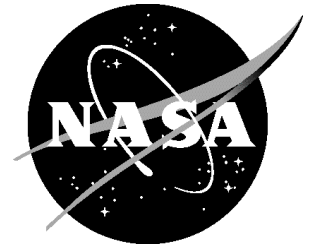


# NASA Facts

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## THE LOCKHEED YF-12



YF-12 in flight. (NASA photo EC72-3150)

The YF-12 "Blackbird" was an experimental fighter-interceptor version of the Lockheed A-12 reconnaissance aircraft. In Air Force flight tests on May 1, 1965, the YF-12 set a speed record of 2,070.101 mph and an altitude record of 80,257.65 feet. First publicly displayed at Edwards Air Force Base in 1964, the YF-12 was never adopted by the military as an operational aircraft. It was, however, a precursor to the SR-71 Blackbird reconnaissance plane.

Two YF-12s were flown in a joint Air Force-NASA research program at the NASA Flight Research Center (after 1976, the NASA Dryden Flight Research Center) between 1969 and 1979. A third shared plane, piloted primarily by the Air Force, was lost to an in-flight fire in 1971.

The YF-12 allowed NASA researchers at all four of the agency's aeronautical centers (Langley, Lewis [now Glenn], and Ames as well as the Flight Research Center) to study the thermal, structural, and aerodynamic effects of sustained, high-altitude, Mach 3 flight. Painted flat black, the YF-12 was fabricated primarily from titanium alloy, which enabled it to withstand skin temperatures of over 500° F.

Work on the YF-12 began in secret in the late 1950s at the Lockheed Advanced Development Projects office, better known as "Skunk Works," in Burbank, Calif. Flight data remained classified long after President Lyndon Johnson announced the plane's existence on Feb. 29, 1964. After the announcement, the plane received the Air Force designation YF-12A.

(The "Skunk Works" was the unofficial designation of Lockheed's secret development entity in Burbank. It was located near a plastics plant that exuded a rather strong odor. Since the engineers were also brewing up their secret designs, the "Skunk Works" in Al Capp's comic strip "L'il Abner," where Kickapoo Joy Juice was made, seemed an appropriate designation. However, it was changed to Skunk Works to avoid plagiarism.)

Although it yielded large amounts of research data, the YF-12 program was terminated in the late 1970s when NASA's research agenda shifted from speed to efficiency. During its nine-year life, the YF-12 research program logged 297 flights in the joint NASA-Air Force program and approximately 450 flight hours.

Only one YF-12 remains in existence. It is displayed at the U.S. Air Force Museum at Wright-Patterson Air Force Base in Dayton, Ohio.

### **The Development of the "Blackbirds"**

In 1959, Lockheed began work on the design of a long-range, high-altitude plane, then known as the A-11. It was a Cold War project. Heading the project team was Clarence "Kelly" Johnson, Lockheed's Vice President for Advanced Development Projects. Johnson had previously led the development of the U-2 spy plane. Five years after work began on the A-11, on February 29, 1964, President Lyndon Johnson told reporters that the aircraft (by that time modified to the A-12 production version with a reduced radar cross section) had attained speeds of over 2,000 mph and altitudes of more than 70,000 feet in tests at Edwards Air Force Base.

The Air Force YF-12 flight test program lasted until 1966 and was assigned to the 4786th Test Squadron at Edwards. The team of Col. Robert L. Stephens and Lt. Col. Daniel Andre took the plane to the record altitude and speed noted above.

On July 24, 1964, President Johnson announced that Lockheed was also developing "a long-range advanced strategic reconnaissance plane for military use, capable of world-wide reconnaissance for military operations." That plane, the SR-71, was a modified version of the YF-12.

Although heavier than the YF-12, the SR-71 "spy plane" had a longer range and was capable of strategic surveillance. This spy plane was adopted by the military and the YF-12 was not. Usurped by a demand for its successor's capabilities, the experimental YF-12's were essentially shelved until 1969, when two of them were deployed as research vehicles at the NASA Flight Research Center.

