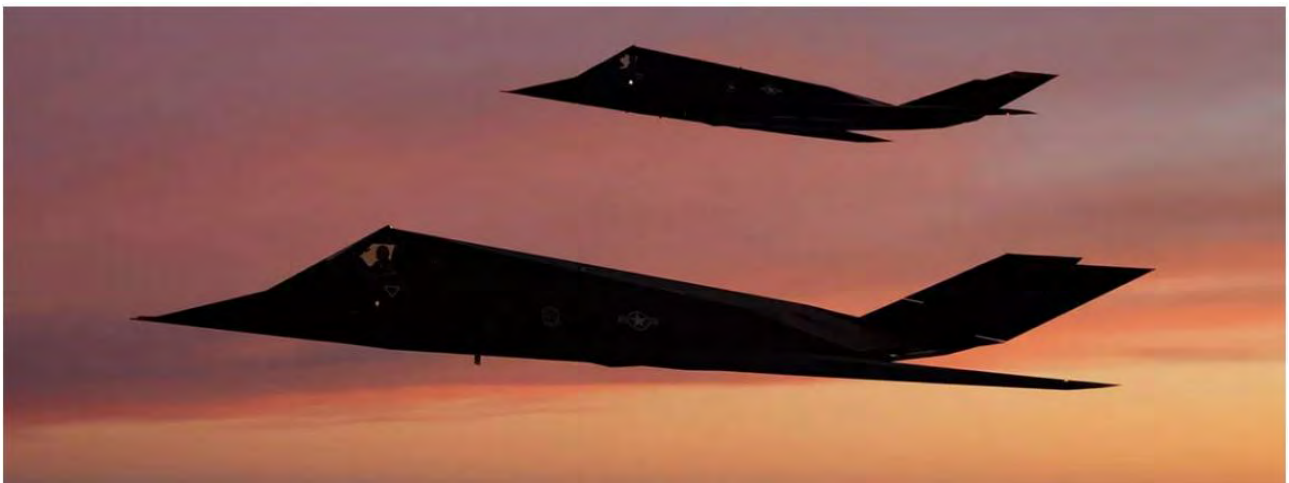


Stealth Secrets of the F-117 Nighthawk

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Don Hollway

Television viewers who tuned to the Cable News Network (CNN) on the evening of January 16, 1991, were treated to a rare live preview of wars to come. Correspondents Bernard Shaw and Peter Arnett, broadcasting live from their room in Baghdad's Al-Rashid Hotel, were covering the state of alert of Saddam Hussein's Iraq.



Two F-117A Stealth Fighters head off into the night. USAF Foto

Five-and-a-half months after Iraqi forces invaded the emirate of Kuwait—and 17 hours after the deadline for their withdrawal set by the coalition opposing them—Baghdad had taken shelter beneath the strongest concentration of air defenses in the world. These included 76 surface-to-air missile (SAM) launchers and nearly 3,000 anti-aircraft artillery (AAA or triple-A) guns.

Iraqi radar operators scoured the moonless skies for the first indication of approaching aircraft, but they saw nothing. "We haven't heard any planes yet," noted Shaw, wondering aloud whether Boeing B-52 bombers flew so high they couldn't be heard.

Six hundred and fifty miles almost due south, at Khamis Mushayt in southwestern Saudi Arabia, U.S. Air Force pilots of the 37th Tactical Fighter Wing also were glued to the CNN newscast. Two hours earlier, some of their squadron mates had departed King Khalid Air Base in the first airstrike of the war. One of their targets, located on the west bank of the Tigris River, was the 370-foot Al-Kark Communications Tower, which transmitted CNN's television signal to the outside world. Now, as the estimated time on target approached, each man at

King Khalid kept one eye on CNN and the other on his watch, counting down. If all had gone according to schedule, the network would go off the air...now!

