

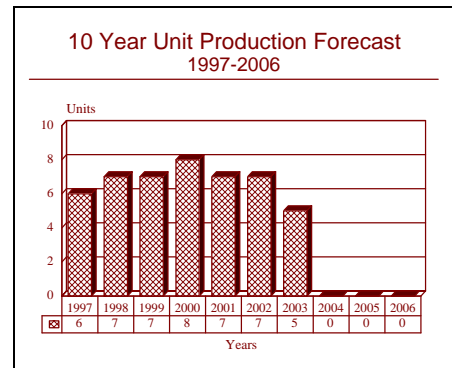
ARCHIVED REPORT

For data and forecasts on current programs please visit
www.forecastinternational.com or call +1 203.426.0800

E-2C - Archived 1/98

Outlook

- Production shifted to Florida
- Estimated 53 new aircraft scheduled
- Additional customers anticipated



Orientation

Description. The E-2C is an all-weather, land or carrier-based, airborne early-warning and C² function platform.

Sponsor

US Navy
 Naval Air Development Center
 Warminster, Pennsylvania (PA)
 USA

Naval Air Test Center
 Patuxent River, Maryland (MD)
 USA

Naval Research Laboratory
 Washington, DC
 USA

Fleet Combat Direction Systems Support Activity
 San Diego, California (CA)
 USA

Contractors

Northrop Grumman Corp
 1111 Stewart Avenue
 Bethpage, New York (NY) 11714-3580
 USA
 Tel: +1 516 575 5119
 Fax: +1 516 575 3691

Lockheed Martin Corp
 Utica, New York (NY)
 USA

Raymond Power-Drive
 217 Smith Street
 Middletown, Connecticut (CT) 06457-9990
 USA
 Tel: +1 203 632 1000

Status. Production and upgrades continue.

Total Produced. Through FY95, inclusive, 145 E-2Cs have been procured by the US Navy, with 141 delivered through 1995. Navy plans include an additional 16 units in FY96-99, plus another 16 from FY2000 onward. E-2C export sales total 33, of which 31 have been delivered through 1995.

Application. Airborne early warning and command, especially for naval applications.

Price Range. Approximately US\$3 million for the GE APS-125 radar. The antenna system, including the radome, costs over US\$1 million. According to US Department of Defense budget documents, the FY95 E-2C unit cost was US\$60.275 million.

Technical Data

Design Features. The E-2C Hawkeye AWACS aircraft provides early warning of the approach of enemy or unknown aircraft to US naval aircraft carriers, battle groups, or aircraft units aloft. The radar and controller stations permit the aircraft to direct air engagements remote from the aircraft carrier. The radar and associated data link system also provide radar imagery to the carrier operations and intelligence center. The E-2C is a key element in the US Navy Tactical Data System.

The APS-125 airborne surveillance radar system was the original basic building block for the E-2C Hawkeye electronics suite. An improved version of the APS-125 was mated with a new antenna system known as the Total Radiation Aperture Control - Antenna (TRAC-A). This resulted in the new configuration designated as the APS-138. The TRAC-A was the first major redesign of the E-2 series in 20 years. The sidelobes of the then existing radar antenna permitted jamming signals to enter the receiver and reduce the range of target detection. Installation of TRAC-A allowed the E-2C to maintain its effectiveness as the jamming threat increased. The existing three-channel

rotary joint was also replaced with an eight-channel unit to permit more access to antenna signals. The increased signal access, in turn, has provided automated cues to the operators on the best radar mode for different jamming levels and directional information of the jamming sources for interception by battle group fighters. The APS-138 radar and automated data processing enable three operators to handle 600+ tracks. Installations began in 1985 and all APS-125 surveillance radar systems delivered to date by General Electric have received the new antenna modification/retrofit.

A Randtron Systems APA-171 antenna system, housed in a rotating dome above the aircraft, provides primary radar data. It also includes an IFF capability. The APS-138 search radar can detect targets as small as cruise missiles at ranges greater than 145 nautical miles. The ALR-73 passive detection system (PDS) detects the presence of radars at distances up to twice the detection range of the radar. This is a significant passive capability for silent battle group operations.

