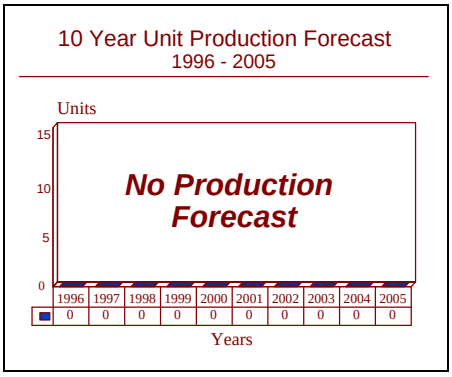
EF-111A - Archived 12/97

Outlook

- To be retired in favor of EA-6B
- Air Force crews training in EA-6B
- 12 EF-111As to be retained through FY99



Orientation

Description. Air Force standoff and escort electronic warfare aircraft.

Sponsor

US Air Force
AF Systems Command
Aeronautical Systems Center
Wright Patterson AFB, Ohio (OH) 45433
USA
Tel: +1 216 787 1110

Contractors

Northrop Grumman Aerospace Corp
1111 Stewart Avenue
Bethpage, New York (NY) 11714
USA
Tel: +1 516 346 2812
Fax: +1 515 575 5776
(EF-111A conversion, SIP prime, ALM-204 Upgrade)

AIL Systems Inc
Commack Road
Deer Park, New York (NY) 11729-4591
USA
Tel: +1 516 595 3096
Fax: +1 516 595 6639
(ALQ-99 Converter/Processor, Digital-Based Exciter)

AEL Inc
305 Richardson Rd
Lansdale, Pennsylvania (PA) 19446
USA
Tel: +1 215 822 2929
Fax: +1 215 822 9165
(ALQ-99 Transmitter components)

Astronautics Corp of America
4115 N. Teutonia Rd
Milwaukee, Wisconsin (WI) 53209
USA
Tel: +1 414 447 8200
Fax: +1 414 447 8231
(Combat computer)

Lockheed Martin Corp
Tactical Systems
(formerly Loral Federal Systems)
1801 State Route 17C
Owego, New York (NY) 13827
USA
Tel: +1 607 751-5601
Fax: +1 607 751-3259
(1750A VHSIC Processors)

Motorola Inc
Government and Systems Technology Group
8201 East McDowell Road
Scottsdale, Arizona (AZ) 85252-1417
USA
Tel: +1 602 441 3905
Fax: +1 602 441 2806
(Band 4 Transmitter Upgrade)

Raytheon Co
Electromagnetic Systems Division
6380 Hollister Ave
Goleta, California (CA) 93117
USA
Tel: +1 805 967 5511
Fax: +1 805 964 0470
(ALQ-99 transmitters/exciters)

Status. In service/upgrades, on-going logistics support.

Total Produced. A total of 42 F-111s were converted to EF-111As. At present, 29 are in operation with the active force. There are none being flown by the Air National Guard or Air Force Reserve.

Application. Tactical support jamming, stand-off, penetration reconnaissance, and electronic countermeasures (ECM)

Price Range. System Improvement Program estimated at US$7.5 million per aircraft. It has been terminated pending the retirement of the EF-111A. The Air Force puts the cost of the EF-111A at $35 million.

Technical Data

Dimensions	**Metric**	**US**
Length:	23 m	76 ft
Wingspan:	19.1 m	63 ft
Height:	6 m	20 ft
Equipment weight:	3,150 kg	3.5 tons
Characteristics		
Speed:	1,650 mph (Mach 2.2)	
Ceiling:	15,152 m	50,000 ft
Flying Range:	2000 mi 1,740 nm)	
On-station time:	4 hrs	
Crew:	2 (Pilot & EW Officer)	
Effective jamming range:	230 km	124 nm

Design Features. The EF-111A Raven is a modified F-111 equipped to perform tactical jamming support missions against air surveillance acquisition and fire-control radars. It replaced the EB-66 EW aircraft.

The EF-111A program modified existing F-111As by adding an EA-6B avionics package, a version of the ALQ-99. A total of 42 aircraft were converted by Grumman under the multi-year, US$1.5 billion EF-111A program.

