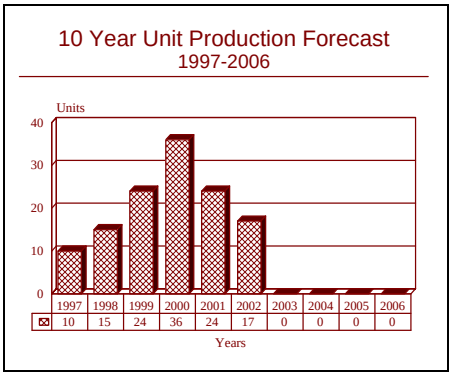
TJS (ALQ-99(V)) - Archived 3/98

Outlook

- This airborne tactical jammer is in service, with ongoing logistics support
- ADVCAP program canceled; but reduced-scope upgrades in development
- EA-6B will be the only stand-off/escort jammer, supporting both Navy and Air Force operations



Orientation

Description. Airborne Tactical Jammer.

Sponsor

US Navy
Naval Air Systems Command
Washington, DC 20361-2140
USA
Tel: +1 703 692 3122
(NAVAIR HQ is in the process of moving to the Naval Air Warfare Center, Patuxant River, Maryland)

Naval Air Systems Command
EW Program Office PMA-272
AIR-21414W
Washington, DC 20361-2140
USA
Tel: +1 703 692 3122
(EA-6B Program)

US Air Force
AF Systems Command
Aeronautical Systems Center
ASC/PAM
Wright Patterson AFB, Ohio (OH) 45433-6503
USA
Tel: +1 513 255 3767
(EF-111A Program)

Contractors

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 Prime, ALQ-99E Exciter/Encoder, Universal Exciter)

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

Litton Systems Inc
Amecom Division
5115 Calvert Road
College Park, Maryland (MD) 20740
USA
Tel: +1 301 454 9315
Fax: +1 301 864 5275

AEL Inc
A Tracor Company
305 Richardson Rd
Lansdale, Pennsylvania (PA) 19446
USA
Tel: +1 215 822 2929
Fax: +1 215 822 9165
(Band 9/10 transmitters)

Lockheed Martin Corp
6801 Rockledge Drive
Bethesda, Maryland (MD) 20817
USA
Tel: +1 301 897-6711
Fax: +1 301 897-6800
(1750A Processors, ALQ-99 and EF-111A SIP)

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
(ALQ-99E Band 4 Transmitters)

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

Status. In service, upgrades in development and production, ongoing logistics support.

Total Produced. An estimated 550 ALQ-99 pods and 50 ALQ-99E pallets have been produced. Some ADVCAP upgrade prototype units were put together.

Application. EA-6B and EF-111A.

Price Range. The original ADVCAP unit cost was estimated at approximately US$3 million. EF-111A System Improvement Program upgrades were put at US$4.5 million per aircraft. These were canceled with a scaled-back, lower-cost upgrade being pursued. The ICAP III design-to-cost goal is US$2.5 to US$3.5 million.

Technical Data

The following listing shows the jamming frequency bands and frequency coverage in GHz.

Band 1 (VHF)
Band 2 (VHF/UHF)
Band 3 (0.3-0.5 GHz)
Band 4 (0.5-1.0 GHz)
Band 5 (1.0 GHz)
Band 6 (2.7 GHz)
Band 7 (2.6-3.5 GHz)
Band 8 (4.3-7.0 GHz)
Band 9 (7.0-10.0 GHz)
Band 10 (12-18 GHz)

Design Features. The ALQ-99 is a complex and capable tactical jamming system, the heart of the electronic warfare suite aboard Navy EA-6Bs and Air Force EF-111As. The EA-6B carries three to five pods on wing hardpoints. Each pod can be configured specifically for the mission planned. The EF-111A carries the ALQ-99E on an internally mounted pallet with 10 transmitters.

The ALQ-99 was designed for jamming enemy land-based, shipborne, and airborne command, control and communications (C3) and radars associated with early warning, target acquisition surveillance, anti-aircraft artillery, and air-to-surface, surface-to-surface as well as surface-to-air missiles. It will support carrier-based tactical aircraft and battle group operations in dense radar-controlled environments.

The ALQ-99 Tactical Jamming System is made up of the following:

Nose Power Supply
Aft Power Supply
Video Display
Antenna
Universal Exciter
Transmitters
Surveillance Receivers
Encoder
Front-End
Computer Interface Unit
Surveillance Receivers
Band 9/10 Transmitter (being added)

The Universal Exciter features totally programmable jamming parameters, as well as advanced power management techniques that optimize performance based on the number of threats being jammed. The receivers are designed for long-range detection. A central processor prepares received signals for display and recording. Detection, identification, direction finding, and jammer-set-on can be performed automatically.

ALQ-99. The podded installation on the EA-6B contributes to operational flexibility by making it possible to configure the pods carried to counter specific threats. Beam steering can focus energy more effectively in the direction of targeted threats. Each pod consists of two 1 kW continuous wave transmitters, an exciter/processor, a control computer that interacts with the CPU, a transmission antenna, and a ram air turbine to provide electrical power.

The heart of the jamming system is the CPU, which has three major duties: jammer management, threat data processing, and operator display generation. The system integrated receiver (SIR) group supplies the basic threat data to the CPU, which identifies the emitter by comparing the data against a preprogrammed library of PRF, wavelength, order-of-battle, and location information. The CPU then recommends jamming selections, or automatically makes the choice, steering the transmission beams and checking transmitter tuning accuracy. Data on the threat situation can be updated in near real time.

