U.S. Command and Control and Intelligence, Surveillance, and Reconnaissance Aircraft

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July 15, 2015

Congressional Research Service
7-5700
www.crs.gov
R44108

CRS REPORT
Prepared for Members and
Committees of Congress

c11173008

Summary

The fleet of manned aircraft accomplishing the Department of Defense's (DOD's) Command and Control (C2) and Intelligence, Surveillance, and Reconnaissance (ISR) missions for the joint military community (E-8, E-3, RC-135, WC-135, OC-135, and E-6) is primarily based on Boeing 707 aircraft procured from the 1960s to the early 1990s. As the age of these legacy C2ISR aircraft increases, understanding the Air Force and Navy modernization and recapitalization plans is likely important for Congress. This report examines the Air Force's and Navy's current sustainment, modernization, and recapitalization efforts for these Boeing 707-based aircraft, and issues Congress may take into account when considering appropriating funds for continued sustainment and modernization of these aircraft versus funding for recapitalization of these missions to new aircraft.

This report addresses potential congressional oversight and appropriations concerns for the sustainment, modernization, and recapitalization of the DOD's Boeing 707-based legacy C2ISR aircraft fleet. It does not address options for recapitalization currently being offered by industry to other countries. Congress has the authority to approve, reject, or modify Air Force and Navy funding requests for C2ISR aircraft sustainment, modernization, and recapitalization, as well as oversight of the nation's C2ISR requirements and capabilities. Congress's decisions on appropriations for the C2ISR force could impact the nation's C2ISR capabilities and have additional consequences for the U.S. aerospace industry.

The starting point for Congress's debate on legacy C2ISR sustainment, modernization, and recapitalization is the existing Boeing 707-based C2ISR fleet consisting of 89 operational aircraft, which includes

- 16 E-8C Joint Surveillance Targeting Attack Radar System (JSTARS) aircraft providing airborne battle management, command and control, intelligence, surveillance, and reconnaissance;
- 31 E-3 Sentry Airborne Warning and Control (AWACS) aircraft with integrated command and control battle management (C2BM), surveillance, target detection, and tracking;
- 17 RC-135V/W RIVET JOINT aircraft supporting theater and national level forces with near real time on-scene intelligence collection, analysis, and dissemination capabilities;
- 2 RC-135U COMBAT SENT aircraft that locate and identify foreign military land, naval, and airborne radar signals to determine detailed operating characteristics and capabilities of those systems;
- 3 RC-135S COBRA BALL aircraft that collect optical and electronic data on ballistic missile targets;
- 2 WC-135 Constant Phoenix atmospheric collection aircraft that collect particulate and gaseous effluents and debris from accessible regions of the atmosphere supporting the Limited Nuclear Test Ban Treaty of 1963;
- 2 OC-135B Open Skies aircraft that perform unarmed observation flights over participating parties of the Open Skies Treaty, and

- 16 E-6B Mercury communications relay and strategic airborne command post aircraft.

Potential congressional oversight and appropriations concerns for the sustainment, modernization, and/or recapitalization of the DOD's Boeing 707-based legacy C2ISR aircraft fleet include

- a potential shortfall in C2ISR capabilities if there is a funding gap for sustainment and upgrades that would keep the weapon systems viable until they are recapitalized;
- ascertaining DOD, Air Force, and Navy priorities for sustainment, modernization, and recapitalization;
- determining if modernization efforts allow for delayed recapitalization efforts;
- consideration of shifting some of the legacy C2ISR missions to remotely piloted aircraft;
- the potential implications of reduced legacy C2ISR aircraft sustainment and modernization, and subsequent diminishing numbers of airframes on any future rounds of base realignment and closure efforts; and
- the ability of the nation's industrial base to sustain the legacy C2ISR aircraft force.

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Without sufficient sustainment and modernization funding, many analysts argue the legacy C2ISR fleet is likely to become a decrepit force ill-suited to the potential challenges posed by future adversaries. The physical wear-and-tear on these aircraft from the demands of their already lengthy service lives leads aging airframe structures to need reinforcement, engines to require maintenance, and computer and electronic components to face obsolescence. Even if corrosion, metal fatigue, and parts obsolescence do not take their toll on the fleet, military analysts point out that potential adversaries are acquiring advanced, anti-access/area-denial (A2/AD) weapon systems that would make it harder for the legacy C2ISR aircraft to get close to the battle.

This report addresses potential congressional oversight and appropriations concerns for the sustainment, modernization, and recapitalization of the DOD's Boeing 707-based legacy C2ISR aircraft fleet. It does not address options for recapitalization currently being offered by industry to other countries. Congress has the authority to approve, reject, or modify Air Force and Navy funding requests for C2ISR aircraft sustainment, modernization, and recapitalization, as well as maintain oversight of the nation's C2ISR requirements and capabilities. Congress's decisions on appropriations for the C2ISR force could impact the nation's C2ISR capabilities and have additional consequences for the U.S. aerospace industry.

A key issue for Congress is whether to continue providing sustainment, modernization, and/or recapitalization funding for DOD's Boeing 707-based legacy C2ISR aircraft fleet, and if so, at what levels. Pertinent to the discussion is the potential for a shortfall in the nation's C2ISR capabilities if Congress or DOD chooses to minimize funding for sustainment and upgrades that would keep the weapon systems viable until they are recapitalized. Another issue for Congress is DOD, Air Force, and Navy priorities for sustainment, modernization, and recapitalization efforts. An important question is whether development of a C2ISR replacement aircraft can or should be further delayed by increasing funding for legacy C2ISR aircraft sustainment and modernization. Additionally, potentially shifting some of the legacy C2ISR missions to remotely piloted aircraft may affect recapitalization efforts. Congress's decisions on these issues could also have implications for any potential future base realignment and closure (BRAC) decisions as well as impact the U.S. aircraft manufacturing industrial base. Ultimately, the priority the DOD places on legacy C2ISR sustainment, modernization, and recapitalization, and any decisions considered by Congress, could have potential consequences for future national defense strategies and on U.S. C2ISR capabilities, given the pivotal role C2ISR plays in implementing those strategies.

A note on sources: As small fleets of specialized aircraft, relatively little has been written on the programs discussed in this paper. Description of each therefore relies on Air Force fact sheets, which are used to introduce each aircraft before discussing the supporting budget items.

Background

Dash 80/Boeing 707[1]

In 1952, the Boeing Company[2] began development of the Model 367-80 prototype aircraft, known as "Dash 80." That prototype led to the military KC-135 tanker and the commercial 707 aircraft, which shared the basic design of the Dash 80 but were very different airplanes, neither being a derivative of the other.[3] A total of 820 C/KC-135s were built through 1966, 732 as tankers and 88 modified for special purposes, including cargo carriers, reconnaissance airplanes, Strategic Air Command airborne command posts, and transports for high-ranking government officials. Boeing delivered 856 Model 707s between 1957 and 1994, with 725 delivered between 1957 and 1978 for commercial use. Most civil 707s left in service after 2007 were converted to freighters, while a number were used as corporate transports.

Current Boeing 707-Based DOD C2ISR Force

The Department of Defense's current C2ISR aircraft fleet based on the Boeing 707 includes 89 operational aircraft. **Table 1** lists the types of aircraft and their average age. Additional information on each aircraft type, the current sustainment and modernization efforts, previous recapitalization efforts (if applicable), and current recapitalization efforts follows the table.

Table 1. Current Boeing 707-Based DOD C2ISR Force

U.S. Air Force Aircraft	Number of Operational Aircraft in Inventory	Average Age (in years)
E-8C JSTARS	16[a]	13.6[b]
E-3 Sentry (B/C/G)	20/5/6	36.1/31.5/33.2
RC-135V/W RIVET JOINT (V/W)	8/9[c]	49.8/51.8
RC-135U COMBAT SENT	2	49.5
RC-135S COBRA BALL	3	52.3
WC-135 Constant Phoenix (C/W)	1/1	50.2/52.3
OC-135B Open Skies	2	52.3
E-6B Mercury	16	21[d]

Source: "Aircraft Assets & Availability," *Air Force Times*, October 20, 2014, p. 19; "2014 Air Force Almanac," *Air Force Magazine*, May 2014, pp. 77-81; Justification books for Air Force procurement accounts and research,

[1] For more information, see Boeing KC-135 Stratotanker Historical Snapshot, accessed May 13, 2015, at http://www.boeing.com/history/products/kc-135-stratotanker.page; Boeing 707/720 Commercial Transport Historical Snapshot, accessed May 13, 2015, at http://www.boeing.com/history/products/707.page; and "Boeing Marks 50th Anniversary of 707 First Flight," accessed May 13, 2015, at http://boeing.mediaroom.com/2007-12-20-Boeing-Marks-50th-Anniversary-of-707-First-Flight.

[2] Now Boeing Commercial Airplanes.

[3] For simplicity, in this report the term "Boeing 707" is used to refer to both derivatives of the Dash 80.

development, test, and evaluation accounts for FY2016 and prior years; and Justification books for Navy procurement accounts and research, development, test, and evaluation accounts for FY2016 and prior years.

a. The E-8C inventory also includes one pilot trainer aircraft, which does not carry the standard mission equipment, and one test aircraft.

b. This age is based on when the aircraft became E-8C JSTARS aircraft, not when they were originally manufactured by Boeing as 707-300s in the 1960s.

c. In addition, there are three TC-135W aircraft used for training (average age of 52.1 years) and one NC-135W aircraft used for testing (52.3 years old).

d. CRS calculation based on delivery schedule of aircraft.

Despite the advanced age of the Boeing 707-based DOD C2ISR aircraft fleet, aircraft availability remain at levels sufficient to sustain current operational requirements. **Table 2** lists the percentage of time aircraft were available, known as mission-capable rates, for the past five years.

Table 2. Boeing 707-Based DOD C2ISR Force Aircraft Availability

Percentage of time aircraft were available (mission-capable rates)

U.S. Air Force Aircraft	2010	2011	2012	2013	2014
E-8C	81.1	77.3	78	73.6	72.1
E-3B	71.2	70.1	72.5	75.2	76.5
E-3C	72.7	74.0	73.3	78.4	76.6
E-3G	N/A	N/A	85.4	88.4	83.4
RC-135V	79.1	77.7	75.0	75.3	75.2
RC-135W	79.6	77.4	79.8	80.0	70.9
RC-135U	81.9	86.5	83.6	85.8	79.6
RC-135S	88.9	83.9	86.5	72.4	81.9
WC-135C	74.0	58.4	85.6	80.5	75.8
WC-135W	74.8	63.1	55.7	82.4	59.8
OC-135B	72.6	64.6	79.9	75.7	77.9
U.S. Navy Aircraft	**2010**	**2011**	**2012**	**2013**	**2014**
E-6B	—	—	—	—	—

Source: "Aircraft Assets & Availability," *Air Force Times*, October 20, 2014, p. 19.

Notes: Data for the E-6B is unavailable.

E-8C Joint Surveillance Targeting Attack Radar System (Joint STARS or JSTARS)

Figure 1. E-8C Joint STARS

Source: U.S. Air Force official website, E-8C Joint STARS Factsheet, March 31, 2005, at http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104507/e-8c-joint-stars.aspx.

The E-8C JSTARS is an airborne battle management, command and control, intelligence, surveillance, and reconnaissance platform. Its primary mission is to provide theater ground and air commanders with ground surveillance to support targeting and attack operations.

The E-8C is a modified Boeing 707-320 commercial airframe extensively remanufactured and modified with radar, communications, operations, and control subsystems required to perform its mission. The most prominent external feature is a 27-foot long, canoe-shaped radome under the forward fuselage that houses a 24-foot long, side-looking phased array antenna. The antenna can tilt to either side of the aircraft where it can develop a 120-degree field of view covering nearly 19,305 square miles, and is capable of detecting targets more than 155 miles away. (In short, the JSTARS' sensors detect and monitor vehicles and other ground-based objects over an area roughly twice the size of New Jersey.) The radar also has limited capability to detect helicopters, rotating antennas, and low, slow moving fixed wing aircraft. The information is relayed in near real time to ground command, control, communications, computers, and intelligence nodes.[4]

The JSTARS concept evolved from U.S. Army and Air Force programs to develop, detect, locate, and attack enemy armor at ranges beyond the forward area of troops.[5] The ability of airborne side-looking radar to detect slow-moving and fixed targets on the ground was demonstrated in the

[4] U.S. Air Force E-8C Fact Sheet, March 31, 2005, at http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104507/e-8c-joint-stars.aspx.

[5] Ibid.

Air Force's Pave Mover program in 1982.[6] JSTARS combines technologies developed in Pave Mover and the Army's Stand-Off Target Acquisition System program.[7]

A developmental contract for the E-8 JSTARS was awarded to Grumman Corporation in September 1985. Original plans called for 10 conversion aircraft. The plan later changed to 22 newly-built aircraft and subsequently changed again to 20 aircraft before a final total of 17 operational aircraft emerged. The production E-8s were originally planned to be new aircraft based on the U.S. Navy's E-6 Hermes aircraft (a Boeing 707-320 aircraft with more powerful engines), however, in October 1989 Boeing announced the end of production of the 707 airframe upon completion of British and French airborne warning and control system aircraft in 1991. As a result, the E-8C aircraft are retrofitted Boeing 707 aircraft acquired from other sources. The first two test aircraft were former Boeing 707-328 commercial airliners from American Airlines and Qantas Airlines. The first E-8C entered operational service in late 1995.[8]

The E-8C aircraft fleet averages 13.6 years of age.[9] This is based on when the aircraft became E-8C JSTARS aircraft, not when they were originally manufactured by Boeing as 707-300s in the 1960s.[10]

The 116th Air Control Wing, a Georgia Air National Guard unit, and the 461st Air Control Wing, an associate active-duty Air Combat Command unit, operate 16[11] operational[12] E-3C JSTARS at Robins Air Force Base, Georgia.[13]

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[6] "Joint USAF/Army JSTARS System Set for Airborne Test in 1988," *Aviation Week & Space Technology*, December 9, 1985, p. 91.