Variants/Upgrades

APS-139. The Navy developed hardware/software changes to the APS-125/138 as part of a two-phase Update Development Program (UDP). UDP Group I (Block Upgrade I, OSIP 110-87) consisted of 12 programs and updated selected APS-138 radars to the APS-139 configuration by adding improved surface detection in high sea state/clutter, improved countermeasures, and an automatic channel monitor/selection capability. Modifications to the tactical software program include increased active track capability, display prioritization, and new radar controls.

The improvements built on existing components of the radar system, with one Weapon Replaceable Assembly (WRA) being replaced and eight out of 40 WRAs modified. Group I would subsequently become the operational standard through fielding of the APS-145 upgrade.

APS-145. UDP Group II modifications to the APS-139 or combined Group I/II modifications to the APS-138 have resulted in the system being redesignated as the APS-145. Over-land performance is said to be equal to that of the E-3 AWACS radar, while retaining the former's inherently superior over-water capability. The APS-145 can operate in the Western European electronic environment without causing undue disruption to the users of the space spectrum.

In March 1988, Grumman received two fixed price incentive contracts totaling US\$10.2 million to integrate the APS-145 and an IFF system into USN E-2C aircraft. Tactical software modifications were made as part of the E-2C Block Update II - Radar Update II aimed at extending the radar's range and automatic processing capability. This block upgrade will affect a total of 50 aircraft. Development of Group II was scheduled to be completed by early 1993.

Conformal Array Radar. Aside from the TRAC-A improvements, the APS-138/139 may receive a conformal array antenna in the future. The Naval Air Development Center awarded Grumman a US\$14 million contract in 1986 to flight test a conformal antenna system that will be incorporated into the leading edges of the E-2C's wings. A similar contract was awarded for the A-6E Intruder. Conformal array antennas are incorporated into the airframe, and through the use of solid state electronics could eventually eliminate the need for a large overhead radome. Grumman is presently working on a passive wing array, which will be used in conjunction with the rotating radar dome to improve the performance of the existing system.

Upgrade Program. The US Navy continues to be interested in a further upgrade program for the E-2C, with the emphasis on improvements that would result in the

capability to more fully meet the AEW mission in the years 2000 to 2015, as well as enhancing the ability to execute the drug-interdiction mission. Among the various improvements being examined are improved avionics such as multi-functional cockpit displays, the addition of an infrared search and track system, a new central computer,

in flight refueling, an updated or new electronic surveillance system, self-protection systems, as well as further radar improvements.

NOTE: For additional information, see the separate reports on each of these APS-(v) units.

Program Review

Background. The APS-138, APS-139 and APS-145 are follow-on improvements to the E-2C's original surveillance radar, the APS-125. The Navy issued APS-125 contracts to General Electric and Grumman in 1972. Improvements sought by the Navy were greater sensitivity in detecting targets in noise and clutter, with a reduction in the number of false alarms. The analog portions of the predecessor APS-120 were to be replaced by digital components, and better electronic counter-countermeasures characteristics were also to be incorporated. Based on analysis of the projected ECM and target threat to United States Sea Control Forces, R&D programs began in 1979 to provide a low sidelobe antenna for the APS-125 radar subsystem, a high-speed processor for the OL-77/ASQ Central Computer Programmer, signal processing extensions for the ALR-73 Passive Detection System, APS-125 radar modifications to optimize surface and airborne target detection and new tactical software programs to fully integrate hardware improvements.

Initial deliveries of APS-125 surveillance radars commenced in 1976, and one year later a retrofit program was launched to upgrade existing APS-120s to the APS-125 configuration. This kit installation program was completed in 1983.

The APS-138 radar replaced the original APS-125 in new production E-2Cs in 1983. A retrofit program has been executed for aircraft carrying the older radar. The updated radar includes a new total radiation aperture control antenna (TRAC-A) to reduce sidelobes and offset new jamming threats. The radar can detect airborne targets within a three million cubic mile surveillance area while simultaneously watching surface traffic at sea. Each E-2C can track more than 600 targets and control more than 40 airborne intercepts simultaneously.

The Navy subsequently began evaluation of an E-2C equipped with a new APS-145 radar, able to track more targets at greater ranges under ECM conditions. The Navy awarded Grumman a contract to flight test conformal microprocessor-controlled, phased-array radar antennas installed in the wing leading edges, fuselage and horizontal tail surfaces of an E-2C. The conformal radar is a potential candidate for the Navy's Airborne Multisensor requirement.

