

Boeing F-15 Eagle

Fighter/Attack
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Program Briefing

The F-15 Eagle is a twin-engine, single-seat, fixed-swept-wing, all-weather, air superiority fighter aircraft and, as the F-15E Strike Eagle, a dual-role, twin-seat, long-range interdiction fighter. The prime manufacturer of the aircraft is Boeing, formerly McDonnell Aircraft Co.

US F-15 procurement was terminated in FY 1991, but was re-instated for a few extra years, allowing for a total USAF buy of 236 F-15Es. The F-15 is in service with the US Air



F-15E Strike Eagle

Force (USAF), Saudi Arabia, Israel, and Japan, where the aircraft was license-built by Mitsubishi. South Korea has also ordered the F-15K, while

Singapore has opted for the closely related F-15SG.

Over 1,700 F-15s have been delivered.

Recent News

Qatar Buys 36 F-15s

In June 2017 Qatar signed an order for 36 F-15QAs worth an estimated \$12 billion, including support, spares, weapons, etc. The QA will

likely be like Saudi Arabia's SA variant. No details on delivery dates have been provided.

In 2016 Congress had approved a sale of up to 72 F-15s in an agreement valued at up to \$21 billion.

Executive

Dept. of the Air Force
US Air Force Systems Command
Aeronautical Systems Div.
Wright-Patterson Air Force Base
Dayton, OH 45433
(513) 255-6151
www.afmc-pub.wpafb.af.mil

Manufacturer

The Boeing Co.
McDonnell Aircraft and Missile Systems
Box 516
St. Louis, MO 63166
(314) 234-3141
www.boeing.com

Subsystems

Airframe

The F-15 airframe includes 2% composites by fly weight. These include boron/epoxy empennage skins and a carbon fiber/epoxy speed brake.

Airframe Subcontractors

Additional subcontractors that are involved with airframe work are listed below:

- AMI Metals: steel and aluminum sheet and plate products
- Alsalam Aircraft Co: wing sets for remanufactured Saudi F-15Ss
- Astech/MCI: structural components
- Cleveland Pneumatics: nose and main landing gear units
- Dorne & Margolin: DM CN18 antenna
- Fuji Heavy Industries: landing gear doors for Japanese F-15s
- GKN Aerospace: rudder, frame and fuselage sections side panels, metal and composite sub-assemblies (starting 2002); integrated canopy system (starting 2004)
- General Dynamics: wideband radomes for AESA radar modernization program
- Goodrich: horizontal aft box assemblies, flight control surfaces
- Héroux: landing gear components
- Israel Aircraft Industries: rudders, doors, vertical stabilizers, conformal fuel tanks, cockpit side panels
- Kawasaki Heavy Industries: wings and tail assembly for Japanese F-15s
- Korea Aerospace Industries: forward fuselages and wings for F-15K (and other F-15s sold after 2003 in Asia)
- Sumitomo Heavy Industries: landing gear for Japanese F-15s

Propulsion

Two Pratt & Whitney F100-PW-220 turbofans (23,770 lbst); F-15A/B/C/D; AFE option

Two Pratt & Whitney F100-PW-229 turbofans (29,100 lbst); IPE competitor

Two General Electric F110-GE-129A turbofans (approximately 30,000 lbst); F-15K, F-15SG, and future new build/retrofit competitor

Engine Options

As part of its Improved Performance Engine (IPE) program for the F-15E (as well as future F-16s; see report), the USAF began installing Pratt & Whitney F110-PW-229 engines in F-15Es starting in 1991. Some early USAF F-15s with old

F100s have gotten retrofit kits, bringing their engines to F100-220E (E = Equivalent) standard. Japan has already begun this program.

An F-15E flew for the first time with a General Electric F110-GE-129 engine in early July 1989, at the company's plant in St. Louis, MO. Qualification testing ended after 1989, but were restarted in 1997. South Korea and Singapore have selected the GE engine for their new F-15s, while Saudi Arabia is re-engining 70 of its F-15Ss with F110s. Only the F-15E and related models can be fitted with the GE engine.

Of the 226 F-15Es built before the FY2000/2001 buys, 125 have the Pratt engine, while 101 have the GE engine.

Propulsion System Subcontractors

Additional subcontractors that are involved with aspects of the propulsion system are listed below:

- Hamilton Sundstrand: EEC-90 engine control system
- Honeywell (Bendix): engine fuel controls
- Honeywell (Garrett): jet fuel starter
- Ishikawajima-Harima Heavy Industries: F100 license production for Japanese F-15s
- Samsung Techwin: F110 license production (78 engines) for Korean F-15Ks

Electronics

<i>Designation</i>	<i>Description</i>	<i>Manufacturer</i>	<i>Note</i>
Communications			
AN/APX-101(v)	IFF transponder	Toyo Communication Equipment	license-built for Japanese aircraft
AN/APX-76A(v)	IFF interrogator	Toyo Communication Equipment	license-built for Japanese aircraft
AN/APX-113 AN/ARC-164	IFF interrogator/transponder UHF Radio	BAE Systems Magnavox	RoK F-15K

AN/ARC-164	UHF Transceiver	Magnavox	F-15 MSIP, F-15E Strike Eagle
AN/ARC-164(v)	UHF radio	Mitsubishi Electric Corp.	license-built for Japanese aircraft
AN/ARC-186 AN/URC-107(V)	VHF Radio JTIDS	Rockwell Collins Rockwell Collins	F-15 MSIP; F-15E Strike Eagle
J/ASW-10	data link receiver	Hitachi Ltd.	license-built for Japanese aircraft
KY-28	secure voice control	Magnavox	
KY-58	secure voice control	Honeywell	

Displays & Instrumentation

AN/ASN-108	attitude & heading reference system	Tokyo Keiki Co.	license-built for Japanese aircraft
AN/AVQ-20	head up display	Shimadzu Corp.	license-produced for Japanese aircraft
AN/AVQ-20 OD-60/A	head-up display indicator group	Boeing (McDonnell Douglas) Tokyo Keiki Co	license-built for Japanese aircraft
DASH	display and sight helmet system	Elbit	F-15I
n/a	HUD/HD display (x5)	Kaiser Electronics	F-15E
n/a	flat panel color displays	Kaiser Electronics	F-15E after 2000; also F-15K (with LG Innotek)
n/a	moving map display	Honeywell	
n/a	up front control panel display module	Hercules Aerospace Display Systems, Inc.	F-15E