[7] "E-8 J-STARS," *Military Periscope*, accessed September 23, 2014, at https://www.militaryperiscope.com/weapons/aircraft/p-r-e/w0003128.html.

[8] "E-8 J-STARS," *Military Periscope*, accessed September 23, 2014, at https://www.militaryperiscope.com/weapons/aircraft/p-r-e/w0003128.html.

[9] "Aircraft Assets & Availability," *Air Force Times*, October 20, 2014, p. 19.

[10] Air Force budget overview documents, justification books for Air Force procurement accounts, and justification books for Air Force research, development, test, and evaluation accounts for FY2016 and prior years.

[11] One operational E-8C was retired in FY2013 due to being damaged beyond economical repair in an air refueling incident on March 13, 2009, reducing the operational inventory from 17 to 16 aircraft. For more information, see Air Combat Command Press Release, "E-8C Accident Report Released," July 9, 2009, at http://www.acc.af.mil/news/story.asp?id=123158008, and Secretary Michael Donley and General Norton Schwartz, *USAF Force Structure Changes: Sustaining Readiness and Modernizing the Total Force* white paper, February 2013.

[12] The Air Force E-8C inventory also includes one pilot trainer aircraft, which does not carry the standard mission equipment, and one test aircraft, T-3.

[13] On October 1, 2002, the Air Force redesignated the 116th Bomb Wing, a Georgia Air National Guard unit, as the 116th Air Control Wing while simultaneously deactivating the 93rd Air Control Wing, an active-duty Air Combat Command unit. The new 116th Air Control Wing was the first organization to activate under the Air Force's Total Force Initiative as a "blended" wing blending Guard and active-duty Airmen into a single unit. On October 1, 2011, the blended wing changed to an Active-Associate construct. The newly activated 461st Air Control Wing assumed administrative oversight of active duty personnel from the 116th Air Control Wing. According to the Air Force, the change was primarily for administrative reasons as updated Air Force regulations did not cover a blended unit, and led to issues with the handling of promotions, disciplinary actions, and other administrative issues. For additional information see U.S. Air Force E-8C Fact Sheet, March 31, 2005, at http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104507/e-8c-joint-stars.aspx and Wayne Crenshaw, "116th's Blended Unit to Be Split Again Friday," *The Telegraph*, September 30, 2011, at http://www.macon.com/2011/09/30/1725024/changes-for-116th-air-control.html.

Current E-8C Sustainment and Modernization Efforts[14]

With the Air Force's decision to recapitalize the E-8C JSTARS fleet beginning in FY2015, the Administration's FY2015 budget request did not include modernization funding for the E-8C JSTARS. To fund E-8C JSTARS recapitalization, the Air Force planned (as part of the FY2015 Budget Request) to divest the E-8C test capability, including the T-3 test aircraft, and begin the retirement of five operational E-8C JSTARS aircraft. As part of the National Defense Authorization Act for FY2015, Congress prohibited the Air Force from taking any action to retire or to prepare to retire operational JSTARS aircraft until 30 days after the Secretary of the Air Force submits a report to the congressional defense committees providing an update of the results of the analysis of alternatives for recapitalizing the JSTARS capability and an assessment of the cost and schedule of developing and fielding a new aircraft and radar system to replace the current JSTARS aircraft.[15] The Administration's FY2016 budget request delays the divestiture of five operational E-8C JSTARS aircraft from FY2016 to FY2019 and restores funding to complete one modernization program for those five operational aircraft that was in progress for the other 11 operational aircraft prior to FY2015.

The following E-8C sustainment and modernization initiatives, currently in the program of record, are either recently completed or currently in progress. Additional information on each effort is detailed in the following sections.

- Prime Mission Equipment (PME) Diminishing Manufacturing Sources (DMS);
- Kill Chain Enhancement Modifications;
- JSTARS Modernization; and
- Test and Infrastructure.
- It may be noteworthy that none of these programs deals with the E-8C engine or airframe.

Prime Mission Equipment (PME) Diminishing Manufacturing Sources (DMS)

The Air Force considers the Prime Mission Equipment (PME) Diminishing Manufacturing Sources (DMS) program a top issue for fleet viability. Parts obsolescence stemming from an overdue technology refresh requires a major modification to maintain the existing processing capabilities and specification compliance. PME is required for JSTARS to maintain net-centric war fighter capabilities – Ground Moving Target Indicator (GMTI) and Battle Management Command and Control (BMC2). The last major modification to the mission computing hardware took place during the Computer Replacement Program (CRP) from 1997-2005. The modification addresses hardware and software DMS issues and commercial-of-the-shelf technology refresh for the Operator Work Station, the Central Computing subsystem, and the Radar Airborne Signal Processor subsystem. Modifications also include mission and maintenance crew trainers, software maintenance, and support systems at Robins AFB, Georgia.

[14] Information for current E-8C sustainment and modernization efforts derived from Air Force budget overview documents, justification books for Air Force procurement accounts, and justification books for Air Force research, development, test, and evaluation accounts for FY2016 and prior years unless noted. Previous modernization efforts are not included in this report.

[15] P.L. 113-291, Section 219. See the **Appendix** for full text.

In October 2013, the Air Force awarded a contract for seven modernization kits for the PME-DMS program.[16] Two of the seven kits were procured with $5.85 million of National Guard and Reserve Equipment Appropriation funding.[17] The remaining five kits were procured with JSTARS funding. In September 2014, the contract was amended to add four additional kits for a total of 11 overall. Beginning in FY2016, the Air Force plans to award the contract for the remaining five JSTARS aircraft to complete the fleet retrofit of 16 aircraft. Funding lapsed in FY2015 because the Air Force planned to end JSTARS modernization efforts to focus funding on recapitalization efforts. Funding was restored for FY2016 through FY2018 to complete the modification to the entire fleet.[18]

Kill Chain Enhancement Modifications

The JSTARS Kill Chain Enhancement program monitors, identifies, evaluates, compares and prioritizes projects that expediently deliver warfighting capabilities. The program focused on rapid implementation and delivery, rather than long-term production. The Air Force implemented emerging technologies that greatly increase system and system-of-systems capability, as well as interoperability with joint service, allied, and coalition systems. Representative efforts include imagery comparison, Remotely Piloted Aircraft (RPA) data integration, Broadcast Intel track correlation, multi-sensor radar service and tracker improvements, time critical targeting initiatives, Internet Protocol enabling technologies to enhance command and control to shorten the kill chain, machine-to-machine data exchange, enhanced targeting and interdiction, radar & Synthetic Aperture Radar (SAR) enhancements.

Project candidates under this program typically arise out of warfighter experiments, exercises, analysis of operational data, or real world lessons learned. Priority is based on immediate benefit to the warfighter, technical feasibility, and overall executability.

The operational and trainer aircraft were modified with procurement funds, while the test aircraft (T-3) was modified with RDT&E funds.

[16] A complete "kit" actually includes two different kits (a Group A kit and a Group B kit). The kits referred to in this section treat one A kit and one B kit together as one kit.

[17] Congress established the National Guard and Reserve Equipment Appropriation (NGREA) in 1981 to provide the equipment necessary to maintain the readiness of National Guard and Reserve components. NGREA funding is intended to supplement the services' base procurement appropriations, not substitute for it. The Active Components are still expected and required to fund and equip their respective Guard and Reserve components to ensure reserve units are at a high level of readiness should they need to be deployed. The Chiefs of the National Guard and Reserve components enhance readiness by procuring items that the services' base appropriations do not fund. NGREA funds are used to procure new aircraft; major weapon systems that are already established as a stable procurement program; equipment support items; and modifications to rebuild, overhaul, or refurbish existing items without expanding on the platform capability currently supported by the Active components. NGREA provides the needed flexibility to the Chiefs of the National Guard and Reserve components to procure priority readiness items subject only to the authority, direction, and control of the Secretary of Defense. (Source: U.S. Congress, Senate Committee on Appropriations, *Department of Defense Appropriations Bill, 2014*, Report to accompany S. 1429, 113th Cong., 1st sess., August 1, 2013, S.Rept. 113-85, pp. 142-143.)

[18] The pilot trainer aircraft does not carry the standard mission equipment, so it does not require this modification. The test aircraft, T-3, was previously modified with RDT&E funds.

Aircraft Spares and Repair Parts

This program provides funding for repair parts for the E-8.

JSTARS Modernization

This development program encompassed multiple efforts to develop and integrate system improvements across the E-8C platform. Program accomplishments in the last year of funding in FY2014 consisted of multiple efforts to develop and integrate platform wide system improvements such as Multi-Agency Communication Capability, CENTRIX, Ground Moving Target Indicator Risk Reduction and Beyond-Line-of-Sight Network Architecture Upgrades. Additionally, training and support systems upgrade efforts included Weapon Systems Trainer, Navigator Training System, and Mission Crew Trainers to include a Mission Maintenance Trainer, Prime Mission Equipment-Maintenance Training Device (PME-MTD) and the Mission System Trainer.

Test and Infrastructure

The test infrastructure program included the JSTARS Extended Test Support (JETS), JSTARS Test Force (JTF), and C2 Enterprise Integration Facility. All JSTARS efforts relied on the components of this test infrastructure to carry out RDT&E activities. The infrastructure included a T-3 test aircraft, laboratories, support facilities, security, information assurance, and range support. All of the developmental programs have been completed. In FY2014, the program began the transfer of test infrastructure assets to Robins AFB, GA. The JETS contract and JTF lease was extended into the second quarter FY2015 to facilitate preparation of the T-3 aircraft for retirement and the disposition of residual Government Furnished Equipment.

Table 3 is the FY2016 budget submission for E-8C procurement and E-8C research, development, test, and evaluation programs derived from Air Force budget justification books. It summarizes prior-year and estimated future-year expenditures for E-8C sustainment and modernization programs that either recently completed or are currently in progress.

Table 3. Current E-8C Sustainment and Modernization Efforts

(in millions of dollars)

Procurement Items	Prior Years	Total Cost FY2014	Total Cost FY2015	Total Cost FY2016	Total Cost FY2017	Total Cost FY2018	Total Cost FY2019	Total Cost FY2020	Cost to Complete	Total Cost
Prime Mission Equipment (PME) - Diminishing Manufacturing Sources (DMS)	49.716	55.967	—	18.001	6.300	10.800	—	—	—	140.784
Kill Chain Enhancement Modifications	112.106	0.011	—	—	—	—	—	—	—	112.117
Aircraft Spares and Repair Parts	—	0.523	—	—	—	—	—	—	—	0.523
Total Procurement Items	**161.822**	**56.501**	—	**18.001**	**6.300**	**10.800**	—	—	—	**253.424**
RDT&E Items	**Prior Years**	**Total Cost FY2014**	**Total Cost FY2015**	**Total Cost FY2016**	**Total Cost FY2017**	**Total Cost FY2018**	**Total Cost FY2019**	**Total Cost FY2020**	**Cost to Complete**	**Total Cost**
JSTARS Modernization	—	10.050	—	—	—	—	—	—	—	27.308
Test and Infrastructure	—	17.258	—	—	—	—	—	—	—	17.258
Total RDT&E Items	—	**27.308**	—	—	—	—	—	—	—	**27.308**

Source: Prepared by CRS based on justification books for Air Force procurement accounts and Air Force research, development, test, and evaluation accounts for FY2016 and prior years.

Previous E-8C Recapitalization Efforts[19]

E-10 Program

Figure 2. E-10A

Source: Boeing File Photo, http://www.boeing.com/news/frontiers/archive/2004/july/photos/july_i_ids2.jpg.

Initially, the E-10A was intended to replace the E-8C JSTARS aircraft to provide improved tracking of moving ground targets. Additionally, it was designed to detect low-flying cruise missiles. Later derivatives of the E-10A were intended to replace the E-3 Sentry AWACS airborne surveillance aircraft (E-10B) and RC-135 RIVET JOINT signals intelligence aircraft (E-10C).[20]

In FY2003, the Air Force established the Multi-sensor Command and Control Constellation (MC2C) program. The MC2C was a horizontally integrated architecture of command and control and intelligence, surveillance, and reconnaissance capabilities. The MC2C was a key enabler for the effects-based capabilities needed to achieve Global Strike Task Force objectives. The MC2C Program contained two separate projects – the airframe and the sensors. The MC2C program absorbed and continued the Multi-Platform Radar Technology Insertion Program (MP-RTIP) radar effort that was previously reported in the Joint STARS program.[21] MC2C transitioned the 707-based MP-RTIP radar to a 767-based MP-RTIP radar with funding from the Joint STARS program.

[19] Information for previous recapitalization efforts derived from justification books for Air Force research, development, test, and evaluation accounts for FY2010 and prior years unless noted.

[20] Diane Stratman, "Eyes and Ears Above," *Boeing Frontiers*, July 2004, at http://www.boeing.com/news/frontiers/archive/2004/july/i_ids2.html.

[21] The MP-RTIP project was the result of a restructuring of the Joint STARS Radar Technology Insertion Program (RTIP), a formerly pre-planned product improvement for the Joint STARS. The RTIP effort began in FY1998 and was restructured into the MP-RTIP project in FY2002 to better track program funding.

In FY2005, the MC2C program was renamed Command and Control (C2) Constellation and the airframe and sensor projects were transferred to a new program, the Multi-sensor Command and Control Aircraft (MC2A.)[22] In FY2006, the MC2A Program was renamed E-10 Squadrons to directly associate the approved Mission Data Series designation for the MC2A. The airframe and sensors projects remained in the new E-10 Squadrons Program.