The primary electronic countermeasures unit is the ALQ-99E jamming subsystem, an improved version of the Navy's first ALQ-99 jamming subsystem. Improvements to the Navy version included the capability to more rapidly detect and identify transmissions; greater automation with less reliance on human involvement and manual operations; expanded computer functions providing sophisticated and flexible jamming options; as well as more independent jamming signals over a wider range of frequencies. Interior modifications included a rearranged cockpit with the right-seat crew member becoming an electronic warfare officer responsible for navigation, terrain-following flight and electronic warfare operations.

The ALQ-99E Tactical Jamming System (TJS) employs 10 transmitters and five exciters. The EF-111A may carry up to 10 ALQ-99s mounted internally on a pallet, compared to the five ALQ-99s carried aboard the EA-6B. There is roughly 70 percent commonality between the two versions of the ALQ-99. The transmitters are housed in a 16-foot-long, retractable, canoe-shaped radome situated on the original weapons bay doors. The weapons bay houses the high-power jammers.

The ALQ-99E detects radar signals, processes them and compares them to known threat radar characteristics stored in an on-board computer library. The jamming subsystem receivers scan across select frequency bands under computer or manual control. When threats are identified, appropriate countermeasures are initiated. Information about new threats, not in the memory of the computer, can be fed into the system either through entries on the electronic warfare officer's cockpit keyboard or by programming the computer via a

cassette that plugs directly into the plane. Changing the programming takes about five minutes if plug-in modules are used. The electronic warfare officer can test the information and, if necessary, make corrections using the keyboard and cockpit display unit.

With the receiver and passive detection components located on the tip of the vertical stabilizer, the aircraft fuselage acts as a buffer between the active and passive sections of the system. This enhances reception and makes continuous band searching possible, even during transmission or "look-through" jamming.

The aircraft were being updated with modern digital navigation and flight-control systems, which equip the airplane with ring-laser gyro and global-positioning navigation systems, as well as improved controls and displays. The radar and terrain-following flight system are also being updated.

Operational Characteristics. The EF-111A mission is standoff jamming, deep-penetration escort, forward- edge-of-battle support missions, counter jamming against enemy formations, and support of NATO forces with countermeasures against early warning, ground-control intercept, and acquisition radars. The EF-111A provides protection by using a jamming orbit where it stands off from threat radars to cover friendly aircraft entering and leaving the threat areas, or by using the aircraft's high-performance capabilities to directly support attacking forces. In the direct support mission, the Raven may fly as in escort position or enter a threat area to the best jammer position. Ravens engaged in direct support often use the extensive night terrain-following capability built into the basic F-111 design.

The electronic warfare officer plans jamming tactics in advance, and then programs, operates and monitors the jamming system. Previous radar-jamming aircraft required several operators and more equipment to perform radar-jamming sessions.

Variants/Upgrades

EF-111A System Improvement Program (SIP). This project would update the EF-111A Tactical Jamming System (TJS) to keep system capability current against the evolving threat. Most modern radars use state-of- the-art Electronic Counter-Countermeasure (ECCM) techniques which limit the present jamming system's capability to counter them. The SIP included a new encoder/processor, a mil-qualified computer, a MIL- STD 1553-B data bus, an improved Band 4 transmitter, an upgraded digital exciter, and software changes.

The program will evaluate the integrating narrow-beam antennas, Band 1/2 improvements and ALR-62I Radar Warning Receiver (RWR). These improvements are designed to defeat the threat by placing concentrated jamming, with an improved power management system, on specific radars of interest.

Encoder/Processor (E/P) Group upgrade. This effort would increase the ability of the system to process data from more threats more quickly. It replaces the current encoder, converter synchronizer, and signal processing 4Pi computer with a single encoder/converter interface. It is based on a Mil-Std 1750A VHSIC embedded processor set. The system will reportedly have 100 times the tracking capability and be 100 times faster. Response will be cut 50 percent, memory reserve (for software updates) increased 50 percent, and the overall capacity increased by about 70 percent.

Digital-Based Exciter (DBE) upgrade. This adds the ability to jam coherent and other sophisticated radars. It will also add more jamming 'spots' and significantly increase effective radiated power.

Band 4 Transmitter. Increases ability to jam in this frequency band.

Band 9/10 Transmitter. Adds a band 9 similar to that of the EA-6B.