The control/display components include a CRT and associated keyboards located at the three EW officers' stations. The forward EW officer (next to the pilot) is senior and responsible for about half of the system's operation. The officers in the rear stations cover the remainder of the primary functions and the communications jamming, respectively. The keyboards provide automatic, semiautomatic and manual mode capabilities.

The SIR components (originally an ALR-42) consist of a fin-top blister fairing inside which is a spiral antenna covering Bands 4, 5/6, 7, 8, and 9, and four blister fairings mounted in pairs on each side of the fin and covering Bands 1 and 2, thus providing 360° coverage. The primary function of the SIR is to supply threat data to the CPU, and its secondary job is to ensure that the ALQ-99 is responding to a genuine threat by monitoring the TJS's output.

ALQ-99E. The ALQ-99E carried by the Air Force EF-111A shares about 70 percent commonality with the ICAP/ICAP-II Prowler variants, but is considered quite different. Although the original system's basic architecture was kept, there are three major differences. The level of automation was increased to make one- person operation possible, an internal primary jamming capability was added, and the primary receiver system was separated from the jamming subsystem.

The EF-111A's EW officer has at his or her disposal a large CRT display, a jamming mode selection panel, a jammer status panel, a display control panel on the main instrument board, a chaff/flare dispensing control panel (also on the main instrument board), an ALQ-99E control panel, and a side console with a subsystem control panel and an SIR group control panel. With such a layout, the EW officer can set up the required countermeasures, with the CPU activating and controlling the measures as required.

The ALQ-99E's computer is the system's processing center. Before the mission, the system is programmed with information on all emitters likely to be encountered. Using these data, the ALQ-99E's computer can then rapidly follow up on each detected emission, and if it is identified as hostile, locate and prioritize it, also recommending operator action. The system automatically responds to preprogrammed threats by using signal-matching techniques.

The jammer components are internally housed with the active segment located in a specially designed, 15-foot-long, canoe-shaped radome that is situated on the original weapons bay doors, with the added feature of retractability to allow access to the weapons bay.

The weapons bay itself houses the pallet-mounted primary jamming capability, high-power equipment that weighs some two tons. This includes 10 transmitters that cover frequency bands 1/2, 4, 5/6, 7, 8 and 9. This installation incorporates significant new technology including increased individual transmitter coverage, modulated jamming instead of noise jamming, and new multi-band, multi-spot exciters (each of which includes its own modulation microprocessor).

With the receiver and passive detection components being located on the tip of the vertical stabilizer, the aircraft's fuselage acts as a buffer between the active and passive sections of the system. As a result, enhanced reception and continuous searching are possible, even during transmission operation or "look-through" jamming.

Modifications to the EF-111A Raven included replacing the original 60 kW system with a 90 kW power generator, better air cycling and liquid cooling, a greater capacity air conditioning system (needed to handle the heat generated by the high-power transmitters), and rewiring over 25,000 cables.

Operational Characteristics. The ALQ-99 system has three operational modes:

Automatic in which the processor sorts detected signals and directly controls the jamming components against the detected threat. Two operators monitor system operation.

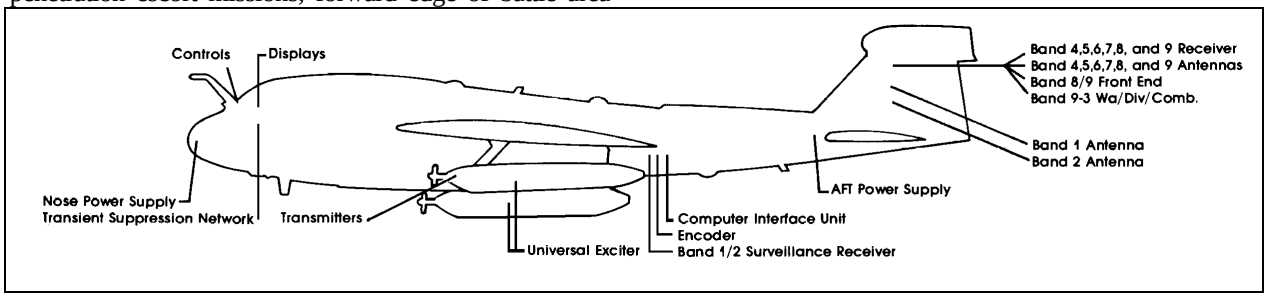
Semi-automatic operation detects threats and identifies them for the operators who select the ECM mode of operation.

Manual modes are set up where operators scan selected parts of the spectrum, identify threats, and select a jamming response.

The EA-6B is a carrier-based electronic warfare strike escort. Aircraft characteristics closely match the typical Naval strike package, which makes it possible to include one or more EA-6Bs in a penetration attack. The Prowler uses its powerful jammers to disable or disrupt the early warning, surveillance, and ground control intercept systems of hostile forces. The range of coverage is estimated to be up to 400 km (216 nm) when operating at a 30,000 foot altitude. This increases the survivability of the force and success of the attack. Terminal self-protection from surface-to-air missiles and antiaircraft guns is provided by electronic combat equipment carried by individual strike aircraft. The Prowler can orbit along the ingress path of a strike force, setting up a wall of jamming to screen the attack force from detection.

The EF-111A mission was stand-off jamming, deep-penetration escort missions, forward edge of battle area (FEBA) support missions, counter jamming against enemy formations, support of NATO forces, and countermeasures against early warning, ground-control intercept, and acquisition radars. Possible scenarios have one or more EF-111As flying "race-track" patterns near the battle front or flying with the lead aircraft of a strike package to put up an unbroken jamming screen. Effective jamming range is around 230 km (124 nm). Effective flying range of the aircraft is over 2,000 miles. On-station time is as much as four and a half hours without refueling.