The E-10 was intended to be a key C2 Constellation node bringing operational command and control through the use of advanced sensors, sensor fusion, high-speed, wide-band communications systems, and battle management integration software to enable detection, designation, and prosecution of time critical targets. The E-10 also would have interfaced with multi-Service ground/air/space-based sensors, intelligence and communications assets to shorten the decision cycle for combat operations. In short, the E-10 would have added interoperability and capability beyond the existing JSTARS platform, with an especial emphasis on speed. The result, according to the Air Force, would have been weapons-quality target cueing for joint and coalition shooters to engage time sensitive cruise missiles and other fleeting high-priority targets.

The E-10's Multi-Platform Radar Technology Insertion Program (MP-RTIP) radar would have addressed targets the E-8 could not, with Air Moving Target Indicator (AMTI) capability for cruise missile defense. Next-generation Ground Moving Target Indicator (GMTI) and Synthetic Aperture Radar (SAR) imaging for improved surface surveillance would have improved on E-8 capabilities. An open system architecture to facilitate dynamic Battle Management, Command & Control (BMC2) gave the E-10 growth potential for remotely piloted aircraft control, space radar interface and ISR management functions. The Air Force envisioned future E-10 increments would incorporate advanced sensors for air surveillance operations.

The E-10 program, as well as the E-10 portion of the MP-RTIP radar development, was terminated in FY2008.[23] According to the Air Force, the E-10 was canceled because of cost growth with the program.[24] Others believe the complexity of the E-10 program made it controversial and led to the cancellation. Additionally, according to some views, policymakers differed on the future of the ISR mission itself. Some people believed the mission could be accomplished by space-based assets, while others viewed unmanned aircraft as most cost effective, while others believed in downgrading with role of high-cost platforms in favor of networked, distributed collection systems.[25]

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[22] The new C2 Constellation program absorbed Horizontal Integration efforts and Joint Expeditionary Force Experiments to support Horizontal Integration efforts. The aperture of the program expanded beyond the previous MC2C focus, no longer being solely tied to what would become the E-10.

[23] The E-10A Program was terminated in February 2007 with amended termination direction in May 2007 that authorized a limited risk reduction of Battle Management Command and Control (BMC2) Mission Execution, BMC2 Kill Chain, and Wide Area Surveillance (WAS) Radar Hardware verification. Funding for these efforts beyond FY2008 was provided in other program elements not associated with the E-10 Project. Additionally, the smaller version of the MP-RTIP program continued to be developed to provide a radar for the MQ-4 Global Hawk Block 40 configuration. In FY2009, the E-10 Squadrons Sensors project transferred to the Global Hawk program element.

[24] Testimony of Gen Michael Moseley, Air Force Chief of Staff, to U.S. Congress, Senate Committee on Armed Services, *Department of the Air Force in review of the Defense Authorization Request for Fiscal Year 2009 and the Future Years Defense Program*, 110th Cong., 2nd sess., March 5, 2008.

[25] Loren B. Thompson, *U.S. Air Dominance in a Fiscally Constrained Environment: Defining Paths to the Future - Intelligence, Surveillance and Reconnaissance*, Lexington Institute, March 2013, p. 10, at http://lexingtoninstitute.org/wpcontent/uploads/2013/09/AirDominance-ISR.pdf.

Table 4 summarizes previous expenditures for the E-8C recapitalization efforts under the E-10 and related programs as reported in justification books for Air Force research, development, test, and evaluation programs.

Table 4. Previous E-8C Recapitalization Efforts Under the E-10 Program

(in millions of dollars)

RDT&E Items	Total Cost FY1998	Total Cost FY1999	Total Cost FY2000	Total Cost FY2001	Total Cost FY2002	Total Cost FY2003[a]	Total Cost FY2004	Total Cost FY2005	Total Cost FY2006	Total Cost FY2007	Total Cost FY2008	Total Cost
Radar Technology Insertion Program (RTIP)[b]	0.005	0.017	0.063	0.050	—	—	—	—	—	—	—	0.135
Multi-Platform – Radar Technology Insertion Program (MP-RTIP)[c]	—	—	—	—	0.073	—	—	—	—	—	—	0.073
Multi-Sensor Command and Control Constellation (MC2C) – Airframe	—	—	—	—	—	129.395	209.747	—	—	—	—	339.142
Multi-Sensor Command and Control Constellation (MC2C) – Sensors	—	—	—	—	—	208.369	145.586	—	—	—	—	353.955
Multi-Sensor Command and Control Aircraft (MC2A) – Airframe	—	—	—	—	—	—	—	198.394	—	—	—	198.394
Multi-Sensor Command and Control Aircraft (MC2A) – Sensors	—	—	—	—	—	—	—	192.563	—	—	—	192.563
E-10 Squadrons – Airframe	—	—	—	—	—	—	—	—	247.140	169.629	0.368	417.137
E-10 Squadrons – Sensors	—	—	—	—	—	—	—	—	131.731	182.295	37.307	351.333
Total RDT&E Items	**0.005**	**0.017**	**0.063**	**0.050**	**0.073**	**337.764**	**355.333**	**390.957**	**378.871**	**351.924**	**37.675**	**1,852.732**

Source: Prepared by CRS based on justification books for Air Force research, development, test, and evaluation accounts for FY2010 and prior years.

a. MC2C received $147M in FY2003 Defense Emergency Response Fund (DERF) funding which is included in the above table as follows: $64.8M to MC2C-Airframe, $61.7M to MC2C-Sensors, and $20.5M for MC2C horizontal integration efforts (accounted for in MC2C-Airframe, in addition to the $64.8M).

b. Funding for this effort was contained in the Joint STARS program element, not as a separate program element or project.

c. MP-RTIP became a separate project in FY2002, but funding remained in the Joint STARS program element until FY2003.

Current E-8C Recapitalization Efforts[26]

The Air Force began the current JSTARS Recapitalization[27] effort in FY2015.[28] JSTARS Recap is a manned aircraft replacement for the legacy E-8C.

JSTARS Recap is designed to integrate current and mature sub-system technologies onto a commercially available business class jet to provide tactical Battle Management, Command and Control (BMC2) and Battlespace Awareness (BA) across the full range of military operations. An on-board crew, powerful radar, and robust communications and information systems would enable theater ground and air commanders to make quick decisions during complex and rapidly unfolding operations. JSTARS Recap aims to enable rapid decisions by using advanced battle management aids and information fusion technologies to automate tracking and addressing time-critical targets. JSTARS Recap is intended to address the sustainment challenges in the aging E-8C fleet while focusing on known mission area gaps.

Industry Options for JSTARS Recap

Although the Acquisition Decision Memorandum is awaiting final approval, press reports indicate industry vendors have identified their preliminary plans for competing for the JSTARS Recap program. Boeing, Bombardier, Gulfstream, and Northrup Grumman are all expected to compete. Boeing plans to offer the 737-700 Boeing Business Jet (BBJ). Boeing previously looked at an offering based on the Navy's P-8A Poseidon which uses the longer Boeing 737-800, but appears to have opted for the lighter BBJ aircraft. Bombardier will likely offer its Global 6000, a long-range business jet. Gulfstream will likely offer the G650, a twin-engine business jet. Northrup Grumman, which is not an aircraft manufacturer, appears to be testing a G550 aircraft.[29]

[26] Information for current E-8C recapitalization efforts derived from Air Force budget overview documents, justification books for Air Force procurement accounts, and justification books for Air Force research, development, test, and evaluation accounts for FY2016 and prior years unless noted.

[27] The current JSTARS Recapitalization effort is shortened to "JSTARS Recap" in Air Force budget documents. The shortened name is used in this report when referring to the current recapitalization effort. "JSTARS Recapitalization" is used in this report when referring to overall recapitalization efforts over the years.

[28] The Air Force completed an Analysis of Alternatives (AOA) for JSTARS Recapitalization in 2011, which concluded the optimum choice for the future was to use a business jet class aircraft with an advanced radar and on-board BMC2 suite. The AOA also concluded upgrading the current E-8C fleet with an advanced radar and new BMC2 Suite would be the next best solution, but has significantly higher lifecycle costs. In testimony before the Senate Armed Services Committee in March 2012, then-Air Force Chief of Staff General Norton Schwartz testified there was not enough budget space to undertake a new start ISR platform. In testimony before the House Armed Services Committee in March 2014, Air Force Chief of Staff General Mark Welsh testified the current Air Force proposal to recapitalize the JSTARS is by downsizing capability in the current JSTARS program to provide the money to start a recapitalization effort. (Sources: Written statement of Lt Gen Burton M. Field, Deputy Chief of Staff for Operations, Plans, and Requirements and Lt Gen Charles R. Davis, Military Deputy, Office of the Assistant Secretary of the Air Force for Acquisition, to U.S. Congress, House Committee on Armed Services, Subcommittee on Tactical Air and Land Forces, *Fiscal Year 2014 Department of Defense Combat Aviation Programs*, 113th Cong., 1st sess., April 17, 2013; testimony of Gen Norton Schwartz, Air Force Chief of Staff, to U.S. Congress, Senate Committee on Armed Services, *Department of the Air Force in review of the Defense Authorization Request for Fiscal Year 2013 and the Future Years Defense Program*, 112th Cong., 2nd sess., March 20, 2012; and testimony of Gen Mark Welsh, Air Force Chief of Staff, to U.S. Congress, House Committee on Armed Services, *Fiscal Year 2015 National Defense Authorization Budget Request from the Department of the Air Force*, 113th Cong., 2nd sess., March 14, 2014.)

[29] Bill Sweetman, "Weight Saving Key to Boeing Joint STARS Platform Choice," *Aerospace Daily & Defense Report*, September 18, 2014, p. 2 and Kris Osborn, "Air Force Works to Replace JSTARS Fleet," *DOD Buzz.com*, October 3, 2014, at http://www.dodbuzz.com/2014/10/03/air-force-works-to-replace-jstar-fleet/.

The JSTARS Recap system is designed for day and night worldwide deployment in all weather conditions. The Air Force's intent is to relatively quickly field an initial capability that provides an equivalent to the E-8C JSTARS, not to make the replacement fundamentally different or significantly better in performance,[30] and upgrade the capability in the future.

The JSTARS Recap program consists of multiple efforts culminating in the integration of four major subsystems: BMC2, Sensor, Air Vehicle, and Communications. The Air Force has developed an open source reference architecture to integrate these subsystems, which can be competed separately. The Air Force hopes this approach will bolster competition, improving affordability and reducing overall weapons system life-cycle costs. Such an architecture should also allow the system to be adaptable and flexible to meet changing threats.

Currently a pre-Major Defense Acquisition Program, JSTARS Recap is expected to undergo a Milestone A review in the third quarter of FY2015 to determine whether to advance to a technology maturation and risk reduction phase and, if so, a Milestone B in the fourth quarter of FY2017 to decide whether to proceed to engineering and manufacturing development. The program is to determine if the use of incentives for the EMD contract are appropriate for both the delivery of test aircraft and modified/certified test aircraft. Post a successful Milestone C, the program is to follow with a Low Rate Initial Production (LRIP) contract award, procuring 3 aircraft aimed at achieving initial operational capability in the fourth quarter of FY2023. The remaining 12 aircraft would be procured in full rate production to support a full operational capability in the fourth quarter of FY2026.

Remotely Piloted Aircraft Considerations

While the U.S. Air Force's Analysis of Alternatives for JSTARS Recapitalization from 2011 concluded the optimum choice for the future was to use a business jet class aircraft, some analysts believe increases in technology allow for more consideration of the use of remotely piloted aircraft or autonomous systems in accomplishing more of the missions currently accomplished by manned aircraft.[31] The DOD has identified that "[remotely piloted] systems open up new avenues for pursuing systems that are smaller, lighter, faster, and more maneuverable and that take more risk than equivalent manned platforms."[32] Additionally, great strides in autonomy, teaming, multi-platform control, tipping, and cueing have reduced the number of personnel required to operate and maintain the remotely piloted systems, but more work remains.[33] "Research and development in automation is advancing from a state of automatic systems requiring human control toward a state of autonomous systems able to make decisions and react without human interaction."[34]

Table 5 is the FY2016 budget submission for JSTARS Recap procurement and JSTARS Recap research, development, test, and evaluation programs derived from Air Force budget justification books. It summarizes current and estimated future-year expenditures for JSTARS Recap programs.

[30] According to Col Henry Cyr, Commander of the 461st Air Control Wing, Robins AFB, GA as quoted by Kris Osborn, "Air Force Works to Replace JSTARS Fleet," *DOD Buzz.com*, October 3, 2014, at http://www.dodbuzz.com/2014/10/03/air-force-works-to-replace-jstar-fleet/.

[31] For a detailed discussion on DOD remotely piloted aircraft see CRS Report R42136, *U.S. Unmanned Aerial Systems*, by Jeremiah Gertler, and for a detailed discussion of the technological capabilities of autonomous systems see P.W. Singer, *Wired for War: The Robotics Revolution and Conflict in the 21st Century* (New York: Penguin Books, 2009).

[32] Department of Defense, *Unmanned Systems Integrated Roadmap, FY2013-2038*, Publication Reference Number 14-S-0553, p. 18.

[33] Ibid, p. 25.

[34] Ibid, p. 72.

