Flight Testing The SR-71 Blac

Test pilot Robert J. Gilliland about to make another test flight in the SR-71 Blackbird. He graduated from the US Naval Academy in 1949 and immediately began flying with the US Air Force. *(Lockheed)*

Warren Thompson interviews retired Lockheed test pilot Robert J. Gilliland

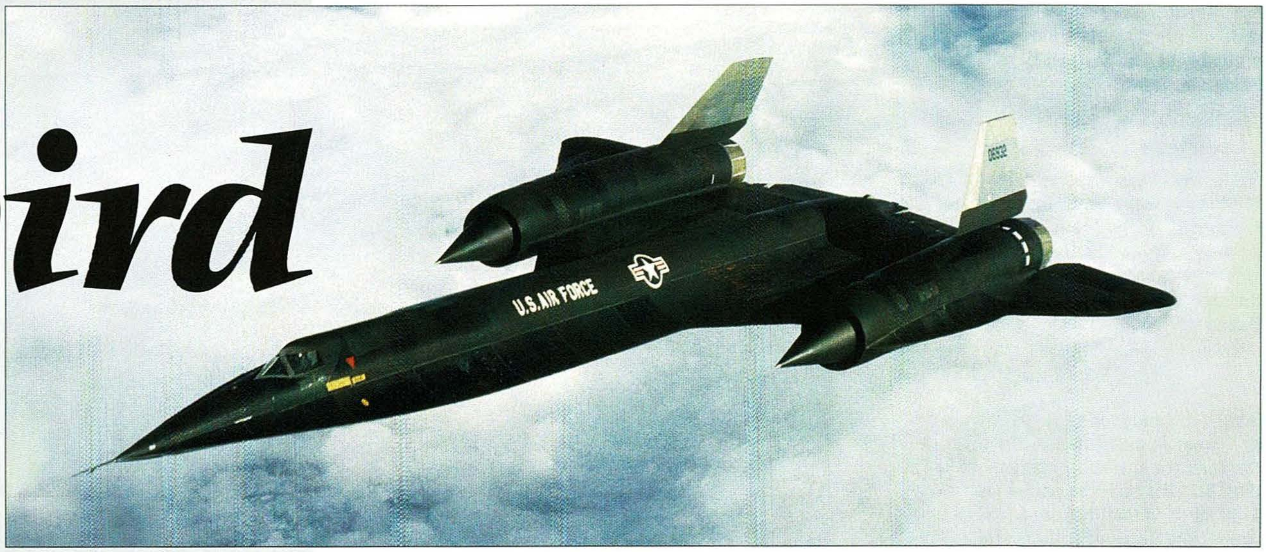
"No one is going to come along and produce an aircraft with greater performance than this one ... by the year 2000." This bold statement was attributed to legendary aircraft designer Clarence "Kelly" Johnson, of Lockheed's famous "Skunk Works," when he was referring to his SR-71 Blackbird reconnaissance jet. Indeed, the aircraft set unofficial and official records in the 1960s and 1970s that have never been broken, and the Soviet Union was unable to create anything to match its performance and capabilities. During the 20 years leading up to that time, Robert J. Gilliland had been flying as a US Air Force pilot, gaining first hand experience of the P-47 Thunderbolt, F-84 Thunderjet, F-86 Sabre and several other types. He was stationed in Germany with the 86th Fighter Wing during the early 1950s when he managed to secure a combat tour in Korea. Based at Taegu AB, he flew 25 missions in F-84s before returning to his unit in Germany. On completion of his overseas posting, he volunteered as a test pilot and soon found himself at Eglin AFB, Florida, test-flying just about every type the USAF had in its inventory. His Air Force experience set the stage for his extraordinary career at Lockheed, for whom he was a test pilot on the F-104 Starfighter program and chief test pilot for the SR-71 Blackbird. He was chosen to take the revolutionary black jet on its first test flight and, during his career, has logged more experimental supersonic flight time above Mach 2 and Mach 3 than any other pilot. In 1964, Gilliland was honored with the Iven C. Kincheloe Award by the Society of Experimental Test Pilots, which voted him top test pilot.

Thompson: Lockheed recognized the U-2 was ever more vulnerable to attack by surface-to-air missiles. What were the biggest obstacles the designers faced when building the family of high-Mach/high-altitude aircraft that culminated with the SR-71?