The need for an aircraft that could penetrate modern air-defense systems had actually arisen from another Middle Eastern conflict almost 20 years earlier. In the 1973 Yom Kippur War, Israeli-flown McDonnell-Douglas F-4 Phantom fighters suffered heavily from Egypt's radar-guided SA-6 SAMs. In Vietnam, meanwhile, the U.S. Air Force was devoting more than half its aircraft to radar suppression rather than bombing. The first real solution to these problems would not come until 1975. It came from the most likely source, the Advanced Projects Division of Lockheed-California—the famous "Skunk Works." Engineers there reasoned that curved surfaces reflect energy in many directions, the way a soap bubble reflects sunlight. If an aircraft's surfaces were flat, like the facets of a diamond, reflections could be limited to directions of the designers' choice—namely, away from enemy receivers. Models tested outdoors at Lockheed's Palmdale facility bore out the hypothesis—even a bird atop one model caused its radar cross section (RCS) to enlarge or to "bloom."



Lockheed built two technology demonstrator aircraft under the code name "Have Blue." The two prototypes were smaller aircraft, one quarter the weight of the F-117, with a wing sweep of 72.5° and inward-canted vertical tails. (Lockheed Martin)

But faceting caused handling problems for pilots, so Skunk Works team leader Ben R. Rich—a close associate of Lockheed's brilliant engineer Kelly Johnson and a veteran of the firm's U-2

and SR-71 spy plane programs—secured government funding of two full-sized, flying **prototypes under the appropriately meaningless code name “Have Blue.”** Skinned with flexible radar-absorbent material (RAM), they featured sharply swept wings with twin fins canted sharply inward, not for supersonic capability but to avoid bouncing reflected signals back to their source. For the same reason, doors for the cockpit canopy, the access panel and the landing gear were given jagged, sawtooth edges that had to fit perfectly flush when closed.

The mere reflection of the pilot’s helmet would outshine the rest of the plane put together, so the canopy was also given a transparent coating to render it impenetrable to radar. Similarly, because modern radars can look down engine inlets to bounce returns off the highly reflective compressor blades (and in many cases identify them by counting the rotating blades), the two engine inlets were covered with a fine, radar-opaque mesh. Screw heads were redesigned because at one point just three screws that had been insufficiently tightened **caused the jet’s RCS to bloom.**

Radar, however, is not the only popular method of aircraft detection. To reduce their vulnerability to heat-seeking missiles, the prototypes used slit-like exhausts, shielded from **beneath by a wide, flat, “platypus” tail.** Exhaust emerged in cool, diffuse fans rather than hot, concentrated streams. The canted fins also were intended to screen the engine exhausts from enemy fighters looking down from above.

The prototypes were shipped to the top-secret facility at Groom Dry Lake, in the Switzerland-size Nellis Air Force Range north of Las Vegas, Nev. Home to both the U-2 and SR-71 testing programs—**as well as the “Red Hat” squadron, the top-secret stable of captured MiG fighters—Groom Lake was the natural choice for the Air Force’s newest “black” (top-secret) program.**

The first prototype flew in early 1978. Naturally unstable and made airworthy only by virtue of computerized, quadruple-redundant, fly-by-wire controls, it exhibited rapid speed loss in nose-up attitudes, a high landing speed and a high sink rate. These problems ultimately proved its undoing when Lockheed test pilot Bill Park bounced it off the ground, jamming the right gear halfway up. Unable to land or even belly in, he burned off the excess fuel and ejected at 10,000 feet over the Nevada desert. The prototype was destroyed, and Park, injured during the ejection, never flew again.

The second prototype, however, was a success, proving for all practical purposes its invisibility to radar. It showed at most a low-intensity, nebulous radar sparkle that was nearly indistinguishable on a radar scope from background noise until the aircraft was well within a **ground missile’s minimum launch range.** Only the massive airborne antenna of the Boeing E-3 Sentry AWACS (airborne warning and control system) and some ground-based low-frequency and very-high-frequency radars had success detecting it, but because of their large antennas the latter two are unsuitable for battlefield use.

Because the airplane offered virtual immunity to radar, the Air Force quickly underwrote production of full-scale development (FSD) aircraft. The new design reflected lessons learned

during the Have Blue program. Engine power was increased. The inlets and exhausts were baffled and soundproofed to minimize noise-emitting, instead of the typical jet turbine scream, a high-pitched whine said to set dogs barking before the plane appeared in the sky. The prototypes' inward-canted fins had actually acted to reflect the exhausts' heat emissions, so the FSD's fins were canted outward in a V-shaped "butterfly" tail.