Table 5. Current E-8C Recapitalization Efforts

(in millions of dollars)

Procurement Items	Prior Years	Total Cost FY2014	Total Cost FY2015	Total Cost FY2016	Total Cost FY2017	Total Cost FY2018	Total Cost FY2019	Total Cost FY2020	Cost to Complete	Total Cost
JSTARS Recap Production	—	—	—	—	—	0.214	268.277	537.000	4,039.259	4,844.750
Total Procurement Items	—	—	—	—	—	**0.214**	**268.277**	**537.000**	**4,039.259**	**4,844.750**
RDT&E Items	**Prior Years**	**Total Cost FY2014**	**Total Cost FY2015**	**Total Cost FY2016**	**Total Cost FY2017**	**Total Cost FY2018**	**Total Cost FY2019**	**Total Cost FY2020**	**Cost to Complete**	**Total Cost**
Technology Maturation and Risk Reduction (Product Development)	—	—	53.085	21.579	—	—	—	—	—	74.664
Test Activities	—	—	—	2.054	—	—	—	—	—	2.054
Technology Maturation and Risk Reduction (Management Services)	—	—	20.003	20.710	—	—	—	—	—	40.713
Total RDT&E Items	—	—	**73.088**	**44.343**	**298.521**	**377.827**	**192.073**	**313.959**	—	**1,299.811**

Source: Prepared by CRS based on justification books for Air Force procurement accounts and Air Force research, development, test, and evaluation accounts for FY2016 and prior years.

Notes: According to the Air Force, the FY 2016 President's Budget decreased the FY 2016 request for JSTARS Recap by $289.794M compared to the FY2015 President's Budget because the draft acquisition strategy was revised to put more emphasis on the upfront TMRR phase, addressing top integration risks. As a result, the TMRR phase was extended to 14 months, allowing the government adequate time to validate industry's system-level design maturity/readiness. Some people may say this change is a result of the National Defense Authorization Act for FY2015 prohibiting the Air Force from taking any action to retire or to prepare to retire operational JSTARS aircraft until a report requirement is satisfied.

E-3 Sentry (AWACS)[35]

Figure 3. E-3 Sentry (AWACS)

Source: U.S. Air Force official website, E-3 Sentry (AWACS) Factsheet, November 1, 2003, at http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104504/e-3-sentry-awacs.aspx.

The E-3 Sentry is an airborne warning and control system (AWACS) aircraft with integrated command and control battle management (C2BM), surveillance, target detection, and tracking. The E-3 provides an accurate, real-time picture of the air battlespace to the Joint Air Operations Center. AWACS provides situational awareness of friendly, neutral, and hostile activity, command and control of an area of responsibility, battle management of theater forces, all-altitude and all-weather surveillance of the battle space, and early warning of enemy actions during joint, allied, and coalition operations. In effect, AWACS provides an air commander with real-time information on everything flying within 250 miles of the aircraft.

The E-3 is a modified Boeing 707-320 series commercial airframe with a rotating radar dome. The dome, 30 feet in diameter, six feet thick, and held 11 feet above the fuselage by two struts, contains a radar subsystem that permits surveillance to more than 250 miles from the Earth's surface up into the stratosphere, over land or water. The radar, combined with an identification friend or foe (IFF) subsystem can look down to detect, identify, and track enemy and friendly low-flying aircraft by eliminating ground clutter returns that confuse other radar systems.

Major subsystems in the E-3 are avionics, navigation, communications, sensors (radar and passive detection) and identification tools. The mission suite includes consoles that display computer-processed data in graphic and tabular format on video screens. Mission crew members perform surveillance, identification, weapons control, battle management, and communications

[35] Information for this section is from U.S. Air Force E-3 Fact Sheet, November 1, 2003, at http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104504/e-3-sentry-awacs.aspx unless noted.

functions. The radar and computer subsystems on the E-3 can gather and present broad and detailed battlefield information including position, status, and tracking information on both friendly and adversary aircraft and ships. That information can be sent to command and control centers in rear areas or aboard ships. In time of crisis, the data can be forwarded directly to the President and Secretary of Defense.

In support of air-to-ground operations, the E-3crew can provide direct information needed for interdiction, reconnaissance, airlift, and close-air support for friendly ground forces. The E-3 crew can also provide information for commanders of air operations to gain and maintain control of the air battle. As an air defense system, E-3s can detect, identify, and track airborne adversary forces far from the boundaries of the United States or friendly countries. The E-3 crew can direct fighter-interceptor aircraft to adversary targets. The E-3 can fly approximately 8 hours without refueling; its range and on-station time can be increased through in-flight refueling and the use of an on-board crew rest area.

Engineering, test, and evaluation began on the first E-3 in October 1975. In March 1977, the 552nd Airborne Warning and Control Wing (now 552nd Air Control Wing, Tinker Air Force Base, Oklahoma), received the first E-3s.

The Air Force inventory includes 31 E-3s in three different versions: 20 E-3Bs (average age 36.1 years), 5 E-3Cs (average age 31.5 years), and 6 E-3Gs (average age 33.2 years).[36]

The E-3B and E-3C are upgrades of the earliest E-3A. The E-3B is equipped with enhanced computer capabilities, jam-resistant communications, an austere maritime surveillance capability, upgraded radios, and five additional mission consoles. E-3B upgrades were completed in 1994. The E-3Bs received completed Block 30/35 modifications in 2001, which integrated and enhanced four major subsystems. The E-3C upgrade included five additional mission consoles, Have Quick anti-jamming equipment, and Block 30/35 upgrades. E-3G is the designation of aircraft that have completed the Block 40/45 Upgrade described in in the next section, "Block 40/45 Upgrade (E-3G)."[37]

The Air Force operates E-3s at three locations. The 552nd Air Control Wing at Tinker Air Force Base, Oklahoma operates E-3s for Air Combat Command. The 18th Wing at Kadena Air Base, Japan and the 3rd Wing at Elmendorf Air Force Base, Alaska operate E-3s for Pacific Air Forces. There is one test aircraft at the Boeing in Seattle.

Current E-3 Sustainment and Modernization Efforts[38]

The FY2015 President's Budget sought to divest seven E-3 aircraft, which would have reduced the fleet size from 31 to 24. Congress prohibited the Air Force's proposed FY2015 E-3 divesture plan in the National Defense Authorization Act for FY2015,[39] and in response, the Air Force re-

[36] "Aircraft Assets & Availability," *Air Force Times*, October 20, 2014, p. 19.

[37] "2014 Air Force Almanac," *Air Force Magazine*, May 2014, p. 77.

[38] Information for current E-3 sustainment and modernization efforts derived from Air Force budget overview documents, justification books for Air Force procurement accounts, and justification books for Air Force research, development, test, and evaluation accounts for FY2016 and prior years unless noted. Previous modernization efforts are not included in this report.

[39] P.L. 113-291, Section 136. See the **Appendix** for full text.

phased the E-3 force reduction of seven aircraft from FY2016 to FY2019. The impact of the planned divestiture of the seven E-3s on each modification effort, if any, is described in each section below.

These E-3 sustainment and modernization initiatives currently in the program of record are either recently completed or are currently in progress. Additional information on each effort is detailed in the following sections:

- Block 40/45 Upgrade;
- Next Generation Identification Friend or Foe (NGIFF);
- Training, Support, and Infrastructure (TSI);
- Diminishing Manufacturing Sources Replacement of the Avionics for Global Operation and Navigation (DRAGON);
- Electronic Protection (EP);
- Internet Protocol Enabled Capability (IPEC);
- Combat Identification (CID) Diminishing Manufacturing Sources (DMS);
- Air Education and Training Command (AETC) Maintenance Training Device (MTD) Upgrades – Field Training Detachments;
- Reliability, Maintainability, and Availability (RM&A) Modifications;
- Vertical Stabilizer and Rudder Modifications;
- Low Cost Modifications – Airframe;
- Low Cost Modifications – Avionics & Mission Systems;
- Aircraft Spares and Repair Parts;
- Command and Control, Intelligence, Surveillance, and Reconnaissance (C2ISR); and
- Communications Network Upgrade.

Block 40/45 Upgrade (E-3G)

The AWACS Block 40/45 modification upgrades legacy E-3 mission systems computers, display processors, and displays, and adds a new data architecture designed to enable future modifications with commercial-off-the-shelf (COTS) hardware. The Block 40/45 Upgrade also includes an upgrade to Electronic Support Measures sensor data processing; data fusion of both off-board and on-board sensor data through multi-source integration; a Data Link Infrastructure upgrade with prioritized data link bandwidth management; new battle management tools; capability to parse, allow user access to, and integrate updates to Tactical Data Information Link (TADIL)-J message formats and protocols; enhanced mission and console recording capabilities while maintaining legacy chat communications and on-board training; modification of system software to accommodate Diminishing Manufacturing Sources (DMS).

The AWACS Block 40/45 modification is also to be installed on multiple trainers and ground systems. The development of the training systems, the Mission Crew Training Set and Mission Computing Maintenance Trainer (MCMT), began in FY2011 and each type was delivered to the

user in FY2014. Under the MCMT contract line item, the program developed up to 150 ground systems used for mission planning and post-mission processing at Tinker Air Force Base, Oklahoma, Elmendorf Air Force Base, Alaska, and Kadena Air Base, Japan, and up to ten Deployable Ground Systems for use when the aircraft deploys to other locations.

LRIP was approved for six aircraft in November 2008 with one bought in FY2009, two in FY2010, and three in FY2012. AWACS Block 40/45 Full Rate Production was approved in November 2012 for the remaining 25 aircraft and technology refresh of the six LRIP aircraft, with the corresponding production contract awarded on December 27, 2012. With the planned divestiture of seven E-3 aircraft in FY2019, only 18 of the remaining 25 aircraft will receive the AWACS Block 40/45 Upgrade, leaving a total of 24 upgraded aircraft in the fleet.

In FY2013, the program office began depot activation to procure test equipment, modules, training, repair documentation, and other items to support the E-3G. Funding is to support stand-up of the depot at Warner Robins Air Logistics Complex, Georgia, for repairs of selected units, and the Avionics Integration Support Facility at Tinker Air Force Base, Oklahoma to perform mission computing software maintenance activities.

For FY2016, five aircraft are planned to commence modification and three aircraft that began modifications in FY2015 are expected to be delivered to operational units. Due to end of life issues for a majority of the programmatic COTS equipment, the program office will have to contract for engineering support to procure the last four Block 40/45 Upgrade kits as well as retrofit the six LRIP aircraft. The program office plans to award a contract to procure 10 modification kits, six to be used to retrofit the LRIP aircraft and the other four kits to modify the remaining Block 30/35 aircraft.

Next Generation Identification Friend or Foe (NGIFF)

The Next Generation Identification Friend or Foe (NGIFF) program funds acquisition and retrofit of the E-3's IFF capability. The National Security Agency declared IFF Mode 4 unsecure and obsolete on November 5, 2003. NGIFF provides the E-3 with enhanced IFF interrogator operation to add IFF Mode 5 interrogation capability, as required by Joint Requirements Oversight Council Memo 047-07. While NGIFF did not meet initial operating capacity by the memo's target date of FY2014, the current projection of FY2016 is anticipated to meet current user expectations.

The program develops and integrates a basic Mode 5 capability on Block 30/35 aircraft which started in FY2008 and full Mode 5 on Block 40/45 aircraft which started in FY2011. Hardware will be common between the two types of block platforms. Production started in FY2012 after development of the Block 30/35 capability. Installation on Block 30/35 aircraft is planned to start in FY15. An Engineering Change Proposal is currently underway to modify the Block 40/45 units to fully integrate with NGIFF. NGIFF also integrates Mode S, a civilian air traffic control capability built into the hardware, as funding allows.

As NGIFF modifications conclude prior to the proposed FY2019 divesture of seven E-3s, all 31 aircraft are planned to receive the modification.

Training, Support, and Infrastructure (TSI)

The Training, Support, and Infrastructure (TSI) program provides continuing management support for AWACS modernization and enhancement. These activities include managing the AWACS Development Test and Evaluation (DT&E) infrastructure and tracking and monitoring AWACS training, support equipment, and program Government Furnished Property. The DT&E test infrastructure supports development, production, and sustainment projects and maintains facilities to support AWACS aircraft during system and sub-system testing at Boeing Field, Washington. Funding is shared between Research, Development, Test, and Evaluation (RDT&E) and production funds. The TSI assets also support Airborne Early Warning and Control projects for France, Saudi Arabia, United Kingdom, Japan, and the North Atlantic Treaty Organization (NATO) on a maintenance fee basis.

Key TSI programs include contract management of the AWACS Avionics Integration Laboratory integrated with the Block 40/45 configured Advanced Development Lab and the AWACS Radar Systems Integration Lab/Software Development Facility. These labs support U.S. and international customers with AWACS system and radar development, production, and sustainment. TSI also supports trainer/simulator upgrade analysis and requirements definition to ensure trainers and simulators are kept current with the AWACS baseline.

DMS Replacement of the Avionics for Global Operation and Navigation (DRAGON)

DMS Replacement of Avionics for Global Operations and Navigation (DRAGON) meets provides the E-3 fleet with the flight instruments and other avionics for the navigation performance and surveillance and communication capabilities required to meet international standards and maintain unrestricted access to global airspace. DRAGON replaces the existing Global Positioning System Integrated Navigation System with a modern flight management system that includes Mode 5 IFF and Joint Mission Planning System. The modification also adds data link communications, voice and data link digital radios, improved visual displays, and competitive acquisition of DRAGON flight simulators. According to the Air Force, employing COTS avionics is expected to lower cost, reduce the tech refresh cycle, and enhance life cycle management. The EMD phase of DRAGON is being executed as a cooperative program between the United States and NATO.

Electronic Protection (EP)

The Electronic Protection program provides improved radar processing in a specific flight environment to meet a classified requirement. EP installs an adjunct processor that works in parallel with the current Radar System Improvement Program (RSIP) system. The EP-processed radar picture appears on the battle manager's display in place of the current RSIP output when the EP radar modes are selected.

