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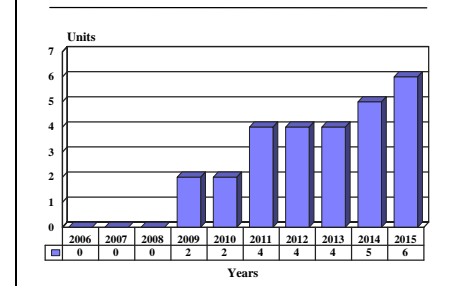
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## E-2D Advanced Hawkeye - Archived 2/2007

### Outlook

- Will replace the E-2C Hawkeye 2000
- Major internal and sensor re-design
- LRIP planned for 2009
- IOC planned 2011

10 Year Unit Production Forecast  
2006 - 2015



### Orientation

**Description.** The advanced airborne surveillance radar and other sensor and avionics improvements being implemented will combine with major structural and system improvements to continue the Hawkeye's steady development as the Navy's only all-weather, carrier-based tactical warning and control system aircraft.

#### Sponsor

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**Status.** In development.

**Total Produced.** Two Hawkeye 2000s will be converted to prototype Advanced Hawkeye configuration.

**Application.** Carrier- and land-based Fleet support.

**Price Range.** Estimated to be \$5.0 million for the radar subsystem.

Price is based on an analysis of contracting data and other available cost information, and a comparison with equivalent items. Individual acquisitions may vary, depending on program factors.

### Contractors

Northrop Grumman AGS&BM Systems, <http://www.is.northropgrumman.com>, 2000 NASA Blvd, PO Box 9650, Melbourne, FL 32902-9650 United States, Tel: + 1 (407) 951-5447, Fax: + 1 (407) 951-6876, Prime

### Technical Data

	<u>Metric</u>	<u>U.S.</u>
<b>Dimensions</b>		
Rotodome	0.76 x 7.32 m	2.5 x 24 ft

**Characteristics**AESA Radar

Frequency	UHF
Antenna	ADS-18 ESA (mechanical azimuth scan 360 degrees) Electronic elevation scan Co-located electronic scan IFF
Radar range	
Target capacity	2,000+
IFF	Upgraded, integrated with the ADS-18

E-2D (based on E-2C)

Speed	300+ knots (552+ kmph)
Ceiling	30,000 feet (9,100 m)
Crew	5
Sortie duration	4.5 hr, typical

Features

	Upgraded communications suite (internal and external) MIDS and Intelligence Broadcast Receiver Six ARC-210 radios and a new HF (secure) radio, 2 Voice SATCOM radios CNS/ATM compliance NAV System mods Three 17" displays with backup flight displays
Mission Processor	COTS Open Architecture

E-2D

Aircraft	Engine modifications and eight-bladed propellers Single-piece machined airframe components Upgraded electrical generators Cooling System mods New "Glass Cockpit"
Speed	300+ knots (552+ kmph)
Ceiling	30,000 feet (9,100 m)
Crew	5
Sortie duration	4.5 hr, typical

**Design Features.** The Hawkeye 2000, the latest generation E-2C, features improved situational awareness and provides over-the-horizon communications and non-organic data access. It has enhanced theater missile defense capabilities and the ability to generate a better theater composite tactical picture with Cooperative Engagement Capability (CEC) improvements. It will be replaced by 75 to 78 (planned) Advanced Hawkeye (AHE) aircraft.

Advanced Hawkeye Radar Modernization Program.

This is considered a two-generational leap in radar technology for the E-2C. The design will give the Navy greater threat detection capability over land and water, and greater range and precision than the E-2C. It will provide an enhanced airborne command and control capability, making it a major node in the Navy's FORCEnet information/decisions grid. The modernized system will provide and integrate key information and

surveillance data, fuse decision data, and provide control and communications capabilities.

The Advanced Hawkeye will have a new cockpit. Going beyond the single-purpose "glass" cockpits of modern aircraft, Northrop Grumman engineers are designing displays that will allow either the pilot or the copilot to participate as a fourth mission system operator. Operator input guided these designs using the substantial simulation laboratory and demonstration capabilities available to the E-2 program. Other features of the Advanced Hawkeye include terrain avoidance and global air traffic management system enhancements.