Electronic Warfare

AN/ALQ-128 AN/ALR-56 AN/ALE-45	threat warning receiver radar warning receiver countermeasure dispenser	Magnavox BAE Systems BAE Systems (Tracor)	standard with TEWS -56C on MSIP, E, and K F-15 MSIP, F-15E Strike Eagle
AN/ALE-47 AN/ALQ-119 AN/ALQ-127 AN/ALQ-135 BOL n/a	chaff and flare dispenser ECM pod tail receiver/jammer noise/deception jamming system countermeasures dispensers Digital Electronic Warfare Systems (DEWS)/Common Missile Warning Systems (CMWS)	BAE Systems Northrop Grumman (Westinghouse) General Electric Northrop Grumman Saab Avionics BAE Systems	RoK F-15K F-15E/K added 2001 Added to Saudi F-15S fleet starting 2012
EL/L-8222 J/ALQ-8	ECM pod radar jamming system	IAI Elta Mitsubishi Electric Co.	Israeli AUP F-15s indigenous unit for Japanese aircraft.
J/APR-4	radar warning system	Tokyo Keiki Co.	indigenous unit on Japanese aircraft
XJ/APQ-1 SPS-2110	rear-warning receiver self-protection system	Mitsubishi Electric Elisra	for JASDF F-15J F-15I, F-15SG

Miscellaneous or Multipurpose Systems

ADCP AIC-12 AN/APX-76 AN/ASK-6	Advanced Display Core Processor air intake control IFF interrogator air data computer	Honeywell Hamilton Sundstrand BAE Systems (Hazeltine) Tokyo Keiki Co.	RoK F-15K license-built for Japanese aircraft
AN/ASK-6 CP-1075 CP-1075	air data computer central computer central computer	Unisys IBM Mitsubishi Electric Corp.	license-built for Japanese aircraft
IFF transponder n/a n/a n/a	AN/APX-101 video recorders VHSIC CC airborne video tape recorder	Teledyne Electronics Photo-Sonics Lockheed Martin TEAC	on some aircraft F-15E Strike Eagle license-built for Japanese aircraft
n/a n/a n/a	auto. analog flight control system digital flight control system data transfer unit	General Electric Lear Siegler Astronics RADA Electronic Industries	All versions except F-15E F-15E Strike Eagle

Navigation

AN/ARN-111	TACAN	Gould	
AN/ARN-112	ILS Receiver	Rockwell Collins	
AN/ARN-118(v)	Tacan unit	Nippon Electric Co.	license-built for Japanese aircraft
AN/ASN-109	inertial navigation system	Toshiba Corp.	license-built for Japanese aircraft
H-770	ring laser gyro INS	Honeywell	F-15E
LN-94	ring laser gyro INS	Honeywell	
n/a	air navigation indicator	Honeywell	
n/a	miniature airborne GPS receiver	Rockwell Collins	F-15E

Sensors

LN-94	ring laser gyro INS	Honeywell	
DB-110	long range oblique photography pods	Goodrich	Saudi F-15SAs and Ss for retrofit
AN/APG-63	multi-mode fire control radar	Mitsubishi Electric Corp.	license-built for Japanese aircraft
AN/APG-70	multi-mode radar	Raytheon (Hughes)	MSIP, F-15E Strike Eagle
AN/APG-82	AESA radar	Raytheon	F-15E, F-15I retrofit
ANS-42	infrared search and track pod	Lockheed Martin	F-15K; for retrofit to some USAF C/Ds
n/a	LANTIRN Radar	Raytheon (TI)	terrain-following radar for LANTIRN

Weapons Control/Targeting

AAS-42 Tiger Eye	infrared search and track	Lockheed Martin	RoK F-15K/SG; Saudi F-15SA
AN/AAQ-14	LANTIRN Targeting Pod	Lockheed Martin	F-15E
AN/AAQ-33	Sniper Advanced Targeting Pod	Lockheed Martin	F-15SG
AN/AWG-27	armament control system	Komatsu	Japanese F-15s
CN-1377/AWG	lead computing gyro	Toshiba Corp.	license-built for Japanese aircraft
JHMCS	Joint Helmet-Mounted Cueing System	Vision Systems International	145 F-15Es starting in 2008
n/a	helmet-mounted site	Elbit	F-15I

Weapon Systems**F-15A/B/C/D**

The F-15 Eagle is armed with a Lockheed Martin 20mm M61A1 six-barrel cannon with 940 rounds of ammunition. Air-to-air missile (AAM) options include four Raytheon AIM-9 (including AIM-9X) Sidewinder and four AIM-7 Sparrow AAMS, or eight AIM-120 AMRAAMs. The missiles can be launched from wing-tip launch systems or from centerline pylons, or from stores carriers on the conformal fuel tanks.

Other missile options, being added or already available, include Mitsubishi's AAM-3s with NEC seekers, and AAM-4s (with the AAM-4B and AAM-5 added under the F-15MJ upgrade), and Israel's Python.

Air-to-ground weapons can be carried on three stations (two underwing, one centerline), or five if the conformal fuel tanks (CFT) are attached.

Israeli F-15s are being upgraded to carry Rafael AGM-142D Popeye TV/IR-guided AGMs.

F-15E

By design, the F-15E has tremendous air-to-ground weapon enhancements over the F-15 without losing its air-to-air capabilities. The AAM carriage capability is identical between the two, but the F-15E's ground attack stores are different. The F-15E can be rigged with either single or triple rail launchers underwing for AGM-65 Maverick missiles. The CFTs also can carry up to six bomb racks each. Triple ejector racks also are available for underwing or centerline carriage. The LANTIRN system is used for AGM-130 standoff bombs, and AGM-88 HARMs were added in 1996. The F-15E can carry nuclear weapons as well (but not cruise missiles).