Internet Protocol Enabled Capability (IPEC)

The Internet Protocol Enabled Communication program provides the Block 40/45 E-3 with a medium-bandwidth IP communications capability to connect to the Global Information Grid and support net-centric operations/warfare. The modification provides a permanent INMARSAT-

based IP-enabled communications package supporting increased bandwidth SIPRNET and multi-domain networks.

Combat Identification (CID) Diminishing Manufacturing Sources

Current AWACS combat identification capability is based upon 1960's era technology that the Air Force says is no longer sustainable, requiring an update to retain a significant part of AWACS overall mission capability. The CID program addresses current shortfalls with a modernized, persistent Airborne Moving Target Indication BMC2 upgrade. The upgrade is designed to also provide better integration into Block 40/45 and NGIFF equipped AWACS aircraft.

Air Education and Training Command (AETC) Maintenance Training Devices (MTD) Upgrades – Field Training Detachments

This program supports fielding and installing modification kits for E-3 Maintenance Training Devices to keep them consistent with modifications made to the actual E-3.

Reliability, Maintainability, and Availability (RM&A) Modifications

RM&A modifications are designed to help fleet E-3 AWACS to maintain its mandated mission capable rate of 79%. Modifications include the purchase of aircraft kits, upgrading labs, installation, technical data and engineering support. RM&A modifications are intended to resolve issues or reduce maintenance burdens, resolve component obsolescence, or remove deactivated equipment.

Vertical Stabilizer and Rudder Modifications

This program funds minor modifications to the E-3 vertical stabilizer and rudder.

Low Cost Modifications – Airframe

This is a miscellaneous budget entry to anticipate urgent operational low cost mods that occur in the execution year and are necessary for continued operational support of Combatant Commanders.

Low Cost Modifications – Avionics & Mission Systems

This is also a miscellaneous budget entry to anticipate urgent operational low cost mods that occur in the execution year and are necessary for continued operational support of Combatant Commanders.

Aircraft Spares and Repair Parts

This program provides funding for repair parts for the E-3.

Command and Control, Intelligence, Surveillance, and Reconnaissance (C2ISR)

The Command and Control, Intelligence, Surveillance, and Reconnaissance program investigates improvements and develops future capabilities of the E-3 AWACS. These efforts include investigation, analysis, and development to help ensure that the E-3 AWACS successfully integrates with joint and coalition forces in a net-centric environment. C2ISR primarily supports pre-systems acquisition in the areas of materiel solution analysis and technology development. This is accomplished by prototyping and demonstrating new capabilities but also includes developing an E-3 Modernization & Sustainment Roadmap that projects user capability needs, as well as materiel solutions for the user needs.

Communications Network Upgrade

The Communications Network Upgrade program provides an upgrade to 20-year-old communication equipment that has sustainability, diminishing manufacturing sources, and capability issues. The Multifunctional Information Distribution System (MIDS) Radio System provides a Link 16 capability with high-jam-resistance, high-speed, crypto-secure computer-to-computer connectivity in support of every type of military platform from Air Force fighters to Navy submarines.

Table 6 is the FY2016 budget submission for E-3 Sentry AWACS procurement and E-3 Sentry AWACS research, development, test, and evaluation programs derived from Air Force budget justification books. It summarizes prior-year and estimated future-year expenditures for E-3 Sentry AWACS sustainment and modernization programs that are either recently completed or are currently in progress.

Table 6. Current E-3 AWACS Sustainment and Modernization Efforts

(in millions of dollars)

Procurement Items	Prior Years	Total Cost FY2014	Total Cost FY2015	Total Cost FY2016	Total Cost FY2017	Total Cost FY2018	Total Cost FY2019	Total Cost FY2020	Cost to Complete	Total Cost
Block 40/45 Upgrade[a]	543.807	114.439	191.284	183.308	226.429	103.643	58.221	29.533	—	1,450.664
Next Generation Identification Friend or Foe (NGIFF)	28.403	17.277	9.899	6.786	3.253	—	—	—	—	65.618
Training, Support, and Infrastructure (TSI)	10.270	2.845	3.335	4.015	3.902	3.716	4.044	4.165	—	36.292
Diminishing Manufacturing Sources Replacement of the Avionics for Global Operation and Navigation (DRAGON)	—	—	—	—	54.689	89.668	86.344	117.856	—	348.557
Electronic Protection (EP)	—	—	—	—	1.288	11.960	12.930	11.870	—	38.048
Internet Protocol Enabled Capability (IPEC)	—	—	—	—	12.961	9.263	17.904	5.488	—	45.616
Combat Identification (CID) Diminishing Manufacturing Sources (DMS)	—	—	—	—	—	—	4.491	14.268	—	18.759
Air Education and Training Command (AETC) Maintenance Training Device (MTD) Upgrades – Field Training Detachments	4.916	0.100	0.608	0.687	0.693	0.706	0.719	0.731	—	9.160
Reliability, Maintainability, and Availability Modifications	15.216	3.590	2.266	0.825	0.668	0.320	0.095	0.505	—	23.485
Vertical Stabilizer and Rudder Modifications	0.077	0.238	0.107	0.665	0.287	0.135	0.018	—	—	1.527
Low Cost Modifications – Airframe	0.100	0.012	0.138	0.100	0.100	0.031	—	—	—	0.481
Low Cost Modifications – Avionics & Mission Systems	0.100	0.012	0.138	0.100	0.100	0.031	—	—	—	0.481
Aircraft Spares and Repair Parts	—	11.681	2.957	16.234	23.806	22.682	24.132	24.552	—	126.044
Total Procurement Items	**602.889**	**150.194**	**210.732**	**212.720**	**328.176**	**242.155**	**208.898**	**208.968**	—	**2,164.732**

RDT&E Items	Prior Years	Total Cost FY2014	Total Cost FY2015	Total Cost FY2016	Total Cost FY2017	Total Cost FY2018	Total Cost FY2019	Total Cost FY2020	Cost to Complete	Total Cost
Block 40/45 Upgrade	—	11.268	—	—	—	—	—	—	—	—
Next Generation Identification Friend or Foe (NGIFF)	—	21.554	1.500	—	—	—	—	—	—	—
Training, Support, and Infrastructure (TSI)	—	8.371	11.472	11.139	—	—	—	—	—	—
Diminishing Manufacturing Sources Replacement of the Avionics for Global Operation and Navigation (DRAGON)	—	89.482	129.150	88.277	—	—	—	—	—	—
Electronic Protection (EP)	—	9.882	18.604	26.092	—	—	—	—	—	—
Internet Protocol Enabled Capability (IPEC)	—	—	16.575	13.974	—	—	—	—	—	—
Combat Identification (CID) Diminishing Manufacturing Sources (DMS)	—	—	—	9.435	—	—	—	—	—	—
Command and Control, Intelligence, Surveillance, and Reconnaissance (C2ISR)	—	2.847	3.503	3.608	—	—	—	—	—	—
Communications Network Upgrade	—	—	—	9.287	—	—	—	—	—	—
Total RDT&E Items	**3,706.552**	**143.404**	**180.804**	**161.812**	**108.766**	**82.371**	**100.371**	**110.466**	**—**	**—**

Source: Prepared by CRS based on justification books for Air Force procurement accounts and Air Force research, development, test, and evaluation accounts for FY2016 and prior years.

a. Procurement funding for the Block 40/45 Upgrade was previously contained in Weapon System Code (WSC) E00300, but as part of the Major Programs Transparency Act and starting in FY2015, the AWACS Block 40/45 Upgrade was moved to WSC E34045. Prior year funding remains in WSC E00300. The numbers in this table summarize spending in both WSCs.

Previous E-3 Recapitalization Efforts

E-10 Program

See "Previous E-8C Recapitalization Efforts" section for a brief discussion of a previous E-3 recapitalization effort under the E-10 program.

Current E-3 Recapitalization Efforts

Air Force budget documents do not specify a plan to recapitalize the E-3 in the near term. The Air Force is focusing on modernizing the E-3 to the E-3G variant (Block 40/45 Upgrade) which is expected to be completed by 2020.

RC-135 Family of Aircraft

The RC-135 program consists of three unique models of 22 operational aircraft including 17 RC-135V/W RIVET JOINT, 2 RC-135U COMBAT SENT, and 3 RC-135S COBRA BALL.[40] In addition, there are three TC-135W aircraft used for training and one NC-135W used for testing[41] for the RC-135V/W RIVET JOINT. All operational and training RC-135 aircraft are assigned to the 55th Wing, Offutt Air Force Base, Nebraska.[42]

A 2008 RC-135 viability assessment reported that despite the fleet average airframe age of 44 years and total of 38,000 flight hours as of the end of FY2007, the RC-135 should be able to continue to meet the Combatant Commanders' needs through at least 2040. The viability assessment also summarized that the RC-135 fleet has experienced significant improvements in reliability, maintainability, and availability since FY2001.

[40] Unlike the E-3 Sentry or E-6 Mercury, these RC-135 variants carry the names of the programs under which they were originally developed. Although the names are not acronyms, they are typically rendered in all-capitals, and CRS has retained that style.

[41] Department of Defense, *Model Designation of Military Aerospace Vehicles*, DOD Directive 4120.15-L, May 12, 2004, p. 29.

[42] U.S. Air Force RC-135V/W RIVET JOINT Factsheet, May 23, 2012, at http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104608/rc-135vw-rivet-joint.aspx, U.S. Air Force RC-135U COMBAT SENT Factsheet, February 14, 2005, at http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104495/rc-135u-combat-sent.aspx, U.S. Air Force RC-135S COBRA BALL Factsheet, February 16, 2012, at http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104498/rc-135s-cobra-ball.aspx, "2014 Air Force Almanac," *Air Force Magazine*, May 2014, pp. 79-80.

RC-135V/W RIVET JOINT[43]

Figure 4. RC-135V/W RIVET JOINT

Source: U.S. Air Force official website, RC-135V/W RIVET JOINT Factsheet, May 23, 2012, at http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104608/rc-135vw-rivet-joint.aspx.

The RC-135V/W RIVET JOINT reconnaissance aircraft supports theater and national level leaders with near real time on-scene intelligence collection, analysis, and dissemination capabilities. The aircraft is an extensively modified C-135. Those modifications are primarily related to its on-board sensor suite, which allows the mission crew to detect, identify, and geolocate signals throughout the electromagnetic spectrum. The mission crew can forward information in a variety of formats via an extensive communications suite. The interior seats more than 30 people, including the cockpit crew, electronic warfare officers, intelligence operators, and in-flight maintenance technicians.

The current RC-135 fleet is the latest iteration of modifications to this pool of C-135 aircraft going back to 1962. RIVET JOINT achieved initial operating capability in January 1964. According to Air Force data, the average age of the RC-135V RIVET JOINT is 49.8 years, the

[43] Information for this section is from U.S. Air Force RC-135V/W RIVET JOINT Factsheet, May 23, 2012, at http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104608/rc-135vw-rivet-joint.aspx unless noted.

RC-135W RIVET JOINT is 51.8 years, the TC-135W trainer aircraft is 52.1 years, and the NC-135W test aircraft is 52.3 years.[44]

RC-135U COMBAT SENT[45]

Figure 5. RC-135U COMBAT SENT

Source: U.S. Air Force official website, RC-135U COMBAT SENT Factsheet, February 14, 2005, at http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104495/rc-135u-combat-sent.aspx.

The RC-135U COMBAT SENT provides strategic electronic reconnaissance information to national leaders and theater commanders. The COMBAT SENT locates, identifies, collects, and examines foreign military land, naval, and airborne radar signals, providing strategic analysis. Collected data is stored for further analysis by electronic systems theorists and the intelligence community. Information garnered from the data helps determine detailed operating characteristics and capabilities of foreign systems. Evasion techniques and equipment are then developed from this knowledge to detect, warn of, or defeat these electronic systems.

The RC-135U COMBAT SENT is composed of a wide variety of commercial-off-the-shelf and proprietary hardware and software. The current configuration allows for both manual and automatic analysis of electronic signals. Communication equipment includes high frequency, very high frequency, and ultra-high frequency radios. The navigation equipment incorporates ground navigation radar, a solid state Doppler system, and an inertial navigation system that merges

[44] "Aircraft Assets & Availability," *Air Force Times*, October 20, 2014, p. 19.

[45] Information for this section is from U.S. Air Force RC-135U COMBAT SENT Factsheet, February 14, 2005, at http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104495/rc-135u-combat-sent.aspx unless noted.

celestial observations and Global Positioning System data. Although the flight crew stations are similarly configured, the reconnaissance equipment is slightly unique within each airframe. The aircraft are identified by their distinctive antennae arrays on the "chin" and wing tips, large cheek fairings, and extended tail. All RC-135U COMBAT SENT aircraft are equipped with an aerial refueling system, theoretically yielding unlimited flying range.

COMBAT SENT crews include two pilots, one navigator, two airborne systems engineers, at least ten electronic warfare officers, and at least six electronic, technical, and area specialists.

Initial operating capability was in April 1964. According to Air Force data, the average age of the RC-135U COMBAT SENT is 49.5 years.

RC-135S COBRA BALL[46]

Figure 6. RC-135S COBRA BALL

Source: U.S. Air Force official website, RC-135S COBRA BALL Factsheet, February 16, 2012, at http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104498/rc-135s-cobra-ball.aspx.

Equipped with a sophisticated array of optical and electronic sensors, recording media, and communications equipment, the RC-135S COBRA BALL collects optical and electronic data on ballistic missile targets. Its operators track and monitor missiles during boost and re-entry phases to provide reconnaissance for treaty verification and theater ballistic missile proliferation.[47] This data is also used to develop U.S. missile defense concepts.