Gilliland: All of the supersonic fighters built have been "dash" vehicles. The SR-71 was not. It was designed to stay up there and "cook" ... taking a prolonged "heat soak." Metal not only expands when it gets hot, it also weakens. Knowing this, you can imagine the difficulties that Kelly Johnson and his design team faced when they were trying to come up with something that would have structural and hydraulic integrity ... and still be capable of expanding and contracting all the time. Taking on fuel provides a good example of the problem. We had to refuel the Blackbird when it was flying subsonic of

 July 1999

bird



course, when the temperature could be as low as minus 70° F. Then we took it right back up to extreme altitudes at a high Mach, causing the airframe to take a serious "heat soak" for a long period of time. The SR-71 was designed to take the heat at about 800° F. That compares with about 425° F for a self-cleaning oven, and 550° to 600° F for a soldering iron. Everything had to be designed to take this wide temperature range, with all the expansion and contraction. It was amazing that Kelly could design an aircraft to take all of this without popping the rivets! At the same time, he had to make the aircraft fuel efficient. Unless everything was efficient, both aerodynamically and fuel consumption-wise, he would not get the range ... and the purpose of the project would have been defeated.

Kelly Johnson was one of the smartest men I ever met. He was generally considered to be the greatest aeronautical designer of all time, even by the Russians! He knew better than anyone the difficulties of designing a supersonic aircraft that would be an air-breather capable of absorbing extreme temperatures. Compare the air-breathing SR-71 with the rocket-powered Bell X-15 or the rocket motors for the space shuttle. All are designed for high speeds, but rocket motors carry their oxygen as part of their chemistry and don't need to take a sustained "heat soak." The SR-71 obtained its oxygen from the atmosphere. What's more, at 90,000 feet the local atmospheric pressure is just above 1 percent of sea level density, and the aircraft is operating in a zone that is partially aerodynamic but largely inertial. You literally can't turn because you are going faster than the muzzle velocity of a bullet. Imagine trying to turn a bullet!

Thompson: Why was there such a pressing need to fly so high?

Gilliland: The interest in developing a high-flying supersonic aircraft, that would be extremely difficult to knock down, came about because of the advances being made in surface-to-air missiles (SAMs) back in the late 1950s. The prediction that Kelly had made a few years earlier, that someday one of our U-2s might be shot down, had come true in 1960 when Francis Gary Powers was downed over Russia. Fortunately, the influence Kelly had developed with the government over the years enabled us to get funding for the Blackbird programs. Frankly, I was surprised at his audacity in undertaking a program this difficult when the likelihood of failure was so great.

Thompson: What were your thoughts about the SR program back then?

Gilliland: When I first heard about the program, I went to Kelly and told him that I wanted to be the main test pilot. I had already been test flying the A-11/A-12 and YF-12A. Right then he said, "I was hoping you would say that." During those early days, I spent a lot of time with the cockpit design group. Most, if not all, fighter cockpits were cramped and uncomfortable, especially for someone who stood 6' 3" and weighed 195 lb, like me. For that reason, I worked closely with the design people to make sure the it was properly designed and had ample room. Before this, most fighter-type cockpits had been laid out for smaller pilots.

The standard SR-71 was to have two cockpits, in tandem. The backseater (RSO) had no flight controls, but he was to be the expert on the specialty systems on board. However, Kelly and I both agreed that on the first test flight, I would be the only one aboard the aircraft.

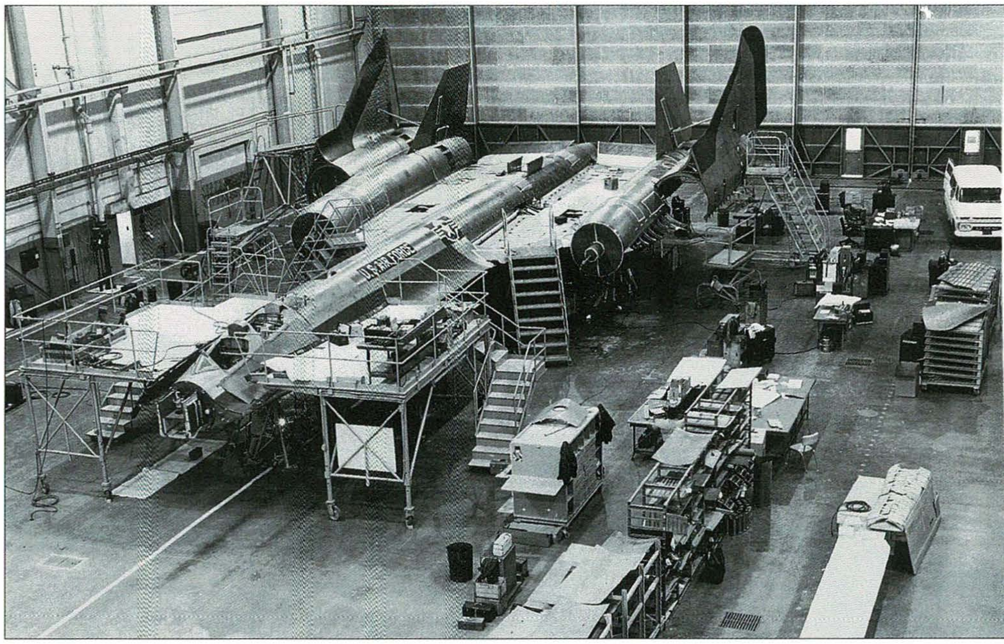
Thompson: What specifics were discussed leading up to the first flight?