Various new smart weapons are being added to the F-15E, starting in 2000. The first was Raytheon's EGBU-15. Others will include Raytheon's JSOW, Lockheed Martin's WCMD, and Boeing's JDAM. The GBU-39 Small Diameter Bomb will be added, starting in late 2006. The F-15K is the first Eagle that can carry Boeing's Harpoon anti-ship missile. In February 2004 the F-15 made its first flight with the AGM-84 SLAMER, which will also equip the F-15K.

In July 2012 integration was completed of Lockheed Martin's AGM-158 Joint Air-Surface Standoff Missile (JASSM) on the F-15E.

In June 2013 South Korea selected Taurus Systems' Taurus KEPD cruise missile for its F-15K.

EDO Corp., College Point, MD, produces bomb release units for the F-15E. TAAS-Israel (formerly Israel Military Industries) produces centerline pylons. For Japanese F-15s,

Nippi produces pylons and missile launchers, while Shin Meiwa produces drop tanks.

Other Systems

Conformal Fuel Tanks

The key to the later model F-15C/D/E's capability to operate at long ranges is conformal fuel tanks (CFT). The tanks, installation of which can be completed in approximately 15 minutes, are attached to the aircraft's engine air intakes, and each can provide the aircraft with an additional 4,875 lbs. of fuel. The tanks also can be configured to carry a wide range of avionics and sensor equipment, as well as stores stations, without affecting the carriage of other systems and weapons. In addition, the aircraft can take advantage of up to three 610-gallon (2,309-liter) external fuel tanks.

Additional Contractors

Further subcontractors involved with miscellaneous subsystems are as follows:

- Abex: engine driven pumps
- Advanced Electronics Company: parts for electronics systems
- BAE Systems: rudder feel control actuators

- Dowty: rudder actuators
- Ducommun (MechTronics): electromechanical enclosures and systems for Raytheon on APG-63
- Dynasciences Corp: windshield anti-icing valve
- Electro Development Corp: transformer-rectifiers for power generating system
- Goodyear: nose wheel and tire (all models except F-15E), internal fuel tanks
- Hamilton Sundstrand: air inlet controllers, generator constant speed drive units, LANTIRN environmental control system
- Honeywell (Bendix Wheels and Brakes): main wheels and brakes (all models), nose wheel (F-15E)
- Honeywell (Garrett): auxiliary power unit
- Hydraulic Research and Manufacturing Company: modular hydraulic packages
- Hydro-Aire: wheel braking skid control unit
- Litton Life Support: MSOGS/OBOGS

- Lucas Aerospace: electrical power generating system
- Michelin: AIR X radial tires (F-15E)
- Moog: flight controls
- National Water Lift: air inlet actuators, hydraulic actuators for ailerons and tailplane
- Ronson Hydraulic Units: hydraulic actuators for rudders
- Saab Avionics: BOL countermeasure dispensers
- Sargent-Fletcher: external fuel tanks
- Signal Technology: power supply for radar warning receiver
- Simmonds: fuel gauge system, liquid oxygen indicator
- Smiths Industries: power generating system
- Universal Propulsion Company: aircrew escape system components
- Weber Aircraft (now Boeing): Advanced Concept Ejection Seats (ACES)

Specifications

	<u>F-15</u>
Length (overall):	63 ft 9 in (19.1 m)
Height (overall):	18 ft 6 in (5.5 m)
Wing span:	42 ft 10 in (12.8 m)
Wing area:	608 sq ft (56.5 sq m)
Empty weight (F-15C/D):	28,200 lb (12,790 kg)
Empty weight (F-15E):	32,000 lb (14,515 kg)
Max. T-O weight (F-15C/D) w/CFT:	68,000 lb (30,600 lb)
Max. T-O weight (F-15C/D) w/ext. tanks:	58,470 lb (26,521 kg)
Max. T-O weight (F-15E):	81,000 lb (36,741 kg)
Ferry range (w/CFT):	3,560 mi (5,696 km)
Ferry range (w/ext. tanks):	2,878 mi (4,604 km)

Costs

USAF

The last unit price paid by the USAF for an F-15E was \$75 million, for the proposed FY 2001 buy.

Under the original FY 1990 budget request unit cost for the F-15E was \$37.1 million, but appropriated funding for FY 1990 shows a unit cost of \$36.7 million. The FY 1991 request shows a unit price of \$50.4 million, the increase reflecting, in part, termination costs. Flyaway cost for the F-15E was \$35 million. The 18-unit FY 1996-1998 buy had a unit cost of \$55 million, and FY 1998 requested unit cost was \$53 million. For FMS buys, see Funding History, below.

The F-15S/MTD demonstrator cost \$117.8 million under an October 1984 cost-sharing contract.

Exports

FY 1990 flyaway costs for Mitsubishi-built F-15s were \$55.2 million. FY95 unit cost for five Mitsubishi-built F-15s (requested) is \$115.3 million. FY 1996 unit cost for four F-15DJs is \$116.8 million.

The F-15S/MTD demonstrator cost \$117.8 million under an October 1984 cost-sharing contract.

The unit cost for the first lot of 40 F-15K airframes and engines (fly away cost) was 75.3 billion won (\$84.4 million). This rose to 87.66 billion won for the second lot of 20, according to a Korean National Assembly document. US records indicated a \$3.6 billion program cost for the first 40 aircraft, with a program unit cost of \$90 million. Currency

fluctuations may account for the discrepancy. And these sums (for the 40 aircraft) were in 2002 dollars, so program unit cost would be around \$115 million in today's money.

Israel paid \$1.76 billion for its 21 F-15Is acquired in 1993. In December 2005 Singapore signed for 12 F-15SGs, with AESA radars. The value of this deal was given as \$1.6 billion, a program unit cost of \$133 million.

Boeing's recent 84-aircraft F-15 sale to Saudi Arabia was valued at \$11.4 billion (program cost) implying a program unit cost of \$135.7 million.