Full-scale development, test and evaluation of the TRAC-A antenna group and construction of the engineering development models of the High Speed Processor weapon replaceable assemblies were funded in FY82. The FY83 plan included completion of Group I improvements for limited production approval. It also began design of tactical program software and development of engineering models of extended-range environmental processing and expanded radar electronic countermeasures capabilities (Group II functions). In FY84, engineering began on radar weapon replaceable assemblies for extended-range and electronic countermeasures capabilities. In addition, tactical program software to be integrated with Group I hardware and tested against operational scenarios continued in development.

The FY87-88 program was a continuation of prior efforts. New software for tactical applications, as well as technical control applications, continued in development. Flight testing of both Group I and II hardware and software continued. Development and Operational Testing Phase II continued on both groups. In FY89 Navy flight evaluations of Group II, DT-IIC and operational evaluation of Group I were conducted. In FY91 Operational Testing OT-IIC was completed and Milestone IIIA (Low Rate Initial Production) approved.

FY92 program accomplishments included completing Developmental Testing (DT-IID/DT-IIIA) Technical Evaluations/board of Inspection and Survey of UDP Group II, and completing software ground and flight test evaluation (DT-IIIE) for UDP Group II).

During FY93, scheduled work was conducted in the following areas: OPEVAL for UDP Group II (OT- IID); UDP II Milestone III to establish the UDP Group II baseline; and authorizing development of new data processing subsystem for the E-2C at MCU Milestone IV/II (MS IV/II), to result in a FY94 contract award.

The US DoD terminated the E-2C production line for the US Navy in FY93, citing a declining defense budget. This was a year earlier than the originally scheduled date of 1994. The Navy had planned to seek six E-2Cs in FY93; however, without continued production, the Navy had little choice but to continue with massive upgrades.

(Note: In 1994 the E-2C program was reinstated - see below)

FY94 saw the establishment of the UDP Group II baseline at Milestone III and the authorization of the development of the Mission Computer Upgrade (MCU) at Milestone IV/II. The year's activities also included the definition/documentation of the system segment specification, establishment of a functional baseline and preparation for the System Design Review.

The agenda for FY95 called for initiation of the hardware design and fabrication of MCU engineering development models (EDM), initiation of EDM software development, and initiation of aircraft/MCU EDMs. The plan also included conduct of a laboratory assessment, the Preliminary Design Review, the Critical Design Review and the System Design Review.

FY96 plans call for the continuation of laboratory operational assessment and aircraft integration design activities, delivery of EDM hardware and start of preproduction hardware fabrication. Also scheduled are the continuation of tactical software development, design of the CEC software interface with the MCU, and aircraft integration hardware design including CEC installation. The plan is rounded out with the conduct of the Critical Design Review of Build 0 software and environmental, maintainability and reliability qualification tests.

In FY97 Development Test/Operational Test IIA will be conducted with airborne testing of hardware/software. Preproduction systems will be delivered and the Critical Design Review of the Build I software configuration will be conducted. MCU/CEC software development will be continued and upgraded to the DT/OT IIA configuration. Aircraft modification and MCU/CEC hardware integration will also be continued. The scheduled culminating activity for the year is the initiation of Low Rate Initial Production (LRIP).

Recent Activity. In April 1994, the Navy reversed its earlier aircraft production termination decision and announced it was considering buying another 16 E-2Cs beyond the year 2000, in addition to an extra 20 aircraft between 1995 and 2000 (for a total of 36). As shown in the funding listed below, the Defense Department has already requested the initial seven aircraft.

The Navy apparently determined that procurement of additional new-production E-2Cs was more cost effective

than a massive upgrade of the existing fleet. The additional 16 E-2Cs would be purchased starting in 2000. Congress is not expected to oppose the procurements.