A new combat computer and digital display indicator would increase electronic warfare officer situational awareness. A Collins multi-function display replaces the original switch-laden control panels and control boxes. Smiths Industries is producing a new, smaller loader/verifier.

The SIP upgrades were designed to extend the life of the EF-111A through 2017, the projected life of the airframes; but they were canceled due to the Air Force decision to retire the Aardvark fleet.

Program Review

Background. The program to convert several F-111A's to EF-111A electronic warfare prototypes and to evaluate their ability to provide electronic counter-measures jamming coverage began in 1972. Grumman

Aerospace Corp. was awarded a contract to convert two existing F-111A's to EF-111A prototype configuration in January 1975. The first prototype flew in March 1977 and the second in May 1977. In January 1975 the Air Force selected Grumman to convert 42 F-111 aircraft to the EF-111A Tactical Jamming System (TJS) configuration by installing the ALQ-99 in the weapons bay.

Operational testing revealed a number of deficiencies in August 1978, and DoD withheld full-scale production authority until 1979. Delivery of the first aircraft took place in the fall of 1981. The final EF-111A was delivered to Mountain Home Air Force Base, Idaho, in November 1985, but by mid-1994, all EF-111A's were relocated to Cannon AFB, NM

In February 1987, the Air Force canceled the program to provide a new internal ECM self-protection suite for the F-111 aircraft, citing high cost. The Air Force decided to purchase additional ALQ-131 Block II pods instead.

ALQ-99E Upgrade. In FY84, a team led by Eaton AIL edged out a team headed by Grumman for the ALQ-99E upgrade contract. The upgrade would provide new exciters to support a larger number of jamming modulations, a new signal processor with greatly increased memory capacity, and receiver modifications to add a new analog-digital converter.

The program was to be undertaken in two phases. The first would concentrate on software improvements, with the second focused on antennas, exciters and receivers. The planned upgrade would be similar to, but less ambitious than, the Navy's original ALQ-99 ADVCAP program for the EA-6B. A US$65.8 million FSD contract (F33657-84-C-2306) was awarded on October 3, 1984.

In FY86, the AIL team began fabricating ALQ-99E upgrade full-scale development kits, initiated reliability testing, and started integrating development kits into aircraft for flight testing.

By late 1987, the program had slipped by an announced 1.5 years, primarily due to problems with the 1750A processor development. The Development Test & Evaluation was slipped from May 1988 to January 1989. On June 10, 1988, the Air Force announced that it was terminating for default the EF-111A ALQ- 99E Upgrade contract with Eaton AIL. According to the Air Force:

"The contractor was terminated for failure to make progress, so as to endanger performance and for failure to meet a required delivery. The development contract was awarded October 3, 1984, and had a current value of US$81.5 million. The current estimate to completion for this contract is US$153 million. The contractor has projected at least 30 more months' work before the contract could be completed."

Eaton officials stated that the Magic V 1750 Processor, manufactured by Delco, was the main cause of trouble, but that the Air Force shared blame for the delays and cost increases.

The Air Force convened a high-level Steering Group in May 1988 to consider contractual and technical alternatives to the AIL Upgrade effort. Grumman had been awarded a small contract to evaluate using EA-6B components for upgrading the Raven.

In mid-1989, the Air Force announced restructuring the ALQ-99E Upgrade program into a two-phase effort. The first stage would develop a processor and encoder; the second an advanced exciter for the transmitter group.

By following this program rather than the original simultaneous development of the processor/encoder and exciter elements, the Air Force hoped to eliminate some of the original problems and have the system upgraded sooner.

Phase One was planned to take up to six years, but Phase Two would be fielded in less time. This approach dropped some of the original requirement.

On March 18, 1991, the Air Force awarded a US$1155.8 million contract to a team led by Grumman Aerospace for the EF-111A System Improvement Program (SIP). Team members included AIL Systems (Encoder), IBM (1750A Processor), Astronautics Corp of America (Display equipment), Comptek (software), and Smiths Industries (Loader/Recorder).

The Full Scale Development phase was planned to run three years, including flight test. The effort was scheduled to be complete in January 1996. Improvements to the ALR-62(V)4 were included in the effort.

