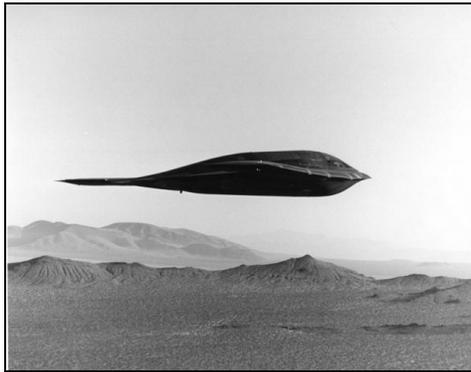


B-2 SPIRIT



The B-2 Spirit is a land-based, long-range bomber capable of delivering both conventional and nuclear munitions. The aircraft features a flying wing design and incorporates advanced technology to reduce its radar observability and its infrared (IR) signature. The crew consists of two pilots, one of whom serves as the mission commander. The aircraft's characteristics include four engines and two side-by-side weapon bays.

The B-2's most notable design feature is its low radar cross section (RCS), achieved by a combination of shaping and application of surface treatments, including sealants used to fill gaps between panels, adhesives, and tapes to cover the joints.

B-2s from the Main Operating Base were employed in combat during Operation Allied Force (OAF) in 1999, delivering Joint Direct Attack Munitions (JDAMs) against targets in Serbia and Kosovo.

BACKGROUND INFORMATION

The B-2 IOT&E concluded in June 1997. However, the aircraft did not fully meet operational requirements at the conclusion of IOT&E. Principal deficiencies included:

- Defensive Management System (DMS) – inaccurate information, cluttered display and excessive workload to operate.
- Low Observable (LO) Systems – low reliability and poor maintainability.
- Terrain Following/Terrain Avoidance (TF/TA) – potential radar blind spots in turns.
- Mission Capable Rate and Sortie Generation Rate – did not meet operational requirements.
- Deployability – shelter protection required for LO maintenance and protection from rain intrusion; extensive support equipment required.

The B-2 development program has initiated a series of upgrades aimed in part toward correcting the above deficiencies discovered in earlier testing. Significant upgrades that have progressed into development testing (DT) include:

- Upgraded aircraft software through version P2 – improved TF/TA and DMS performance, but some issues remain.
- Alternate High Frequency Materials (AHFM) – improved LO materials, substitutes magnetic radar absorbing material (MAGRAM) in lieu of caulk and tape.
- Joint Air-to-Surface Standoff Missile (JASSM) – hardware and software provisions to support delivery.
- UHF Satellite Communications (SATCOM) – improves interoperability with other force assets.

Additional upgrades have been initiated but are not yet ready for DT&E. These initiatives include:

- Additional LO improvements and diagnostic tools (Various dates).
- 500-pound JDAM – capability to carry and release 80 GPS-guided weapons (DT&E in FY03).
- Enhanced Guided Bomb Unit (EGBU)-28 – replaces GBU-37 (DT&E in FY03).
- Link 16, Center Instrument Display and In-Flight Replanner – improves battlefield situational awareness (DT&E in FY04).
- EHF SATCOM – adds nuclear survivable SATCOM capability (DT&E in FY05/06).
- DOT&E placed the B-2 under Live Fire Test and Evaluation (LFT&E) oversight in May 1995, after its strategic nuclear mission changed to include conventional weapons delivery. The LFT&E relied on data from limited past testing, plus reports and analysis from the government and contractor.

TEST & EVALUATION ACTIVITY

B-2 IOT&E was followed by a period of FOT&E (through September 1998) and more recently by several increments of Force Development Evaluation (FDE). During FY01, FDE activity focused on the following areas:

- Evaluating B-2 aircraft software upgrade versions P1.3 and P1.4.
- Testing weapon delivery capabilities.
- Assessing survivability against selected threat systems.
- Evaluating reliability and maintainability of improvements to LO systems.
- Evaluating a deployable shelter for use by B-2.