In the 1993/1994 time frame Northrop Grumman and the Navy became engaged in a series of additional upgrades. Enhancements investigated/ initiated include: a new mission computer (MCU); an improved APX-100 IFF, a Global Positioning system, a satellite communications terminal, the Joint Tactical Information Distribution System (JTIDS); new workstation-based mission displays; and the integration of a Cooperative Engagement Capability (CEC). The Navy expects to demonstrate the ability of an E-2C to acquire over-the-horizon targeting information and relay that information to ships within a battle group, hopefully before the turn of the century. Such enhancements would make the E-2C the airborne link in the Navy's Cooperative Engagement Capability (CEC) program, which is designed to weave together sensor and weapon systems from several ships to act as a single distributed anti-air warfare net.

A September 1994 contract worth US\$25 million was awarded to Raytheon for a new mission computer based on off-the-shelf technology. The Raytheon system, titled the Model 940 computer, is a hardened version of the Digital Equipment Corporation 2100 MA500MP processing system. The core of the new system is based on a recently introduced chip developed by Digital Equipment known as the Alpha AXP. Raytheon will build 14 preproduction model 940 units and two commercial 2100 model units. If successful, a follow-on production contract could be worth a total of some US\$100 million, as well as some foreign sales.

If the Navy goes ahead with the total purchase of 36 aircraft, Northrop Grumman can expect to earn over one billion dollars and possibly more if foreign military sales are included. According to Northrop Grumman officials, the Navy has firm plans to buy at least 20 E-2C Group 2 aircraft over the next five years at the rate of four planes per year. The most recent foreign sales activity is the commitment by the French Navy in its 1995 budget to purchase two E-2C aircraft with orders for two additional aircraft to be placed at a later date. The company has shifted much of its E-2C work to its site in St. Augustine, Florida, which has been devoted to E-2C modification work and structural enhancements, and where the fourth E-2C for Taiwan has recently rolled off the production line.

Funding

	US FUNDING							
	FY94		FY95		FY96		FY97 (Req)	
	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
RDT&E (US Navy)								
PE #0204152N								
E-2 Squadrons								
Project E0463								
E-2c Impv.	-	18.1	-	51.3	-	53.0	-	71.3
	FY98 (Req)		FY99 (Req)		FY00 (Req)		FY01 (Req)	
	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
RDT&E (US Navy)								
PE #0204152N								
E-2 Squadrons								
Project E0463								
E-2c Impv.	-	41.7	-	1.07	-	0	-	0
	US FUNDING							
	FY94		FY95		FY96		FY97 (Req)	
	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
PROCUREMENT (US Navy)								
E-2C Less								
Adv Pro	-	-	4	241.1	3	171.2	4	247.5
E-2C								
Adv Pro	-	37.8	-	41.4	-	43.0	-	44.9
Total								
Procure.	-	37.8	4	282.5	3	214.2	4	292.4

All US\$ are in millions.

Recent Contracts

Contractor	Award (\$ millions)	Date/Description
Grumman	28.7	Mar 1990 - Increment to contract for the necessary material and services to integrate the design engineering and software of JTIDS into the E-2C (N00019-83-C-0337)
Grumman	11.8	Apr 1990 - Modification for the incorporation of four enhanced main display units into the E-2C (N00019-88- C-0331)
Grumman	6.7	Nov 1990 - Increment to contract for an enhanced high- speed processor, improved radar, and an IFF system for installation into E-2C aircraft as part of the E-2C Update Development Program, Group II, Part 2 effort (N00019-86-C- 0356)
Grumman	15.9	Mar 1991 - Increment to contract to integrate JTIDS into the E-2C (N00019-83-C-0337)
Grumman	5.5	Aug 1991 - Modification to contract for R&D tasks associated with the upgrade of the radar and other avionics in the E-2C (N00019-86-C-0356)