An SDD contract was awarded to Northrop Grumman in August 2003, and has focused on reducing production and total operational support costs. Two Hawkeye 2000s will be modified into a prototype Advanced Hawkeye configuration to support SDD. Besides the

near complete change of mission electronics, there are airframe changes planned. Some of the structures on current Hawkeyes are built from individual sheet metal parts. These will be replaced by single-piece machined parts to reduce both cost and time needed to construct subassemblies and mate fuselages. Two-level maintenance, coupled with automated system test capabilities, are being explored to reduce total ownership costs.

The Radar Modernization Program (RMP) is a ground and flight prototype test demonstration that focuses on risk mitigation of multiple technologies. It initiates the application of new radar technologies to modernize the primary radar sensor to provide a definitive littoral surveillance capability integral to the Navy's Theater Air Missile Defense (TAMD) Integrated Warfare Architecture. None of the APS-145 radar will be kept.

Key technologies to be integrated are Space-Time Adaptive Processing (STAP), an electronically scanned array, a solid-state transmitter, and high dynamic range digital receivers. UHF was the frequency of choice for the Navy. The solid state, high power radar will feature "significantly" improved performance compared to the APS-145. The COTS/open architecture design will allow for future growth.

The Rotodome Antenna Group (RAG) provides an 18-channel UHF antenna with 18-channel rotary coupler. The IFF system will feature a 36-element, 2-channel (sum, difference) rotary coupler. Azimuth scan will be 360° mechanical (variable rate) with electronic elevation scanning. There are mounting provisions for a beam former (part of the IFF segment) and slip ring and signal transmission line for SATCOM. Mounting and provisions for a radio antenna segment is included. Future plans are to consider designs for a fully electronic azimuth scan.

The Mark XII IFF interrogator system will handle Modes 1, 2, 3/A, C, 4, and embedded crypto. There will be a monopulse target detection capability and room for future growth.

The E-2D will be fully Cooperative Engagement Capability compatible.

The resulting detection system will feature substantially improved overland performance, enhancing all current mission requirements while contributing to the emerging TAMD mission requirements. The impact of the dominant battlefield awareness provided by this improved airborne early warning system will substantially contribute to the development of a Single Integrated Air Picture.

**Operational Characteristics.** The Hawkeye has been the Navy's all-weather, carrier-based tactical warning and control system aircraft for decades. It provides all-

weather airborne early warning and command and control functions for the carrier battle group. Additional missions include surface surveillance coordination, strike and interceptor control, search-and-rescue guidance, and communications relay. An integral component of the carrier air wing, the E-2 uses computerized sensors to provide early warning, threat analyses, and control of counteraction against air and surface targets. During operations in Kosovo, E-2Cs operated more as battle managers than airborne early warning platforms.

The E-2C has been the Navy's AEW command post for over 30 years, and it is the only carrier-based airborne early warning command post in the world. The radar can monitor a surveillance area of over 6 million cubic miles. Automated features will reduce operator workload by optimizing radar performance without the need for operator intervention.

Over land, the radar can track aircraft over most terrain, and ground vehicles when the target density is relatively low. At sea, the radar is used to track all significant naval targets (large ships, fast patrol boats, and stationary platforms) in most sea states.

High-altitude flight allows the battle group radar horizon to extend well beyond that of surface ship sensors, a significant part of naval tactical planning. The system automatically modifies track processing as required to maintain track integrity at land-sea interfaces. Beyond-the-horizon targeting has made the Hawkeye the sensor heart of the Navy's Cooperative Engagement Capability program.

The Advanced Hawkeye is being designed to fully support the Chief of Naval Operation's plan to support the Sea Power 21 Vision. The design specifically targets the following:

The communications suite and net centric architecture will be the Navy's transformational FORCEnet enabler. This includes the ability to provide target information and sensor cues to the Global Information Grid (GIG). AHE will also receive inputs from the GIG to improve its Battle Management mission.

Increased battlespace awareness, improved detection and tracking, as well as the sensor-to-shooter link will compress the kill chain against time-sensitive targets to support the Sea Strike mission. Radar and ESM information will be added to the overall situational awareness of the command net. UAV imagery and radar data will be included in the overall E-2D operation.