TEST & EVALUATION ASSESSMENT

B-2 effectiveness and suitability have changed very little from previous years. Improvements have occurred in several areas; however, the overall status of the B-2 has improved only slightly (since the changes resulting from software upgrade P1.1).

Although the B-2 cannot support the sustained operations requirements specified in the ORD and standards specified by the Air Combat Command (ACC), it has proven to be an effective weapon delivery platform, capable of striking targets anywhere in the world during combat operations (OAF & OEF). Assessments are provided for each of the five B-2 Critical Operational Issues: Rapid Strike; Sustained Operations; Mission Survivability; Weapons Effectiveness; and Reliability, Maintainability, and Deployability.

Rapid Strike: This area is marginally satisfactory. Time to generate and launch the B-2 is considered marginally satisfactory based on nuclear and conventional generation exercises conducted in FY00. However, regeneration timelines were not met due to the time required for LO maintenance (discussed below). If aircraft are allowed to accumulate a large number of LO discrepancies, generation times cannot be met. Nevertheless, since aircraft with LO defects can still be flown, training schedules can be met. Operational commitments for fully LO aircraft are supported by keeping a number of aircraft ready on the ground and not flying them, while conducting training with remaining aircraft.

As noted in previous reports, recent software upgrades beginning with version P1.1 have improved TF/TA performance to the point where operational requirements are met. Development testing of the improvements was completed; however, operational testing of TF/TA at the lowest altitudes has still not been completed. Air Combat Command (ACC) has placed a low priority on OT&E of TF/TA since conventional missions do not normally use TF/TA at the lowest altitudes.

Weapon System Reliability (WSR), which measures the probability that an aircraft will function correctly to reach the target and release weapons, continues to be rated as satisfactory for nuclear and conventional missions.

Sustained Operations: This area still does not meet requirements, primarily because of unreliability and difficulty in maintaining LO systems. Some improvements have already been fielded, but the most promising improvements to LO maintainability are still in development testing and have neither undergone OT&E nor reached the operational squadrons.

Mission Capable Rate (MCR) for FY 2001 was 31 percent, compared to an ORD requirement of 60 percent and an ACC standard of 50 percent. This represents a significant decline from FY 2000 (37 percent). The following major drivers impacted the MCR: continuing LO maintainability issues, shortage of fully qualified LO maintainers, and management decisions by 509th Bomb Wing to meet the flying hour program while deferring maintenance.

The MCR, not considering LO discrepancies, was 65 percent, also below that for FY00 and below the ACC standard of 80 percent. Major non-LO factors impacting MCR were: hourly post-operations inspections, power takeoff shaft failures, phase inspections, aircraft incidents, and failures of engine inlet seals.

Sortie Generation Rate (SGR) for FY01 at the MOB was comparable to the 0.2 sorties per aircraft per day seen in FY00. The ORD requirement for deployed SGR is considerably higher than the

rate achieved at the MOB. The required deployed SGR has yet to be demonstrated with an operationally significant number of aircraft and cannot be achieved without adequate shelters and substantial improvement to reliability and maintainability, not just to LO systems, but to other B-2 systems that affect downtime.

Mission Survivability: This area is satisfactory except for the DMS. There is no significant change to DMS performance since the improvements brought about in FY00 with the introduction of P1.1 aircraft software and changes to the mission data file. Although the system demonstrated improved location and identification performance and raised crew confidence in the information presented by the system, overall situational awareness provided by DMS remains marginally satisfactory. Location accuracy and response time performance against pop-up threats requires improvement. Improvements to DMS antennas and revised mission data files are anticipated in FY01 and may improve pop-up threat location accuracy.

During FY01, the 72nd Test and Evaluation Squadron conducted survivability assessments against three additional threat systems. Results of these assessments are used to validate signature templates used in mission planning for the B-2. Although the B-2's LO signature is considered satisfactory in the present configuration, introduction of new LO materials may lead to changes in aircraft signature and will require continued testing to update or validate signature templates.