Sales/Deliveries Data

Deliveries

	<u>Through 1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>
McDonnell/Boeing	695	93	58	48	57	60	42	38	42	43	28
	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>2000</u>	<u>2001</u>	<u>2002</u>
	6	20	9	4	11	20	39	35	5	—	3
	<u>2003</u>	<u>2004</u>	<u>2005</u>	<u>2006</u>	<u>2007</u>	<u>2008</u>	<u>2009</u>	<u>2010</u>	<u>2011</u>	<u>2012</u>	<u>2013</u>
	4	3	6	12	12	14	13	13	15	8	14
	<u>2014</u>	<u>2015</u>	<u>2016</u>	<u>Total</u>							
	14	12	15	1,511							
Mitsubishi	<u>Through 1981</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985</u>	<u>1986</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>1990</u>	<u>1991</u>
	1	12	12	17	19	15	17	14	14	10	10
	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>Total</u>		
	14	11	7	8	3	6	8	1	199		

Order Book

User	Version	Ord./Del.	Note
Israel	F-15A/B	21/21	25 more ex-US aircraft delivered
Israel	F-15C	18/18	
Israel	F-15D	13/13	10 more ex-US aircraft
Israel	F-15I	25/25	
Japan	F-15J	165/165	all but 2 license-built
Japan	F-15DJ	48/48	all but 12 license-built
Qatar	F-15QAA	36/—	
Republic of Korea	F-15K	61/61	

Saudi Arabia	F-15C	55/55	24 more ex-US aircraft delivered
Saudi Arabia	F-15D	19/19	
Saudi Arabia	F-15S	72/72	
Saudi Arabia	F-15SA	84/58	
Singapore	F-15SG	32/32	officially 24; possibly 40
USAF	F-15A	365/365	includes ten YF-15s
USAF	F-15B	59/59	includes two YF-15s
USAF	F-15C	409/409	deliveries completed 11/89
USAF	F-15D	61/61	
USAF	F-15E	236/236	6 funded from transfer to Saudi Arabia

Contract Briefs

The following is a listing of contract announcements made by the Pentagon involving the award of, or modification to, unclassified prime contracts with a base value of \$7 million or more for a period of one year prior to the date at the end of this report.

Date	Contract Number	Agency	Details
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Advanced Electronics

11/17/2016	FA8730-16-C-0019	\$12,378,909	modification (P00001) to a previously awarded contract action issued by the Air Force Life Cycle Management Center (US Air Force) for F-15SA cyber protection and related facilities Phase IIA contract. Contractor will provide system and facilities site survey through system requirements review close-out and the architecture and engineering design. The contract is scheduled to be completed by 11/16/2018. Program involvement: F-15.
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Al Raha Group for Technical Services

09/19/2016	FA8505-13-C-0012	\$355,903,318	firm-fixed-price contract action issued by the Air Force Life Cycle management Center (US Air Force) for F-15 Saudi Arabia integrated fleet support services. Contractor will provide comprehensive material management of unclassified spares, support equipment, and support services required to support base stand-ups and continued F-15 and F-15SA Royal Saudi Air Force flying operations. The contract is scheduled to be completed by 12/31/2017. Program involvement: F-15.
06/19/2017	FA8505-14-D-0004	\$185,722,274	firm-fixed-price contract action issued by the Air Force Life Cycle Management Center (US Air Force) for F-15 Saudi Arabia Depot prime vendor support services. The contract is scheduled to be completed by 10/4/2017. Program involvement: F-15.

Alpha-Omega Change Engineering

01/31/2017	FA4890-17-C-0006	\$8,290,188	firm-fixed-price contract action issued by the Acquisition Management and Integration Center (US Air Force) for F-15E, F-16 and F-22A aircrew training and courseware development. Contractor will provide all personnel, equipment, tools, materials, supervision, and all other items and services that are required to perform F-15E, F-16, F-22A contract aircrew training courseware development to include instrument refresher course instruction, distributed mission operations and distributed mission training. Work will be performed at Seymour Johnson AFB, NC; Shaw AFB, SC; Langley AFB, VA; Hill AFB, UT; Mt. Home AFB, ID; and Nellis AFB, NV. The contract is scheduled to be completed by 3/31/2022. Program involvement: F-15, F-16, F-22.
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Boeing, Defense, Space & Security - Global Systems & Support

09/27/2016	FA8538-16-D-0010	\$0	increment as part of an \$11,230,459 indefinite-delivery, requirements and firm-fixed-price requirements contract action issued by the Air Force Sustainment Center (US Air Force) for the F-15 E Flat Panel Up Front Control (UFC) program. The UFC is a multifunction control used in the F-15E to control and display status of communication navigation and identification systems. The FPUFC utilizes a single, new technology liquid crystal display (LCD) flat panel display to replace the current segmented LCDs of
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the F-15 UFC. Work will be performed in Alpharetta, GA. The contract is scheduled to be completed by 3/29/2021. Program involvement: F-15.

