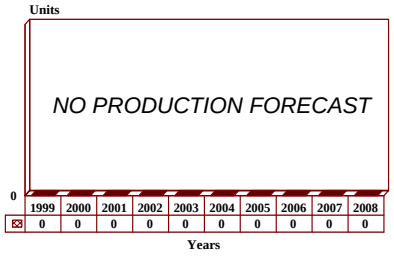
ALQ-161A - Archived 4/2000

Outlook

- In service; ongoing logistics support
- Defensive System Upgrades will install IDECM (ALQ-214, ALE-55) and ALR-56M and remove most of the ALQ-161
- First B-1B combat missions flown

10 Year Unit Production Forecast
1999-2008



Orientation

Description. Airborne Defensive Electronics Countermeasures System.

Sponsor
US Air Force
AF Systems Command
Aeronautical Systems Center
ASC/PAM
Wright Patterson AFB, Ohio (OH) 45433-6503
USA
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Contractors
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Commack Road
Deer Park, New York (NY) 11729-4591
USA
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(ALQ-161 prime)

Status. In service; ongoing upgrades and logistics support, replacement pending.

Total Produced. A total of 100 systems were produced; 95 aircraft remain in the inventory.

Application. B-1B.

Price Range. Estimated unit cost is approximately US$20.0 million.

Technical Data

	Metric	US
Dimensions		
Weight:	2,363 kg	5,200 lb
Characteristics		
Frequency range:	200 MHz to 25 GHz	

Power consumption: 120 kW (full power operation)
LRUs: 107

Design Features. The B-1B defensive avionics system has an integrated design. The original system parameters called for the ability to detect, prioritize and counter hostile electronic signals from radar as well as other threat emitters within milliseconds while simultaneously monitoring emissions to determine the effectiveness of the jamming.

The ALQ-161 Defensive Avionics System is composed of 107 Line Replaceable Units (LRUs). There are about 50 unique LRU designs, including over 30 antennas and an IBM AP-101F digital computer. All of the LRUs are linked to the B-1B's MIL-STD 1553 electrical multiplex bus. The system is housed in several B-1B flight stations, with passive antennas and high-power jamming transmitters positioned behind the wing root panels and inside the empennage bay.

The addition of a new frequency-band capability and an integrated tail warning function to the ALQ-161A increases system weight and volume. Besides the ALQ-161A, the B-1B Defensive Avionics System includes the ASQ-184 defensive management system and an expendable countermeasures system.

Signals are received by omnidirectional and direction-finding antennas mounted in a variety of positions on the aircraft. As the signals are fed through the receiver, their parameters are measured and encoded into a digital signal. The digitized signals are then fed through a data filter to the computer for threat evaluation.

The original LC-4516D computer supplied by Litton Industries for the B-1A was replaced by an IBM AP-101F digital computer, the standard B-1B onboard processor.

An added ALQ-161 feature was a built-in system monitoring network called Status Evaluation Test (SEAT) that tied into the Rockwell Central Integrated Test System (CITS). The SEAT system automatically monitors and reports any EW system degradation or CITS computer failures. The system independently routes electronic signals around failed or battle-damaged components via a 1553 databus, to maintain full jamming capability against high-priority threats.

The Tail Warning System uses a pulse Doppler radar integrated into the ALQ-161 and was designed to detect the presence of missiles from the rear. It time-shares the aft ECM transmitter and antenna, but uses its own receiver antenna and receiver/processor. The Tail Warning System can operate in a stand-alone mode.

The TWS experienced significant false alarm problems because of signal reflections and backlobe clutter at low altitude and high speed. Installations were halted while a solution was sought. New RF filters in the receiving system, some receiver modifications, and firmware changes were tested, found acceptable and installed in the fleet.

Operational Characteristics. Using all of its subsystems in sync, the ALQ-161 was designed to locate, identify, prioritize and jam or deceive many radars. The jamming and receiving subsystems are completely integrated, with the receiving subsystems picking up, identifying and jamming in a fraction of a second. The two subsystems, working together using a look-through program, can detect new signals while jamming in the same frequency band. The system automatically optimizes the jamming frequency according to the threat encountered; in addition, antenna pointing and modulation techniques are automatically tailored to the threat radar.

The system counters surface-to-air missile, anti-aircraft gun, and air-to-air missile fire control radars, as well as degrading early warning and ground control intercept radars with sophisticated noise jamming. It jams several systems simultaneously. Threat parameters and modulation techniques can be changed with software re-programming.

The ALQ-161 was designed to counter ground radar systems in the 0.5 to 10 GHz range. It also covers the 10.4 to 18 GHz frequency range to reduce the threat from aircraft with a look-down/shoot-down capability. To counter, monopulse jamming, terrain bounce and scatter jamming technology were added to the system.

The Air Force admits that the B-1B ALQ-161A ECM system can protect the aircraft on penetrations into medium-capable threat environments, but more intense defenses require support or escort jammers or modified tactics which avoid or hide from the threats. Thus, upgrades are planned to improve the defensive system to enable it can to cope with advanced threats during medium- to high-altitude penetration missions by the turn of the century.

After long evaluation and program work, the Air Force has opted for installing a new radar warning receiver and towed decoy defensive suite on the B-1B. The towed decoy has been found to provide more effective protection than onboard jammers. Even when decoying or deception fail, a missile warhead detonates away from the aircraft.

Variants/Upgrades

The ALQ-161A system has no specific variants. All aircraft have been brought to the CORE (original) configuration. Ongoing improvements to hardware and software continue. During a congressionally mandated Operational Readiness Assessment in 1994, the Air Force initiated improvements to the involved aircraft which resulted in significant improvements in system availability. Pressurizing the TWT transmitters increased reliability significantly. The process for repairing the band 8 transmitter also improved productivity.

The Air Force is modifying the B-1B for conventional munitions. The Conventional Weapons Upgrade Program (CWUP) is a major effort which will prepare the bomber for its planned role set out by the Bomber Roadmap.

