The B-2 is built for penetration. It will be a while before a Soviet long-range radar is good enough to detect it.

On Stealthy Wings

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THE Air Force has removed some of the secrecy that had veiled the Northrop B-2 Stealth bomber. In ceremonies at Palmdale, Calif., on November 22, the rollout of the B-2 gave the public its first look at the flying wing, which has been in development for nearly ten years.

Air Force Secretary Edward C. Aldridge, Jr., one of the principal speakers at the ceremony, said that the B-2 "represents a stabilizing system in time of crisis and [is] an essential component of our strategic nuclear force as we progress down the path of nuclear arms reductions" and that the bomber "would promote deterrence."

The Secretary explained that the aircraft will begin flying soon and that, since "we are not just going to fly [the B-2] at night or in remote locations," the supersecret bomber would have been seen anyway. Another, unspoken, reason for the rollout was to show Congress and the public what they're getting for their money.

Security was tight, as many details about the program are still classified. Attendance at the rollout was limited to 500 invited guests (including thirteen members of Congress), approximately 2,000 employees of Northrop and its subcontractors who work at Air Force Plant 42 (many of whom had not seen the completed airplane), and sixty representatives from the media. Two hundred plant and Air Force security guards, some tending police dogs around the aircraft, were present.

The ceremonies were beamed live via satellite TV to other Northrop and subcontractor plants, as well as to several Air Force organizations that have already played, or will play, a part in the B-2's development.

Fifteenth Air Force band played an original composition titled "Stealth Fanfare" as the gray-and-black airplane was towed out of its hangar. Guests were kept almost 200 feet away and were not allowed to see the aft end of the B-2. The aft end incorporates features that mask the plane's infrared (or heat) signature and help it avoid detection by enemy radar.

Knowns and Unknowns

"This aircraft combines all the best attributes of a penetrating

bomber—long range, efficient cruise, heavy payload, all-altitude penetration capability, accurate delivery, and reliability and maintainability," said Air Force Chief of Staff Gen. Larry D. Welch, who was also one of the speakers at the ceremony. "Added to that is the greatly enhanced effectiveness and versatility provided by its Stealth characteristics."

The B-2 will have a crew of only two, but there are provisions for a third crew member if needed "for whatever reasons," said Secretary Aldridge. The cockpit is believed to have flat-panel displays and is thought to be controlled by fighter-type sticks, rather than yokes or wheels.

All weapons carriage will be internal, with the stores attached to the Boeing-built advanced applications rotary launcher. Elimination of external carriage will greatly reduce drag and will also improve the B-2's ability to avoid radar detection. The plane's primary payload will be nuclear weapons (missiles and/or gravity bombs), but the B-2 will have a conventional capability. The weapons payload is classified, but is known to be less than the 134,000-pound designed payload of the B-1B.

The B-2, which looks something like a manta ray, has a wingspan of approximately 172 feet. It is roughly sixty-nine feet long and seventeen feet high.

The B-2's wingspan, interestingly, is the same as that of the Air Force's first flying wings, the Northrop XB-35 and YB-49. These aircraft, which first flew in 1946 and 1947, were regarded as ahead of their time. Both encountered many problems in flight. Only a handful of these planes was built, and both YB-49 prototypes eventually crashed. The B-2 is longer (by sixteen feet) than the earlier flying wings.

The B-2's four engines are General Electric F118-GE-100s, nonafterburning derivatives of the F110 used in the Air Force's F-16 and the Navy's F-14A (Plus) and F-14D aircraft. The engine is in the 19,000-pound-thrust class. The B-2 will be subsonic. The absence of a supersonic "footprint" will enhance its ability to slip into a target area unnoticed.

The B-2's main aids in avoiding detection are its shape and the materials it is made of. Since the B-2 has no sharp edges or vertical surfaces exposed during flight, radar beams have nothing to bounce off. Beams that do find the B-2 will be absorbed by the aircraft's structure of what is believed to be carbon fiber or other composite materials.

"The airplane is not invisible," noted Secretary Aldridge. "It's just that radars can't see it until it's at close range. And we don't anticipate the Soviets developing a [long-range radar] system in the near future that will be able to see it. The B-2 has a very low [radar cross section] that will allow it to get to any target it needs to." Those targets include mobile missiles and high-value command and control centers.

The airplane has an in-flight refueling receptacle. The flying wing shape is very fuel-efficient, however, so the B-2 will need less tanker support than B-52s or B-1Bs do. Experts have estimated the unrefueled range of the B-2 at between 6,000 and 7,500 nautical miles.

Although guests at the rollout were prohibited from viewing the B-2's aft end, *Aviation Week* magazine enterprisingly obtained aerial photographs without the Air Force's cooperation. These photos show the trailing edges of the saw-toothed wing to be fitted with long control surfaces that could act as elevons (elevator/ailerons) or flap-

erons (flap/ailerons) for directional and lift control.