### **Program Managers**

Engineer Gene Matranga led a NASA research team that had begun studying Blackbird data in 1967. He continued to manage the project after the planes were acquired by NASA and the YF-12 project was formally initiated in 1969. In its later years, the YF-12 program had two other NASA managers, Ming Tang and Berwin Kock.

### **NASA YF-12 Crews**

The YF-12 carried a crew of two - a pilot and a flight engineer (in Air Force parlance and practice, a fire control officer). Research pilots Fitzhugh Fulton and Donald Mallick flew NASA's YF-12 flights at the NASA Flight Research Center from 1970 to 1979, with several other pilots performing familiarization and a few research flights. The flight engineers on NASA's YF-12 crews were Victor Horton and Ray Young. Air Force crews also conducted testing.

Under its research agreement with NASA, the Air Force provided the agency with two YF-12As in 1969. On June 24, 1971, one of the planes experienced an in-flight fuel line failure that led to a fire in the right engine. Unable to save the smoking aircraft, Air Force pilot Lt. Col. Ronald Layton and fire control officer Major Billy A. Curtis ejected and were not injured, but the YF-12A was lost in a fiery explosion in the desert. The plane was replaced by a "YF-12C." The YF-12C (so-called) differed from the YF-12A in that the A-model had a round nose while the C-model had its chine carried forward to the nose of the airplane (see three-views below). There were other differences in internal and external configuration, but the two aircraft shared common inlet designs, structural concepts, and subsystems.

In fact, the "YF-12C" was a then-secret SR-71A (serial no. 61-7951) given the NASA tail no. 60-6937. The reason for this bit of subterfuge lay in the fact that NASA, while flying the YF-12A interceptor version of the aircraft, was not allowed to possess the strategic reconnaissance version for some time. The bogus tail number actually belonged to a Lockheed A-12 (serial no. 60-6937), but the existence of the A-12 remained classified until 1982. The tail number 06937 was selected because it followed in the sequence of

tail numbers assigned to the three existing YF-12A aircraft: 06934, 06935, and 06936.

### The History of NASA's YF-12 project

On July 18, 1969, NASA and the Air Force announced joint involvement in a YF-12 research program. The agendas differed, with the Air Force focusing on combat



"YF-12C" (foreground) and YF-12A in flight. (NASA photo ECN-4775)

research and NASA engineers initially focusing on a study of flight loads and structural heating. Much of the NASA research was concerned with the viability and development of supersonic cruise aircraft. Two YF-12As (tail numbers 935 and 936) were removed from Air Force storage for the program. On December 11, 1969, 935 successfully made its first flight as a NASA-USAF research plane and inaugurated the program. On June 24, 1971, 936 experienced the fuel line failure described above.

Unless grounded for maintenance or modification, the YF-12s flew nearly every week for most of the program's lifespan. The fiery end of 936 on the desert floor was the program's only crash, but flight crews were forced to make emergency landings at least twice because of in-flight problems. The planes were also prone to an airflow problem involving the engine inlets called an "unstart," which caused a thrust imbalance and resulted in violent yawing.

The YF-12's ability to sustain a cruise speed of greater than Mach 3 allowed NASA to expand its research capabilities. A large amount of flight research was performed in aerodynamics, propulsion, controls, structures, subsystems and

other areas such as the physics of the upper atmosphere, noise tests and measurements, and handling qualities. The YF-12 flight research data was augmented by a series of wind tunnel tests, laboratory experiments, and analyses. As a result, the combined ground/flight research generated vast amounts of information that was later incorporated into the design of other supersonic aircraft. The program yielded over 125 technical reports.

YF-12 flight tests included propulsion studies, investigations of a flight path oscillation known as phugoid, studies of the plane's loads and handling capabilities, and performance tests that involved flights with the ventral fin removed. Other research included the use of attached vanes to investigate airflow and wind gusts, studies of jet wake dispersion, engine stalls, elevation-hold at high Mach speeds, boundary layer noise, and the effect of a boattail design on drag.