Other efforts include:

The **B-1B DSUP (Defensive System Upgrade Program)** will improve the bomber's survivability in the conventional weapons arena. The Air Force will be replacing most of the ALQ-161A with the IDECM towed decoy system and ALR-56M. An interim installation of the ALE-50(V) towed decoy is planned beginning in FY99. This decoy will be used until the ALE-55(V) is fielded. Follow-on plans are to add an IR/EO towed decoy to the system.

The B-1B variant will require some redesign and adaptation for both the physical configuration of the bomber and different operational characteristics needed to provide protection to a significantly larger aircraft. The decoy will be deployed from fairings on either side of the aircraft tail.

A **Computer Upgrade Program** will modernize the B-1B's data processing through hardware and software upgrades. The new computer will better integrate sensors with aircraft systems and create a standard base for future upgrades and sensor enhancements or additions. EMD for this was conducted in FY96, with flight testing scheduled for FY02.

Program Review

Background. AIL began designing the B-1B defensive system in 1971, and received the development contract from the Air Force in early 1972. The Air Force exercised several contract options for improvements to be incorporated into the unit. When development of the B-1B was canceled in FY79, Congress decided to continue with the ALQ-161 for other possible applications. In FY79, Congress provided US$3.5 million for the program, then called the Advanced B-52 Defensive Electronics Program.

In FY80, the Air Force requested US$18 million for the ALQ-161 under PE#64216F (Bomber Defensive System). However, the service told Congress that the ALQ-161 was too expensive for use on the B-52. The estimated cost of completing development and modifying the ALQ-161 and the B-52 for interface and production was US$6.5 billion.

ALQ-161 work continued under PE#63252F (Bomber Penetration Evaluation). In February 1981, AIL was given funds to extend system flight tests.

With the revival of the B-1B during the Reagan administration, AIL began full-scale development in FY82. Two full-scale development contracts were awarded in June and August. They included hardware acquisition for pre-production equipment, Lot I production of one ALQ-161 for the first operational B-1B, and long-lead funding for Lot II production, as well as system integration services and data. They also contained an option for Lot II production of seven ALQ-161s.

During FY82, the Air Force considered using the Westinghouse ALQ-153 tail-warning system on the B-1B, until Eaton-AIL proposed that this function be added to the ALQ-161. The contractor argued that using existing hardware would reduce cost and weight. After a three-month technical study by Eaton, the Air Force accepted the company proposal. In FY83, fabrication and ground testing of the defensive avionics suite was completed, and installation and integration work began soon thereafter.

The initial increment of 50 LRUs for the ALQ-161 was delivered ahead of schedule in February 1984. AIL would deliver more than 10,000 production LRUs during the program.

The ALQ-161 was installed in the first production B-1B bomber in summer 1984. The first flight of the number one aircraft took place on October 19, 1984, five months ahead of schedule. Delivery of seven ALQ-161s began in FY85, with the production rate increasing to two systems per month in August 1985. The production rate was expected to reach its peak of four per month in May 86. However, the rate slowed

because of problems with printed circuit board manufacture.

In September 1986, the Air Force disclosed that it was withholding US$131.5 million in payments because of performance problems with the ALQ-161. The most serious, first experienced in February 1987, was the lack of performance repeatability. According to AF officials, "During one flight test we could easily detect and jam an emitter, but a couple of months later, we might not even detect the threat."

Initial Operating Capability for the B-1B was declared on October 1, 1986, when the first aircraft was placed on alert status. In April 1988, the last of 100 B-1B aircraft rolled out of the Rockwell International plant in California.

In September 1987, a B-1B on a low-level mission crashed as the result of a mid-air collision with a large white pelican. The accident revealed the need for major structural upgrades to protect vulnerable parts of the airframe. It was also the beginning of serious questions concerning the entire B-1B program, including the DECM equipment.

In FY88, the Air Force revised its plan for upgrading the EW capabilities of the B-1B. It would, in the near-term, continue with plans for ALQ-161 modifications that would bring system performance up to specifications. This work would be done under the B-1B Baseline funding.

In August FY88, the Congressional Budget Office reported on a special study, *"The B-1B Bomber and Options for Enhancements."* The report covered a variety of issues affecting the overall performance of the B-1B as a penetrating bomber.

The major problems were found in the following areas:

- Defensive avionics
- Offensive avionics
- Payload capacity at low altitude
- Logistical support

The shortcomings in defensive avionics were the need for upgrades to protect the B-1B from Soviet air defenses. The Air Force planned a three-phase approach to bring the defensive avionics system on the B-1B bombers up to design specifications by 1992.

In October 1988, the Air Force released a report which stated that it was unlikely that it could achieve the goal of bringing the defensive avionics on all B-1Bs up to design specifications by 1992. The cost of reaching those design specifications "could cause the baseline costs of the B-1B to exceed the Congressional ceiling of US$20.5 billion."

The Air Force's plan was for an engineering program which would equip all B-1Bs with identical ALQ-161 systems which met the original specifications by 1992.

The first phase of a three-phase plan, Mod 0, would modify the defensive avionics system on each aircraft so that the entire fleet would have an identical configuration, facilitating the introduction of Mod 1 and Mod 2. Mod 0 configuration was to be installed on most B-1B aircraft by June 1988.

The second phase, Mod 1, would provide several features, including selected automatic (versus manual) jamming and operation of the tail warning function. While Mod 1 involved some hardware changes, this phase focused on developing a new version of the defensive avionics software designated as "block 4.0."

The third phase, Mod 2, would entail additional software and hardware changes to bring the ALQ-161 up to the original B-1B specifications established at the start of the program in 1982. Installation of Mod 2 was to start in 1989 and be completed on all B-1Bs by 1992.

Production lots 1, 2 and 3 made up the first 19 B-1Bs, while lot 4 accounted for aircraft numbering 20-44. All new aircraft, including lot 5, were delivered with the Mod 0 baseline production system. Lot 4 aircraft were retrofitted to Mod 0 in October 1987. AIL proposed an update of the first 19 B-1B (lots 1, 2 and 3) delivered to the Air Force, but the service chose not to install Mod 0 on these 18 aircraft to save costs, planning to go directly to Mod 2 when it became available.