During Operation Desert Storm, EA-6Bs and EF-111As combined with US and British attack aircraft to disable and destroy the Iraqi air defense system. They flew both standoff and jamming missions in support of Coalition strike packages and as deception-generating foils to distract Saddam Hussein's forces from the ingress of stealth aircraft. EA-6Bs also fired AGM-88 HARM anti-radiation missiles to destroy some of the Iraqi radars.



Variants/Upgrades

Initial variants involved hardware upgrades to enhance operational capability and reliability. They were:

ALQ-99B. Reliability enhancements.

ALQ-99C. Reliability and operational improvements.

The more distinct variants are:

BASIC. The initial version covered only Bands 1/2, 4 and 7. These were fitted to the first 23 EA-6Bs, which saw active duty in Southeast Asia in 1972-73.

EXCAP. Next was the replacement for BASIC, known as the EXCAP (EXpanded CAPability) ALQ-99. This upgrade doubled the frequency coverage to Bands 1/2, 4, 5/6, 7, 8, 9. It also included additional computer software, new wide-band transmitters, a recording capacity for future threat analysis, and new exciters which provided a track-breaking and constant false alarm rate jamming capability. The EXCAP version was installed in 21 surviving BASIC aircraft (1976-79) and 25 new-build EA-6Bs.

ICAP. The ICAP (Improved CAPability) ALQ-99 was the next version, entering service in 1976. ICAP improved on EXCAP by featuring a reduction in response time, new encoders, digital transmitter tuning, and improved multi-format displays. ICAPs were installed on new EA-6Bs and 21 existing EXCAP Prowlers.

ICAP-II. The fourth variant (ALQ-99F) is called ICAP-II and first flew in 1980. ICAP-II featured improved jammer management, an enhanced threat identification capability, new multi-band exciters, software and display enhancements, easier maintenance, and improved reliability. This is the standard version with aircraft in the fleet today.

ADVCAP. The US Navy has been developing the ADVanced CAPacity (ADVCAP) as a follow-on to ICAP-II. This development and upgrade program is expected to cost in excess of US$400 million for 100 EA-6B aircraft. Litton Industries' Amecom Division, leading a team that included Texas Instruments and ITT, won the ADVCAP engineering development contract in 1983.

A prototype system has been installed on test aircraft. It was an extensive upgrade of the original system, with the heart of the change being an improved receiver- processor group (RPG) which could counter the improved threat radars expected through the turn of the century. In included more pulse-to-pulse agility and wider bandwidth capability. Litton delivered the first developmental RPG in February 1988. The new Prowler would also carry an ALQ-149 communications jammer to expand the overall mission capability of the aircraft.

On 7 February 1994, the Navy terminated the contracts for the full ADVCAP program. This budget-based decision has generated significant debate on Capitol Hill and in the Pentagon.

EA-6B ICAP III. The pressure is on to accelerate EA-6B upgrades to replace ADVCAP. This has become known as ICAP III. A June 1996 RFI expressed hope that the program could be accelerated from an FY99 to an FY97 start, moving IOC to 2001 from 2003.

The ICAP III upgrade has two principal goals: to add a selective, reactive, narrowband jamming capability that will be able to detect the frequency and frequency changes of a limited number of threat emitters and to quickly make the necessary jammer adjustments or frequency assignments and a more robust hard-kill capability from anti-radiation missiles. The RFI stipulated the primary requirement for a integrated receiver system that covers frequency bands 1 through 10, with sufficient direction-of-arrival measurement for emitter classification and jammer management.

The new system will have to have superior frequency-measurement accuracy for narrowband jamming assignments; as well as the ability to detect frequency changes for a limited number of emitters that are undergoing selective, narrowband jamming. It will have to be able to provide geolocation accurate enough for High Speed Anti-Radiation Missile (HARM) range-known targeting as well as the ability to perform Electronic Support and HARM-targeting functions concurrent with jamming.

A goal, but not a requirement, for the receiver system is that it be able to make specific emitter identifications. The ICAP III upgrades will be used to improve situational awareness and aid the jamming and lethal suppression of enemy air defenses by integrating off-board surveillance information (TRAP, TADIX B and TIBS); better communications connectivity with other assets (via Link 16); and the installation of a new display system that can display the on-board and off-board data.

The RFI also called for the full system integration of the USQ-113 communications jammer so that it may be controlled and its data viewed through the main display system.

The upgrades planned include replacing the current ALQ-99 On-board System Receivers, integrating off-board connectivity, integrating the USQ-113 into the jamming suite, and replacing obsolete avionics. Using off-the-shelf and non-developmental equipment is acceptable, as is using government-furnished equipment.

Baseline for the ICAP III upgrade will be an EA-6B Block 89A configuration. This includes structural and avionics improvements, embedded GPS/INS, the low-band and high-band transmitters, the universal exciter upgrades underway, and the USQ-113. The design-to-unit cost goal for 126 aircraft is US$ 2.5 to US$ 3.5 million.

Contractor responses were reportedly submitted to the Program Office on September 13th, 1996.

ALQ-99E There is approximately 70 percent commonality between the EF-111A and EA-6B units. The Air Force system can carry up to ten transmitters mounted on an internal pallet. The transmitters cover the ½, 4, 5/6, 7, 8 and 9 bands. The EF-111A version employs five exciters, each powering two of the transmitters.

