NASA facts

SR-71 Blackbird

EC97 43933-4

During the 1990s two SR-71 Blackbird aircraft were used by NASA as testbeds for high-speed and high-altitude aeronautical research at Dryden. The aircraft included an SR-71A and SR-71B (the trainer version), loaned to NASA by the U.S. Air Force.

The SR-71, the most advanced member of the Blackbird family that included the A-12 and YF-12, was designed by a team of Lockheed personnel led by Clarence "Kelly" Johnson, then vice president of Lockheed's Advanced Development Company Projects, commonly known as the "Skunk Works" and now a part of Lockheed Martin Corp.

The Blackbird design originated in secrecy during the late l950s with the A-12 reconnaissance aircraft that first flew in April 1962 and remained classified until 1976. President Lyndon Johnson publicly announced the existence of the YF-12A interceptor variant on Feb. 29, 1964, more than half a year after its maiden flight. The SR-71 completed its first flight on

Dec. 22, 1964. More than a decade after their retirement the Blackbirds remain the world's fastest and highest-flying production aircraft ever built.

The Blackbirds were designed to cruise at Mach 3.2, just over three times the speed of sound or more than 2,200 miles per hour and at altitudes up to 85,000 feet. The extreme operating environment in which they flew made the aircraft excellent platforms for conducting research and experiments in a variety of disciplines: aerodynamics, propulsion, structures, thermal protection materials, high-speed and high-temperature instrumentation, atmospheric studies and sonic boom characterization.

SR-71 activities at Dryden were part of NASA's overall high-speed aeronautical research program and involved other NASA research centers, other government agencies, universities and commercial firms. Data from the SR-71 research program will aid designers of future supersonic/hypersonic aircraft and propulsion systems.

Research at Mach 3

One of the first major experiments flown on the NASA SR-71 involved a laser air-data sensor. The sensor used laser light instead of air pressure to generate airspeed and attitude data such as angle of attack and sideslip, data normally obtained with small tubes and vanes extending into the airstream or from tubes with flush openings on an aircraft's outer skin. These flights also provided information on the presence of atmospheric particles at altitudes above 80,000 feet, where future hypersonic aircraft will operate. The system used six sheets of laser light projected from the bottom of the airplane. As microscopic-size atmospheric particles passed between the two beams, direction and speed were measured and processed into standard speed and attitude references. An earlier laser air-data measurement system was successfully tested at Dryden on a modified F-104 testbed aircraft.

The first of a series of flights using the SR-71 as a science camera platform for NASA's Jet Propulsion Laboratory, Pasadena, Calif., was flown in March 1993. From the nose bay of the aircraft, an upward-facing ultraviolet video camera recorded data on celestial objects in wavelengths blocked to ground-based astronomers by Earth's atmosphere.

In another project, researchers at the University of California-Los Angeles used the SR-71 to investigate the use of charged chlorine atoms to protect and rebuild the ozone layer.

As part of NASA's commercialization assistance program, the SR-71 served as a testbed in development of a commercial satellite-based, instant wireless personal communications network called IRIDIUM. The IRIDIUM system was developed by Motorola's Satellite Communications Division and during developmental testing, the SR-71 acted as a surrogate satellite for transmitters and receivers on the ground.

Because of its high-speed capabilities, scientists used the SR-71 in a program to study ways of reducing sonic boom overpressures that are heard on the ground much like sharp thunderclaps by aircraft exceeding the speed of sound. Aircraft designers have used data from the study in efforts to reduce the "peak" of sonic booms and minimize the "startle effect" they produce on the ground.

In 1997 and 1998 the SR-71 carried the Linear Aerospike SR-71 – or LASRE – experiment. The LASRE test apparatus was a half-span scale model of a lifting body with eight thrust cells of a linear aerospike engine, mounted on the back of an SR-71 aircraft during flight at high speeds and altitudes. Outfitted with the test fixture, the aircraft operated like a kind of flying wind tunnel that allowed engineers to gather aerodynamic data under realistic flight conditions.

EC97 44295-100

By the time the Air Force loaned the two SR-71s to Dryden the center already had a decade of past experience with the Blackbirds. Three of the aircraft were flown at the facility between December 1969 and November 1979 in a joint NASA/Air Force program aimed at learning more about the capabilities and limitations of high-speed, high-altitude flight. The first two were YF-12A prototypes of a planned interceptor aircraft based on the initial A-12 design that ultimately evolved into the SR-71 reconnaissance aircraft. While plans were under way to add another aircraft to the fleet, one YF-12A was lost in a non-fatal mishap in 1971. The third aircraft, an SR-71A that was given the designation YF-12C for administrative purposes, soon took its place.

NASA researchers used the YF-12s for a wide variety of experiments involving aerodynamic and thermal loads, aerodynamic drag and skin friction, heat transfer, airframe and propulsion system interactions, inlet control system improvements, high-altitude turbulence, boundary-layer flow, landing gear dynamics, measurement of engine effluents for pollution studies, noise measurements and evaluation of a maintenance monitoring and recording system. On many YF-12 flights medical researchers obtained information on the physiological and biomedical aspects of crews flying at sustained high speeds. Research data from the YF-12 program also validated analytical theories and wind-tunnel test techniques that will improve design and performance of future military and civil aircraft.

From February 1972 until July 1973, one YF-12A was used for heat loads testing in Dryden's High Temperature Loads Laboratory (now the Thermostructures Research Facility). The resulting data helped improve theoretical prediction methods and computer models dealing with structural loads, materials, and heat distribution at up to 800 degrees Fahrenheit, the surface temperatures reached during sustained speeds of Mach 3.