The program was ordered terminated in 1977, but NASA used some residual funding to keep the project alive into 1979. Plane 935 made its last NASA flight on October 31, 1979. On November 7, 1979, it was ferried by an Air Force crew to the Air Force Museum at Wright-Patterson Air Force Base in Dayton, Ohio.

### The Cold Wall

Because air friction subjected the plane to extreme heat during flight, the YF-12 was also used to study high-temperature phenomena unrelated to the plane itself. Perhaps the most significant of these studies was the Cold Wall Experiment, which involved exposing a cooled cylinder to the friction and heat of a Mach 3 environment.

The cylinder, which was hollow, equipped with sensors, and mounted beneath the aircraft, was cooled with liquid nitrogen and insulated from the heat that was generated during flight. When the plane neared Mach 3, a primer cord



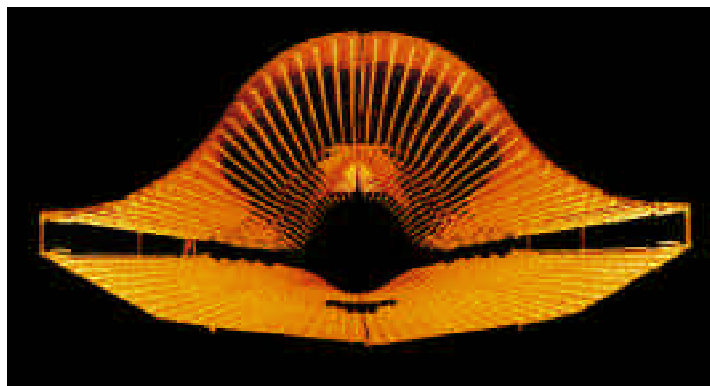
YF-12A 06935 with insulated hollow cylinder used on the Cold Wall Experiment. (NASA photo ECN-4777)

was used to blow the insulation from the frigid cylinder. Temperature, pressures, and friction readings from the cylinder in flight were compared with information developed from theoretical analysis and wind-tunnel simulation. The findings were a major achievement in fluid dynamics research.

### Thermal Loads Research

To measure the thermal loads on the YF-12 required some extraordinary ground tests. At the supersonic speeds the aircraft achieved, high temperatures produced by friction with the atmosphere made it difficult to separate the aerodynamic from the purely thermal effects upon the airplane. As a result, the Flight Research Center conducted one of the most complex series of tests ever done on an aircraft, combining flight and ground-facility techniques and resources. In the Thermal Loads Facility a YF-12A Mach 3 heating simulation collected an enormous data base. This led to methods for separating the aerodynamic and thermal forces operating on an aircraft - a capability that will be of great importance for the design, structural integrity, and safety of future supersonic and hypersonic aircraft.

Remarkably, this research still supports one of the ten goals of NASA's Office of Aeronautics and Space Transportation Technology by providing design tools for the next generation of aircraft. In addition, with respect to the YF-12A alone, the thermal calibration on the ground corrected high-Mach-number loads data for adverse thermal effects, which frequently proved to be large and were always significant.



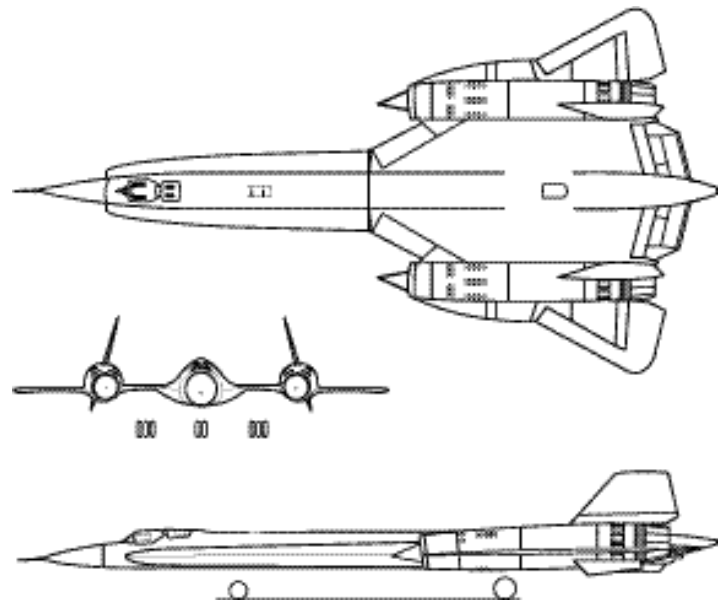
YF-12 forebody heater undergoing a lamp check in the Thermal Loads Facility.(NASA photo EC71 2789)