Upon completion of Mod 0 modifications, the Air Force began the second phase of the program and flight-tested Mod 1 from March through June 1988. The CBO report noted that on completion of the Mod 1 tests, the Air Force found that the system's basic architecture, the way the system processes enemy radar signals, was deficient.

The ALQ-161A could not simultaneously process a large number of hostile radar signals across the eight frequency bands it was designed to cover. The system was overwhelmed, and the crew could not employ the appropriate electronic countermeasures to defeat the eight-band threat spectrum. Although the Mod 1 system could identify and counter the top ten airborne threats in a low-threat environment, it became overloaded in a high-threat environment.

Faced with this dilemma, USAF took a new approach to the ALQ-161A's problems, establishing a revised recovery plan in November 1988. Known as the "CORE Plan," it was intended to bring the limited ECM capability of the B-1B as close to the original specifications as possible within the inherent limitations of the system.

The CORE recovery program would complete the Mod 1 phase; install an independent radar warning receiver; correct deficiencies in the Central Integrated Test System onboard maintenance diagnostic system; complete the associated logistics support tasks; and improve reliability of the receiving and jamming functions against the top 10 threats.

Mod 1, block 4.01 flight testing was completed in 1989, and the company began implementation of block 4.02. Block 5.0 followed with completion scheduled for 1992.

The Air Force also proposed adding a new Radar Warning Receiver to the B-1B to overcome some of the problems encountered with spurious system overloads discovered while testing the airplane's Block 4.0 software. The candidate RWR was to be the Loral ALR-56M. Congress mandated a comparison of the ALR-56M and ALR-69I as candidate RWRs. In its FY92 Defense Authorization legislation, Congress changed its direction and prohibited spending funds on the side-by-side comparison effort.

AIL's CORE proposal included a change to the ALQ-161A's integrated radar warning receiver known as the Single Frequency Encoder. The major problem arose when the aircraft was flying at low altitude through a powerful radar signal that produced harmonics or extraneous signals in the RWR. The resulting large number of spurious signals or "spurs" overloaded the ALQ-161's processor as it tried to sort out and analyze them as possible threat signals. The Single Frequency Encoder would screen for these false signals so they would be filtered out before the remaining signals were digitized and sent to the system processor.

Air Force officials announced that they were considering the long-term options for the B-1B's defensive avionics. They were concerned that even the updated system may not meet the original specifications or performance requirements without major modification. Further enhancements above the B-1B Baseline would be required to enable the aircraft to be an effective penetrator beyond the year 2000. These included:

Monopulse Countermeasures: To counter the more sophisticated Soviet air defense systems. Estimated cost: US$1.4 billion.

Forward Warning System: To enhance the detection of air-to-air missiles approaching from the front quarter. This would enhance the "all-aspect" protection. Estimated cost: US$660 million.

Improved #1122 Countermeasures: This would improve classified countermeasures against Soviet air-to-air missiles. Estimated cost: US$60 million.

The FY89 budget request was amended to US$221.6 million for Baseline upgrades. Enhancements to the ALQ-161 were to be carried under a separate line, but funding was zeroed out in the amended FY89 budget request.

In late 1990, AIL announced a proposed complete fix to the B-1B's defensive avionics – a fix, the company claimed, that would provide all the penetrating capability that could be added by a radar warning receiver. The program, company sources said, would cost up to US$500 million less than the RWR plan, and they were willing to fund much of the development with company money.

The upgrade was called the Spurious Free Encoder and could provide all of the capability outlined in the original requirements documents. A tentative company estimate put the cost of the program at US$100 million.

The fix would include solving problems discovered with the Tail Warning System, a radar warning chaff dispenser combination designed to counter missile threats during very low-level flight. Company officials noted that because of the laws of physics, some of the tail warning problems may be unsolvable, but the proposed upgrades could come close.

"M" Account Debate. A major debate began in FY90 and centered on the Air Force plan to use "M" account or merged surplus authority moneys to fund US$526 million for the Core Plan. Earlier in the year, the House Appropriations Committee's Defense Subcommittee requested that the GAO evaluate the Air Force's planned use of these funds with the focus on whether such actions were legal and whether the planned ALQ-161A modifications were within the scope of the original contracts.

The GAO responded mid-year saying that the modifications were within the scope of the contract and eligible for expired funds. The report further stated that under the Air Force's current plan, the B-1B program would use about US$500 million more in expired funds than the program contributed. The plan did not appear to conflict with relevant statutes or regulations governing the use of expired appropriations.

However, the B-1B program was restricted to a US$20.5 billion (in FY81 dollars) baseline cost cap by appropriations bill provisions. Therefore, the Air Force could use the total balance in the surplus and merged surplus accounts only to the extent that it did not exceed the cost cap, the GAO said. While the cost of the Core Recovery Plan is not expected to exceed the cap, other requirements such as deferred support equipment and the independent RWR would breech this

cap. Those procurements would require new appropriations.

Finally, as part of the FY90 Defense Act, Congress imposed several requirements and restrictions on the USAF's plan of action. The major requirement was for the DoD to provide to Congress a comprehensive program plan for systematic testing of the Core configuration modification of the ALQ-161A and integration of the RWR.

Following completion of the test program, the DoD would be required to provide for an independent assessment of the B-1B's capabilities to penetrate Soviet air defenses. The DoD could use expired or lapsed funds to carry out B-1B avionics modifications and testing program and, upon completion of testing, to carry out modifications on the remainder of the B-1B fleet to a sum not exceeding US$527.1 million. Funds in excess of the limitation for the Core plan or for other purposes would have to be authorized and appropriated by Congress.

Debate on the "M" Account funds resulted in a decision to terminate AIL's CORE upgrade efforts in March 1991. Congress also said that the fix would have to be competed, another complication in an already complex program.

During the FY92 budget debate, anti-icing and engine problems compounded the problems the B-1B faced in getting funding for fix actions. The engine troubles grounded the aircraft, delaying CORE ECM system tests. The Air Force said that it was committed to fixing the ALQ-161. AF Secretary Rice told the House Armed Forces Committee that it would cost approximately US$300 million, plus re-start expenses, to put the CORE fix into production. The Air Force continued to debate the "M" account funding issues, blaming this confusion on its inability to fully implement these fixes.