Sea Shield operations will take advantage of the AHE's role as the Navy's principal Theater Air and Missile defense (TAMD) asset. There will be 250 percent more

detection volume and the ability to exploit AEGIS/CEC/F-18 AESA warfighting effectiveness.

Planners. Planners project that by including the E-2D in naval operations network there will be a 200 percent increase in AEGIS/CEC kills and 600 percent improvement in F/A-18 AESA kills.

Command and control will dominate as a result of the advantages offered by the intelligent internal sensor

suite and fusion of data from the battlespace. The sensors will operate effectively in the littoral and extend the battlespace with 24/7 persistence and are being designed to accommodate future growth.

Sea Basing is supported because AHE will provide carrier-based Battle Management Command and Control, supporting mobile force projection from the sea.



E-2D Advanced Hawkeye

Source: U.S. Navy

## Variants/Upgrades

None yet, the E-2D is in initial development.

## Program Review

**Background.** The Advanced Hawkeye Radar Modernization Program RDT&E effort began in FY98 and applied new radar technologies to modernize the primary sensor of the E-2 to provide a definitive littoral surveillance capability integral to the Navy's Theater Air Missile Defense (TAMD) Integrated Warfare Architecture.

In January 2002, the Navy awarded Northrop Grumman a contract for Pre-Systems Development and Demonstration (Pre-SD&D) for the Hawkeye Radar Modernization Program. The 12-month contract advanced the design of the mission system and defined the physical architecture of the system, produced preliminary weapon system specifications, and provided associated program plans.

Key technologies being integrated are space-time adaptive processing, electronically scanned array, solid-state transmitter, and high dynamic range digital receivers. The resulting sensor will provide improved overland performance while contributing to the emerging cruise missile mission requirements.

The improved detection and longer range performance will increase performance in all environments. Multisensor integration will enable operators to use information from many sources: radar, IFF, CEC, Link 4, Link 11, Link 16, and satellite data feeds. This will help create Single Integrated Air Picture (SIAP) fused information. The result should be a clear, coherent picture of the battlespace.

L-3 Communications Randtron Antenna Systems will provide the next-generation antenna to replace the current TRAC-A antenna and rotary coupler. In addition to increased performance, the new antenna will be lighter than the current one.

The full SDD contract was awarded in August 2003. It called for modifying two Hawkeye 2000 aircraft to the AEH configuration.

PE0604234N, E-2 Advanced Hawkeye. "The Advanced Hawkeye (AHE) will replace the existing E-2C fleet. The AHE program develops, demonstrates, tests, and procures the replacement of the APS-145 radar system and other aircraft system components that modernize the E-2C weapon system to maintain open ocean mission capability while providing the United States Navy with an effective

littoral surveillance and Theater Air and Missile Defense (TAMD) capability. Key radar technologies are Space-Time Adaptive Processing (STAP), Electronically Scanning Array (ESA), solid state transmitter, high dynamic range digital receivers and Identification Friend or Foe (IFF)/radar aperture integration. The resultant detection system will provide a substantially improved overland performance by correcting current sensor shortfalls and enhancing all current required mission areas, while simultaneously contributing to the emerging TAMD mission requirements.

The AHE program also upgrades or replaces aircraft system components that are either obsolete or becoming unsupported, upgrades or replaces other aircraft systems as required to support the radar upgrade, and improves the producibility of the weapons system. The impact of the dominant battlefield awareness provided by this improved airborne early warning system will substantially contribute to the development of a single integrated air picture.

This PE was utilized for AHE (Radar Modernization Program (RMP)) pre-System Development and Demonstration (Pre-SD&D) in FY03, followed by SD&D beginning in 4<sup>th</sup> quarter of FY2003. The program ramps up in FY04 and FY05 to support a Preliminary Design Review (PDR) in 1<sup>st</sup> Qtr of FY2005 and a Critical Design Review (CDR) in 1<sup>st</sup> Qtr of FY2006.

The program continues growth in FY2005 to FY2006 to support Critical Design Review (CDR) and SDD production.