### Specifications

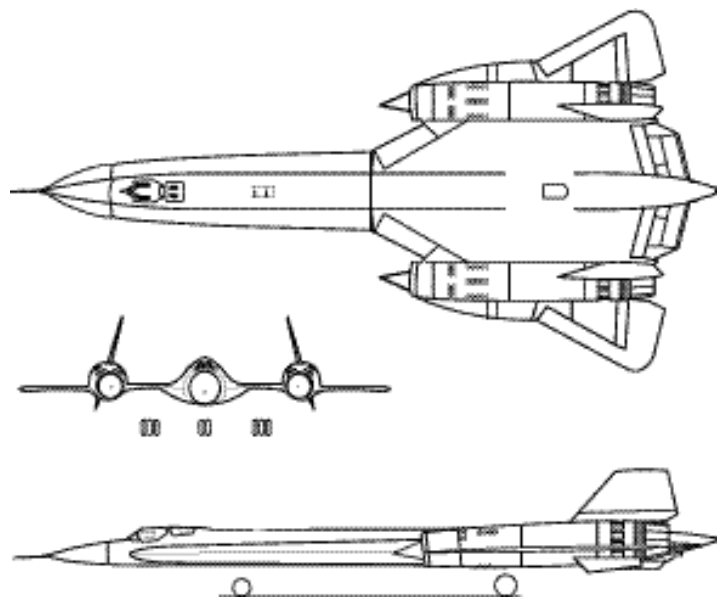
The YF-12A (tail number 935, serial number 60-6935) has a wingspan of about 55 feet 6 inches. and a length of about 101 feet 8 inches. It is roughly 18 feet 4 inches high. The plane's maximum loaded weight was 127,000 pounds. It derived its power from two Pratt & Whitney J58s, each

with 32,000 pounds of thrust (as rated at sea level) with afterburners. However, a significant portion of the thrust as the aircraft neared Mach 3 speeds came from the supersonic shock wave captured within each engine inlet and exited through the engine nozzles.

The YF-12 carried a two-person crew, had a maximum



Three-view of YF-12A.



Three-view of "YF-12C."

speed of Mach 3.2 and a range of more than 2,000 miles. Its service ceiling was above 80,000 feet.

### Pilots in the Joint NASA/USAF Program

Maj. William J. Campbell, USAF  
William H. Dana, NASA Dryden Flight Research Center (DFRC)

Einar K. Enevoldson, NASA DFRC  
Maj. Mervin L. Evenson, USAF  
Fitzhugh L. Fulton, NASA DFRC  
Stephen D. Ishmael, NASA DFRC  
Lt. Col. Calvin F. Jewett, USAF  
Gary E. Krier, NASA DFRC  
Lt. Col. Ronald J. Layton, USAF  
Donald L. Mallick, NASA DFRC  
John A. Manke, NASA DFRC  
Thomas C. McMurtry, NASA DFRC  
Col. Joseph W. Rogers, USAF  
Col. Hugh C. Slater, USAF  
Col. James V. Sullivan, USAF  
Michael R. Swann, NASA DFRC

#### **Fire Control Officers/Test Engineers and Affiliation**

Lorenzo C. Barnett, NASA DFRC  
Maj. Billy A. Curtis, USAF  
Maj. William J. Frazier, USAF  
Maj. Gary I Heidelberg, USAF  
Victor W. Horton, NASA DFRC  
Col. R. Uppstrom, USAF  
Maj. Sammel M. Ursini, USAF  
William R. Young, NASA DFRC

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