Contractor	Award (\$ millions)	Date/Description
Grumman	6.0	Dec 1991 - Increment to contract to integrate JTIDS into the E-2C (N00019-83-C-0337)
Grumman	6.0	Mar 1992 - Increment to contract to integrate JTIDS into the E-2C (N00019-86-C-0356)
Raymond Engineering	6.0	Jun 1992 - Contract award to provide 107 digital data recorder reproducers for the E-2C (N000383-92-C-0737)
Grumman	11.3	Sep 1992 - Procurement of ARA-63 systems for E-2C aircraft (N00019-90-G-0275)
Grumman	14.8	Jan 1993 - Order against BPA for procurement of nine enhanced computer verifiers/basic equipment change kits for the Japanese Self Defense Force E-2C aircraft under the FMS program (N00019-90-G-0275)
Grumman	38.6	Feb 1993 - Mod to definitize a ADV ACQ for procurement of two E-2C aircraft for the Japanese Air Self Defense Force for FY92 (N00019-91-C-0059)
Grumman	10.0	May 1993 - FFP mod to incorporate an engineering change proposal for the major upgrade of three E-2C tactics trainers located at NAS Norfolk, VA and NAS Miramar, CA to bring them into alignment with current fleet requirements (N61339- 91-C-0094)
Grumman	307.3	May 1993 - FPIA FVI for the completion of the first two production E-2C Joint Stars aircraft (F19628-92-C-0035)
Grumman	33.8	Jun 1993 - FFP mod for the navigation upgrade program for the E-2C (N00019-90-C-0288)
GEC-Marconi	25.7	Aug 1993 - FFP for Lot 4 of JTIDS low rate initial production which includes procurement of three navy E-2C terminals, 30 MCE terminals, and one E-2C spare set (F19628- 93-C-0187)
Grumman	21.4	Sep 1993 - FFP contract mod for the procurement of peculiar support equipment and integrated logistics support of the E-2C (N00010-90-C-0288)
Northrop Grumman	63.8	Jun 1994 - FFP contract for retrofit of four E-2C aircraft to improve surveillance and communication capabilities (N00019-93-C-0056)
Northrop Grumman	41.1	Jul 1994 - Contract to provide new technical manuals in support of the E-2C and other aircraft. Five percent of this contract goes to orders from Egypt, Japan, Singapore, and Taiwan for E-2C manuals. (N00140-94-D-BD43)
Raytheon	25.0	Sep 1994 - Initial contract award from Northrop Grumman to replace the mission computer on the E-2C. A total of 14 Model 940 preproduction systems and two commercial 2100 Model A500MP systems are to be delivered. This contract is tied to Northrop Grumman receiving the E-2C upgrade prime contract from the Navy (No contract number is available)
GEC-Marconi	25.2	Mar 1995 - FFP contract for 24 Joint Tactical Information Distribution System (JTIDS) Class 2H terminals applicable to Navy E-2C aircraft, 2 JTIDS Class 2 submarine terminals, and four JTIDS modular control equipment for the Air Force. Contract expected to be completed Sept 1999 (F19628-95-C- 0056)
Grumman	17.5	Jan 1995 - LTR CTRC to retrofit two E-2C aircraft from Group I configuration to Group II configuration. Expected completion date July 1997 (N00019-94-C-0068)

Contractor	Award (\$ millions)	Date/Description
Grumman	10.0	Feb 1995 - Ceiling priced mod to exercise option for long lead material for two E-2C aircraft for the government of France. Work expected to be completed Dec 1997 (N00019-94-C-0020)
Lockheed Martin	6.7	Feb 1995 - CPO for multiple spare parts for the APS-145 radar system installed on the E-2C aircraft. Expected to be complete Oct 1997 (N00383-95-G-002G)
Grumman	7.3	Mar 1995 - FFP contract for installation of four navigation upgrade kits for E-2C aircraft. Expected completion date April 1998 (N00019-94-G-0028)
Grumman	14.5	Apr 1995 - FFP contract for long-lead spares to support E-2C aircraft for the government of France. Expected to be completed April 1998 (N00019-94-C-0020)
Grumman	29.0	May 1995 - LTR CTRC for non-recurring engineering integration of a satellite communication kit into the E-2C Group II aircraft. Expected to be completed Nov 1999 (N00019-95-C-0085)
Litton Systems	9.3	Jul 1995 - REQ contract for various repair parts for E-2C aircraft AN/ALR-59/73 passive detection system. Expected completion date June 1997 (N00383-95-D-210F)
Grumman	19.0	Aug 1995 - FFP contract for additional long lead spares to support E-2C program for the government of France. Expected to be complete Aug 1998 (N00019-94-C-0020)
Grumman	20.0	Oct 1995 - Mod to previous contract for two E-2C aircraft for the government of France for administration of offset program. Work expected to be completed Dec 2002 (N00019-94-C-0020)