During FY91, the Air Force initiated Engineering & Manufacturing Development (EMD) of the TJS upgrade, completed Band 4 modification kit design specification and awarded an EMD contract to start the design effort. Program personnel completed the System Design Review and Preliminary Design Review for the encoder processor, data bus, and Ada based operation flight program (Digital Subsystem). Engineers successfully completed exciter risk reduction efforts and began studies of ALR-621 RWR integration, narrow-beam antenna and Band 1/2 directivity.

In FY92, the Air Force continued Engineering and Manufacturing Development (EMD) of the EF-111A TJS. They completed a Critical Design Review for encoder processor, data bus, and Ada-based operational flight program (Digital Subsystem). Engineers fabricated a System Integration Laboratory (SIL) and began integrating and testing Digital Subsystem (DSS) components. They completed the Band 4 transmitter Preliminary Design

Review and Critical Design Review. They also began Band 4 transmitter prototype fabrication, Exciter EMD, and completed studies of ALR-62I RWR integration, a narrow beam antenna, and Band 1/2 directivity.

During the FY93/94 budget cycles, there were changes in the funding levels for the SIP program. The Air Force decided to make both management and program structure changes to eliminate the program's fragmented management organization. The Air Force Deputy Assistant Secretary for Acquisition determined that the program should be managed as a "acquisition category one" effort. A single Program Executive Officer (PEO) was put in charge of the program and the program oversight streamlined.

The Air Force also decided that the effort would be changed from 60 to 90 months and the development rationalized. An independent review of the SIP was undertaken, with recommendations going to a major three-star conference for evaluation and a decision on the Air Force program emphasis and requirements. This independent evaluation gave the new plans a satisfactory rating.

In support of the FY95 Air Force RDT&E program, the following revised program description was issued by the program office:

PE 0604270F, EW Development, Project 2066 EF-111A System Improvement Program (SIP). The EF-111A System Improvement Program (SIP) updates the EF-111A Tactical Jamming System (TJS). The update was required to keep the system current against the evolving threat. Most modern radars use state-of-the-art electronic counter-countermeasure (ECCM) techniques which limit the present jamming system's capability to counter these radars.

The EF-111A SIP consisted of four RDT&E projects:

1. The Band 4 Transmitter project would improve the reliability, maintainability, and availability (RM&A) of the current band 4 transmitter.
2. The ALM-204 Update project would replace existing components of the TJS's intermediate/depot level tester with more reliable and more supportable equipment.
3. The Encoder/Processor (E/P) project [a.k.a. Digital Subsystem (DSS) Project] would increase the system's effectiveness and RM&A.
4. The Digital Based Exciter (DBE) project to increase the EF-111's ability to deny, deceive, degrade, and disrupt evolving enemy radars by replacing two of the aircraft's five multi-band exciters with a reprogrammable exciter.

The EF-111A SIP System Program Director (SPD) has re-phased the encoder/processor (E/P) and digital based exciter (DBE) projects to acquire the E/P project at the fastest prudent pace and the DBE project as soon as possible with the remaining funding. Schedule/cost growth and FY94 congressional reductions caused the SPD to re-phase the E/P and DBE projects. Re-phasing the EF-111A SIP program resulted in program cost increases.

The following accomplishments/plans include milestone dates and/or cost estimates for that specific item.

The FY93 program, under the Encoder/Processor (E/P) Project, completed the fabrication and assembly of the Encoder/Processor in November 1992. This was funded at US$45.5 million. Engineers began the hardware/software integration of the E/P in December 1992. Planners also completed the Preliminary Design Review of the Digital Based Exciter (DBE) Project in December 1992 (US$19.5 million), and the DBE Critical Design Review in September 1993).

The Band 4 Transmitter Critical Design Review was completed in January 1993 (US$1.9 million). Hardware assembly and integration began in January 1993).

Five encoder/processor units were delivered to Grumman by AIL between December 1992 and May 1993. The units were slated for use in testing and integration efforts. One unit will be used for environmental qualification testing, one integrated into an EF-111A for flight testing, two units will be used in laboratory testing, and one is a spare.

The FY94 program effort saw the completion of hardware/software integration (July 1994) of the Encoder/Processor (E/P) Project (US$49.3 million). Engineers continued hardware/software assembly and test of the Digital Based Exciter (DBE) Project (US$7.1 million). Planners completed project developmental test and evaluation (DT&E) of the Band 4 Transmitter Project (US$0.3 million) and the complete Band 4 project initial operational test & evaluation (IOT&E) and trial installation. The Navy conducted a Milestone III review in August 1994.