During conference markup negotiations, Congress reconciled drastically different positions in the Senate and House, with the Senate Defense Authorization deferring B-1B fixes in lieu of B-2 funding. The conference denied new production for the B-2 and agreed to provide US$20 million for limited work on the ECM CORE recovery effort. This would allow the Air Force to complete technical drawings. The authorization also made funding contingent on a series of reports on the projected capability of the B-1B.

USAF Bomber Roadmap. On June 17, 1992, Secretary of the Air Force Donald B. Rice announced "The Bomber Roadmap," the plan for the manned bomber in the changed world threat climate. With the force freed of the demands of nuclear deterrence, the Air Force would concentrate on conventional capabilities and the rapid response to regional threats.

Under the new plan, the B-2 Stealth bomber is the main penetrating platform and will be assigned the most demanding missions. Low-level penetration would be the major tactic during direct attacks on targets in high-threat target arenas.

The B-1B would be a penetration or standoff platform, adding mass and precision to composite strike packages. The B-1B would be assigned targets in low-to medium-threat arenas.

All B-52Gs have been retired and an enhanced fleet of B-52Hs assigned to perform standoff weapons launches and direct attacks in low-threat arenas. New weapons capabilities and modified avionics are adapting these aircraft to a totally conventional role. The Air Force is going from 95 B-52Hs to 66 in the active inventory. But the Air Force continues to study bomber needs, weapons requirements, and deep-strike options, and reserves the option of changing this to ensure the overall size of the bomber force meets its operational needs. Budget constraints and a reevaluation of the overall force requirement will drive these decisions.

During a special briefing in early 1995, Air Combat Command commander General John M. Loh declared that the B-1B was "the backbone of the bomber fleet."

ECM Upgrades. In July 1992, the Air Force issued an information-seeking announcement to locate potential contractors to improve the B-1B defensive avionics, anticipating an FY93 contract award. This announcement said that the ALQ-161 would be improved or replaced, possibly by an initial contractual action with two or more contractors working on parallel demonstration programs that would lead to an Engineering and Manufacturing Development.

In September 1992, the Air Force announced it was seeking sources for a mid-FY93 contract award for a single integrating contractor to manage the total system, integrating future modifications to the B-1B. The contractor would manage adding the conventional weapons capabilities to the aircraft, as well as be responsible for the ECM upgrade. All bombers had been brought up to Mod 0 standard as a result of Project Lancer. This was accomplished by mid-1993.

Options listed were upgrading the existing ALQ-161 or replacing all or part of the EW hardware. Enhancements would improve situational awareness, jamming, reliability and maintainability. The contracted team would have some leeway in determining the best ECM fix.

In April 1995, the US Air Force agreed to join the Navy IDECM program as a potential replacement for the F-15 ECM suite and possible use on the B-1B. This followed negotiations on the Air Force desire for a system with higher power and wider frequency range, and more jamming modes than originally proposed for IDECM.

According to the Navy/Air Force Memorandum of Understanding on IDECM, the joint effort would concentrate on the techniques generator and fiber optic towed decoy, emphasizing an open architecture and modular approach to accommodate the needs of both services. The Air Force agreed that the Navy would lead for the joint development of the techniques generator and towed decoy. Management and funding of installation, integration, and developmental/operational tests would be the responsibility of the individual services for each respective platform.

The contract was awarded to Sanders, a Lockheed Company. ITT Avionics is teaming with Sanders. Engineering and manufacturing development (EMD) is to be complete by December 2000.

The Air Force executed an option for the design, development and test of a common high powered towed decoy system under the IDECM contract. The Air Force scope included a B-1B architecture study to determine how IDECM could support the B-1B Defensive System Upgrade Program (DSUP).

The IDECM hardware was determined to be a cost-effective solution for the B-1B Defensive System Upgrade Program, which would fund integration and test of this hardware on the B-1B.

B-1B Operational Readiness Assessment (ORA). The Air Force Air Combat Command and AF Operational Test and Evaluation Center conducted a Congressionally mandated operational readiness assessment of the B-1B from June 1 to November 30, 1994. The bomber had been operating at a mission-ready rate of 55 percent, but the established mission capable rate for a mature bomber was at least 75 percent. The following Congressional direction was issued as part of the FY94 Defense Authorization Act:

"The Secretary of the Air Force shall develop a plan to test the operational readiness rate of one B-1 bomber wing that could be sustained if that wing were provided the planned complement of base-level spare parts, maintenance equipment, and maintenance manpower, and logistics support equipment.

The plan shall also test the operational readiness rates of one squadron of that wing operating at a remote operating location for a period of not less than two weeks, in a manner consistent with Air Force plans for the use of B-1B bombers in a conventional conflict."

Congress was willing to support the B-1B if the Air Force could demonstrate that the B-1Bs are supportable, measured by a fully manned and funded test wing at Ellsworth AFB being able to maintain at least 75 percent Mission Capable Rate.

According to Air Combat Command Commander General John M. Loh, the B-1B had historically shown low mission capable rates because it was never adequately funded for its mission. The bomber had been operating at an Interim Operational Rate of 55 percent rather than Mature Operational rate of 75 percent. B-1Bs have never been adequately funded, and have therefore demonstrated continually low MCR (interim MCR standard has been 55 percent). Manning and spares were never adequate to ensure a fully operational fleet. The ORA demonstrated that if adequate funding/manning were provided, the B-1B would be supportable at greater than 75 percent Mission Capable Rate.

The ORA bomber performance was better than expected. Demonstrated MCR was 84.3 percent and the Air Force showed that "a B-1B unit can pack up, go anywhere, and put bombs on target at the operational rates we need and would expect. Testing should instill confidence among decision makers that the B-1B has been a good investment for projecting power on a global scale," General Loh said. "The B-1B remains the backbone of our bomber fleet."