The ALQ-99E is heavily automated to allow for operation by one EW officer using a single display console. The Navy version carried by the Prowler uses three Electronic Warfare officers, each supplied with a CRT, to operate the ALQ-99.

Because of budget constraints, the Air Force terminated the EF-111A program and will rely on EA-6B support for jamming missions. Air Force crews are training in the Prowler.

Program Review

Background. The ALQ-99(V) was developed in the 1960s and saw its first application on Grumman EA-6B Prowler EW aircraft. The US Air Force began taking notice of the system's performance and investigated producing a USAF version, the ALQ-99E. The first ALQ-99-equipped EF-111 flew in March 1977.

The ALQ-99 grew from a naval requirement for a "smart" jamming system, one that could counter a wide range of present and future threats as well as provide electronic cover for the US Navy's airborne and seaborne units. It was to be carried by EA-6B Prowlers, dedicated EW variants of the Grumman A-6 Intruder strike aircraft. The concept was to combine a noise jammer, track breaker, and VHF jammer into a single system. Early versions saw combat in Vietnam. After Southeast Asian operations, the aircraft went through a steady program of evaluation and upgrade to keep pace with mission changes and technology developments.

PE 0604270N, Project E0556 — EW Counter Response (EA-6B Advanced Capability (ADVCAP). This Program Element funds development of and upgrades to the electronic countermeasure response to advanced threat weapon systems and C3 networks which are expanding in density and technical complexity. This Project funds the continuing development or integration of all EW systems for the EA-6B Electronic Countermeasures Support Aircraft.

The efforts under this PE provide for the electronic countermeasure response to the advanced threat weapon systems and C3 networks which are expanding in density and technical complexity. This PE also funds the continuing development or integration of all EW systems for the EA-6B Electronic Countermeasures Support Aircraft.

In FY90, the Navy conducted a reliability development and weapon replaceable assembly maintainability demonstration on the ALQ-149. Contractor flight testing and ALQ-99 ADVCAP RPG development continued. HARM Block III/IV integration continued. The Navy conducted a preliminary evaluation of the RPG.

During FY91, the Navy continued qualification testing, Reliability Development Testing (RDT) and Electromagnetic Interference (EMI) testing on the RFG. Engineers continued PCM software development for initial baseline ADVCAP capability, continued integration of RPG and ALQ-149 on EA-6B, and continued software development and logistics support development for the RFG and ALQ-149 (ADVCAP). Planners continued Contractor integration/test Band 2/3 Transmitter and commenced the Universal Exciter Upgrade (UEU) study.

The Navy also began the Coherent Countermeasure Program for the EA-6B. Planners completed Navy Developmental and Operational flight testing on HARM block III/IV and commenced Technical Upgrade for Teams (TUT) and ADVCAP TEAMS (ATEAMS).

FY92 accomplishments included software development and logistics support for the RPG and ALQ-149 (ADVCAP), and continued integration of the RPG/ALQ-149 on the EA-6B ADVCAP. The Navy began the Universal Exciter Unit Program and continued the COCM and PCM Programs. Planners conducted developmental and operational testing to support RPG and ALQ-149 Milestone IIA decision planned for FY 1993. Engineers continued qualification testing, Reliability Development Tests (RDT) and EMI testing on the Radar Processor Group. They also continued Technology Upgrade for TEAMS (TUT) Tactical EA-6B Mission Support (TEAMS) and ADVCAP TEAMS (ATEAMS) integration.

In FY93, engineers continued software development, logistics and test support for Radar Processor Group (RPG) and ALQ-149 (ADVCAP). (US$16.898 million) and integration of the RPG and ALQ-149 on the EA-6B ADVCAP (US$4.852 million). They continued the Universal Exciter Unit Development Program (US$30.000 million), COCM and PCM programs for the EA-6B (US$4.650 million), contractor acceptance test for Band 2/3 (funding N/A), and delivery of Band 2/3 Engineering Development Models (EDM) 1 through 5 (funding N/A). The Navy continued Band 2/3 qualification and Electro Magnetic Interference (EMI) testing (US$682,000) and the Technology Upgrade for Teams (TUT) and ADVCAP Teams (ATEAMS) integration (US$2.520 million).

The program office also began the groundwork for integration of the Software Development Station (SDS) at the Naval Air Warfare Center Weapons Division, Point Mugu, California (US$200,000), and completed OT-IIA testing of ALQ-149/RPG in support of Milestone IIA (US$1.240 million)

In FY94, the effort completed a wing fatigue study analysis using US$300,000 in FY93 funding. Engineers began developing and integrating the Universal Exciter Upgrade (UEU) into Improved Capability (ICAP) II aircraft with US$2.477 million in FY93 funding. Planners continued software and Jammer technique development and test support for ICAP-II development programs (US$8.193 million FY93 funding). Planners began a Joint Tactical Air Electronic Warfare Study (JTAEWS) (US$5.000 million in FY94 funding) and integration studies of ALQ-149 into EA-6B ICAP-II

(US$5.845 million in FY94 funding). Developers completed delivering Band 2/3 Engineering Development Models 1 through 5.

The Navy terminated the EA-6B ADVCAP program. Congress began pressuring the service to develop a lower-cost upgrade for the Prowler. The Navy was encouraged to use prior-year funds to upgrade their premier jammer.