COBRA BALL crews include two pilots, one navigator, three electronic warfare officers, two airborne systems engineers, and two or more airborne mission specialists.

[46] Information for this section is from U.S. Air Force RC-135S COBRA BALL Factsheet, February 16, 2012, at http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104498/rc-135s-cobra-ball.aspx unless noted.

[47] "2014 Air Force Almanac," *Air Force Magazine*, May 2014, pp. 79-80.

The current RC-135S aircraft trace their lineage to C-135 aircraft originally modified in 1961. Initial operating capability for the RC-135S COBRA BALL was in March 1972. According to Air Force data, the average age of the RC-135S COBRA BALL is 52.3 years.

Current RC-135 Sustainment and Modernization Efforts[48]

As the most numerous variant, the RC-135V/W RIVET JOINT drives the integration and modification upgrade strategy for the entire RC-135 fleet. The majority of the modification budget is directly related to RIVET JOINT baseline strategy enhancements which subsequently transfer into follow-on enhancements for COBRA BALL and COMBAT SENT.

The RC-135 program aims to maintain collection parity with evolving and emerging adversarial weapons systems used by state and non-state actors. The baseline upgrade strategy requires purchase agreements for long-lead items that take approximately 12 months from contract award to delivery. Items contracted for purchase and integration in a given baseline upgrade are bought in the first year of the procurement funding cycle and are installed in the subsequent year. According to the Air Force, this acquisition strategy has been successful in maintaining combat capability in the ISR arena over the last 40 years.

The following RC-135 sustainment and modernization initiatives, currently in the program of record, are either recently completed or are currently in progress. Additional information on each effort is detailed in the following sections:

- RIVET JOINT Baseline Modification;
- COMBAT SENT Baseline Modification;
- COBRA BALL Baseline Modification;
- Aircraft Spares and Repair Parts;
- Defense Airborne Recce Projects (DARP) RC-135;
- Baseline Configuration Development; and
- Airborne SIGINT Development - RC-135 RIVET JOINT.

RIVET JOINT Baseline Modification

Current modernization efforts concentrate on completing the integration and fielding efforts of the RIVET JOINT's Baseline 11 and initial integration of Baseline 12. Baseline 11 subsystem upgrades consist of precision multi-angle direction finding communications intelligence (DF COMINT) capability, electronic intelligence (ELINT) recorder expansion, precision ELINT digital SIGINT system integration, Wideband Global Satellite (WGS) enhanced integration, increased near real time national tactical integration, continued cockpit avionics enhancements to include addressing any obsolescence issues, new steerable beam antenna, weight reduction phase

[48] Information for current RC-135 sustainment and modernization efforts derived from justification books for Air Force procurement accounts and research, development, test, and evaluation accounts for FY2016 and prior years unless noted. Previous modernization efforts are not included in this report.

3, improved operator interface and reporting tools, and enhancing capabilities in dense signal environments.

Baseline 12 subsystem upgrades consist of increased digital signal exploitation, increased digital signal recorder bandwidth, enhanced spatial processing/exploitation, enhanced weather radar, digitally enhanced electronic flight instrument system, AF-DCGS interoperability, operator work station 3-D map projection, enhanced operator reporting management tools, modernized communications security protocols, and new steerable beam antenna.

COMBAT SENT Baseline Modification

Current COMBAT SENT modernization efforts focus on Baseline 5 enhancements. Baseline 5 subsystem upgrades consist of WGS reachback connectivity, precision ELINT systems replacement, liquid cooling system, super wideband receiver, airborne tracking system, improved operator interface and reporting tools, integration of the RIVET JOINT Baseline 11 COMINT suite, and enhancing capabilities in dense signal environments. COMBAT SENT Baseline 5 configurations most closely align with the RIVET JOINT Baseline 11 configuration.

COBRA BALL Baseline Modification

Current COBRA BALL modernization efforts also focus on the same Baseline 5 enhancements as COMBAT SENT.

Aircraft Spares and Repair Parts

This program provides funding for repair parts for the RC-135 family of aircraft.

Defense Airborne Recce Projects (DARP) RC-135

Detailed information on the Defense Airborne Recce Projects RC-135 program remains classified. This program is reported in accordance with Title 10, U.S. Code, Section 119(a)(1) in the Special Access Program Annual Report to Congress.

Baseline Configuration Development

RC-135 operational systems development and enhancement activities support the design studies, engineering analysis, non-recurring engineering, and other efforts associated with integrating and modifying the RC-135s and their specialized mission systems, both air and ground. The program seeks to use COTS based solutions and mitigate the impact of Diminishing Manufacturing Sources (DMS)/Vanishing Vendor Items.

In FY2016, this program plans to support the RIVET JOINT Baseline 12 and 13, COMBAT SENT Baseline 5, and COBRA BALL Baseline 5 configurations.

RIVET JOINT Baseline 13 upgrades consist of, but are not limited to, providing a continuous recording capability, Super Wideband Compressive Receiver and Nyquist Folding Receiver, global air traffic management avionics upgrades (e.g., new autopilot), Mode 5 IFF system, and

family of beyond-line-of-sight terminals advanced extremely high frequency communications suite.

Airborne SIGINT Development - RC-135 RIVET JOINT

The Airborne SIGINT Development - RC-135 RIVET JOINT program supports design studies, engineering analysis, non-recurring engineering, and other efforts associated with the integration and modification of the RC-135 SIGINT sensors and their associated air and ground components. The program seeks COTS-based solutions to field needed capabilities. Funding is split among the RC RIVET JOINT, COMBAT SENT, and COBRA BALL programs. Funding reflects the SIGINT Capabilities Working Group priorities and the accomplishment of other Airborne SIGINT Enterprise initiatives.

Table 7 is the FY2016 budget submission for RC-135 procurement and RC-135 research, development, test, and evaluation programs derived from Air Force budget justification books. It summarizes prior-year and estimated future-year expenditures for RC-135 sustainment and modernization programs that are either recently completed or are currently in progress.

Table 7. Current RC-135 Sustainment and Modernization Efforts

(in millions of dollars)

Procurement Items	Prior Years	Total Cost FY2014[a]	Total Cost FY2015[b]	Total Cost FY2016	Total Cost FY2017	Total Cost FY2018	Total Cost FY2019	Total Cost FY2020	Cost to Complete	Total Cost
RIVET JOINT Baseline Modification	—	154.940	146.745	143.388	186.270	189.421	172.665	175.773	—	1,169.202
COMBAT SENT Baseline Modification	—	10.444	10.539	6.633	6.728	6.893	6.834	6.957	—	55.028
COBRA BALL Baseline Modification	—	9.129	6.062	6.144	6.325	6.537	6.776	6.898	—	47.871
Aircraft Spares and Repair Parts	—	28.280	57.119	54.016	48.632	49.407	50.331	51.237	—	339.022
Defense Airborne Recce Projects (DARP) RC-135	—	20.577	24.710	25.072	25.496	25.933	26.393	26.861	—	175.042
Total Procurement Items	—	**223.370**	**245.175**	**235.253**	**273.451**	**278.191**	**262.999**	**267.726**	—	**1,786.165**
RDT&E Items	**Prior Years**	**Total Cost FY2014**	**Total Cost FY2015**	**Total Cost FY2016**	**Total Cost FY2017**	**Total Cost FY2018**	**Total Cost FY2019**	**Total Cost FY2020**	**Cost to Complete**	**Total Cost**
Baseline Configuration Development	—	13.491	13.516	13.245	14.184	14.366	14.462	14.720	Continuing	Continuing
Airborne SIGINT Development - RC-135 RIVET JOINT	—	32.556	15.007	41.846	23.152	43.611	51.430	58.353	Continuing	Continuing
COBRA BALL[c]	—									
Total RDT&E Items	—	**46.047**	**28.523**	**55.091**	**37.336**	**57.977**	**65.892**	**73.073**	**Continuing**	**Continuing**

Source: Prepared by CRS based on justification books for Air Force procurement accounts and Air Force research, development, test, and evaluation accounts for FY2016 and prior years.

a. FY2014 funding totals includes an Overseas Contingency Operations (OCO) add of $2.7M for X-Net integration.

b. FY2015 funding totals includes a Congressional Add of $10.6M for baseline modernization shortfalls.

c. RDT&E budget exhibits for this program were not available due to classification.

Previous RC-135 Recapitalization Efforts

E-10 Program

See "Previous E-8C Recapitalization Efforts" section for a brief discussion of a previous RC-135 recapitalization effort under the E-10 program.

Current RC-135 Recapitalization Efforts[49]

The RIVET JOINT Baseline 11 and 12 integration efforts address the 2012 RC-135 Multi-Attribute Utility Assessment (MUA) that detailed operational effectiveness, cost, and program analyses of the alternative weapon system configurations. The MUA determined that retaining and sustaining the RC-135V/W airframe offers the highest assessed weapons system utility (measured as a benefit of cost-to-risk ratio) over the 25-year assessment period.

[49] Information for current RC-135 recapitalization efforts derived from justification books for Air Force procurement accounts and research, development, test, and evaluation accounts for FY2016 and prior years unless noted.

WC-135 Constant Phoenix[50]

Figure 7. WC-135 Constant Phoenix

Source: U.S. Air Force official website, WC-135 Constant Phoenix Factsheet, May 27, 2005, at http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104494/wc-135-constant-phoenix.aspx.

The WC-135 Constant Phoenix atmospheric collection aircraft supports national leaders by collecting particulate and gaseous effluents and debris to detect nuclear weapons testing and detonations from accessible regions of the atmosphere.

General Dwight D. Eisenhower commissioned the Constant Phoenix program on September 16, 1947, when he charged the Army Air Forces with the overall responsibility for detecting atomic explosions anywhere in the world. In September 1949, a WB-29 flying between Alaska and Japan detected nuclear debris from Russia's first atomic test, an event thought not possible until mid-1950. Beginning in August 1950, WB-50 aircraft were converted for the air-sampling mission over a two-year period. WC-135 aircraft began replacing the WB-50s in December 1965 and became the workhorse of the atmospheric collection program.

Currently, the air-sampling mission supports the Limited Nuclear Test Ban Treaty of 1963, which prohibits any nation from above ground nuclear weapons testing. WC-135s are currently the only aircraft in the inventory conducting air-sampling operations.

[50] Information for this section is from U.S. Air Force WC-135 Constant Phoenix Factsheet, May 27, 2005, at http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104494/wc-135-constant-phoenix.aspx unless noted.

The aircraft is a modified C-135B or EC-135C platform. The Constant Phoenix's modifications are primarily related to its on-board atmospheric collection suite, which allows the mission crew to detect radioactive "clouds" in real time. The aircraft is equipped with external flow-through devices to collect particulates on filter paper and a compressor system for whole air samples collected in holding spheres. There are two versions of the WC-135, a WC-135C and a WC-135W, with one of each version in the active inventory. According to Air Force data, the age of the WC-135C is 50.2 years and the age of the WC-135W is 52.3 years.

The aircraft and cockpit crew are assigned to the 55th Wing while the special equipment operators are assigned to Detachment 1, Air Force Technical Applications Center, both located at Offutt Air Force Base, Nebraska.

Current WC-135 Sustainment and Modernization Efforts[51]

Air Force budget documents do not specify a plan to modernize the WC-135 Constant Phoenix aircraft in the near term.

Current WC-135 Recapitalization Efforts[52]

Air Force budget documents do not specify a plan to recapitalize the WC-135 Constant Phoenix aircraft in the near term.

[51] Information for current WC-135 sustainment and modernization efforts derived from justification books for Air Force procurement accounts and research, development, test, and evaluation accounts for FY2016 and prior years unless noted. Previous modernization efforts are not included in this report.

[52] Information for current WC-135 recapitalization efforts derived from justification books for Air Force procurement accounts and research, development, test, and evaluation accounts for FY2016 and prior years unless noted.

OC-135B Open Skies[53]

Figure 8. OC-135B Open Skies

Source: U.S. Air Force official website, OC-135B Open Skies Factsheet, February 1, 2001, at http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104496/oc-135b-open-skies.aspx.

The OC-135B Open Skies Observation Aircraft supports the Open Skies Treaty.[54] The aircraft flies unarmed observation flights over participating parties of the treaty.

[53] Information for this section is from U.S. Air Force OC-135B Open Skies Factsheet, February 1, 2001, at http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104496/oc-135b-open-skies.aspx unless noted.

[54] The Treaty on Open Skies was first proposed by President Eisenhower to the former Union of Soviet Socialist Republics at the Geneva Conference of 1955. In the context of the Cold War, this bilateral proposal was rejected by the Soviet Union and lay dormant for a generation. In May 1989, Open Skies was proposed as an instrument of confidence building, which would promote and consolidate the international trends toward openness already in progress. Formal negotiations on a Treaty on Open Skies began in Ottawa in February 1990, and continued in Budapest in April and May 1990. At that time, however, the Soviet Union was still not prepared to open all of its territory to aerial observation. Following the stalemate at Ottawa and Budapest, the Open Skies negotiations lapsed for over a year, although the United States and others continued to press the issue bilaterally. After the abortive coup in Moscow in August 1991 the former Soviet Union changed its position and agreed to open all of its territory for aerial observation. This change cleared the way for productive negotiations, which commenced in November 1991 in Vienna, leading to the signing of the Treaty in Helsinki on March 24, 1992. The Treaty on Open Skies is designed to enhance mutual understanding and confidence by giving all participating countries, regardless of size, a direct role in gathering information about military forces and activities of concern to them. The Treaty on Open Skies is based on complete territorial openness, on the use of unarmed observation aircraft, on sensors on board those aircraft, and on quotas of observation flights which each participating country is willing to accept, and entitled to conduct, annually. (Source: Department of State, *Letter of Submittal - Treaty on Open Skies*, August 12, 1992, http://www.state.gov/t/avc/trty/102337.htm#submittal.)