Engineers completed the ALM-204 Project developmental test and evaluation (DT&E) and initial operational test and evaluation (IOT&E) (March 1994). Planners conducted a MS III review in May 1994).

By late 1994, the first Universal Exciter Unit was in test and ready for imminent delivery to the Air Force. Qualification testing was planned to start in January 1995.

In FY95, the Navy programmed US$49.9 million to continue hardware/software integration of the Encoder/ Processor (E/P) Project (March 1995) and began

developmental test and evaluation (DT&E) in June 1995. Engineers continued hardware/software assembly and test of the Digital Based Exciter (Nov 96).

The first flight of the EF-111A SIP took place Spring 1995. This was a delay from the originally planned September 1993 flight because of reported software problems. These flights were with the encoder/ processor configuration only.

The SIP effort was zeroed out from FY96.

FY95 Appropriation. The conference committee for the FY95 Defense Appropriation legislation adjusted EF-111A SIP funding for FY94 and FY95. The conference committee added the following to the FY95 budget: US$700,000 to begin acquisition of a system integration test station (SITS) troubleshooting capability, US$300,000 for installation, integration, and test of a radio frequency scenario generator. US$500,000 of FY95 funds should be used to acquire the RF scenario generator.

These changes were made to support improved testing of the EF-111A SIP since existing test equipment was considered lacking in all the capability needed to thoroughly evaluate the new hardware.

FY96 Appropriation. The FY96 conference committee voiced concern over the Air Force plan to retire its EF-111A force. They acknowledged top-level officials' statements that both aircraft are tactically necessary, and questioned if the EA-6B could meet all of the Air Force's support jamming needs. The committee directed the Secretary of Defense to report on plans to use the EA-6B as the single jamming platform for both services, assuring that the current EF-111A mission is not compromised. Reports were due in February 1996.

Congress also directed that the DoD maintain at lease 12 EF-111As in the primary aircraft inventory through FY99, and required that these aircraft receive robust support. Attrition reserves would be maintained to replace the active jammers, if necessary.

FY97 Appropriation. By FY97, Congress was pressuring the Navy to take the necessary action to upgrade the EA-6B Fleet to support its new, wider mission. In the appropriations conference report, the legislators told the Navy that if the Secretary of the Navy had not submitted the certification and reports to verify that all EA-6B funds had been obligated for jammer upgrades the Navy had been holding back on, along with a detailed plan for upgrading the Prowlers described in subsection (a) to the congressional defense committees before June 1, 1997, then, on that date, "the Secretary of Defense shall transfer to Air Force, out of appropriations available to the Navy for fiscal year 1997 for procurement of aircraft, the amount equal to the amount appropriated to the Navy for fiscal year 1997 for modifications and upgrades of EA-6B aircraft."

Congress noted that any funds so transferred to the Air Force would be available for maintaining and upgrading the jamming capability of the EF-111A aircraft. This came after the Senate Appropriations Defense Subcommittee strongly expressed its displeasure over what they saw as an unwillingness to maintain through FY99.

The Air Force scheduled five EF-111As for depot maintenance in FY97. These aircraft were to be retired in FY98, but now will be available for operations through FY99 or later. It was also revealed that the Navy had found the funds to upgrade the EA-6B aircraft that would be needed to create the additional squadron needed to support the Air Force requirement.

Funding

US FUNDING

	FY94		FY95		FY96		FY97 (Req)	
	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
RDT&E (USAF)								
PE0604270F								
EW Development								
2066 EF-111A (SIP)		58.1	-	56.3	-	0.0	-	0.0
Procurement (USAF)								
EF-111A (SIP)	-	23.4	-	23.5	-	0.0	-	0.0

All US$ are in millions.

Recent Contracts

(Contracts over US$5 million.)