The Navy's FY95 plan was to use US$3.483 million in FY94 funding and US$2.556 million in FY95 funds to continue software and techniques development and test support for ICAP-II development programs. Planners would take delivery of seven UEU EDMs, and complete the ICAP-II UEU follow-on test and evaluation (FOT&E) (OT-IIIA/SEP 95). Engineers would complete the UEU development program and integration on CAP-II (US$16.4 million FY94 funding). They also planned to complete JTAEWS (US$1.0 million FY94) and begin the low-band transmitter development program (US$2.0 million FY95 funds) and develop enhanced joint C2W capabilities associated with the Air Force EF-111A termination (US$3.0 million FY95). The program office would continue the Coherent Countermeasures (COCM) and Proforma Countermeasures (PCM) programs for the EA-6B. The level of effort would be commensurate with available funds.

In August 1995, the Naval Air Systems Command announced that it intended to procure approximately 78 Upgraded Universal Exciters, along with associated data and ILS. The procurement would include a priced option for 102 additional systems.

Also in August, NAVAIR announced plans to competitively procure seven Engineering Development Models (EDM) of a Low Band Transmitter for use with the EA-6B Prowler Aircraft Tactical Jamming System (TJS). The new transmitter must install in and interface with the current ALQ-99 Pod, and be fully integrated with the ALQ-99 TJS. To support effective long-range jamming, the transmitter must perform the functions of accepting low-level Band A/B Radio Frequency (RF) signals from the ALQ-99 Pod Exciter, amplifying signals to a high power level, and effectively radiating signals through its antennae. The development effort is scheduled to begin after source selection in the second quarter of FY96. Release of a Draft RFP took place during the fourth quarter of FY95, with release of the final RFP planned for the first quarter of FY96. Production of up to 130 transmitters was planned to begin in FY98.

The FY96 plan was to continue software and techniques development, and test support for ICAP-II development programs (US$2.929 million in FY95 funding and US$3.314 million in FY96 dollars). The program would award a low-band transmitter development contract (US$12.0 million FY95). Planners would conduct an EA-6B follow-on system Cost and Operational Effectiveness Analysis (COLA) and risk reduction (US$2.0 million FY95), and continue COCM and PCM programs for the EA-6B at a level of effort commensurate with available funds.

In FY97, the Navy planned to continue software and techniques development and test support for ICAP-II development programs (US$2.693 million). Programmers would continue COCM and PCM programs for the EA-6B, again at a level of effort commensurate with available funds.

FY95 Congressional Action on EA-6B:

Defense Authorization. The Navy requested US$38.4 million for EA-6B modifications, including various structural and common configuration modifications, such as the Block 89A wing center sections, pod hardback, and band 9/10 transmitter modifications. After debate, the authorization conferees denied the FY95 modification funds.

The conference committee directed the Secretary of the Navy to proceed with a lower-cost alternative to ADVCAP. The conferees expressed concern about possible delays, while the Navy waited for the results of a joint Navy/Air Force electronic warfare study. They were worried that a delay could preclude the ability to capitalize on prior ADVCAP investment or capturing current technology.

Defense Appropriation. The Defense Appropriation conference added US$25 million to the RDT&E EW Development program for development of a follow-on program to ADVCAP. They also required the DoD to submit a development plan by December 31, 1994, in conjunction with the results of the Joint Tactical Air Electronic Warfare requirements study.

The conferees included bill language which would permit the Navy to use prior-year funds to begin non-developmental engineering changes and procure a lower-cost follow-on system and aircraft upgrades. They directed the Navy to give high-priority consideration to incorporating already developed systems, or systems already under development into the follow-on systems.

FY96 Congressional Action on EA-6B:

Defense Authorization. Congress continued to focus on the ADVCAP termination, expressing dismay that the Navy had failed to fund EA-6B improvements other than the ADVCAP capability upgrades, enhancements impacting reliability, maintainability, and safety. The Senate Armed Services Committee also stated that they

believed that the Navy decision "incorrectly ignored the EA-6B's dwindling capability against a wide array of threats."

The Navy's position was complicated by the Air Force decision to cancel the EF-111A SIP upgrade and retire their jammers on a phased basis by FY2000. Twenty additional EA-6Bs would be required to support the Air Force stand-off jamming mission. The Committee saw the Navy airborne EW program as drifting backward. "The committee sees no coherent DoD plan for a joint future capability to conduct integrated strike air warfare. The JTAEWS analysis was supposed to define the future shape of airborne EW by examining the dominant elements of EW: jamming, self-protection, suppression of enemy air defenses (SEAD), and stealth. However, the budget does not even implement the results of that analysis."

In a scathing continuation, the SASC said, "The Department has ignored congressional intent time and again in this matter. With no coherent plan, and with disregard for Congressional direction, the Department appears to hope the problem will solve itself. The committee believes that this is an unacceptable situation. The combatant commanders will not launch strikes without EW support, yet airborne electronic warfare is not important enough to receive upgrade funds. Unfortunately, because of previous and planned cancellations, the combatant commanders now have less EW capability available now than they had during Desert Storm."

The Senate report directed the DoD to include a warfighting capability improvement component in planned EA-6B upgrades. They recommended adding US$40 million for a robust Band 9/10 capability upgrade for the EA-6B fleet, and directed the Navy to work with the Air Force to ensure that technologies developed in the EF-0111A SIP program for Band 9/10 jammers are used in the EA-6B program.

The Senate also recommended an additional US$140 million to upgrade 20 EA-6Bs to the Block 89 configuration to support the additional Air Force standoff jamming mission. The House of Representatives approved the original request for Navy EW RDT&E without comment.