Gilliland: When the time came for me to make the first flight, there were 379

above: **The Lockheed A-12 was the forerunner of the SR-71 Blackbird, and first flew in 1962. The Blackbird incorporated a longer fuselage to accommodate additional fuel.** *(Lockheed)*

below: **SR-71A patch.** *(Ted Carlson)*

right: **The first SR-71A, serial 61-7950, shown during the early stages of assembly at the "Skunk Works" in Palmdale, California.**



middle: **Lockheed test pilot Robert J. Gilliland took the SR-71 for its first test flight on 22 December 1964, out of Palmdale, California. He is seen here making a subsequent flight as part of the test program at Edwards AFB, California.**

bottom: **Recently rolled out at Palmdale, this example awaits a test flight. During the peak years of its operational life, the SR-71 Blackbird operated from RAF Mildenhall in the UK, Kadena AB in Japan, and Beale AFB, California.**

(photos Lockheed Martin "Skunk Works")

"open" items ... that is, nonfunctioning items. We had numerous meetings with the engineers to determine which needed to be working to accomplish what we had to do. The sole criterion, of course, was safety of flight. On a first flight for any new aircraft, the landing gear is not normally retracted. But Kelly wanted not only to retract the gear but also to go supersonic. It meant a greater risk and he and I discussed this. I told him it didn't matter to me because if there was a major malfunction, I could always "punch out." We had a lot of confidence in the aircraft and he made the decision to raise the gear that would enable us to go supersonic.

Thompson: What were the objectives for the first flight?

Gilliland: Like any first flight, the most important objective was to land! Of course, there were several things we hoped to accomplish and Kelly and I drew up the test flight card. This list was attached to the upper part of my leg so it would be easy to refer to it while I was flying the aircraft. Before the first flight, however, we had to go through all of the procedures as if we were going to take off. A high-speed taxi test had to be made first and this gave us a chance to check all of the instrumentation and systems. After starting the engines, I checked out everything and gave the OK to pull the chocks. Taxiing out and turning onto the main runway, I eased the throttles forward to military power. The aircraft accelerated rapidly and I scanned the instruments. Then I went to afterburner for a few seconds before pulling back to idle. At this time, I deployed the drag chute and tested the antiskid braking system. After slowing down, I jettisoned the chute and taxied back to the hangar. All of the extensive instrumentation had to be checked to make sure we were ready for the first flight which was to be made several days later.

I undertook this on 22 December 1964. One of the most important things we wanted to do after takeoff was to climb up to 25,000 feet, get into the middle of the "envelope" and turn off the artificial stability. We had to find out what the effect would be on control of the aircraft. Without it, the SR flies very sloppily. It displayed its inherent aerodynamic characteristics in all three axes ... roll, pitch and yaw.

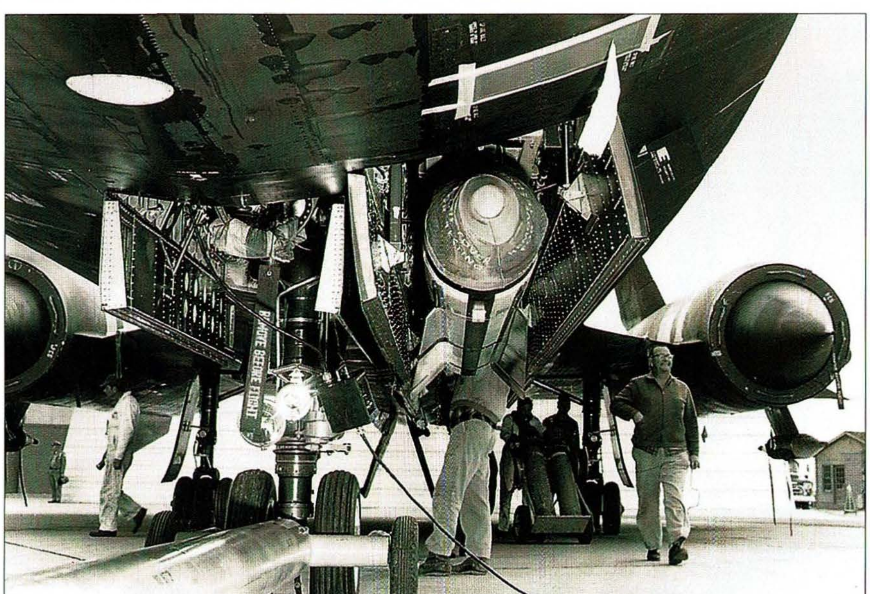
Later on in the testing process, the Air Force requested a demonstration whereby the artificial stability was to be turned off while at maximum Mach, to prove that it could be controlled and brought back safely to base. This had to be accomplished before the Blackbird could become operational.