Asked if the plane made use of "fly-by-light," or fiber-optic control linkages, which are impervious to electromagnetic interference, Secretary Aldridge replied with an emphatic, "I'm not going to answer that." The B-2's huge main landing gear doors may also function as an empennage and provide some lateral stability for the aircraft, especially in crosswind takeoffs and landings.

The B-2 Program

"The B-2 is the first computer-age airplane," said Thomas V. Jones, Northrop's chairman of the board and chief executive officer, "but the airplane wasn't built by computers. And computers didn't replace people. Computers brought people together and gave them the tools they needed to make the most of their individual skills and imagination."

Indeed, the B-2 is the first aircraft to be designed and built with a three-dimensional integrated database. This computer network electronically linked Northrop's engineering, tooling, and manufacturing segments with contractor logistics support, the Air Force, and the major subcontractors (Boeing Advanced Systems Co., LTV Aircraft Products Group, and General Electric's Engine Group).

The other major subcontractors (Link Flight Simulation Corp., Hughes Radar Systems Group, and Boeing Military Airplane Co.) and more than forty known subcontractors *(see box, p. 46)* were also in constant contact with Northrop.

The network resulted in a ninety-seven percent success rate for first-time fit of tubing, fluid systems, and mechanical systems. This compares with a sixty percent success rate for a conventional design process. Northrop invested more than $1 billion in the system, which includes 400 terminals and thirty computer graphics rooms at the company's 3,300,000-square-foot Pico Rivera, Calif., facility (where the B-2 was designed and engineered) alone.

The avionics system has already been tested for 44,000 hours. Engineering development testing took another 16,000 hours, and the flight-control system has logged 9,000 hours on the test bench. Strategic Air Command flight crews (the eventual users) have accumulated 6,000 hours in the B-2 simulator.

The airplane was also designed for high reliability and maintainability. Crew chiefs and line maintenance troops were consulted about access to components, and Air Force Logistics Command officials provided input on sustainability.

Eliminating Contrails

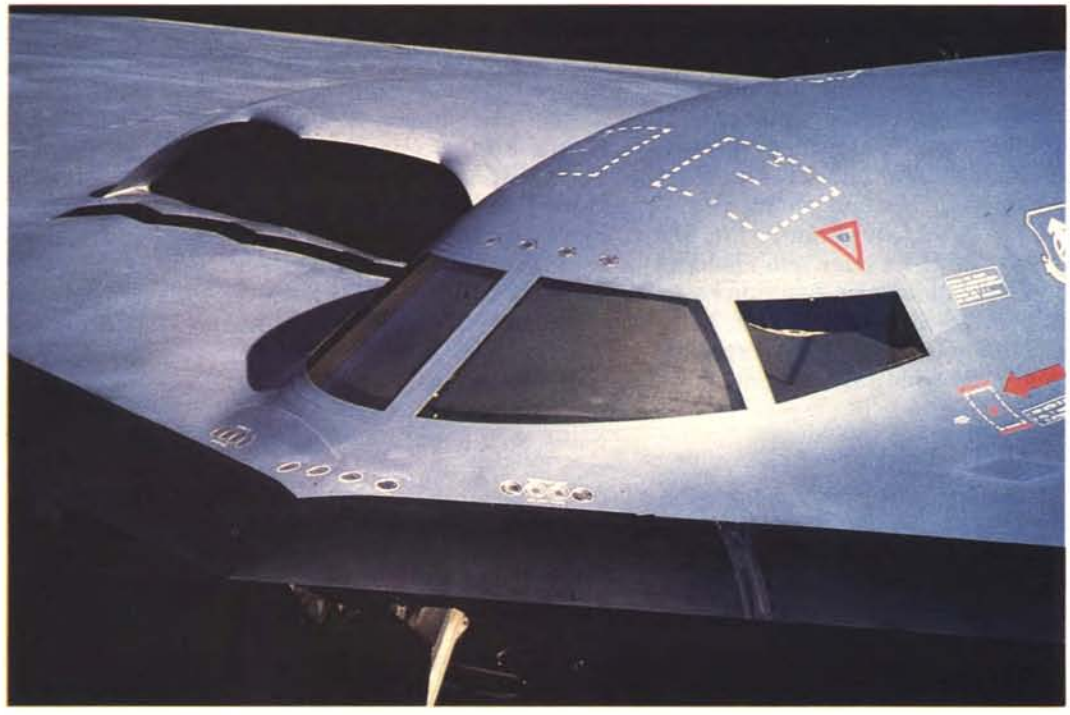
The B-2 was originally conceived as a high-altitude bomber, and that created the problem of eliminating contrails, which would give the airplane's position away to mankind's oldest sensor—the human eye.