Contractor	Award ($ millions)	Date/Description
Grumman Aerospace	155.8	Mar 1991 — Cost plus incentive fee for the system improvement program for the EF-111A. The full-scale development addresses various aspects of the ALQ-99E jamming system and ALR-62(V)4 radar warning receiver. Completed Jan 96. (F33657-90-C-0001)
Grumman Aerospace	76.1	Nov 1991 — Face value increase to CPIF contract for EF-111A System Improvement Program Digital Based Exciter. Completed Feb 1996. (F33657-90-C-0001)

Timetable

	1971	Program initiated
Jan	1975	Modification contract awarded
Mar	1977	First test flight
Nov	1981	First aircraft delivered
Oct	1983	ALQ-99E Upgrade contract awarded
Jun	1988	Upgrade program terminated
	1989	USAF announced restructuring of ALQ-99E Upgrade
Mar	1991	System Improvement Program (SIP) contract awarded
Nov	1992	Planned delivery of 1st aircraft to be upgraded
Dec	1992	DBE PDR, E/P fabrication/assembly
Sep	1993	DBE CDR
	1994	Program re-structured
Mar	1994	ALM-204 DT&E, IOT&E
May	1994	ALM-204 DT&E complete, Milestone III
Aug	1994	Band 4 Transmitter IOT&E complete
Sep	1994	Band 4 Transmitter Milestone III, contract award
Nov	1994	Band 4 Transmitter hardware/software integration
Feb	1995	E/P integration complete
May	1995	E/P CT&E end
Spring	1995	First flight of modified EF-111A
Aug	1995	Program Decision Memorandum augmenting Navy EA-6B force from 80 to 104 and directing the retirement of the EF-111A
	1996	Began retirement of EF-111As
	1999	Retirement of final EF-111A (tentative)

Worldwide Distribution

Total Raven inventory built for the USAF consists of 42 aircraft, all of which are F-111A rebuilds.

Forecast Rationale

There is no doubt about the EF-111A's performance during the Persian Gulf War. Although the aircraft had been employed effectively in training exercises such as Red Flag and Green Flag, Operation Desert Storm used the jammers in actual combat. They were employed in both escort and standoff roles, a tactic that made the best use of the EF-111A's high-power capability.

The basic jammer works and the Air Force anticipated the future threat environment, taking advantage of

technological advancements to improve operation, reliability, and maintainability. The Air Force and SIP team came up with a new operational guideline to follow in enhancing the jammer. By admitting to its problems and re-structuring the System Improvement Program, officials exposed themselves to criticism for past problems, but could justify what they were doing and point to a significant risk reduction in the program.

Budget constraints and the need to cut costs has generated the recent EF-111A versus EA-6B debate. Both programs have a number of pros and cons that support either recommendation. All services took a hard look at their programs, and found it necessary to jettison some favored systems.

It is interesting to note that the Air Force Chief of Staff has been quoted as saying that he made the final decision to retire the EF-111As in lieu of the EA-6B after talking to the ground threat operators at the Nellis Air Force Base Electronic Combat Range in Nevada. They told the chief that in exercises, the EA-6B always significantly out-performed the EF-111A, reiterating statements made by this analyst during initial tests of the two aircraft over a decade ago, recommending at that time that the EA-6B would be a better choice as a support jammer.

The FY96 direction to maintain a small EF-111A force will insure that the Air Force does not totally abandon the capable aircraft too quickly. The reporting called for in the legislation will also make it necessary for the service to justify its actions to a skeptical Congress. This was probably a wise approach, considering that Navy officials moved slowly in making the needed changes to expand the Prowler Fleet.

The EF-111A upgrade program has gone through a series of problems and restructuring, and ran afoul of budget constraints. The SIP program with its new approach and planning was not the ideal effort, but it is an attempt to upgrade the aircraft in spite of budget cuts.

But the facts are clear. There are 120 EA-6Bs and only 29 aircraft in the active inventory. The performance of the Navy aircraft is somewhat superior to that of the Air Force jammers, and that would improve even more, once the enhancements required by Congress are implemented. The change in operational requirements from strategic attack and interdiction to contingency operations makes the EA-6B an adequate escort for the most likely missions that joint operations can be expected to face.

Given the pressure on both services from Congress, most of the Navy's unwillingness to spend money on the EA-6B conversion, and the Air Force's reluctance to adopt a "navy" airplane, is changing into an appropriate level of accepting enthusiasm for the change. The Navy is beginning to move on the upgrades, and Air Force pilots are well along in training in the Prowler. Both services are now expressing enthusiasm for the whole idea.

Ten-Year Outlook

No further production.

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