In the FY96 Defense Authorization House and Senate conference, Congress authorized US$ 165 million for Prowler upgrades. Of this, US$ 25.0 million was to go to procure 30 USQ-113 radio countermeasures sets for installation in the EA-6B.

Defense Appropriation. House and Senate conferees completed work on an initial appropriation bill, which was rejected by the House of Representatives and sent back to conference. Issues had nothing to do with the EA-6B. The conferees were able to come to a new agreement and the legislation became law on December 1, 1995.

The bill provided US$165 million for modifications and improvements to the EA-6B; with US$100 million to modify 20 more aircraft to support the Air Force jamming mission. The conference appropriated US$40 million to buy 60 shipsets of Band 9/10 jammer transmitters and US$25 million to buy 30 USQ-113 radio countermeasures sets. The bill added US$10 million to the original request of US$87.44 million. These funds were for the Navy to begin developing a reactive jamming capability for the EA-6B and to improve the aircraft's connectivity with other critical warfighting platforms.

FY97 Congressional action on EA-6B:

Defense Authorization. In the authorization legislation, Congress included specific language to require that the funds appropriated for modifications or upgrades of EA-6B aircraft may be obligated only for a reactive jammer program for the aircraft until 30 days after the Secretary of the Navy submits to the congressional defense committees a certification that some or all of the funds have been obligated for a reactive jammer program for the EA-6B, and submits a report that sets forth a “detailed, well-defined program” for developing and incorporating the reactive jamming capability.

The legislators included a contingency whereby if the Secretary of the Navy did not submit the certification and report called for before June 1, 1997, on that date, the Secretary of Defense would transfer to the Air Force, out of Navy FY97 aircraft appropriations funds equal to the FY97 EA-6B modification appropriation. These monies would be used by the Air Force for maintaining and upgrading the jamming capability of EF-111 aircraft.

In specific legislative provisions adopted, the Authorization conferees said that they felt that attack aviation continues to require a robust electronic warfare capability. They were of the opinion that the decision to retire the Air Force EF-111s and rely on the EA-6B for the tactical jamming mission made it imperative that the EA-6B fleet be structurally sound and modernized to meet current requirements. The conferees noted that the current jamming transmitters on the EA-6B have not changed substantially since originally designed in the 1960s, although there have been several generations of improved surface-to-air and air-to-air missiles since then, and many of these new systems operate in the high radio frequency range. The legislation pointed out that anti-ship missiles employ seekers in the band 9/10 frequency range.

As a result, the conferees authorized an increase of US$40.0 million to the budget request to procure 60

shipsets of these transmitters. They also authorized an addition of US$11.0 million to the budget request to acquire an additional 24 units of the USQ-113 communications jammer. US$50.0 million was authorized for aluminum wing center sections needed to correct a structural problem.

The FY97 Defense Authorization Act went on to note that "although funds were authorized and appropriated for FY96 to initiate a reactive jammer program for the EA-6B, the Department of Defense chose not to initiate such a program, and elected instead to program funds for such an effort from FY99 to FY01." The conferees found these actions of ignoring congressional direction and refusing to start a modest reactive jamming program unacceptable. The conferees said that they expected the Department to begin at once a program to develop and field a reactive jamming capability in the EA-6B, and authorized an additional US$ 32.0 million for that purpose. The conferees expressed concern about the Navy's slow response to Congressional direction and the need for modern, robust electronic warfare capabilities now.

Defense Appropriation. As expected, the appropriation legislation was less directive that the authorization. The conferees increased the original EA-6B modification request of US$100.6 million to US$228.6 million. US$50.0 million of the increase was for center wing sections and US$5 million for Turbine Blade Containment. US$40.0 for Band 9/10 Transmitters, US$11.0 million for USQ-113 Communications jammers, and US$22.0 million for connectivity.

The EW Development RDT&E line was increased from US$78.7 million to US$127.3 million. This included US$32.2 million for EA-6B Reactive jamming development. They moved the EA-6B Connectivity Upgrade to the Aircraft Modification line.

USAF's ALQ-99E. In the late 1960s, the Air Force began to show interest in adopting the ALQ-99. They rejected the Prowler as a platform because of range and performance incompatibility with the USAF mission. In 1974, a feasibility study was conducted regarding the suitability of reconfiguring the ALQ-99 for installation in F-111s. A major problem was the four-person crew needed in the EA-6B to operate the ALQ-99. In the EF-111A, this would have meant significant rework of the forward fuselage or a serious reduction in fuel capacity.

The ALQ-99E began development in 1974. This variant was highly automated and was based on the ICAP/ICAP-II versions of the ALQ-99. It was configured to fit in the F-111 without structural modifications and operated by a crew of two.

The EF-111A conversion program began in 1974 with design definition contracts awarded to Grumman and General Dynamics. In January 1975, the Air Force selected Grumman to convert 42 F-111 aircraft to the EF-111A Tactical Jamming System (TJS) configuration through the installation of the ALQ-99 jamming system in the weapons bay, along with the ALQ-137 self-protection system. (In February 1987, the Air Force canceled the program to provide an internal ECM self-protection suite for the F-111 aircraft, citing high cost. The Air Force decided to procure additional ALQ-131 Block II pods instead.)

Modification funding in FY78 covered one aircraft. 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 42nd EF-111A was delivered in FY86.

A full-scale production contract was awarded to Raytheon in 1981, with Grumman the prime contractor for the airframe. The first fully representative F-111 with the ALQ-99E flew in 1977. These aircraft were redesignated EF-111As.