Boeing, Defense, Space & Security - Military Aircraft

07/20/2016	FA8621-16-C-6397	\$27,085,226	firm-fixed-price contract action issued by the Air Force Life Cycle Management Center (US Air Force) firm-fixed-price contract for the tasks associated with Mission Training Center services on contractor-furnished high-fidelity simulation equipment. The Mission Training Center services will provide simulation capability to train pilots and weapons system operator for F-15C and F-15E aircraft platforms. Work will be performed in Seymour Johnson AFB, NC; Mountain Home AFB, ID; Langley AFB, VA; and 2 other locations. The contract is scheduled to be completed by 6/30/2017. Program involvement: F-15.
09/26/2016	FA8634-16-C-2653	\$13,750,000	increment as part of a \$27,500,000 modification (P00008) to a previously awarded contract action issued by the Air Force Life Cycle Management Center (US Air Force) for F-15 radar upgrades. The contractor will provide radar spares and interim contractor support repairs. The contract is scheduled to be completed by 5/31/2019. Program involvement: F-15.
09/27/2016	FA8621-16-C-6397	\$13,200,000	modification (P00002) to a previously awarded contract action issued by the Air Force Life Cycle Management Center (US Air Force) for F-15C and F-15E mission training centers (MTCs). Contractor will provide Mission Package 16 (MP-16) into F-15C and F-15E MTCs to be compliant with Combat Air Force Distributed Mission Operations Standards updates. MP-16 updated changes will be installed into the F-15C and F-15E MTC trainers. Work will be performed in Seymour Johnson AFB, NC; Mountain Home AFB, ID; Langley AFB, VA; and 2 other locations. The contract is scheduled to be completed by 9/30/2018. Program involvement: F-15.
11/03/2016	FA8634-17-C-2650	\$78,204,519	increment as part of a \$478,786,126 cost-plus-incentive-fee contract action issued by the Air Force Life Cycle Management Center (US Air Force) for F-15 Eagle Passive/Active Warning and Survivability System (EPAWSS) engineering manufacturing and development. Contractor will provide planning, design development, integration, testing and risk reduction activities for the F-15 EPAWSS program. The contract is scheduled to be completed by 8/31/2020. Program involvement: F-15, EPAWSS. RDT&E involvement: 0207171F.
11/30/2016	FA8634-16-C-2653	\$397,907,824	increment as part of a \$558,462,269 modification (P00015) to a previously awarded contract action issued by the Air Force Life Cycle Management Center (US Air Force) for F-15 Combined APG-63 Version 3 Radar Improvement Program Version 3 and APG-82 Version 1 Radar Modernization Program (RMP) radar upgrades. Contractor will provide procurement, installation, initial spares and support for 42 Version 3, and 29 RMP radars. The contract is scheduled to be completed by 1/15/2019. Program involvement: F-15, APG-63.
02/06/2017	F33657-01-D-0026	\$18,290,920	modification (14) to a previously awarded contract action issued by the Air Force Life Cycle Management Center (US Air Force) for Royal Saudi Air Force AN/APG-63(V) 3 radar in F-15SA aircraft. Work will be performed in Forest, MS. The contract is scheduled to be completed by 3/31/2017. Program involvement: F-15, AN/APG-63.
03/03/2017	FA8505-14-C-0004	\$46,399,274	modification (PZ0001) to a previously awarded contract action issued by the Air Force Life Cycle Management Center (US Air Force) to definitize a foreign military sales requirement providing interim contractor support for the F-15SA aircraft for the Royal Saudi Air Force. Work will be performed in King Khalid Air Base. The contract is scheduled to be completed by 3/31/2017. Program involvement: F-15.
03/15/2017	SPRPA1-14-D-002U	\$371,242,450	modification to a fixed-price-incentive contract action issued by the Defense Logistics Agency Aviation (Defense Agencies) for adding performance-based supply chain support for the F-15 platform. Work will be performed in Missouri; and Georgia. The contract is scheduled to be completed by 3/14/2022. Program involvement: F-15.
04/28/2017	F33657-01-D-0026	\$7,610,817	increment as part of a \$24,858,522 task order contract action issued by the Air Force Life Cycle Management Center (US Air Force) for F-15 C/E Aircraft Structural Integrity Program (ASIP) services. Contractor will provide services which include the force management execution to include

implementation of an individual aircraft tracking program, collection and processing of Loads/Environmental Spectra survey data, aircraft structural records collection with respect to configuration control, inspections, and repairs, and recertification support; Certification and Force Management Development tasks to include Force Structural Maintenance Plan updates and certification analyses; full-scale testing support to include the interpretation and evaluation of test results; Design Analysis and Development tasks to include damage tolerance and durability analyses and support for corrosion assessments; and design information tasks to include ASIP master plan updates and sustainment. The contract is scheduled to be completed by 4/27/2020. Program involvement: F-15.

06/20/2017	FA8621-16-C-6397	\$20,751,618	firm-fixed-price contract action issued by the Air Force Life Cycle Management Center (US Air Force) for mission training center services on contractor-furnished, high-fidelity simulation equipment. Contractor will provide the simulation capability to train pilots and weapons system operators for F-15C and F-15E aircraft platforms. Work will be performed in Seymour Johnson Air Force Base, NC; Mountain Home Air Force Base, ID; Langley Air Force Base, VA; and 2 other locations. The contract is scheduled to be completed by 6/30/2018. Program involvement: F-15.
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Boeing, Defense, Space & Security - Network & Space Systems

03/31/2017	FA8634-16-C-2653	\$168,832,812	modification (P00028) to a previously awarded contract action issued by the Air Force Life Cycle Management Center (US Air Force) for F-15 Combined APG-63 Version 3 Radar Improvement Program and APG-82 Version 1 Radar Modernization Program radar upgrades. Contractor will provide additional quantity of 18 V3 radars and 16 RMP radars, as well as the associated installation, initial spares, support equipment, ICS, tooling, and other required support. The contract is scheduled to be completed by 2/28/2022. Program involvement: APG-63, APG-82, F-15.
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General Electric, GE Aviation

11/15/2016	FA8122-16-F-0042	\$8,029,735	modification (P00003) to a previously awarded contract action issued by the Air Force Sustainment Center (US Air Force) to provide five Service Life Extension Program F110-100 engine kits. The contract is scheduled to be completed by 1/31/2017. Program involvement: F110, F-16, F-15.
01/17/2017	SPE4AX-16-D-9408	\$98,133,439	firm-fixed-price delivery order against an existing contract action issued by the Defense Logistics Agency Aviation (Defense Agencies) o remanufacture F110 engines. Work will be performed in Ohio; and Kansas. The contract is scheduled to be completed by 10/30/2018. Program involvement: F-16, F-15, F110.