Five aircraft "full scale development" aircraft were designated YF-117 with the first fighter making its maiden flight from Groom Lake, Nevada on June 18, 1981. (Lockheed Martin)

The demands of combat, as modified by the requirements of stealth, dictated the rest of the redesign. Contrary to most military aircraft designs since the 1950s, the airplane would carry no radar, since even an inactive radar acts as a reflector. Even the normal radio antennas that adorn conventional aircraft were made to retract beneath the airplane's skin when not in use.

Also, since external fuel tanks and weapons would adversely affect the plane's RCS, all fuel and munitions would be carried internally. The limited capacity of inboard fuel tanks could be overcome with aerial refueling. Instead of carrying tons of conventional bombs, the plane would carry only one or two laser-guided "smart" bombs. Essentially comprised of a seeker head and fins attached to a standard "dumb" bomb, smart bombs home in on invisible, infrared laser light shined on the target by the attacking aircraft. The result is a "circular-error

probable" (CEP: the circular distance around the target in which the bomb is likely to strike), measurable in inches.

The Air Force was anxious for a new aircraft, having (temporarily) lost its new Boeing B-1 bomber to government cutbacks. Naturally, speculation in the aviation press centered around a full-sized, advanced-technology bomber. The new airplane might have escaped attention altogether, except that in 1980 the White House intentionally alluded to its existence. Whether this was an election-year ploy remains open to question. The new aircraft—then popularly **known as the "stealth fighter" rather than the "stealth bomber"**—was to become a hot aviation topic over the next decade.

The new airplane was given a new code name, "Senior Trend," as well as the deceptive designation of F-117. **The American "Century Series" of fighter aircraft, beginning with the North American F-100 Super Sabre, supposedly ended with the General Dynamics F-111 Aardvark.** In October 1962, in the interest of cross-service commonality, the Department of Defense began renumbering its combat aircraft, starting with F-1. After the Northrop YF-17 (which became the Northrop/McDonnell-Douglas F/A-18 Hornet) came the Northrop F-20 Tigershark. Aviation journalists naturally guessed the stealth fighter was designated F-19 to fill in the numbering void. The origin of the F-117 designation is somewhat of a mystery, but it began turning up on Lockheed documents regarding Senior Trend, and the Air Force saw no reason to change it. At the very least, it enabled government spokespersons to plausibly deny the existence of an F-19.

The first stealth fighters were flown by Lockheed C-5 Galaxy cargo plane to Groom Dry Lake, where they took to the air for the first time in June 1981. Security was, to put it mildly, tight. Unauthorized ground personnel were required to remain indoors when a stealth jet emerged from its hangar. Test flights were made mostly at night, their schedule arranged to avoid overflights by Soviet reconnaissance satellites. The Nellis Range is also home to the **Air Force's "Red Flag" air combat exercises, which involve aircraft and pilots of American and several foreign military aviation services.** Those other aircraft were kept away from the Groom area by an airborne screen of security aircraft.

Despite the **F-117's 33 percent increase in physical size over the prototype, the stealth fighter's RCS measured between .01 and .001 square meters**—about that of a small bird. For instance, compared to a McDonnell Douglas F-4G Phantom typically used for **"Wild Weasel"** anti-radar missions, which has a head-on RCS of 6 meters, the F-117 was able to get 90 percent closer to ground-based search radars, and 98 percent closer to airborne radars, before being detected.

Testing was still underway when the Air Force ordered an entire wing of the production version of Senior Trend, the F-117A Nighthawk. Until delivery of their F-117As, the pilots trained in Vought A-7D Corsair IIs. The first military pilot to fly a Nighthawk was Lt. Col. Alton C. Whitley, a Vietnam veteran with combat experience in the A-7 and the North American F-100, and former commander of the Air Force's **"aggressor" squadron.** **"When I first looked at**

[the F-117A],” he recalls, “it reminded me of some ‘Star Wars’ type of aircraft. I thought, ‘Boy, is this the 21st century!’”