The aircraft are modified WC-135Bs dating from the early 1960s. One aircraft was converted to an OC-135B in October 1993. Two additional operational OC-135B aircraft were delivered in 1996 and remain the in the active inventory. The original OC-135B is in permanent storage at the Aircraft Maintenance and Regeneration Center at Davis Monthan Air Force Base, Arizona. According to the Air Force, the average age of the OC-135B Open Skies is 52.3 years.

Since the primary mission of the OC-135B is to take pictures, most of the installed equipment and systems provide direct support to the cameras and the camera operator. Cameras installed include one vertical and two oblique KS-87E framing cameras used for low-altitude photography (approximately 3,000 feet above the ground) and one KA-91C panoramic camera, which scans from side to side to provide a wide sweep for each picture (used for high altitude photography at approximately 35,000 feet). The interior seats 35 people, including the cockpit crew, aircraft maintenance crew, foreign country representatives, and crew members from the Department of Defense's Defense Threat Reduction Agency (DTRA).

The integrated data annotation and recording system processes navigational, altitude, time, and camera signals to annotate each picture with correct position, altitude, time, roll angle, and other information. In addition, this system records every picture taken according to camera, frame, and navigational position. Two Barco 12-inch VGA color monitors display camera annotation and other camera data on screen for the sensor operator and observer use.

The OC-135B Open Skies aircraft are assigned to Air Combat Command's 55th Wing, Offutt Air Force Base, Nebraska for operations, training, and maintenance. When tasked, Air Combat Command's role is to transport a DTRA observation team to an Open Skies point of entry airport, conduct the observation flight, then return the team to the continental United States.

Current OC-135B Sustainment and Modernization Efforts[55]

There is one sustainment and modernization initiative currently in progress in the OC-135B program of record.

OC-135 Open Skies Sensors

The Open Skies Sensors program addresses the requirements in Presidential Policy Directive-15 (PPD-15), which on March 1, 2012 directed an upgrade to the sensors on the current aircraft by replacing film-based cameras with available electro-optical sensors. Current film cameras are nearly obsolete, unreliable, hard and increasingly expensive to maintain, and repair parts must be individually manufactured. In addition, film manufacturers are discontinuing production of the film stock. The ultimate imagery product customer also desires digital format products.

This camera replacement program will replace the wet film cameras with modern, digital cameras expected to be more reliable, maintainable, and cost effective. The customer should be able to more readily use the imagery products and equipment service life is expected to be extended significantly.

[55] Information for current OC-135B sustainment and modernization efforts derived from justification books for Air Force procurement accounts and research, development, test, and evaluation accounts for FY2016 and prior years unless noted. Previous modernization efforts are not included in this report.

Table 8 is the FY2016 budget submission for OC-135B research, development, test, and evaluation programs derived from Air Force budget justification books. It summarizes prior-year and estimated future-year expenditures for OC-135 sustainment and modernization programs that are either recently completed or are currently in progress.

Table 8. Current OC-135B Sustainment and Modernization Efforts

(in millions of dollars)

RDT&E Items	Prior Years	Total Cost FY2014	Total Cost FY2015	Total Cost FY2016	Total Cost FY2017	Total Cost FY2018	Total Cost FY2019	Total Cost FY2020	Cost to Complete	Total Cost
OC-135 Open Skies Sensors	—	1.430	13.222	12.137	4.892	—	—	—	Continuing	Continuing
Total RDT&E Items	**—**	**1.430**	**13.222**	**12.137**	**4.892**	**—**	**—**	**—**	**Continuing**	**Continuing**

Source: Prepared by CRS based on justification books for Air Force procurement accounts and Air Force research, development, test, and evaluation accounts for FY2016 and prior years.

Current OC-135B Recapitalization Efforts[56]

Air Force budget documents do not specify a plan to recapitalize the OC-135B Open Skies aircraft in the near term.

E-6B Mercury[57]

Figure 9. E-6B Mercury

Source: U.S. Navy official website, at http://www.navair.navy.mil/img/uploads/E-6B%20fly%201.JPG.

The E-6B Mercury is communications relay and strategic airborne command post aircraft. The E-6B provides airborne command, control, and communications between the National Command Authority (NCA) and U.S. strategic and non-strategic forces. The E-6 replaced the aging EC-130Q in the performance of the Navy's TACAMO ("Take Charge and Move Out") mission. TACAMO links the NCA with naval ballistic missile forces during times of crisis. The aircraft carries a very low frequency communication system with dual trailing wire antennas.

Boeing derived the E-6A from its commercial 707-320 aircraft. The E-6A was assembled on the same production line as the E-3 Sentry AWACS. The Navy awarded Boeing a full-scale

[56] Information for current OC-135B recapitalization efforts derived from justification books for Air Force procurement accounts and research, development, test, and evaluation accounts for FY2016 and prior years unless noted.

[57] Information for this section is from U.S. Navy E-6B Mercury Fact File, February 17, 2009, at http://www.navy.mil/navydata/fact_display.asp?cid=1100&tid=800&ct=1 unless noted.

development contract for the E-6A in 1983 and the prototype E-6A rolled out from Boeing's Renton, Washington factory in December 1986. The first flight was in February 1987. The Navy accepted the first E-6A in August 1989 and the final airplane in May 1992.[58] The Navy E-6Bs were the last 16 aircraft to roll off of Boeing's 707 assembly line after 30 years of production.[59]

The E-6B version was conceived as a replacement for the Air Force's Airborne Command Post due to the age of the EC-135 fleet. The E-6B modified an E-6A by adding battlestaff positions and other specialized equipment. The E-6B is a dual-mission aircraft capable of fulfilling either the E-6A mission or the airborne strategic command post mission and is equipped with an airborne launch control system, capable of launching U.S. land based intercontinental ballistic missiles. The first E-6B aircraft was accepted in December 1997 and the E-6B assumed its dual operational mission in October 1998. The E-6 fleet was completely modified to the E-6B configuration in 2003.

There are 16 aircraft in the E-6B fleet. The E-6B has a normal crew of 13 members (three pilots, two naval flight officers, and eight enlisted aircrew) and a battlestaff crew of 22. All E-6B aircraft are assigned to Strategic Communications Wing One (SCW-1) at Tinker Air Force Base, Oklahoma.[60]

Current E-6B Sustainment and Modernization Efforts[61]

The following E-6B sustainment and modernization initiatives, currently in the program of record, are either recently completed or are currently in progress. Additional information on each effort is detailed in the following sections:

- Safety Deficiencies;
- Tech Insertion;
- Service Life Extension Program (SLEP);
- Communications Upgrade;
- Block I;
- Multi-Role Tactical Common Data Link (MR-TCDL);
- Auxiliary Power Unit (APU);
- Family of Advanced Beyond-Line-of-Sight Terminals/Presidential and National Voice Conferencing (FAB-T/PNVC);
- Common Ground Equipment; and
- Navy Strategic Communications Project.

[58] Boeing, *Airborne Early Warning Systems History*, at http://www.boeing.com/boeing/history/boeing/airborne.page.

[59] U.S. Navy Website, VQ-4, accessed March 27, 2014, at http://www.tacamo.navy.mil/vq4/vq4_home.html.

[60] U.S. Navy Website, E-6B Mercury Factsheet, accessed March 27, 2014, at http://www.tacamo.navy.mil/factsheets.html.

[61] Information for current E-6B sustainment and modernization efforts derived from justification books for Navy procurement accounts and research, development, test, and evaluation accounts for FY2016 and prior years unless noted. Previous modernization efforts are not included in this report.

Safety Deficiencies

The Safety Deficiencies program is intended to correct high risk aircraft safety hazards to protect personnel and equipment. Federal agency directives, aging aircraft material condition, and the operational environment generate safety hazards for correction. Modifications under this program include Fuel Quantity Indicating System installation, aircraft acoustic thermal blankets replacement, Kapton wiring replacement, and other safety deficiencies that require correction.

Tech Insertion

The Tech Insertion program seeks to correct aircraft obsolescence, supportability, weight management, and interoperability deficiencies through new technology insertion. Modifications under this program include CRYPTO modernization, brakes, seats, glare shield, High Power Transmit Set (HPTS) and the HPTS Camera, Automated Dependent Surveillance Broadcast, High Frequency Automatic Link Establishment, Common Very Low Frequency Receiver, Communication Navigation and Surveillance Air Traffic Management, Missions Operation Monitor, aircraft electrical system, Airborne Launch Control System (ALCS), and other tech insertion corrections.

Service Life Extension Program (SLEP)

The Service Life Extension Program (SLEP) extends the service life of the aircraft to at least 2040 through airframe strengthening and structural data recording and analysis. This program also includes just in time modifications to prevent aircraft grounding due to fatigue life expended. Modifications under this program include Individual Aircraft Tracking System and Crash Survivable Flight Incident Recorder Phase 2.

Communications Upgrade

The Communications Upgrade program installs expanded aircraft communication bandwidth capability required to improve Airborne Command Post (ABNCP) operations. Modifications under this program include Internet Protocol (IP) Phase 1 connectivity and wideband communication capability to enable voice, video, and data services, International Marine/Maritime Satellite (INMARSAT), IP Phase 3, and removal of Utility Trailing Wire Antenna.

Block I

The Block I program aims to correct ABNCP operational test deficiencies to improve mission capability, readiness, and legacy system obsolescence. Modifications under this program include Block I, Very Low Frequency Transmit Terminal, and technology upgrade.

Multi-Role Tactical Common Data Link (MR-TCDL)

The Multi-Role Tactical Common Data Link (MR-TCDL) program installs expanded aircraft communication bandwidth capability required to interoperate with U.S. Strategic Command's National Command and Control Architecture.

Auxiliary Power Unit (APU)

The Auxiliary Power Unit program installs an improved APU to meet increased aircraft power requirements.

Family of Advanced Beyond-Line-of-Sight Terminals/Presidential and National Voice Conferencing (FAB-T/PNVC)

The Family of Advanced Beyond-Line-of-Sight Terminals/Presidential and National Voice Conferencing (FAB-T/PNVC) program replaces obsolete Military Strategic Tactical Relay terminals with improved FAB-T, and installs PNVC to provide specialized secure voice capability over the strategic Advanced Extremely High Frequency satellite communications system.

Common Ground Equipment

The Common Ground Equipment program funds procurement of Automatic Test Equipment, various aircraft systems trainers and training aids, support equipment for the Rapid Deployment Force, mobile maintenance facilities for Marine expeditionary forces, and other aircraft ground support equipment that is either peculiar to out-of-production aircraft or applicable to more than one aircraft. This program will also provide a Windows 7 upgrade to correct obsolescence issues.

Navy Strategic Communications Project

The Navy Strategic Communications Project responds to emerging E-6B Airborne Strategic Command, Control, and Communications capability requirements by performing technical evaluations, modeling and simulation, investigative ground and flight testing, enhanced software modifications, and development of configuration modifications. Funding was added starting in FY2015 for advanced development engineering and analysis of hardware and software required to optimize E-6B systems for interoperability in a network-centric strategic environment. These efforts support follow-on aircraft modifications.

Table 9 is the FY2016 budget submission for E-6B procurement and E-6B research, development, test, and evaluation programs derived from Navy budget justification books. It summarizes prior-year and estimated future-year expenditures for E-6B sustainment and modernization programs that are either recently completed or are currently in progress.

Table 9. Current E-6B Sustainment and Modernization Efforts

(in millions of dollars)

Procurement Items	Prior Years	Total Cost FY2014	Total Cost FY2015	Total Cost FY2016[a]	Total Cost FY2017	Total Cost FY2018	Total Cost FY2019	Total Cost FY2020	Cost to Complete	Total Cost
Safety Deficiencies	74.990	3.687	3.355	2.831	2.897	2.210	2.656	1.907	—	94.533
Tech Insertion	122.261	13.820	18.798	8.062	18.747	51.437	122.294	117.295	272.625	745.339
Service Life Extension Program (SLEP)	72.427	22.079	13.769	17.582	4.413	3.551	7.985	9.115	26.564	177.485
Communications Upgrade	177.217	18.828	21.410	15.231	17.311	9.122	—	—	—	259.119
Block I	250.002	65.014	81.251	47.535	54.834	24.526	—	—	—	523.162
Multi-Role Tactical Common Data Link (MR-TCDL)	54.981	23.778	33.579	48.568	54.170	40.765	15.568	—	—	271.409
Auxiliary Power Unit (APU)	5.129	10.332	7.969	20.567	27.801	24.509	14.442	—	—	110.739
Family of Advanced Beyond-Line-of-Sight Terminals/Presidential and National Voice Conferencing (FAB-T/PNVC)	—	—	21.998	24.877	24.022	49.574	42.900	21.002	—	184.373
Common Ground Equipment	3.002	—	3.012	3.886	—	—	—	—	—	9.900
Total Procurement Items	**760.009**	**157.528**	**205.141**	**189.139**	**204.195**	**205.694**	**205.845**	**149.319**	**299.189**	**2,376.069**
RDT&E Items	**Prior Years**	**Total Cost FY2014**	**Total Cost FY2015**	**Total Cost FY2016**	**Total Cost FY2017**	**Total Cost FY2018**	**Total Cost FY2019**	**Total Cost FY2020**	**Cost to Complete**	**Total Cost**
Navy Strategic Communications Project	—	—	0.496	0.797	0.806	0.815	0.827	0.838	Continuing	Continuing
Total RDT&E Items	**—**	**—**	**0.496**	**0.797**	**0.806**	**0.815**	**0.827**	**0.838**	**Continuing**	**Continuing**

Source: Prepared by CRS based on justification books for Navy procurement accounts and Navy research, development, test, and evaluation accounts for FY2016 and prior years.

a. The FY2016 funding request was reduced by $9.635 million to account for the availability of prior year execution balances.

