X-15 mother craft. The X-15 would be mounted under the B-52's starboard wing on a special pylon that provided a variety of support functions before the X-15 was launched. B-52A serial number 52-003 and B-52B serial number 52-008 were sent to North American for their transformation into the NB-52A and NB-52B carrier aircraft.

**First Flights**

By the time the first X-15 was rolled out on October 15, 1958 the Space Age was already a year old and there was a new sense of urgency in the program. The X-15 was the first craft ever built that was capable of sending a man into space and it had a good chance of not only beating the Soviet Union but NASA's just announced ballistic man-in-space initiative. Because of the advanced state of development, North American even proposed using an X-15 variant called the X-15B to be launched into orbit using Titan boosters. Since NASA was committed even at this early date to using a ballistic capsule for its first manned flights, the North American plan lost out to the proposal submitted by the McDonnell Aircraft Company (see **America's First Spaceship** in the April 15, 1999 issue of *SpaceViews*).

In the mean time the X-15 was put through its paces in anticipation of its first powered flight. The first captive flight with the first X-15 attached to the NB-52 carrier took place on March 10, 1959. After several more captive flights, the X-15 flew its first unpowered glide flight on June 8, 1959. At the controls of this and most early flights was North American's test pilot Scott Crossfield - a former NACA pilot who had flown the X-1, D-558-I and D-558-II and had been the first man to fly faster than Mach 2 on November 20, 1953. The first XLR-11 powered flight took place using X-15 #2 on September 17, 1959 with Crossfield easily reaching a speed of Mach 2.11 and an altitude of 15.95 kilometers (9.91 miles).

A near repeat was accomplished a month later but the fourth flight on November 5 was almost catastrophic. An engine fire forced an emergency landing which resulted in a structural failure with the X-15 almost breaking in two between the cockpit and propellant tank. Fortunately Crossfield was not injured. The structural design defect that lead to the failure was corrected and the aircraft was repaired.


*The aftermath of Scott Crossfield's forced landing during the fifth flight of the X-15 on November 5, 1959. (NASA)*

Over the coming months the X-15 performance envelope was gradually increased and new USAF, US Navy, and NASA pilots began flying this manned bullet. After 29 flights with the XLR-11 engines, the X-15 made its first XLR-99 powered flight on March 7, 1961. While the delay in the delivery of the XLR-99 powerplant meant that the X-15 would not make the first manned spaceflight, it did mark the beginning of an unprecedented test program that blazed the trail for future aerospace planes.

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