The program plan begins E-2 AHE Pilot Production in FY2007 (long lead on four aircraft), the production phase with a Low-Rate Initial Production (LRIP) Milestone C decision in FY 2009, and achieves Initial Operational Capability (IOC) in FY 2011.

Two Multi-Year Procurement E-2C aircraft will be modified to provide RDT&E assets for the AHE program.”

**Acquisition Strategy.** The Acquisition Strategy was signed by the USD (AT&L) on March 21, 2003. Milestone B approval to proceed with System Development and Demonstration was given June 6, 2003 by the Defense Acquisition Board (DAB).

The Navy awarded an SDD Contract with Northrop Grumman Corporation and began AHE SDD, conducting engineering and development efforts in preparation for Preliminary Funding from FY04 through FY07. The Program Office supported the Design Review for the AHE weapons system and continued the SDD effort, with engineering and development preparations for Critical Design Review.

This funding was budgeted at \$287.776 million in FY04, \$562.949 million in FY05, \$590.618 million in FY06, and \$399.871 million in FY07. Two test articles were planned for delivery in FY07.

NAWCAD support funds government engineering and contractor engineering support and government oversight. Program personnel will perform engineering and loads analysis, design, preparation, installation, and ground test calibration of instrumentation and for the A-123 Loads Test. They will execute test program risk reduction efforts. This also funds the ramp up for the Software Functional Review/Preliminary Design Review/Critical Design Review. Development and creation of a wind tunnel test model and preparation for the wind tunnel testing includes the re-host of the simulation data, and design and develop a digital engine control system to eliminate obsolescence, weight reduction, and performance improvements.

The funding profile for this part of the project is \$33.395 million in FY04, \$23.534 million in FY05, \$28.068 million in FY06, and \$49.427 million in FY07.

In FY04, \$6.950 million was used to support NC-130H engineering risk reduction efforts, some classified development, and NC-130H AHE Advanced Development Model (ADM) system flight test and test analysis.

Weapons System Trainers (WST), Operational Flight Trainers (OFT), and Simulated Maintenance Trainers (SMT) were funded at \$9.810 million in FY06 and \$107.910 million in FY07.

## Funding

	<b><u>U.S. FUNDING</u></b>							
	FY04	FY04	FY05	FY05	FY06	FY06	FY07	FY07
	<u>QTY</u>	<u>AMT</u>	<u>QTY</u>	<u>AMT</u>	(Req) <u>QTY</u>	(Req) <u>AMT</u>	(Req) <u>QTY</u>	(Req) <u>AMT</u>
<b>RDT&amp;E (USN)</b>								
E3051 E-2 Adv								
Hawkeye	-	328.1	-	590.6	-	629.7	-	558.4

	FY08 (Req) <u>QTY</u>	FY08 (Req) <u>AMT</u>	FY09 (Req) <u>QTY</u>	FY09 (Req) <u>AMT</u>	FY10 (Req) <u>QTY</u>	FY10 (Req) <u>AMT</u>	FY11 (Req) <u>QTY</u>	FY11 (Req) <u>AMT</u>
<b>RDT&amp;E (USN)</b>								
E3051	-	748.6	-	333.9	-	158.6	-	100.0
<b>Other Funding (USN)</b>								
APN-1	-	76.1	-	711.3	-	769.2	-	787.3
APN-6	-		-	21.2	-	11.8	-	19.0

All \$ are in millions.

## Recent Contracts

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(Contracts over \$5 million.)

<u>Contractor</u>	<u>Award (\$ millions)</u>	<u>Date/Description</u>
Northrop Grumman	1,932.0	Aug 2004 – CPFF contract for the system development & demonstration (SDD) of the E-2 Advanced Hawkeye (AHE). The SDD phase will consist of modifying two E-2 Hawkeye 2000 aircraft to the E-2 AHE configuration. Complete December 2011. (N00019-03-C-0057)
Northrop Grumman	22.6	Jul 2005 – mod to a previously awarded CPAF contract to design, develop, fabricate, assemble, integrate, furnish, manage, test, and evaluate an On-Board Oxygen Generating System for the E-2D. Complete December 2012. (N00019-03-C-0057)