Current E-6B Recapitalization Efforts[62]

Navy budget documents do not specify a plan to recapitalize the E-6B Mercury aircraft in the near term. Through the Service Life Extension Program described above, the Navy plans to extend the service life of the aircraft to at least 2040.

Issues for Congress[63]

Potential for Shortfall in C2ISR Capabilities

As the current C2ISR force continues to age and shrink, and development of replacements for some aircraft begins, a potential oversight issue for Congress is whether current DOD plans to sustain, modernize, and/or recapitalize the Boeing 707-based C2ISR fleet may result in a shortfall in the nation's C2ISR capabilities. As discussed in the "Current E-8C Sustainment and Modernization Efforts" and "Current E-3 Sustainment and Modernization Efforts" sections, the Air Force proposed to divest five operational E-8C and seven operational E-3 aircraft to help fund recapitalization efforts for the E-8C and modernization efforts for the E-3. Congress temporarily prohibited the Air Force's proposed FY2015 E-8C and E-3 divesture plans in the National Defense Authorization Act for FY2015.[64] Specific to the E-8C, the FY2015 NDAA prohibited the Air Force from taking any action to retire or to prepare to retire operational JSTARS aircraft until 30 days after the Secretary of the Air Force submits a report to the congressional defense committees providing an update of the results of the analysis of alternatives for recapitalizing the JSTARS capability and an assessment of the cost and schedule of developing and fielding a new aircraft and radar system to replace the current JSTARS aircraft.[65]

DOD, Air Force, and Navy priorities

DOD has argued that it is challenged with reducing defense spending in accordance with the Budget Control Act of 2011, notwithstanding the possibility of further cuts through possible sequestration. At the same time, DOD's priorities require continued sustainment and modernization of aging aircraft to ensure support to combatant commanders until replacement systems come online in the coming decades. According to DOD's Annual Aviation inventory and Funding Plan for FY2015-FY2044:

> The Air Force is modernizing its legacy ISR and C4 fleet and is assessing alternatives with regard to procuring new platforms in the future. In the near-term the Air Force is committed to modernization of E-3B/C AWACS to the E-3G configuration involving advanced mission computing and avionics that ensure the long-term viability of joint airborne tactical command and control. The Air Force is completing an effort to address obsolescence issues

[62] Information for current E-6B recapitalization efforts derived from justification books for Navy procurement accounts and research, development, test, and evaluation accounts for FY2016 and prior years unless noted.

[63] Issues adapted from CRS Report R43049, *U.S. Air Force Bomber Sustainment and Modernization: Background and Issues for Congress*, by Jeremiah Gertler.

[64] P.L. 113-291, Sections 136 and 219. See the **Appendix** for full text.

[65] P.L. 113-291, Sections 219. See the **Appendix** for full text.

> with prime mission equipment onboard the E-8C JSTARS and has funded a program to recapitalize the E-8C JSTARS fleet. The Air Force will divest one E-8C JSTARS test aircraft in FY15 and five operational E-8C JSTARS aircraft in FY16. As the recapitalized JSTARS aircraft are added to the Air Force inventory (projected IOC is FY22), additional E-8Cs will be retired.[66]
>
> The E-6B Mercury derived from the Boeing 707 aircraft supports a flexible nuclear deterrent posture. Programmed mission system upgrades ensure the fleet remains on the cutting edge of full-spectrum communications supporting Nuclear Command, Control and Communications. The E-6B aircraft are expected to reach their 45,000 hours end of life January 2040. A replacement aircraft will be identified to meet anticipated requirements within the 30 years encompassed by this report. The final inventory objective is projected to be 17 aircraft.[67]

The Air Force's FY2016 Posture Statement presented to the Senate Committee on Appropriations, Subcommittee on Defense suggests a change in priorities compared to FY2015.

> The FY16 [President's Budget (PB)] request also reflects changes in the global landscape, buying back combat capabilities in areas where the Air Force accepted risk in the FY15 PB – the E-8, JSTARS, and F-15C. U-2 and E-3 AWACS divestment is re-phased to FY19, so we can continue to operate those platforms and meet combatant commanders' most urgent needs.[68]

According to the Air Force's FY2016 Budget Overview:

> In the FY 2016 budget request, the Air Force maintained capacity, increased investment in the Nuclear C2 enterprise, and pursued modernization critical to ensure a technologically dominant C2 capability in the current fight and future conflicts. This includes a refined acquisition strategy for the E-8 JSTARS recapitalization efforts [and] delaying the divestiture of five E-8C aircraft from FY 2016 to FY 2019.
>
> The Air Force retains modernization funding for the remaining Airborne Warning and Control System (AWACS) fleet, continuing to field the E-3G variant, enhancing the electronic protection capability of the E-3 radar, and equipping the platform with advanced tactical data links.
>
> In FY 2016, the Air Force continues funding E-8C Joint Surveillance Target Attack Radar System (JSTARS) recapitalization. The draft acquisition strategy was refined, restructuring the Technology Maturation Risk Reduction acquisition phase. Although this refinement addresses the program's top integration risks earlier in the program's life-cycle, it pushes the Initial Operational Capability out to FY 2023. To fund JSTARS recapitalization, the Air Force divested the E-8C test capability, including the T-3 test aircraft, and placed the E-8C on a force management to sunset profile with a retirement between FY 2025 - FY 2026.

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[66] Department of Defense, *Annual Aviation Inventory and Funding Plan: Fiscal Years (FY) 2015-2044*, p. 26. The divestiture plan stated in this document was amended in FY2016 budget planning based on congressional action. The FY2016 Annual Aviation Inventory and Funding Plan should account for this change but the document is not yet available.

[67] Ibid., pp. 26-27. The E-6 Mercury is not mentioned in the Navy's FY2016 Posture Statement or Budget Overview document.

[68] Department of the U.S. Air Force, *Fiscal Year 2016 Air Force Posture Statement*, Presented to the Senate Committee on Appropriations, Subcommittee on Defense, February 25, 2012, p. 8.

> Additionally, the Air Force will re-phase the E-3 AWACS divestiture of seven aircraft and AWACS Reserve Association Group from FY 2016 to FY 2019. This Total Force re-phase increases near-term capacity to meet highest-priority combatant commander needs while preparing for future fights.[69]

Will modernization efforts allow for delayed recapitalization efforts?

Another potential oversight issue for Congress is whether development of replacement C2ISR aircraft could be further delayed with sufficient funding for sustainment and modernization of legacy C2ISR aircraft. The Air Force has a current plan to recapitalize the E-8C. The other Air Force aircraft (E-3 and C-135 type) and the Navy E-6B are currently in a sustainment and modernization mode. According to Air Force and Navy budget documents, recapitalization of these other aircraft is not planned in the near term and previous engineering analysis shows their viability into at least 2040. Due to the current age of these aircraft and the plan to utilize them for an additional 25 years, some observers note that recapitalization has already been delayed due to sufficient modernization efforts and budget pressures.

Remotely Piloted Aircraft Considerations

Another potential oversight issue for Congress is to consider how much of the missions currently accomplished by the C2ISR aircraft based on the Boeing 707 might be accomplished by remotely piloted aircraft. Technology in the remotely piloted aircraft field has advanced tremendously in the last decade, which may allow for some missions areas currently accomplished by manned aircraft to shift to remotely piloted aircraft.[70]

Implications of Modernization and Recapitalization on Basing

Another potential oversight issue is the possible implications of reduced legacy C2ISR aircraft sustainment and modernization, and subsequent diminishing numbers of airframes, on any future rounds of base realignment and closure (BRAC). Although DOD repeatedly included requests for a new BRAC effort in recent years' budget submissions, Congress has not authorized any such closures or realignments. In the continental U.S., Boeing 707-based C2ISR aircraft are at three locations: Robins Air Force Base, Georgia for the E-8C; Tinker Air Force Base, Oklahoma for the E-3 and E-6B; and Offutt Air Force Base, Nebraska for the C-135 variants. There are also two overseas locations for the E-3. Unlike other aircraft that are stationed at multiple bases in the United States and have been consolidated at one base in previous BRAC rounds, the legacy C2ISR aircraft are already consolidated by aircraft type. Further consolidation by having multiple legacy C2ISR aircraft types at fewer locations is an option for consideration by future BRAC rounds, if they occur.

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[69] Department of the U.S. Air Force, *Fiscal Year 2016 Budget Overview*, prepared by the Secretary of the Air Force Office of Financial Management and Budget, February 2, 2015, pp. 8-9.

[70] For more information on remotely piloted aircraft capabilities, see CRS Report R42136, *U.S. Unmanned Aerial Systems*, by Jeremiah Gertler.

Industrial Base Concerns Associated with C2ISR Sustainment

Another potential oversight issue is the ability of the nation's industrial base to sustain the legacy C2ISR aircraft force. A potential problem with sustaining a fleet of aircraft of their age is that the industrial base that developed and produced these aircraft may no longer possess the capability to manufacture and supply parts in the necessary quantities to affordably keep these aircraft flying. All of these aircraft struggle with diminishing manufacturing sources and material shortages in an effort to replace and repair aircraft parts and equipment that original manufacturers no longer produce. As the nation's current budget debate shifts towards spending cuts, some analysts note the potential for deep defense cuts may drive the defense industry to streamline and consolidate operations, potentially exit prior production lines, and undergo internal restructuring in an effort to maintain their existing profit margin. Consequently, a question to be answered is whether the defense industrial base will be capable of meeting the sustainment requirements of the legacy C2ISR force out to 2040 and to what extent Congress should consider this issue when evaluating proposed defense cuts.

Conclusion

The manned aircraft that accomplish the DOD's C2ISR missions are primarily based on Boeing 707 aircraft procured from the 1960s to the early 1990s. As these legacy C2ISR platforms continue to remain in the inventory and their age increases, understanding the Air Force and Navy sustainment, modernization, and recapitalization plans is likely important for Congress. The central issue is how much Congress should consider appropriating for the continued sustainment and modernization of these aircraft compared to funding for recapitalization of these missions to new aircraft. Without sufficient sustainment and modernization funding, many analysts argue, the legacy C2ISR fleet will quickly become a decrepit force ill-suited to the potential challenges posed by future adversaries. Other suggest that moving to recapitalization and new platforms will result in greater mission effectiveness over the long term, and better cost-effectiveness than keeping up older platforms.

A key issue for Congress is whether to continue providing sustainment, modernization, and/or recapitalization funding for the DOD's Boeing 707-based legacy C2ISR aircraft fleet, and if so, at what levels. Pertinent to the discussion is the potential for a shortfall in the nation's C2ISR capabilities if Congress or the DOD chooses to minimize funding for sustainment and upgrades that would keep the weapon systems viable until they are recapitalized. An important question to ask is whether development of a C2ISR replacement aircraft can be further delayed given sufficient levels of funding for legacy C2ISR aircraft sustainment and modernization, and if that is a good idea. Additionally, Congress's potential oversight of whether to shift some of the legacy C2ISR missions to remotely piloted aircraft bears directly on recapitalization efforts. Finally, Congress's decisions on these issues could also have implications for any potential future base realignment and closure (BRAC) decisions as well as impact the U.S. aircraft manufacturing industrial base. Ultimately, the priority the DOD places on legacy C2ISR sustainment, modernization, and recapitalization, and Congress's response could have potential consequences on U.S. C2ISR capabilities and for the future national defense strategies they support.

Appendix. Legislative Activity

FY2015 National Defense Authorization Act (P.L. 113-291)

DIVISION A – DEPARTMENT OF DEFENSE AUTHORIZATIONS

TITLE I – PROCUREMENT

Subtitle D – Air Force Programs

SEC. 136. LIMITATION ON AVAILABILITY OF FUNDS FOR RETIREMENT OF E–3 AIRBORNE WARNING AND CONTROL SYSTEM AIRCRAFT.

(a) LIMITATION. None of the funds authorized to be appropriated by this Act or otherwise made available for fiscal year 2015 for the Department of Defense may be obligated or expended to make significant changes to manning levels with respect to any E–3 airborne warning and control systems aircraft, or to retire, prepare to retire, or place in storage any such aircraft.

(b) RULE OF CONSTRUCTION.—Nothing in this section shall be construed to limit or otherwise affect the requirement to maintain the operational capability of the E–3 airborne warning and control system aircraft.

TITLE II – RESEARCH, DEVELOPMENT, TEST, AND EVALUATION

Subtitle B – Program Requirements, Restrictions, and Limitations

SEC. 219. LIMITATION ON AVAILABILITY OF FUNDS FOR RETIREMENT OF JOINT SURVEILLANCE AND TARGET ATTACK RADAR SYSTEMS AIRCRAFT.

(a) LIMITATION. None of the funds authorized to be appropriated by this Act or otherwise made available for fiscal year 2015 for the Air Force may be used to make any significant changes to manning levels with respect to any operational Joint Surveillance and Target Attack Radar Systems aircraft or take any action to retire or to prepare to retire such aircraft until the date that is 30 days after the date on which the Secretary of the Air Force submits to the congressional defense committees the report required by subsection (b).

(b) REPORT. The Secretary shall submit to the congressional defense committees a report that includes the following:

(1) An update of the results of the analysis of alternatives for recapitalizing the current Joint Surveillance and Target Attack Radar Systems capability.

(2) An assessment of the cost and schedule of developing and fielding a new aircraft and radar system to replace the current Joint Surveillance and Target Attack Radar Systems aircraft that would deliver two replacement aircraft to the Joint Surveillance and Target Attack Radar Systems aircraft operating base by fiscal year 2019.

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