As a finale to the assessment, the 77th Bomb Squadron deployed to Roswell, New Mexico, to demonstrate operating in an austere environment. The aircraft flew all scheduled sorties and exceeded the test plan operational tempo, achieving a cumulative 86 percent MCR in 14 days of round-the-clock operations under wartime flying conditions. The unit operated primarily out of a wartime spares kit, without full logistical support, and flew under combat surge conditions. Every sortie scheduled was flown.

At the same time, non-test B-1B units held the line on their mission capable rates, and actually increased them. Readiness of non-test units rose to 59 percent because of process improvements developed for the test units.

General Loh said that the Air Force had proven that when properly equipped the B-1B can achieve the mature bomber operational rate. The General expects the airplane to receive the support it needs in the future, which includes US$2.75 billion to upgrade the precision weapons capability and enough funding to maintain all 95 aircraft in the inventory.

At the end of the ORA, B-1Bs flew Global Power missions to Operation Red Flag (which included range-scored EW missions), and two B-1Bs flew nonstop to Kuwait for a live-drop mission in reaction to Iraqi moves toward Kuwait. The aircraft flew 24.8 hours and achieved a 40-meter CEP.

B-1B Conventional Mission Upgrade Program (PE#0604226F). This Program Element funds the B-1B Conventional Mission Upgrade Program (CMUP). The Air Force plans to provide theater commanders with long-range, large payload airpower in the early days of a conflict when forward location operations are restricted, as well as support for sustained in-theater air operations in combination with other forces. This effort has been continually updated and changed annually.

In the FY98 Program Element Descriptors, the Air Force noted that with the drawdown of forward-based US ground, naval and tactical air forces, defense strategy calls for long-range, conventionally armed strategic bombers to play a major role in the initial stages of a regional contingency. The 95 B-1B *Lancers* in the Air Force inventory will constitute over half of all US strategic bombers, making them the centerpiece of the conventional bomber force well into the next century. To maximize the aircraft's contribution in this role, the Air Force must enhance its capability to perform precision attacks against moderately defended targets deep in enemy airspace.

The needed enhancements fall into two categories: improved lethality through integration of advanced conventional weapons, and improved survivability through upgrades to the electronic countermeasures system. The Air Force established the Conventional Mission Upgrade Program (CMUP) to fulfill these requirements. The CMUP consolidated a variety of separate projects: ECM Improvements, AFMSS, B-1B Simulator and the Conventional Weapons Upgrade.

The program achieved Required Assets Available (RAA) of Cluster Bomb Units (CBUs) in September 1996. Funding in the FYDP covers integration of the Joint Direct Attack Munition (JDAM), Wind Corrected Munitions Dispenser (WCMD), Joint Stand-Off Weapon (JSOW), Joint Air to Surface Stand-Off Missile (JASSM), and upgrades to the existing ECM suite. Parallel and complementary enhancements include an upgrade to the avionics computers to enable simultaneous carriage of multiple weapon types, provide growth capability, and reduce support costs; development of an interface to the Air Force Mission Support System (AFMSS) for more effective employment of the B-1 in a theater scenario; and upgrades to the air crew and maintenance training systems to keep them consistent with the aircraft's configuration.

Defensive System Upgrade Program (DSUP): The existing ALQ-161 defensive system was designed and optimized for the strategic nuclear mission of low-altitude penetration against specific air defense threats and has limited effectiveness in the B-1B's new conventional mission. DSUP will remove most of the ALQ-161 system and replace it with an ALR-56M radar warning receiver and the RF Countermeasures (RFCM) portion of the Navy's IDECM program, which includes a techniques generator (ALQ-214) and a fiber optic towed decoy (ALE-55). A new low-band on-board jammer will be installed to provide the requisite threat coverage. These new systems will significantly improve situational awareness and the survivability of the B-1B in the medium- and high-altitude regimes where most conventional missions will be conducted. (Formerly Project 1019, ECM Improvements.)

These enhancements are required to maximize the effectiveness of the new weapons capability provided under CMUP. Additionally, these modifications will eventually reduce annual O&M costs by approximately US$50M after full fleet modification.

The other efforts include:

B-1B Mission Planning System: This improves B-1 mission planning capabilities by adding an aircraft-specific software module to the ongoing AFMSS program This was formerly Project 1020, AFMSS.

Training Systems: This provides updates to the existing training system needed to match the recent changes made to the aircraft. The total B-1B Training System consists of a Simulator System to train air crew members and Maintenance Training Equipment (MTE) to train maintenance personnel. This was Project 1021, B-1 Simulators.

Conventional Weapons Upgrades: Current B-1B conventional combat capability is optimized for the delivery of 84 non-precision 500-pound gravity bombs. The Conventional Mission Upgrade Program (CMUP) will significantly increase the aircraft's capability, both by upgrading conventional weapons employment and by enhancing aircraft survivability.

It will improve the B-1B's effectiveness in conventional operations by integrating advanced conventional weapons. Specific enhancements include integration of CBUs (EMD completed in FY95), the Wind Corrected Munitions Dispenser (WCMD), JDAM, JSOW, JASSM, and aircraft enhancements necessary to carry these weapons. Aircraft enhancements included under the JDAM integration effort are an anti-jam secure-voice radio upgrade for improved interoperability with other theater forces, a Mil-Std-1760 electrical interconnection system that will provide a common interface

between aircraft and precision weapons, and a Global Positioning System (GPS) receiver for providing position updates to precision weapons.

The Air Force accelerated the DSUP RAA date in the FY98 POM. The Secretary of the Air Force accelerated procurement of JDAM modification kits for six aircraft. The ALE-50 towed decoy system was accelerated in conjunction with JDAM to yield enhanced operational capability in FY99. The decoys would be installed as an interim upgrade pending availability of the IDECM ALE-55.

An upgraded avionics computer suite will handle the advanced weapons requirements and significantly improve computer reliability and maintainability. Also included are preliminary engineering and planning studies for potential weapon system enhancements and for weapon system operational support improvements, as well as the Live Fire Test and Evaluation. This was formerly Project 4143, Conventional Weapons Upgrade.