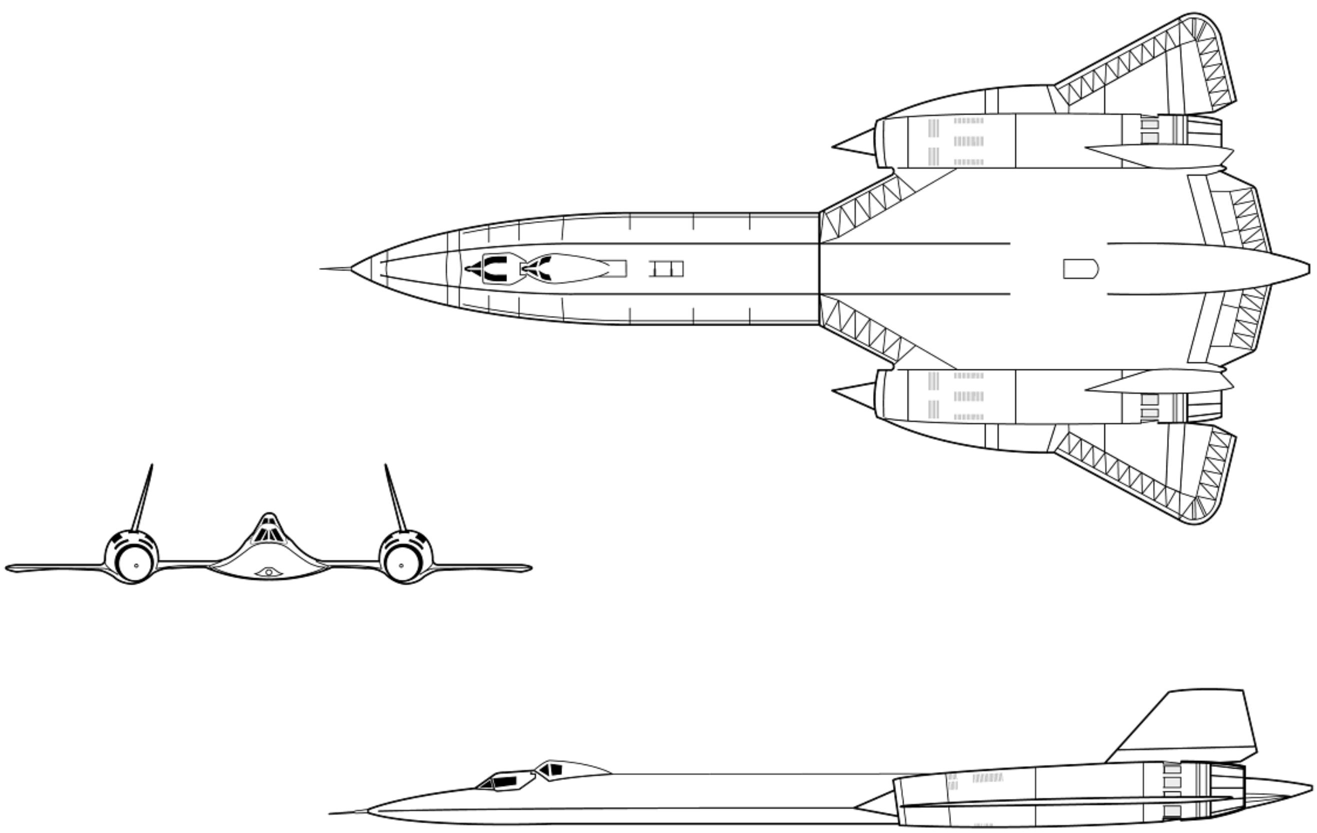
SR-71 Specifications and Performance

Two Pratt and Whitney J58 axial-flow turbojets with afterburners, each producing 32,500 pounds of thrust, powered the Blackbirds. Less than 20 percent of the total thrust used to fly at Mach 3 was produced by the engine itself, however. During high-speed cruise conditions the balance of total thrust was produced by the unique design of the engine inlet and a moveable conical spike at the front of each engine nacelle. Under these conditions, air entering the inlets bypassed the engines, going directly to the afterburners and ejector nozzles, thus acting as ramjets.

The airframes were built almost entirely of titanium and other exotic alloys to withstand heat generated by sustained high-speed flight. Capable of cruising at Mach 3 continuously for more than one hour at a time, the Blackbirds provided a unique research platform for thermal experiments because heat-soak temperatures exceeded 600 degrees Fahrenheit.

The aircraft was 107.4 feet (32.73 meters) long, had a wingspan of 55.6 feet (16.94 meters), and stood 18.5 feet (5.63 meters) high (from the ground to the top of the rudders when parked). Gross takeoff weight was about 140,000 pounds (52,253.83 kilograms), including a fuel weight of 80,000 pounds (29,859.33 kilograms). Aerodynamic control surfaces consisted of all-moving vertical tail fins above each engine nacelle and elevons on the outer wings and trailing edges between the engine exhaust nozzles.

NASA crews flew four Lockheed SR-71 airplanes during the 1990s. Two were used for research and two to support Air Force reactivation of the SR-71 for reconnaissance missions. Although the Air Force retired the Blackbirds in 1990, Congress reinstated funding for additional flights several years later. SR-71A (61-7980/NASA 844) arrived at Dryden on Feb. 15, 1990. It was placed into storage until 1992 and served as a research platform until its final flight on Oct. 9, 1999. SR-71A (61-7971/NASA 832) arrived at Dryden on March 19, 1990, but was returned to Air Force inventory as the first aircraft was reactivated in 1995. Along with SR-71A (61-7967), it was flown by NASA crews in support of the Air Force program. SR-71B (61-7956/NASA 831) arrived at Dryden on July 25, 1991, and served as a research platform as well as for crew training and proficiency until October 1997.



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FS-2008-6-030-DFRC