Having outgrown the Groom Lake facilities, the stealth unit—now officially the 4450th Tactical Group—operated out of the remote Tonopah Test Range airfield in the northwest corner of the Nellis Range. Although overlooked by public land, the Tonopah facility was some 40 desert miles from the nearest town—sufficiently remote to discourage all but the most persistent observers. Pilots of the 4450th flew into Tonopah each Monday aboard a government-chartered airliner for four nights of training before returning home on Friday afternoon.

By this time the second Have Blue prototype had caught fire in midair and crashed, and the first F-117A had been retired after going inverted and backward on takeoff. Both test pilots survived. The first incident was attributed to a broken fuel line, and the second to inadvertently cross-connected pitch and yaw controls. (Normally the Nighthawk’s fly-by-wire system compensated for its instability so well that when one jet lost an entire rudder at high speed, the pilot had to be informed of the fact by the chase plane, after which he landed safely.)

With low wing loading and G limits comparable to that of the F-4, the F-117 reportedly handles well. The widely publicized nickname “Wobbly Goblin” apparently derives from its “departure” characteristics—once out of control, it cannot be recovered.

In June 1986 and again in October 1987, pilots flew their Nighthawks into the ground. Both incidents were attributed to pilot fatigue and disorientation. Despite U.S. Air Force efforts to the contrary, word filtered to the outside world. Public interest in the stealth fighter had been renewed in July 1986, when Testor Corporation released a curvaceous plastic model of an “F-19,” insisting it was 80 percent accurate.

Finally, in November 1988, the Pentagon publicly revealed a grainy, retouched photo notable mostly for how little it revealed of the F-117. By then, the 4450th, now activated as the 37th Tactical Fighter Wing (the “Defenders of the Crossroads”) and consisting of the 415th and 416th Tactical Fighter squadrons (the “Nightstalkers” and “Ghost Riders,” respectively) and the 417th Tactical Fighter Training Squadron (the “Bandits”), was combat-ready. Twice, stealth fighters were within an hour of taking off to bomb targets in Libya, only to have their missions scrubbed to avoid revealing their existence. Not until December 1989 and the U.S. invasion of Panama—Operation Just Cause—did the F-117A see action.

Refueling in midair, six Nighthawks made their way to Panama via Texas and the Caribbean Sea. Two of these were backup aircraft, which turned back unneeded. Two more were assigned to support special forces troops attempting to kidnap General Manuel Noriega, but their mission was scrubbed.

Confusion over the last-minute change resulted in a mix-up over the remaining target, a barracks housing two battalions of elite enemy troops. The intent was not to kill but to stun; the lead F-117A did just that with a single 2,000-pound Mark 84 bomb. Colloquially known as

"the Hammer," the bomb—with a lethal radius of 400 feet and capable of blowing out eardrums half a mile away—exploded in a field next to the barracks, throwing the Panamanians into confusion. The second stealth jet also hit its aim point, which, however, turned out to be in error. Still, the Air Force declared the mission a success. After all, the stealth jets had gone unnoticed on Panamanian radar.

On August 17, 1990, the 37th Tactical Fighter Wing received a new commander—Colonel Al Whitley. **"Four hours later," the colonel recalls, "the word came in to deploy our first squadron."** The United States and its allies planned to oust Saddam Hussein's Iraqis from Kuwait, by force if necessary, and the Nightstalkers were among the first allied units to deploy to Saudi Arabia.

Located 6,500 feet up in the mountains near the Red Sea, King Khalid Air Base — **nicknamed "Tonopah East"**—had been built in the late 1970s in return for delivery of McDonnell-Douglas F-15 Eagle fighters and AWACS airborne sentries to Saudi Arabia. Because the base was well beyond the reach of Iraqi Scud-B ballistic missiles, the stealth jets would require three midair refuelings each in order to reach their main target—downtown Baghdad.

"I generally put the F-117s against the Baghdad targets," stated the Air Force's chief mission planner, Brig. Gen. Buster C. Glosson, **"where we would have lost [conventional] airplanes."** Mission personnel included only three combat veterans—Whitley, his deputy commander, and one Just Cause pilot. But five months after the F-117s were deployed to Saudi Arabia the incessant training above the barren Nevada desert paid off. The Nightstalkers and Ghost Riders lugged 2 tons of bombs apiece across more than 1,000 miles of nighttime desert. Shortly before 3 a.m. local time, January 17, 1991, eight black jets arrived, lights out and radio silent, above Baghdad.