ALQ-99E Upgrade. A team led by Eaton AIL edged out a team headed by Grumman on October 3, 1984, to win the ALQ-99E upgrade contract for EF-111A aircraft. The AIL team consisted of General Dynamics (original F-111 builder), General Motors' Delco Division (signal processor), Tasker Systems and Comptek Research. Grumman's team included Raytheon, Teledyne and Intermetrics.

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 would 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 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 Eaton AIL team (ALQ-99E upgrade) began fabricating 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, and 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 has also been working on a small contract to evaluate using EA-6B components for upgrading the Raven. The Air Force Systems Command planned to have specific alternatives developed by fall of 1988.

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

On March 18, 1991, the Air Force announced a US$155.8 million award 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.

PE 0604270F, EW Development, Project 2066EF-111A System Improvement Program (SIP). TheEF-111A System Improvement Program (SIP) was to update the EF-111A Tactical Jamming System (TJS) 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 to improve the reliability, maintainability, and availability (RM&A) of the current band 4 transmitter.

2. The ALM-204 Update project to 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] to 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) 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 total cost increases. Estimates are that the program cost would increase as a result of the changes.

FY92 accomplishments included continued Engineering and Manufacturing Development (EMD) of the TJS upgrade. The Air Force completed the Critical Design Review for the encoder processor, data bus, and Ada-based operational flight program (Digital Subsystem). Engineers fabricated the System Integration Laboratory (SIL) and began integration and test of Digital Subsystem (DSS) components. They also held a Band 4 transmitter Preliminary Design Review and Critical Design Review. Personnel began Band 4 transmitter prototype fabrication and Exciter EMD, and completed studies of ALR-62I RWR integration, narrow beam antenna and Band 1/2 directivity.

Five encoder/processor units were delivered to Grumman between December 1992 and May 1993. The units were slated for use in testing and integration efforts. One unit would 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 would be a spare.

The FY93 program incorporated the Encoder/Processor (E/P) Project valued at US$45.5 million. This covered the complete fabrication and assembly of the E/P and the initiation of hardware/software integration of the E/P in December 1992. The Digital Based Exciter (DBE) Project (US$19.5 million) covered completion of the DBE Preliminary Design Review in December 1992 and completion of the DBE Critical Design Review in September 1993. The Band 4 Transmitter Project (US$1.9 million) included the Critical Design Review in January

1993 and the commencement of hardware assembly and integration the same month.

The EF-111A SIP System Program Director (SPD) re-scheduled 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.

In 1994 and 1995 the Air Force made several announcements concerning the retirement of the EF-111A. To save money, the service planned to eliminate the fleet and use Navy EA-6Bs for support and escort jamming missions. Although this has caused significant debate in many quarters, including on Capitol Hill, the plan became to retire the EF-111A in FY97, a year later than originally planned. The SIP program is scheduled to be canceled after FY96. Some of the technology developed may find its way into the re-vamped EA-6B upgrade effort.

This project was not funded from FY95 on.

FY95 Congressional action on EF-111A:

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, and 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 Congressional action on EF-111A:

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 least 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.

Funding

US FUNDING

	FY94		FY95		FY96		FY97	
	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
RDT&E (USN)								
PE0604270N								
EW Development								
E0556 EW Counter Response	-	31.7	-	24.5	-	3.3	-	2.7(a)
Procurement (USN)								
EA-6B Reman	-	77.6	-	0	-	0	-	0
EA-6B Mods	-	23.1	-	38.8	-	160.0	-	228.6(b)

RDT&E	FY98 (Req)		FY99 (Req)		FY00 (Req)		FY01 (Req)	
(USN estimate)(a)	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
E0556	-	2.6	-	3.2	-	3.2	-	3.3

(a) NOTE: Figures are from the FY96 Program Element Descriptors. At the time of writing, PE0604270N had not been released by the Navy.

(b) NOTE: The original request for US$100.6 million was increased by the FY97 Appropriations bill.

	FY94		FY95		FY96		FY97	
	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

Contractor	Award ($ millions)	Date/Description
Grumman	8.6	May 1994 — Indefinite delivery/indefinite quantity contract for engineering and logistics transition support for the EA-6B. Complete April 1995 (N00019-94-D-0005)
AIL	54.3	Sep 1996 - FPC for 94 Universal Exciter Upgrades, integrated logistics support equipment, interim spares which will be used to generate jamming modulations for the transmitters carried by the Tactical jamming System Pod on the EA-6B. Complete Sep 1999 (N00019-96-C-5349)
AEL	9.8	Sep 1996 - CPFF contract fro seven ALQ-99 Low-Band Transmitters, technical data, engineering and integrated supply data, and test interrogation software for the EA-6B. Complete Jun 1999 (N00019-96-C-0101)

Timetable

EA-6B

	1966	EA-6A design contract
	1969	Initial EA-6B production
	1983	ADVCAP contract awarded
	1988	First ADVCAP delivery
	1989	ADVCAP production start
	1991	Final EA-6B production
	1990s	Remanufacturing
	FY93	EA-6B ADVCAP Milestone IIA
Jul	1993	ADVCAP LRIP
Dec	1993	Band 2/3 DT-IIH TECHEVAL
	FY94	Begin integrating Universal Exciter Unit into ICAP II, five EDM units delivered
Apr	1994	OT-IIB OPEVAL
Feb	1994	ADVCAP Contract terminations announced
Aug	1995	Program Decision memorandum ups Navy Prowler force from 80 to 104 aircraft, increasing the force by one squadron, and directs retirement of EF-111A
Feb	1996	OSD Program Budget Decision releasing US$200 million to upgrade the EA-6B radar receiver
	FY97	EA-6B assumes joint mission responsibilities
	1998	Block 89A upgrades begin entering inventory
	2015	Planned life of the EA-6B

EF-111A

	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 restructured
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
	1996	Begin retirement of many EF-111As
	1999	Retirement of final EF-111A (tentative)

Worldwide Distribution

United States. EA-6B - over 100 aircraft carry 3 to 5 ALQ-99 pods, EF-111A - 42 aircraft carry the ALQ-99E.