Thompson: What are your recollections of the first flight?

Gilliland: All of this happened a long time ago but it is still clear in my memory. I had three F-104 "chase" planes on that initial test flight. Normally, there would be only one, but it was extremely important that everything was documented. Two of these F-104s were two-seaters, so that allowed a cameraman to be carried in the backseats. I asked them to keep a safe distance because I was so busy in the cockpit I didn't have the time to keep an eye on them. I headed away from Palmdale north toward the Sierra Nevada Mountains at subsonic speed. Everything was working the way we anticipated and, after making a gradual turn, I headed back towards the base. The time had come to take it supersonic. If an emergency had come up as I increased the speed, I would not have to worry about turning the Blackbird around. I added power, gradually accelerating and climbing. The aircraft responded as we expected it to, but when my airspeed reached Mach 1.2, a red light came on indicating the canopy was unsafe. I came back to minimum burner and evaluated the situation. I knew the guys who had designed the canopy back at the "Skunk Works" were among the best in the business. I figured it might be an aerodynamically created low-pressure area over the canopy that was causing it to lift just a fraction. It triggered one of the micro-switches and caused the red light to come on. After thinking along these lines for a few seconds, I added power again. All the while the red-light warning continued. I kept climbing and accelerating up to 50,000 feet, the agreed-upon cutoff point. The SR-71 hit Mach 1.5 before I brought the power back and started descending. The flight lasted about one hour. Back on the ground at Palmdale the problem with the canopy was checked and the cause was found to be aerodynamic, as I had guessed.

above and below: **The YF-12A was proposed as a supersonic interceptor for the Air Force, but was subsequently cancelled. During tests it was used to successfully fire several AIM-47 air-to-air missiles at drone targets during the mid/late-1960s.**

(photos Lockheed)



Thompson: How was it possible to power the SR-71 for such high-altitude flight?

Gilliland: The SR-71's engines were very unique. They were hybrids that were part turbojet and part ramjet, in combination with the inlets. That is where the aircraft achieved its efficiency. If you take an "X-Y" chart and plot speed on the "X" axis and efficiency on the "Y" axis, a turbojet shows reduced efficiency the faster it goes. For a ramjet, the opposite is true ... the faster you go, the greater the efficiency. So we married these two curves at about Mach 2.3. As the speed increased, we went from turbojet mode to ramjet mode. Just remember that we had to make this efficient or we would not have got the range we wanted. In the beginning, Kelly told me that he would be happy if he got a range of 1,200 nautical miles but ended up getting twice that. He and the engineering staff did an outstanding job of optimizing the range and efficiency of the SR-71 whose forte was to go from point A to point B in a straight line ... with impunity ... flying at an extremely high altitude and high Mach.

Thompson: What difficulties were encountered on the test flights?

Gilliland: On nearly all early flights there were problems, and often multiple emergencies. Most test pilots like the challenge, danger and the excitement. You come to thrive on it. As Chuck Yeager once stated, "We test pilots are all adrenalin junkies." I can remember one flight where I lost both engines up at 85,000 feet. I couldn't get either one lit until I was down to around 12,000 feet. I was very close to "punching out" and that would have been a very bad scene for me because we had about 30 knots of wind on the ground that day. There was a saying amongst test pilots at Edwards about "shaking hands with a Joshua tree at 30 knots!"

I recall several other situations when there were problems. On one occasion, I had an electrical failure and couldn't transfer any fuel. As you go supersonic your center of lift moves aft, so we designed our center of gravity (CG) system so the fuel tanks were used in a special sequence. You need the CG to remain within bounds while the airplane is trimmed to get the most range and efficiency, without any unnecessary drag. If you have to fly around with the elevons sticking up, it is like flying with your speed brakes out. The CG is automatically programmed and if it doesn't work properly the pilot has to get "into the loop" to make it work properly. The center of lift and CG have to be correlated to minimize trim drag on the elevons.