It was Captain Marcel Ker David who was assigned to bomb the Al-Kark tower. **"Even though I felt very well prepared with my training, I was somewhat apprehensive about the aircraft,"** he admitted later. **"Its stealthiness had not been tested in combat, and everyone wondered whether or not this stealth stuff really worked."****The New 'Stealth Fighter'?**

Does the U.S. military have a new "black" aircraft program in the works? Since the mid-1980s, the aviation press has been investigating Pentagon paper trails and eyewitness encounters with what may be the stealth fighter of the next century.

Listed (perhaps accidentally) in a February 1985 Pentagon budget request along with **Lockheed's SR-71 Blackbird and U-2 spy planes, the project's code name, "Aurora,"** may have been intended as a ruse similar to the F-19 ploy—it had been applied to a maritime patrol aircraft developed for the Canadian military. But the Canadians had already taken delivery of their Auroras, and the Pentagon was apparently still developing its Aurora—to the tune of \$80 million in fiscal 1986, increasing almost thirtyfold to about \$2.3 billion by 1987.

Typically, the Air Force had no comment. But by 1988 it was reportedly at work on a replacement for its SR-71 reconnaissance aircraft, which it retired with uncharacteristically little reluctance in March 1990. What kind of aircraft could make the **SR-71's Mach 3-plus**

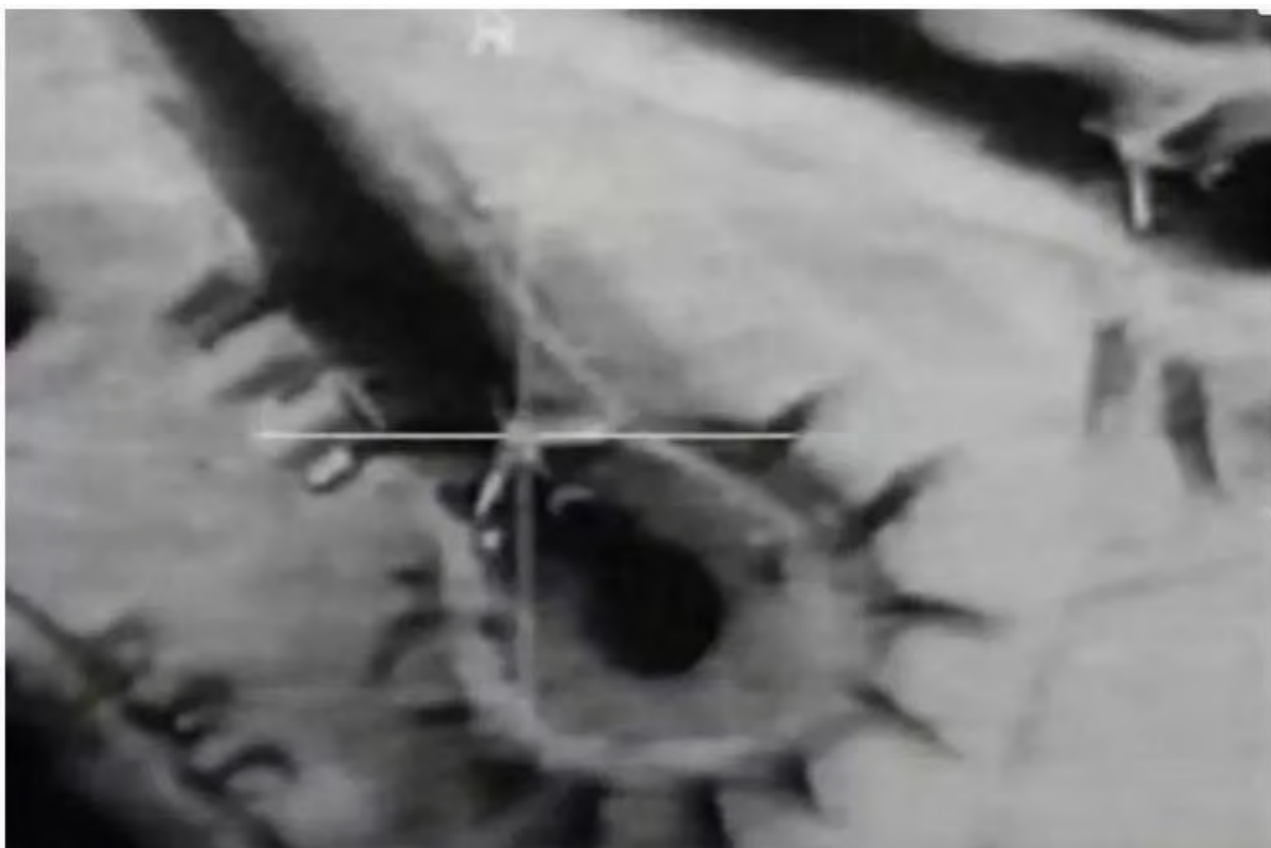
cruise and 80,000-foot ceiling obsolete? Artists' conceptions, some perhaps purposely misleading, depict super-Blackbirds weighing in at more than 150 tons, powered by variable-cycle turbo-ramrockets burning liquid methane or even liquid hydrogen, cruising the edge of space at Mach 6. According to eyewitness accounts, Aurora is more modest, in size if not performance.