Honeywell International

03/10/2017	FA8109-16-D-0016	\$7,200,000	modification contract action issued by the Air Force Sustainment Center (US Air Force) to overhaul and repair aircraft accessories and aircraft instruments to support and sustain the A-10, B-52, C-130, C-135, C-5, E-3, F-15 and F-16 weapon systems. Contractor will provide overhaul and repair of aircraft accessories and aircraft instruments items produced under the basic contract to insure serviceable assets are available. Work will be performed in Tempe, AZ; Tucson, AZ; Phoenix, AZ; and 2 other locations. The contract is scheduled to be completed by 2/28/2021. Program involvement: A-10, B-52, C-130, C-135, C-5, E-3, F-15, F-16.
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Moog

02/23/2017	FA8118-17-D-0017	\$1,349,150	increment as part of a \$7,691,865 firm-fixed-price and indefinite-delivery/indefinite-quantity contract action issued by the Air Force Sustainment Center (US Army) for F-15 sustainment. Contractor will remanufacture up to 285, but not less than 50, F-15 rudder actuators. The contract is scheduled to be completed by 2/22/2022. Program involvement: F-15.
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PAE Aviation and Technical Services

10/06/2016	FA4890-15-C-0018	\$7,494,496	increment as part of a \$14,938,540 modification (P00014) to a previously awarded contract action issued by the Air Combat Command (US Air Force) to provide maintenance of aerial targets, and operations and maintenance of range instrumentation systems at Tyndall AFB, FL; and maintenance of full-scale aerial targets at Holloman AFB, NM, for Air Combat Command Acquisition Management and Integration Center contracting and program management oversight. This includes functional and
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quality assurance support for the Aerial Targets Program, which directly supports live-fire weapons system testing and enables the 53rd Weapons Evaluation Group in the developmental and operational weapons testing for all air-to-air missiles and for the F-22, F-35, F-16, and F-15 aircraft. Work will be performed in Tyndall AFB, FL; and Holloman AFB, NM. The contract is scheduled to be completed by 9/30/2017. Program involvement: F-15, F-16, F-22, F-35.

PKL Services

09/01/2016	FA3002-16-D-0011	\$495,000,000	indefinite-delivery/indefinite-quantity contract action issued by the 338th Specialized Contracting Squadron (US Air Force) for Royal Saudi Air Force F-15 S&SA type aircraft maintenance upgrade training. The contract is scheduled to be completed by 8/31/2021. Program involvement: F-15.
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Raytheon, Missile Systems

06/20/2016	FA8675-14-D-0009	\$0	increment as part of a \$28,000,000 modification (P00007) to the maximum ordering amount of previously awarded contract action issued by the Air Force Life Cycle Management Center (US Air Force) for integration of the Advanced Medium Range Air-to-Air Missile (AMRAAM) onto various Air Force and Navy aircraft platforms. Contractor will facilitate several new task orders for platform integration support including the F-16 Block 30, F-35, F-15 Eagle Passive Active Warning Survivability System; F-16 Active Electronically Scanned Array; AMRAAM Real Time Integration Simulator; and multiple F/A-18 configurations. Work will be performed in Fort Worth, TX; Eglin AFB, FL; Hill AFB, UT; and 8 other locations. The contract is scheduled to be completed by 1/30/2020. Program involvement: AIM-120 AMRAAM, F-15, F-16, F-35.
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United Technologies, Pratt & Whitney

09/01/2016	N00019-14-C-0004	\$38,459,410	modification P00010 to a previously awarded cost-plus-incentive-fee, fixed-price-incentive-firm-target contract action issued by the Naval Air Systems Command (US Navy/Marine Corps) for sustainment program administrative labor in support of the F-35 Lightning II low-rate initial production Lot IX procurement. This modification provides for program administrative labor in support of F-135 sustainment efforts. Work will be performed in East Hartford, CT (85%); and Indianapolis, IN (15%). The contract is scheduled to be completed by 6/30/2019. Program involvement: F-15, F135.
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Program Overview

History

Origins

McDonnell Douglas was chosen in 1969 over North American Rockwell and Fairchild as the winner of the FX competition to develop a new USAF air superiority fighter. McDonnell had started work on the design after the FX program was initiated, in April 1965. There was no competitive fly-off.

In March 1970 the Air Force chose Pratt & Whitney for the engine contract.

McAir received a contract for 20 test aircraft, 18 of these being single-seat F-15A and two being twin-seat TF-15A training variants. The first flight of the aircraft, an F-15A, took place on July 27, 1972, while the TF-15A flew for the first time on July 7,

1973. The twin-seat versions were later re-designated F-15B.

The F-15 long-lead production decision was made in October 1972, and the full production decision was made in February 1973. The first operational F-15A was delivered in November 1974. Initial operating capability (IOC) was reached in July 1975. Total production came to 365 F-15As, including 10 YF-15As, and 59 F-15Bs, including two YF-15Bs.

F-15C/D

Starting in June 1979, production for the USAF switched to the F-15C/D versions (the D referring to the two-seat operational training variant). The F-15C flew for the first time on Feb. 26, 1979, while the F-

15D flew for the first time on June 19, 1979.

The major modification to the F-15 for the F-15C/D versions was the addition of the conformal fuel tanks (see Weapon Systems above). In later F-15C/Ds, improvements also were made to the aircraft's radar to improve its performance during heavy raids, enabling the radar to better assess and identify targets. The modification, a programmable signal processor with an expanded mission computer, was retrofitted to older aircraft.

F-15E Requirement

The F-15E was at first an industry designed aircraft. McDonnell Doug-

las initiated the series of modifications to an F-15B in early 1980 to produce an all-weather long-range strike aircraft. The USAF in 1984 chose this new aircraft, the F-15E, also known as the Strike Eagle, over the F-16XL to fulfill its Dual Role Fighter requirement and replace the General Dynamics F-111 in the long-range interdiction role. The first F-15E was delivered to the USAF in 1988, and the aircraft was expected to reach initial operating capability (IOC) in 1989.

F-15E System Description

The major modifications to the F-15 for the F-15E include the addition of a second seat and the associated systems, a digital flight control system, the redesign of up to 60% of the aircraft's airframe, the addition of LANTIRN (Low Altitude, Navigation, Targeting and Infrared for Night) capability, automatic terrain following systems, and the new AN/APG-70 radar with synthetic aperture. Internal fuel capacity has been reduced, but the ability to carry large amounts of deliverable weapons has been maintained, especially through the use of the CFT.

The rear pilot has at his disposal four CRT displays: radar, FLIR, digital mapping, and threat warning. The front pilot has a lone head-up display. Also, the engine bay is modified to accommodate both General Electric and Pratt & Whitney versions of the IPE options (although as of 2001 no customers have selected GE engines).