Weapons Effectiveness: This area is satisfactory except for JSOW. Version P1.4 software has corrected some anomalies seen in earlier JDAM and JSOW testing. Five JDAM weapon were dropped in FY01 with only one anomaly (due to a broken lanyard). Miss distances for weapons that guided successfully were well within required values.

To date, only four JSOW weapons have been released from the B-2. Of these, early flights had several anomalies, in part due to B-2 software. On one early flight B-2 software caused a JSOW to fly direct to the target instead of flying through its planned waypoints. This error was corrected in software version P1.4. Two of the four JSOWs delivered by the B-2 had significant miss distances. The first involved an inadequate wind estimator model in the weapon software that will be fixed when JSOW version 9.0 software is fielded, and the second involved failure of the weapon guidance and control unit to acquire GPS and navigate correctly. Further testing is needed.

Reliability, Maintainability, and Deployability: This area is assessed as unsatisfactory because of poor reliability and maintainability of B-2 LO systems. Deployability of an operationally significant quantity of B-2s also remains undemonstrated.

A number of improved materials and processes are being introduced to improve LO reliability and maintainability. New caulks, paints, and fillers with improved cure times, currently being qualified, promise to reduced the repair times for some LO surface treatments. Additionally, several LO improvement and durability initiatives have been partially fielded and show promising results. These include modified designs for the crew entry door, jackpads, and arrowhead panels.¹

The most significant LO improvement initiative is the AHFM configuration that replaces 60 percent of the caulk and tape surface treatment areas with MAGRAM. To date, this configuration has been applied only to the B-2 test aircraft at Edwards AFB. EMD and development testing of AHFM are

¹ Arrowhead panels on the underside of the aircraft provide access to the engine bay and engine exhaust nozzle bay.

complete and the program is proceeding with production on the basis of development testing alone. Minor design changes were accommodated in the production AHFM design with the intention of correcting problems seen in development testing, including significant areas of cracking and disbonding of MAGRAM from conductive sealant below the surface. Data showed that predicted AHFM MC Rate and MMH/FH reductions can be achieved in a development test environment (including a southern California high desert climate). A by-product of AHFM is that the test aircraft has already produced significant improvement in test operations and efficiency. Additional test issues awaiting resolution include how well AHFM aircraft meet signature requirements over the long term, whether design changes to correct early problems were successful, and how well the materials hold up in cold weather. If FDE in an operational environment bears out the program office's expectations, AHFM will represent a significant maintainability, sortie generation, and cost improvement over Block 30.

Only minor changes have occurred in the area of LO verification. Two LO verification tools were fielded in FY01: a resistive probe for evaluating surface conductivity and a hand-held reflectometer for evaluating the paint beneath AHFM coatings.

Development testing on a deployable B-2 Shelter System (B2SS) was conducted at Whiteman AFB in FY01. The shelter was erected and disassembled three times. The most recent assembly in June 2001 took a total of 34 days. Indications are that the shelter will provide adequate environmental protection for the B-2 but that assembly takes longer than desired. Additionally the shelters require concrete pads, aprons, and utilities. Because of these factors, ACC adopted an approach of erecting and maintaining B-2 shelters as semi-permanent facilities at forward operating locations (FOLs).

A production decision was made in September 2001 to buy four additional shelters and to upgrade the qualification shelter to a production level configuration. The first production shelter will be available to ship in April 2002. The qualification shelter will be upgraded, packed and ready to ship/store by mid-November 2001. Initial shelter operational capability (one shelter/fixed facility at each FOL) is expected in FY03 assuming adequate funding is appropriated.

Live Fire Test and Evaluation (LFT&E): LFT&E results were reported in the B-2 LFT&E Report submitted to Congress in March 2001. Based on review of the Air Force furnished documents, discussions, and briefings, the B-2 LFT&E program was inadequate. However, there was enough information to conclude that the vulnerability of the B-2 to threats expected on conventional combat missions could be reduced significantly using proven design approaches and relatively inexpensive available technology.

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