Acquisition Strategy:

These major upgrades will be accomplished during three phases and integrated in conjunction with ongoing sustainment block upgrades. RDT&E work on Phase I, "Enhanced Capability," contains the Block C CBU upgrade (EMD completed in FY95). Phase II, "Near Precision Capability," contains Block D (GPS/Comm Navigation Management System, JDAM, and Mil-Std-1760 integration), Block E (Computer and WCMD upgrades) and the Block F DSUP integration upgrade. Phase III, "Standoff Capability," contains the Block G JSOW and JASSM integration upgrades. Boeing North American Aviation (formerly Rockwell International, North American Aircraft Division) is the integrating contractor for all major aircraft upgrades. AFMSS and training system upgrades will be released periodically during Phases I, II and III.

The overall CMUP acquisition strategy includes using sole source contracts with a prime/integrating contractor; assignment of Total System Installed Performance Responsibility (TSIPR) to the integrating contractor; use of cost plus award fee (CPAF) development contracts; and combining developmental upgrades with software sustainment blocks to minimize the number of software releases, aircraft downtime and differences in fielded configurations. The Phase I CBU capability is being fielded in Block C. Block D will include JDAM/Mil-Std-1760 and GPS/Comm modifications (as well as the ALE-50 Towed Decoy). The computer and WCMD upgrades will be fielded as part of Block E. DSUP will be fielded as Block F. JSOW and JASSM capability will be fielded in Block G.

Three test articles were purchased in FY97 (US$4.562 million). They were computer set kits to be installed in labs to support Block E EMD. The 17 test articles to be purchased in FY98 consist of 12 computer set kits (US$18.249 million). Eight will be installed in labs, two in aircraft, and two as test spares. Five DSUP kits (US$5.647 million) will support Block F EMD (three in labs and two in aircraft).

Program Details:

Project 1019 provided for ECM improvements to the B-1. It was separated from Project 4143 to allow the Air Force to proceed more carefully and deliberately in the ECM work. The bomber's defensive avionics needs improvements in supportability, radar warning capability, and countermeasure effectiveness, particularly for medium- to high-altitude operations. Improved defensive system supportability is vital to improving B-1 reliability and maintainability, while ECM capability improvements will enhance aircraft survivability.

FY92 accomplishments saw the completion of the System Threat Assessment Report (STAR), validated by the Defense Intelligence Agency (DIA) in August 1992. The Air Force released a draft Air Combat Command (ACC) Mission Need Statement (MNS) for conventional operations. Joint Requirements Oversight Counsel (JROC) validation came in May 1993. Planners completed the Requirements Correlation Matrix on September 28, 1992.

In FY93, the Air Force awarded a contract to an integrating contractor for risk reduction planning. This was accomplished on August 30, 1993, and cost US$5.963 million. Planners also began Congressionally mandated and other studies, at a cost of US$5.259 million. They began a Cost and Operational Effectiveness Analysis (COEA) study with Institute for Defense Analyses at US$4.750 million. Mission Support and other requirements were programmed for US$2.235 million in funding.

As per Congressional direction, there was no activity in FY94. Prior year funds of US$31.0 million from FY93 and US$7.2 million from FY94 were reallocated from the ECM project to the conventional weapon upgrade project. In addition, approximately US$100 million was moved from Project 3010 to Project 3600 and accelerated two years to begin to implement the Integrated Logistics Support process in FY98.

The DSUP was restructured as an incremental program, matching specific ECM improvements to mission requirements based on priority threats at discrete points in time. Priority threats would be those which Air Combat Command determined to be most critical to counter in a typical B-1 mission supporting Defense

Planning Guidance scenarios. These defensive system enhancements would concentrate on three areas: situational awareness, countermeasures effectiveness, and reliability and maintainability.

Planned ECM activities included development of a Request for Proposal, a risk reduction activity for studies, and the evaluation of several candidate systems to support a single ECM solution in Engineering and Manufacturing Development program.

The original acquisition strategy for DSUP called for a pre-EMD risk reduction phase, in which the Air Force would refine system requirements and an integrating contractor, supported by up to four subcontractors, would demonstrate potential system solutions. The contractor would then make a selection from among these candidate solutions and proceed into EMD. This strategy was initiated in FY93, with risk reduction planning leading up to development of an RFP by the prime contractor.

Responding to Congressional restrictions in FY94, the Air Force stopped work on the ECM project except for completing studies underway to support the Cost and Operational Effectiveness Analysis. With additional cuts in FY95 and FY96, the program could not be executed. In response, ACC requested the acquisition community develop an incremental upgrade strategy which would introduce capability enhancements as soon as possible given a prudent acquisition strategy. RDT&E work in FY95, 96 and 97 supports this new strategy and focused on four activities:

Translate ACC operational requirements into detailed system engineering requirements.

Define the revised acquisition strategy through the Integrated Acquisition Strategy Panel (IASP) process. This included an assessment of whether the Navy Integrated Defensive Electronic Countermeasures suite would provide a cost-effective, viable solution for some or all of the B-1's requirements (this assessment was funded in a separate PE).

Fund the integrating contractor to develop an RFP to select an EMD subcontractor, and complete System Requirements Review and System Functional Review prior to awarding an EMD contract.

Award an EMD contract in FY97 after a Milestone II decision.

Contractual work in FY95 and FY96 was executed via a Contract Change Proposal (CCP) to the existing CMU "Phase IIA" contract. Once the integrating contractor selected a subcontractor, the Air Force would award a new, sole-source, cost-plus-award fee contract for EMD.

B-1B ECM capability will be significantly enhanced in the near term with integration of the ALE-50 towed decoy. The first DSUP increment is to be fielded as part of CMUP Block F. It will capitalize on the capabilities provided by the ALE-50.

In FY95, planners spent US$976,000 for risk reduction and planning for EMD for the incremental upgrade program. US$1.488 million was used for other support and risk reduction activities.