In addition, the aircraft's central computer has been upgraded (with increased memory) so it may handle more data and process it faster; the aircraft's old armament system control panel has been replaced by a programmable Sperry full-color multi-purpose system, which, with the new computer, has the capability of handling new versions of current AAMs, including AMRAAM; a tactical electronic warfare system (TEWS) has been integrated, which includes Northrop Grumman's AN/ALQ-135

ECM, a Loral (now Lockheed Martin) AN/ALR-56C radar warning receiver, a Tracor (now BAE) AN/ALE-45 chaff dispenser, and a Magnavox AN/ALQ-128 threat warning receiver.

F-15 Terminated After FY 1991

Procurement of the F-15E was declared terminated after FY 1991 in the FY90/91 amended budget request. The original units requested at 36 were left intact for both years, but \$103.6 million was added to the original FY 1990 request of \$1,235.2 million, and \$700 million was added to the original FY 1991 request of \$1,291.9 million, these supplements to fund the increased costs of FY 1991 aircraft, line shutdown, support and training equipment, and technical data.

This move temporarily ended F-15E procurement at 200 aircraft, with another six aircraft financed by an FY 1991 sale of used USAF F-15s to Saudi Arabia and three more provided in the FY 1992 Desert Storm supplemental weapons buy.

F-15F and U: Two Proposals

McDonnell Douglas announced the development of an export version of the F-15, known as the F-15F, in January 1990. Aware that the US DoD would probably not permit export of F-15E technology, McDonnell concentrated instead on incorporating some of the aerodynamic changes of the E model into a new single-seat air superiority version. While privately funded by the company, the USAF encouraged development of the F, fearful of being reduced to only one active fighter production line (F-16) in a few years.

In September 1994 McDonnell proposed a new version of the F-15E with thicker, trapezoidal wings. The target customer for the new variant—called F-15U+—was the United Arab Emirates, but the UAE rejected the proposal, as did the USAF.

USAF Gets More F-15Es, Courtesy of Congress

In 1995, the USAF decided to buy 17 more F-15Es at about \$55 million per plane. Unfortunately, the service said it could not find the cash for these aircraft, and was hoping Congress could provide some. The Defense Appropriations Conference obliged, and inserted \$311.2 million for six aircraft in the FY 1996 budget. The contract for these was signed in May 1996. The Conference also added \$50.2 million for advance procurement, and more in FY 1997—\$275.4 million for six aircraft.

Congressional F-15 plus-ups also featured in the FY 2000 and 2001 budgets. In 2000, Congress approved five planes for \$267 million, and in 2001 it approved money for an additional five. However, the FY 2000 funding proved insufficient to make the planes mission capable, so an additional \$90 million was added as an emergency supplemental.

These last two batches are known in the Air Force as the E210s and E227s (based on their starting production serial numbers). The 2000 and 2001 buys should (in theory) end F-15E production at 236 planes.

Boeing Unveils Silent Eagle

In March 2009 Boeing unveiled its proposed F-15SE Silent Eagle, a new stealthy version with structural changes and other survivability improvements. The CFTs have been redesigned to allow internal carriage of AAMs, JDAMs, or SDBs. The aircraft can be rapidly reconfigured to allow traditional CFT use with external weapons carriage.

In addition, the SE's radar signature has been reduced with coatings and treatments, and the vertical tails can be canted to improve aerodynamic efficiency and reduce weight. That feature, however, is not definite.

The Silent Eagle flight demonstrator aircraft, F-15E1, completed a successful first flight on July 8, 2010.

There are no known customers, and the program has not been firmly

launched, but Boeing briefed existing F-15 users, including the USAF.

USAF Upgrades & Modifications

MSIP Program

The USAF updated early F-15 versions to keep them effective against evolving threats through a Multi-Stage Improvement Program (MSIP). This program was initiated in June 1982, and FY 1988 saw the completion of development of all MSIP modifications. Delivery of the first MSIP F-15 aircraft was made in June 1985. Among the enhancements being made to the aircraft are avionics changes to expand air combat identification capability, an updated electronic warfare suite, and incorporation of improved communication/identification equipment. Also, improvements are being made to enhance the secondary air-to-ground role for all F-15 versions other than the F-15E; these latter modifications are tied to development of the Strike Eagle.

F-15S/MTD Program

The prototype F-15B, in a modified form, was used to develop STOL (Short Take-off and Landing) and advanced maneuvering capabilities and technologies. As part of a two-phase flight-test program, the F-15S/MTD made its first flight on September 7, 1988, using all S/MTD systems other than the thrust vectoring/thrust reversing nozzles. The first flight using the 2D nozzles took place on May 10, 1989. The F-15S/MTD completed its assigned program of flight tests in August 1991.

F-15 Almost A Wild Weasel/SEAD Aircraft

The Air Force was to use the F-15C as a replacement for the F-4G in the Manned Destructive Suppression of Enemy Air Defenses (MDSEAD) role. The Wild Weasel system was developed to automatically detect, identify, locate, engage, and destroy hostile radars. The F-15E's abilities to locate and attack ground targets,

especially through the use of LAN-TIRN, FLIR, and new APG-70 radar, make the idea of an F-15E derivative attractive, and in mid-1992 the Air Force unveiled a nine-year, \$500 million plan to upgrade McDonnell Douglas F-15Es with a Wild Weasel/SEAD capability. But in October 1993, the Air Force decided to use F-15Cs as a cost saving measure.

This program entered the demonstration/validation phase in July 1994, with the award to McDonnell of a \$21 million Air Force contract. In April 1994 McDonnell selected TRW and Litton to provide their HARM targeting device, the Precision Direction Finding (PDF) unit, for this program. But in August 1994 the Air Force decided to focus its MDSEAD efforts on the F-16, and work on the F-15C was shelved.

APG-63 (V)1/2/3/4 Radar Upgrades and Other Improvements

In July 1997, an F-15 first flew with the upgraded Raytheon (Hughes) APG-63 (V)1 radar. This version includes some APG-70 tactical software. Production of the new radar began in September 1999. It is also available to foreign users for retrofit.