In early 1990, Aviation Week and Space Technology magazine reported incredibly loud air traffic at night over Edwards Air Force Base in California. One source described the sound as **"the sky being ripped open."** In June 1991, a sonic boom similar to those caused by space shuttles re-entering the atmosphere—and strong enough to register on seismographs—rolled across **Southern California. Judging by its sonic "footprints," the object was flying toward the** huge Nellis Air Force Range at more than Mach 3.

Activity also seems to center around the air base at remote Machrihanish in western Scotland (which was linked to the F-117A before the Nighthawk was made public). In November 1991, for instance, a Royal Air Force air traffic controller observed a radar blip depart Machrihanish at Mach 3. And in August 1989, on the other side of Scotland, an engineer on an oil rig in the North Sea observed a midair refueling operation involving a mysterious plane shaped, when seen from below, like an isosceles triangle.

A new Blackbird spy plane? A futuristic superfighter? A prototype supersonic transport, or even an aerospace plane to replace the space shuttle? Only one thing is certain—design teams like the Skunk Works never rest on their laurels. D.H.

Anticipating a pilot-rattling sleet of anti-aircraft fire, mission planners had assigned a **second stealth jet to mark Kerdavid's** target and lighten his workload. (In fact, the prior arrival of several Tomahawk cruise missiles had spurred a flurry of triple-A, but a few minutes before the stealth jets arrived overhead the Iraqi crews actually ceased fire to cool their guns.) As the laser beam touched the Al-Kark's dome-shaped roof, a forward-looking infrared radar (FLIR) **scope in the nose of Kerdavid's plane picked up the signal and displayed it in the cockpit's 8-** inch video display. Using a fingertip control on his throttle stick, Kerdavid locked his aim point **onto the laser glint, and his weapons system projected an imaginary "basket" above it, into** which it would have to drop the bomb for a successful strike.



An Iraqi Air Force, Tupolev Tu-16, 'Badger' sits squarely in the crosshairs of an F-117. (Lockheed Martin)

Ten seconds before release, Kerdauid hit the "pickle" button that enabled his weapons system. The Nighthawk's bomb bay snapped open and lowered its lethal load into the slipstream: a 1-ton GBU-27A/B guided bomb, designed especially for use by the F-117A.

Freed of the necessity of dodging anti-aircraft fire, Kerdauid (who received the Silver Star for his feat) was able to drop his bomb from relatively high above and near the Al-Kark. He immediately veered away north toward his secondary target, a command bunker in the Taji suburbs. The second F-117 loitered on station a little longer, using its belly-mounted, downward-looking infrared radar (DLIR) laser designator to mark the target for Kerdauid's bomb as it fell.

In their room in the Al-Rashid Hotel, the CNN reporters' microphones picked up the rising moan of an air raid warning. "Now the sirens are sounding for the first time," noted Peter Arnett. "The Iraqis have informed us...."