At Air Combat Command's (ACC) request, the Air Force formed a Tiger Team to examine an incremental DSUP approach to correct the B-1B's defensive system deficiencies. In FY95, the Air Force began a 13-month Integrated Acquisition Strategy Process (IASP) that culminated in a successful ASP briefing to SAF/AQ on April 23, 1996. A key element of that strategy was examining the use of the Navy's RF Countermeasures (RFCM) System being developed under the Integrated Defensive Electronic Countermeasures (IDECM) program. The Air Force placed Boeing North American (BNA - formerly Rockwell NAAD) on contract to examine the feasibility of using the RFCM portion of the Navy's IDECM system to meet ACC's requirements. Boeing completed the architecture study and recommended the use of the IDECM RFCM system.

Following a comprehensive Cost as Independent Variable (CAIV) study during the summer of FY96, the Air Force concurred with the use of the IDECM RFCM system. In June 1996, the Air Force awarded a DSUP pre-EMD contract to Boeing that will accomplish a System Requirements Review (SRR), Systems Functional Review (SFR), and preparation of an EMD proposal. EMD contract award was planned for June '97 following a 3Q FY97 Milestone II DAB decision. During EMD, the Critical Design Review (CDR) would be completed in 4Q FY98 and flight tests will start in 2Q FY00. A Milestone III DAB is planned for 3Q FY02.

In FY96, the Air Force spent US$8.307 million to start the systems engineering process that would translate top-level system requirements into lower-level requirements, reduce program schedule risk, and accelerate entry into EMD. US$1.992 million went to acquisition strategy planning for DSUP EMD, with US$792,000 supporting IDECM and Fiber Optic Towed Decoy Risk Reduction Planning.

In FY97, planners spent US$13.757 million to continue the pre-EMD contractor systems engineering process, culminating in System Functional Review (SFR). US$23.555 million was used to begin DSUP EMD.

An April 1998 *Commerce Business Daily* notice sought potential sources for high-power, RF amplifiers/

transmitters to replace the Band 8 transmitter on the ALQ-161. New technology vacuum tube or solid-state transmitters would be considered along with high- and low-voltage power supplies.

First Combat Missions. B-1Bs flew their first combat missions during Operation Desert Fox in Iraq in December 1998. These missions involved bombing runs on Republican Guard barracks. The two bombers did not carry the ALE-50(V). Pilots told Forecast International/DMS that the "electronics" all worked well. EA-6Bs escorted the mission, effectively co-ordinating their operations with the bomber crews.

GAO Report NSIAD 97-94: *Electronic Warfare*: *Towed Decoys Could Improve Survivability of Current Navy Aircraft*. The GAO reviewed the acquisition plans for the ALE-50(V) towed decoy system and the RFCM, which included the more advanced ALE-55(V) towed decoy, focusing on whether towed decoys could improve the survivability of certain Navy and Air Force aircraft.

On September 4, 1997, the GAO released a report, which concluded that the effort to improve aircraft survivability through the use of towed decoys demonstrated positive results. According to test reports and test officials, the ALE-50(V) was effective, and the future RFCM decoy system was expected to be even more capable. The GAO noted that the Air Force was actively engaged in efforts to field towed decoy systems on a number of its aircraft, including the F-15, F-16 and B-1, while the Navy is planning towed decoys only for the F/A-18E/F.

The services expect that these decoys will improve survivability of their aircraft against radar-controlled threats compared to the current technique of emitting the jamming signals directly from the aircraft. In an attempt to overcome the limitations of on-board jammers, the services are acquiring two new towed decoy systems, the ALE-50(V) and the IDECM ALE-55(V), to enhance survivability against radar-controlled threats.

Classified test results showed that the ALE-50(V) towed decoy offered improved effectiveness against radar-controlled threats, including some threat systems against which self-protection jammers have shown little to no effectiveness. The future ALE-55(V) decoy system is expected to further improve survivability due to its use of more sophisticated jamming techniques.

Recognizing the potential for overcoming the limitations of using just onboard jammers, the Air Force is actively pursuing the use of towed decoys for its current aircraft. It has done the necessary modifications to add the ALE-50(V) to the F-16, an aircraft slightly smaller than the Navy's F/A-18C/D, and to the B-1, a much larger aircraft. The Air Force is also considering use of the IDECM decoy system on the F-15, which will use its existing onboard jammer instead of the ALQ-214(V) techniques generator, and on the B-1, as well as several other aircraft. The Navy plans to equip only its future F/A-18E/F aircraft with a decoy system.

Both decoys are single-use systems. Once deployed from the aircraft, the decoy's tow line is severed prior to return to base. Each aircraft is to carry multiple decoys, so if one is destroyed by enemy fire or malfunctions, another can be deployed. Therefore, substantial inventories of decoys are required to sustain potential combat operations.

The Air Force buy of the IDECM system for the B-1 and the F-15, which would use its existing onboard jammer instead of the RFCM techniques generator, has an estimated cost, including 9,107 decoys, of US$574 million.

Funding

US FUNDING

	FY97		FY98		FY99		FY00(Req)	
	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
RDT&E (USAF)								
PE#0604226F B-1B								
1019 ECM Improvements	-	42.7*	-	0.0	-	0.0	-	0.0

* NOTE: Funding transitioned to Project 4596, Conventional Munitions Upgrade, with B-1B ECM efforts becoming the Block F version (IDECM EMD).

All US$ are in millions.