At the rollout, though, Secretary Aldridge announced that "the contrail problem has been solved, but I'm not going to tell you how." Two possible solutions: a fuel additive, or a baffle system on the rear of the aircraft that mixes cold air with the hot engine exhaust to eliminate the formation of the telltale vapor trails.

Sometime around 1983, a reassessment of the threats the B-2 would encounter resulted in a redesign (mostly in the carry-through structure, where the wing halves meet in the center of the aircraft and distribute aerodynamic loads) to help the aircraft withstand the stress of low-level flight. The redesign cost approximately $1 billion.

John K. "Jack" Northrop, the de-

The Northrop B-2 looks particularly sinister in this head-on shot, taken at the rollout ceremonies at Palmdale, Calif. The B-2's wingspan of approximately 172 feet is roughly thirteen feet shorter than that of a B-52. At sixty-nine feet long and seventeen feet high, the B-2 is about six feet longer than an F-15 and the same height as an FB-111.



—USAF photo by Bob Simons

Despite the public rollout, many B-2 details are still classified. The plane's two-person cockpit was shrouded during the ceremonies, and guests were prevented from getting a close look at the aircraft's aft end, whose shape and materials help the B-2 avoid detection. Evident in this picture are some of the many compound curves that help reduce the B-2's radar signature.

signer who pioneered the flying-wing concept in the 1920s and built the first practical flying wing (the N-1M) in 1940, was given a specially arranged briefing on the B-2 before he died in 1981 at the age of eighty-five. One of Mr. Northrop's sons, John, his granddaughter, Janet Northrop, and a grandson, Jere Johansing, were present at the rollout.

The first B-2's serial number (82-1066) indicates that money to build the aircraft was authorized in FY '82. Construction was done on "hard," or production, tooling, instead of the "soft" prototype tooling. This method resulted in a cost savings, but the redesign of the airplane necessitated changes to the tooling and delayed development.

"Costs for the program now will be determined and given in the January budget submissions to Congress," noted Secretary Aldridge at the rollout. "The [airplane's development and production] schedule is causing some revisions [to the estimated costs]." The $36.6 billion cost estimate for 132 aircraft has escalated by sixteen percent into the neighborhood of $68.1 billion, or about $42.5 billion in 1981 dollars. That figure works out to $516 million per plane in current dollars.

After the rollout, the B-2 was scheduled to undergo engine and high-speed taxi tests and other final checkouts. The aircraft was scheduled for its first flight about the time this article appears. It will make the short hop from Palmdale to Edwards AFB, where it will undergo a full test program. It will be flown by one Northrop and one Air Force pilot on that first flight.

The B-2 and the first five B-2As will be assigned to the flight-test program at Edwards, with five of the aircraft eventually going to the operational fleet. A 171,000-square-foot hangar and two additional buildings have been built at the Air Force Flight Test Center to support the B-2 test program.

The first operational B-2s will be assigned to Whiteman AFB, Mo. Currently home to the 351st Strategic Missile Wing, Whiteman will eventually receive thirty-four B-2s, which will be housed in individual hangars. Over the past two fiscal years, $144.3 million in construction has been authorized for the base, which has no fixed-wing flying mission. The B-2's initial operational capability is expected to be reached by early 1993.

If the B-1B deployment schedule is an accurate guide, the B-2s will likely be assigned to wings at four other bases, not yet identified. The primary depot facility for the new bombers will be the Oklahoma City Air Logistics Center at Tinker AFB, Okla. ■

The B-2 Industrial Team

The B-2 industrial team is headed by prime contractor Northrop Corp. Boeing Advanced Systems Co., LTV Aircraft Products Group, and General Electric Engine Group are key members of the contractor team. Other major subcontractors include Link Flight Simulation Corp., Boeing Military Airplanes, and Hughes Radar Systems Group.

The Air Force has also declassified a partial list of other members of the B-2 industrial team. They include Abex Corp., Adams-Russell Co. Inc., Allied Signal Corp., Arkwin Industries Inc., Bell Systems Engineering, Collins Defense Communications, Continental Microwave and Tool Co., Eldec Corp., E-Systems Inc., Fairchild Communications and Electronics Co., Fenwal Inc., G. E. Aircraft Control Systems Department, G. E. Instrument Products Operation, Gull Inc., Hercules Inc., and Honeywell Inc.

Others are Kaman, Kearfott Guidance and Navigation Corp., Lockheed Corp., McDonnell Douglas Aircraft Co., Miltope Co., Moog Inc., OEA Inc., Parker-Hannifin Corp., PDA Engineering, Raychem Corp., Raytheon Corp., Resdel Engineering Corp., Rockwell International Corp., Rosemount Inc., Sanders Associates Inc., Smith Industries Aerospace and Defense Systems Inc., Sundstrand Corp., Teledyne, TRW Inc., Unisys Corp., United Aircraft Products Inc., United Technologies Corp., Vaga Industries, Vickers Inc., and Whittaker Corp.