At that instant, as if out of nowhere, Kerdauid's GBU-27 slammed into the Al-Kark, drilling halfway down the tower before exploding. The entire building snapped in half—a spectacle lost to CNN viewers and personnel at King Khalid because the network promptly went black. A surviving audio-only land link allowed Arnett to verbally describe the blinding spray of aimless return fire rising above the Baghdad skyline. The Iraqi gunners' radars told them no aircraft were above them.

Seconds later another F-117A's GBU-27 hit directly across the Tigris from the Al-Kark. It fell through the roof of the 12-story Baghdad International Telephone Exchange, known to Air Force mission planners as the "AT&T Building" and the only target in the city slated for a double hit. One of those planners was the 415th Tactical Fighter Squadron's Major Jerry Leatherman, who 60 seconds after the first strike circled in from the northeast to drop a pair of high-blast Mk. 84 homers from three miles up through the hole in the building's roof. The first went a little low, but the second was dead on, and together they demolished the top four floors.

In quick succession, three waves of stealth jets singled out their objectives with a precision at once merciful and merciless—the Iraqi Air Force and Ba'th Party headquarters, air defense control centers, Rashid Airfield, and other high-value targets including two of Saddam Hussein's presidential palaces. A half hour after the initial attacks, the city blacked out, probably not because of Iraqi precautions but because the power grid was destroyed. But Baghdad remained well lit by the triple-A fire.

Back at King Khalid, the ground crews anxiously counted the returning aircraft, the last of which did not touch down until after dawn. Miraculously, not only did every Nighthawk come back, but none of them bore so much as a scratch.

In the first 24 hours of the war, the 42 stealth fighters at King Khalid—just 2.5 percent of the total allied aircraft deployed in the Gulf—accounted for 31 percent of the targets attacked. Damage estimates were lower than expected, partly due to a low layer of mist that obscured Baghdad toward dawn. Not only did cloud cover—three times the seasonal average during the course of the war—interfere with subsequent operations, it compromised the black jets' invisibility.

"If you're just above a cloud deck, with the moon reflecting off it, you can really stick out," explained Leatherman. At one point, an F-117A was shadowed by what appeared to be an Iraqi Dassault Mirage F1 fighter, shining a landing light or spotlight in order to visually acquire the stealth jet. A gentle turn, however, broke whatever lock the Iraqi had; that was the closest any Nighthawk came to a dogfight over Iraq.



F-117 stealth fighters from the 37th Tactical Fighter Wing stand on the flight line with canopies raised following their return from Saudi Arabia and Operation Desert Storm. (USAF photo)

The black jets were consistently assigned the most dangerous, high-priority targets throughout the Gulf War. These included radar sites, SAM and Scud launchers, enemy command/control/communications facilities, bridges, hardened aircraft shelters, and bunkers. Their data recorders provided some spectacular video footage for Air Force publicists. These included a hardened Scud storage facility destroyed by a laser-guided bomb dropping through an air duct; one bomb blowing in the door of an ammunition bunker and a second bomb flying through to explode inside; and a GBU-27 flying down an elevator shaft to detonate deep within the Iraqi Air Force headquarters, blowing out all four walls.

Ultimately the greatest purpose served by Nighthawks' surgical strikes, as opposed to indiscriminate bombing, was the saving of lives on both sides. By successfully handling more than 40 percent of the coalition forces' strategic targets, the F-117s convinced the U.S. Air Force to make significant changes after the war in order to adapt to the new technology and tactics.

The 37th Tactical Fighter Wing, redesignated the 49th Tactical Fighter Wing, relocated from Tonopah to Holloman Air Force Base, N.M. Air Force analysts have so far found no way stealth technology can be compromised in the foreseeable future. In any case, the F-117A Nighthawk, the Skunk Works and Ben Rich are assured their places in aviation history. "We guaranteed to

deliver an aircraft which would have stealth characteristics, be virtually undetectable by today's known radar technologies, and be able to deliver a weapons system with unprecedented accuracy," said Rich. "We've done that. Our accomplishments speak for themselves."