Recent Contracts

(Contracts over US$5 million)

Contractor	Award ($ millions)	Date/Description
Northrop Grumman	6.0	Jun 1996 – FFP contract for repair of 75 Band 8 TWTs for ALQ-161A. Completed May 1997. (F09603-94/D-1056)
Rockwell International	24.3	Jun 1996 – FVI to CPAF contract for requirement planning in support of the upgrade of the defensive systems on the B-1B. Completed April 1997. (F33657-93/C-0024)
Boeing Defense	37.0	Dec 1996 – FVI to a time and material contract for Sustaining Engineering Services for the Offensive Avionics and Defensive Management System on the B-1B. Completed Dec 1998. (F34601-94/C-0121)
AIL Systems	5.8	Jan 1997 – FFP contract to provide for repair of various quantities of 51 components of the ALQ-161. Complete Sep 1999. (F09603-96/D-0057)
Boeing	216.5	Jun 1997 – CPAF contract to provide for the Defensive System Upgrade Program in support of the B-1B aircraft. This program will upgrade the aircraft's ECM system. Complete Feb 2002. (F33657-97/C-0002)
Boeing	5.9	Aug 1997 – FVI to a CPAF contract to provide for LRIP production of seven towed decoy systems applicable to the B-1B. Completed November 1998. (F33657-95/C-2008)
AIL Systems	5.2	Apr 1998 – FFP contract for repair of various quantities of 22 components of the ALQ-161A ECM system. Complete Dec 1998. (F09603-98/D-0083)

Timetable

Month	Year	Major Development
	1972	Engineering development
Mar	1982	Full-Scale Engineering Development (FSED)
Sep	1985	Full-Scale Production contract awarded
Oct	1987	Mod 0 of Lot 4 and 5 complete

Month	Year	Major Development
Nov	1987	Mod 1 testing begins
Mar	1988	Mod 1 flight tests
Nov	1988	CORE Plan is established to correct ALQ-161A
Jun	1990	Begin testing core fixes
Jun	1992	AF releases Bomber Roadmap
3Q	FY93	Risk Reduction Planning
Jun	1994	ORA start
Nov	1994	ORA complete
3Q	FY96	Acquisition Strategy Panel, CCP for Pre-EMD
4Q	FY96	SRR
2Q	FY97	DSUP Milestone II
3Q	FY97	Award ECM DSUP EMD contract
2Q	FY98	PDR
4Q	FY98	CDR
2Q	FY99	Start System Qualification Test
3Q	FY99	Complete System Qualification Test
4Q	FY00	Start flight test, LRIP
1Q	FY02	Complete flight test
3Q	FY02	IDECM Milestone III: DSUP Milestone III, full-rate production
2Q	FY08	Full Operational Capability

Worldwide Distribution

This is a **US** only program.

Forecast Rationale

The Bomber Roadmap established a viable mission for the B-1B, and refocusing of the program with an emphasis on conventional capabilities. Changes in the prime threat eased some of the pressure that had been put on correcting some of the original problems with the troubled ECM system. Changing the bomber's mission from low-level penetration for a nuclear attack on strategic targets in the former Soviet Union, to medium- to high-altitude attacks on conventional targets in less heavily defended areas, made it possible to turn the corner on ECM. The Air Force developed a reasonable comfort level with the idea that the airplane could function effectively in a medium-level threat environment; but operations on more intense missions would call for support/escort jammers or creative tactics to make it possible for the B-1B to be used effectively and have a reasonable chance to survive.

When the Air Force and Congress settled on a B-2 program in FY93, it became possible to further refine efforts on the B-1B. Eliminating the problems and inconsistencies suffered by the fleet was a must. The Air Force made progress in developing an upgrade plan, and the EW industry showed strong interest in teaming arrangements for the work. Selecting Rockwell International NAAD (which was acquired by Boeing) as an overall integrator for B-1B upgrades helped insulate the ECM work from the engine and airframe criticism that had been common on Capitol Hill and among airplane opponents. Making the ECM effort a separate line from the conventional mission upgrades encouraged independence and care in developing and implementing the enhancements. It also ensured that the ECM upgrade did not fall victim to a schedule for efforts that are completely separate.

Congress had stepped in with funding changes during 1993 and established a Cost and Effective Analysis (COEA) requirement. The Air Force got involved, reportedly trying to control the data used during the COEA and pushing weapons upgrades over the ECM work. Industry became frustrated by the constant changes and began questioning the final outcome, and even if there ever would be an outcome. Early interest was significant from most ECM powerhouses in getting involved in the ALQ-161A upgrade or replacement, but the delays caused some interest to wane. Interest on Capitol Hill was ongoing, though, and the program continued. It gave the Pentagon time to develop its

changed plans for the B-1B Defensive Systems Upgrade.

Long-range, standoff weapons reduced the need for powerful ECM equipment on bombers. Standoff attacks can be made from beyond the heart of the threat. Penetration attacks were facing a lesser, but still deadly, level of threat activity. This did not make ECM any less important; but did change what would be needed. The scope of the upgrades planned were scaled back and made more reasonable and better focused, with attention now on the conventional theater. Instead of being able "to counter the most advanced future Soviet defense environment," the upgraded system will have to be able to handle an international environment similar to the one faced by attack aircraft during the Persian Gulf War – an environment that included equipment from Western sources as well as hardware designed and built by the former Soviet Union. It would concentrate on countering the threat anticipated by the year 2000, with upgrades to a 2010 threat later.

The successful Operational Readiness Assessment has defused much of the Congressional criticism that dogged the airplane, and has encouraged a more positive outlook toward funding the requested improvements to the bombers. The image change made all the difference in the world. It may encourage Air Force officials and Congress to adequately fund the day-to-day operations and maintenance requirements of the B-1B. In February 1998 B-1Bs were operationally deployed to support Operation *Desert Thunder* in the Persian Gulf. This was the first time the B-1B was deployed for something other than exercises or tests.

In December 1998, B-1Bs attacked Republican Guard targets during Operation Desert Fox over Iraq. This made it possible to verify that the *Lancer* could perform in actual combat. Telephone crew comments to Forecast International/DMS were positive about all aspects of the missions. Reflecting the new tactics that can be expected, the two bombers were escorted by a joint Air Force/Navy package which included EA-6B support jammers.

The new Defensive Systems Upgrade Plan will eventually remove the ALQ-161A from all aircraft, replacing them with a towed decoy and upgraded RWR system. This may prove to be the best solution, since it takes advantage of the tactical use of towed countermeasures as well as using technology that is much newer than that designed into the ALQ-161A, and which could not reasonably be expected to be retrofitted into the original systems. The GAO report further validated that moving to a towed system was the best solution to enhancing the protection provided to the B-1B.

Ten-Year Outlook

No ALQ-161 production likely. The majority of the system will be replaced by the IDECM towed decoy system and ALR-56M radar warning receiver.

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