ICAP-II export to **Japan, Korea** and most **NATO** counties has been approved.

Forecast Rationale

Upgrades have kept the EA-6B capable of countering the projected threat environment. The value and capability of the system has been proven in test, training, and operational situations. EA-6B participation in Red Flag electronic combat exercises has always been very successful. The ALQ-99 has a track record for effectively disrupting or debilitating early warning capabilities. Its weaknesses have been the lack of low-band coverage of air defense command and control links, and a high-band receiver that can be saturated in a dense signal environment. A new receiver/processor group will overcome the high-band problem and the USQ-113(V) installations will provide the low-band, communications jamming capability

The Persian Gulf experience verified the value and capability of the Prowler. It was a Gulf star. In addition to supporting jamming missions, EA-6Bs fired HARMs against Iraqi defense radars to the detriment of Saddam Hussein's air defense system. This offensive capability is a major advantage of employing the EA-6B.

The Air Force decision to retire the EF-111A means that in the near future, the EA-6B will be the only asset that can be deployed to support contingency operations. But the basis of the Air Force decision is clear. There are 120 EA-6Bs and only 29 EF-111A aircraft in the active inventory. The performance of the Navy aircraft is somewhat superior to that of the Air Force jammers, and that will improve even more, once enhancements 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 joint operations can be expected to face.

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 General Fogleman that in exercises, the EA-6B always signficantly out-performed the EF-111A. This is the same thing this writer told Air Force officials during initial tests of the two aircraft over a decade ago, recommending at that time that the EA-6B would be a better choice for a support jammer.

The Navy has no replacement for the EA-6B under development, so commanders will be relying on the Prowler until well after the turn of the century. It is currently slated to remain in the fleet until 2015.

The Navy decision to terminate the ADVCAP upgrades was done for budgetary reasons, and drew strong reaction from Congress. The Navy needed to find money to fund production of new tactical aircraft, such as the F/A-18E/F and V-22. Planners appeared to be trying to find it at the expense of the EA-6B enhancements, a scheme that did not work. The Pentagon's Bottom-Up Review and Congress were favorably disposed toward technology solutions to military need, and supported the ADVCAP upgrade over other Navy "wish-list" items.

Navy officials told Forecast International that canceling the EA-6B upgrade was one of many ideas being considered as a way of finding funds for the FY95 to FY99 time frame, but it was an option the sea service decided to exercise. Congressional sources told Forecast International that this would not be allowed to happen. Because of Congress' favorable disposition toward the EA-6B, it is not allowing a full termination of the upgrades. The legislators have been very specific in directing the Navy to re-initiate EA-6B upgrades, although a less costly, reduced-scope program is being permitted. Capitol Hill has inserted itself directly into the Prowler upgrade planning.

Companies are finding ways to provide a lower cost upgrade which, they claim, will give 80 percent of ADVCAP's capability at 20 percent of the cost. This design would reduce the capacity of the new system from that planned with ADVCAP; but it would still be four or five times that of the current system. By reducing the amount of software needed, developers can cut back to one AYK-14 mission computer (two were planned for ADVCAP), and use a less complex direction-of-arrival technique.

The ICAP III concept capitalizes on these ideas. The focus on off-the-shelf, non-developmental enhancements validates that the Prowler can be made capable to counter the new anticipated threat at less cost. The concept is not as far-reaching as some of the ADVCAP goals, but is achievable and affordable. Indications are that the ceiling for development has been set at US$130 million. Since the pace of anticipated threat development has slowed since the end of the Cold War, a lesser capable system will keep the EA-6B at the top of the airborne tactical jammer heap.

The Navy will be flying EA-6B aircraft well into the next century. As a result of the need to pick up joint EW missions, the Navy has agreed to fund an additional EA-6B squadron to accommodate Air Force needs. Air Force crews are being trained in the Prowler.

The forecast must be considered tentative at this time. Until a development plan for the ICAP III (as it is currently known) is fleshed out, any projection must be considered an estimate only. There is no certainty that the upgrades will be done one at a time or whether different parts will accomplished in separate schedules.

It is based on the planned milestones and assumes most of the enhancements will be accomplished as aircraft are moved through major maintenance. It is already known, though, that many of the USQ-113 installations will be

done according to a different schedule, with the final integration done as part of the ICAP III program. Timing could change over time as plans and funding issues are worked out. The overall window and general shape of the upgrades is the most important consideration at this time. The key will be, once the upgrades have been designed, to update enough aircraft to support the operational squadrons, with Reserve Prowlers having their installations delayed until the end of the program.

Ten-Year Outlook

		ESTIMATED CALENDAR YEAR PRODUCTION											
		High Confidence Level	Good Confidence Level						Speculative				
Designation	Application	thru 96	97	98	99	00	01	02	03	04	05	06	Total 97-06
EA-6B UPGRADE	EA-6B (USN)	4(a)	10	15	24	36	24	17	0	0	0	0	125

(a) ADVCAP Prototype Systems