## Timetable

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<u>Month</u>	<u>Year</u>	<u>Major Development</u>
Dec	FY04	SDD contract award
1Q	FY04	Software Functional Review
1Q	FY05	Preliminary Design Review
1Q-2Q	FY05-07	Development Test A-123 & NC-130
1Q	FY06	Critical Design Review
3Q-4Q	FY07	Development Test SDD #1 & #2
4Q	FY07	AHE Systems Installation
	FY07	Pilot production
4Q	FY08	Operational Assessment
2Q	FY09	Milestone C, LRIP 1
3Q	FY10	LRIP 2
2Q-1Q	FY10-11	4 aircraft PP Delivery
4Q-4Q	FY10-11	DT/OT Assist – Pilot Production
2Q	FY11	LRIP 3
3Q	FY11	IOC
4Q	FY11	OT Readiness Review

## Worldwide Distribution

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This is a United States Navy program.

## Forecast Rationale

The Hawkeye has been the AEW&C backbone of the Fleet for decades, with one or more E-2Cs constantly airborne during carrier battle group operations. It is the Navy's only airborne command and control asset, the only one the Fleet can bring with it. If a battle group is close to hostilities or to a contingency operation, the E-2C can be on the scene before AWACS can be deployed. The naval strategy of prepositioning carrier battle groups in areas of anticipated conflict puts Hawkeye on the front line first.

The FY94 Defense Appropriations Bill (PL 103-139) required the Navy to develop a viable airborne CEC component, so planners were able to justify and receive funding for new-production aircraft.

Mission computer upgrades made advances in radar capability possible. The L-304 could not fully support the APS-145(V) or expanded AEW operations. CEC's distributed processing made it possible to do much of the heavy-duty processing on ships with advanced computer resources. But the aircraft mission computer had to keep pace with the increase in processing sophistication if the E-2C was to carry its share of Fleet operations.

This resulted in an order-of-magnitude improvement in capability with a system one-third the weight and half the volume of the older system. Flight tests of the new computer began in 1997 and proved the new hardware and software to be mission-capable. LRIP took place in August 1997. Radar technology was also marching forward and offered a chance to take fuller advantage of the processing.

The SDD Advanced Hawkeye award will build on a proven airplane and capitalize on advancing technology.

The switch to an electronically scanned array radar will result in increased performance and capability. There will also be significant improvements in reliability and maintainability. Pre-SDD efforts have focused the engineering and refined the expectations for the Advanced Hawkeye.

Navy planners are using the development of the E-2D to maximize the offensive power of a carrier air wing. There will be a change in emphasis from Combat Air Patrol to a Missile/Sensor Network with Remote Fire capability. The operational mindset is to change from self-defense to force defense as called for by the Sea Shield construct. The E-2D will be a key pillar of the Naval Integrated Fire Control-Counter Air (NIFC-CA) and enabler of a Single Integrated Air Picture (SIAP).

There is no doubt of the Navy's enthusiasm for the new Hawkeye. The one question grows out of pending budget constraints. Supporting the on going cost of the war in Iraq and Afghanistan, the new demands on the nation's budget as a result of hurricane devastation, skyrocketing fuel costs, and other fiscal plans and problems are squeezing the defense budget and making it necessary for planners to take a hard look at their wants, needs, requirements, and resources. Although the administration position is that defense and security will not be cut, the size of the pressing demands on the nation's budget makes it nearly impossible for the defense budget not to have to share in across-the-board cuts. Key programs are going to be, hopefully, safe from termination. But this Pentagon leadership has shown a willingness to unilaterally cut things without seeking service input. One possibility is that the Advanced Hawkeye program could see delays or a reduction in the total number of aircraft procured.

## Ten-Year Outlook

### ESTIMATED CALENDAR YEAR PRODUCTION

Designation	Application	High Confidence Level					Good Confidence Level				Speculative			Total 06-15
		Thru 05	06	07	08	09	10	11	12	13	14	15		
AEH RADAR	E-2D ADVANCED HAWKEYE (USN)	0	0	0	0	2	2	4	4	4	5	6	27	

Notes: Plans include two SDD Hawkeye 2000 conversions to Advanced Hawkeyes