Timetable

	1972	GE and Grumman awarded development contract for APS-125
Nov	1973	Inspection survey trials completed
Feb	1974	APS-125 fleet operational
Jun	1976	Initial deliveries for production aircraft
	1977	Refurbishment program to upgrade APS-120s to APS-125 configuration begun
	1982	TRAC-A testing began
	1983	General Electric awarded contract to upgrade the APS-125
	1984	Delivery of modified APS-125 began
	1988	USN began APS-145 integration on E-2C
	1991	APS-145 installations began
	1993	Final E-2C production for the US Navy due to extensive budget cuts
Mar	1993	Update Development Program II/OT-IIID
	1994	USN announced plans to seek 36 more E-2Cs
Jun	1994	Update Development Program II/OT-III
Jun	1995	Update Development Program II/OT-IV

Worldwide Distribution

Because of its overall complexity, unit and support costs, and protected technology, export sales of the Hawkeye have been limited to close allies of the United States. However, the E-2 is the choice of nations which have relatively small geographical coverage areas. Maritime nations benefit from the E-2 since it was designed from the outset for the marine environment. Furthermore, most nations do not require the long time-on-station, high altitude, or range capability of the more capable and expensive Boeing E-3.

Egypt, France, Israel, Japan, Singapore, and Taiwan are the only current export customers of the E-2C. The Japanese Air Self-Defense Force (JASDF) ordered four E-2Cs in 1979; four in 1981; three in 1989; and two in 1990. Israel has received four Hawkeyes, while Egypt has five units in service with a

sixth to have been delivered in late 1993. Singapore received four aircraft, and Pakistan received the support of the Reagan Administration to buy or lease two aircraft. However, that order never did materialize because the Bush Administration terminated all military aid to Pakistan because of the Muslim nation's nuclear program. Taiwan originally planned to acquire six ex-USN E-2Bs, but subsequently purchased four new-production C models scheduled for delivery in 1994. The French Navy ordered two aircraft in early 1994 with plans to acquire two more during the late 1990s.

Singapore has a requirement for two additional Hawkeyes, and other countries expressing high interest in the E-2C include Indonesia, Malaysia, the Republic of Korea, and Thailand.

Forecast Rationale

Bucking the overall budgetary trend, the long-term outlook for this program has brightened considerably since the spring of 1994. Life cycle cost analysis studies demonstrated that a relaunched new build program would be more cost effective than remanufacturing older inventory aircraft and the Navy now plans to procure an average of four E-2Cs annually in the FY95-99 period, inclusive. An additional 16 figure in the Navy's post-FY99 plans, but these should probably be regarded as speculative at this time. Assuming that at least the first phase of the restart goes through, the extended production will almost certainly help to stimulate further sales to overseas customers such as South Korea, Thailand, and Turkey. A strong indication that this will occur is the fact that the order for the first two of a possible sale of four aircraft to the French navy is included in our projections.

Re-opening the line for the US Navy would appear to effectively shift the requirement for an EX platform, to ultimately replace the Hawkeye, further into the future and

certainly well beyond our forecast time frame. Further upgrades to existing E-2Cs are anticipated, but our forecast of the originally planned 54-unit Block II Upgrade has been scaled down to only 18 aircraft.

Armed with a renewed lease on life due to the Navy's restart decision, the E-2C can be expected to be the subject of a stepped-up international marketing campaign by Northrop Grumman. In addition to additional anticipated sales to overseas air arms, Hawkeyes currently serving with the US allies may well be refitted with some of the upgrades planned by the US Navy. Northrop Grumman is projected to produce approximately 48 new-production Hawkeyes during the ten-year forecast period. The major portion of these, 32 units, will go to the US Navy and all but two of these will result from the recent decision to restart the USN production line. Aside from announced overseas sales, we are forecasting eight aircraft to as yet unidentified customers such as the RoK, Thailand, Turkey, and a follow-on order from Singapore.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR PRODUCTION

Designation	Application	thru 96	High Confidence Level				Good Confidence Level				Speculative		Total 97-06
			97	98	99	00	01	02	03	04	05	06	
E-2C	AEW (US DOD) (US DOD)	142	4	4	5	5	6	6	5	0	0	0	35
E-2C	AEW (VARIOUS) (VARIOUS)	31	2	3	2	3	1	1	0	0	0	0	12
Total Production		173	6	7	7	8	7	7	5	0	0	0	47