It is necessary for the alternators to work properly to run the fuel forward, in this case into number 1 fuel tank, so the CG would be within limits to provide positive stability for the landing. There were times when I had to land the SR with negative stability, which made it "squirrelly" and more difficult to control.

Over the period I was test-flying the aircraft, the problems with the new engines and complex inlets were gradually worked out. Ultimately they performed extremely well and, although the maximum design speed was pegged at Mach 3.2, they could easily move you on up to Mach 3.5 although at greater heat risk. It should be remembered the airplane was designed for maximum efficiency at Mach 3.2.

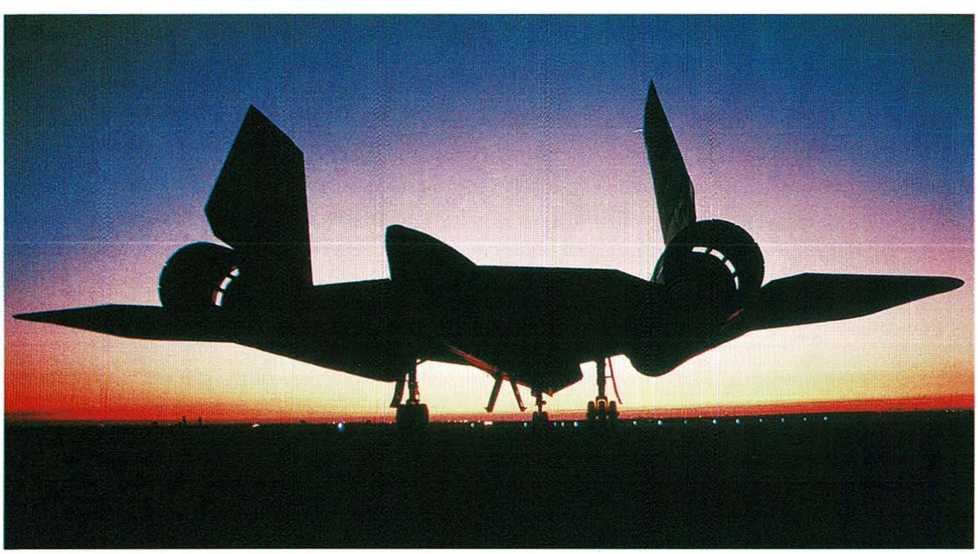
Thompson: Were Soviet SAMs ever a threat to the Blackbird?

Gilliland: The idea of the SR was for an aircraft that could overfly hostile nations without being shot down. Kelly's idea was to build an aircraft that could fly miles higher and about four to five times the speed of the U-2. These characteristics would keep it out of harm's way. On many occasions during U-2 overflights, Soviet fighters would reach their maximum speed, pull their noses up and launch missiles at them. This never succeeded, but the greater danger was ever-improving SAMs.

Mathematically, the odds of getting a hit against an SR-71 were extremely low. In the days of the Cold War, if I had been flying the SR on an operational basis and knew a SAM had been launched against me, it would not have raised my blood pressure one point ... so long as I had altitude and speed. As a matter of fact, you could have announced in advance when and where you were going to fly and there was absolutely nothing any adversary could have done about it. I understand that over the years, the Soviet Union and its satellite states fired between 4,000 and 5,000 SAMs against the Blackbird, but never hit one, simply because of the laws of physics.

Surface-to-air missiles are controlled from the ground, and have the capability to change direction while in flight. But when they got up in the ultrathin air where the SR-71 was flying, a high-mach missile couldn't turn and we couldn't turn ... and it became a standoff. The window of opportunity for a missile launch against the SR was only 4.2 seconds. This means it was next to impossible to bring the Blackbird down with a SAM. At around $1 million for each missile, the "Skunk Works" certainly contributed its share to Soviet military spending!

In terms of being able to go wherever it was sent without real risk of harm, the high-flying, Mach-3, SR-71 Blackbird was master of the skies. Although the American public was unaware of its existence for many years, one can only imagine the pressure it must have put on Soviet military leaders. Thankfully, the West did not have to cope with the thought of its enemies possessing a platform like the SR-71 – with an ability to overfly the United States at will. ❑



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top: **The SR-71 was designed to defeat surface-to-air missiles by flying too fast and too high for them to be effective. For this reason, no fighters of the day could threaten the Mach-3 reconnaissance jet.**

left: **Weather permitting, the SR-71 was capable of photographing any point on the globe within six hours of taking off.**

(photos Lockheed Martin "Skunk Works")