In late 1999 the Air Force also announced that a squadron of F-15Cs was being equipped with the (V)2 model. This is essentially the same as the (V)1, but with an active electronically scanned array (AESA). This AESA is related to the one used on the F/A-18E/F's Raytheon APG-79. A total of 18 F-15Cs were fitted with the new radar, with the last three delivered in December 2000. Development costs for the (V)2 are given as \$277 million, while conversions cost just under \$5 million per shipset.

The (V)3 version is an improved AESA version, selected by Singapore for its F-15SGs. It takes the (V)2

and adds Transmit/Receive hardware from the APG-79 (used on the F/A-18E/F). It will also be retrofitted to up to 160 USAF F-15Cs (on top of the 18 Cs with (V)2s) and 48 additional Air National Guard F-15Cs at a rate of 6-8 per year. Seven were funded in FY 2007, while 16 were authorized in FY 2008 — eight USAF, eight ANG. By FY 2012, 98 radars were programmed for funding through FY 2017.

In April 2010 Boeing rolled out the first C model upgraded with the (V)3 radar. By that time 14 ANG and 10 USAF planes were on contract. By March 2014 60 aircraft had received the new radar. In November 2015 Raytheon announced the delivery of the 200th (V)3 (counting all customers).

All USAF F-15s are also getting a fifth generation electronic warfare suite called Eagle Passive/Active Warning Survivability System (EPAWSS). This \$7.6 billion program will provide retrofits for 413 C and E models.

As of FY 2015 development funding for EPAWSS was covered in a new RDT&E line, below. In October 2015 Boeing and BAE Systems were selected by the Air Force to act as contractors. In November 2016 they received a \$478 million contract to begin full-scale development. EPAWSS passed its critical design review in February 2017.

APG-82 Radar Upgrade for F-15E

Raytheon is also developing a (V)4 model, later re-designated APG-82 (V)1. This is another AESA version with greater capabilities than the (V)2/3, particularly with newer transmit/receive module technology. It uses some back-end processor technology from the F/A-18E/F's APG-79 AESA. The Air Force is

planning to upgrade 217 of its 222 Strike Eagles with the APG-82.

In October 2008 Boeing was awarded an SDD contract to begin work on this upgrade, known as the Radar Modernization Program (RMP). The first F-15E flew with the -82 radar in January 2011.

Export Status

Israel

Israel's first order for the F-15 was placed early in 1976 and covered 23 F-15As and two F-15Bs, although this was later changed to all F-15As. These were delivered by 1978. Orders for a total of 26 F-15C/Ds were placed in 1980 and 1982, and these were delivered by 1987. Israel requested five replacement F-15Ds in late 1988, and the country received 25 more F-15A/Bs from USAF inventories during the war with Iraq.

Saudi Arabia

Under the 1979 PEACE SUN agreement, Saudi Arabia purchased 60 F-15 fighters, 45 C versions and 15 D versions. A further two C versions were purchased in 1981. The Camp David agreements allow only 60 F-15s to be operated at one time, so the two later F-15C were stored out-of-country. All were delivered by May 1983. A 1987 follow-on order of an additional 12 was approved, for a total Saudi buy of 55 Cs and 19 Ds.

During the war with Iraq, the US Air Force transferred 24 F-15C/Ds to Saudi. In August 1991, Congress directed the Air Force to use the cash from the sale—about \$615 million—to buy six F-15Es. Congress later added money for three more F-15Es for Gulf War attrition. The Air Force said it did not need the planes, and was planning to use the money for general fleet maintenance. It got them anyway.

Japan

As a replacement for its 220 Mitsubishi-built F-4 Phantoms, Japan decided to procure F-15 Eagles. This program began with FY 1978 procurement of 23 aircraft. All 223

LRIP approval was granted in September 2011. The first LRIP contract covers six units. The second LRIP, signed in July 2012, covers 10 units. By March 2014 eight had been installed.

aircraft were to have been funded through FY 1990, but funding has been stretched out (see Funding, below), and total procurement cut to 213 aircraft (all funded through FY 1996). An initial 14 aircraft (2 single-seat C/J models and 12 twin-seat DJ) were purchased from McDonnell through FMS channels, and eight were CKD kits provided by McDonnell, but procurement thereafter has been from Mitsubishi Heavy Industries, the licensed producer in Japan.

Other Japanese contractors on the project are listed under Subsystems, above (Teal Group retains extensive files on Japanese F-15 contractors, and clients are encouraged to call for access to these).

F-15 Line Saved by Saudi Sale Approval

In September 1992 President Bush approved the long-awaited sale of 72 F-15s to Saudi Arabia. The deal, valued at \$5 billion, saved the F-15 production line from imminent shutdown.

The US agreed to sell Saudi Arabia a new variant of the F-15 known as the F-15XP (later re-designated F-15S). Based on the F-15E airframe, the F-15S has mostly F-15C/D systems. It uses the F-15E's APG-70 radar, but this was "detuned" to APG-63 standard, and some F-15E software and ECM equipment was deleted. A total of 24 aircraft were configured for air defense and 48 for air-to-ground missions. The aircraft were to be delivered between 1995 and 1998, but stretch-outs delayed the final delivery until 2000. In Saudi service, the F-15S is unofficially known as the Beagle, for Bomber Eagle.

New USAF C/D Wing?

In May 2017, the Air Force announced that it was considering a re-wing program for its C/D fleet. This would add a wing with capabilities and weapons stations like the E model wing, but not the same wing.

On December 23, McDonnell Douglas received a \$122 million FMS contract from the USAF for long-lead items for the sale. This contract represented the first disbursement of funds for the program. The money came just in time to save the McAir production line, although about 20% of the suppliers had been dropped from the program.

The Saudi purchase put an end to months of McDonnell Douglas's begging. The company mounted a major lobbying effort under the "US Jobs Now" banner, complete with numerous press releases explaining how and where it was laying off workers. According to several arms control groups, the company exaggerated the firings to gain congressional sympathy for the sale.

Israel Buys F-15E Variants

In late 1993 the Israeli Air Force selected 21 F-15I variants of the F-15E Strike Eagle, locally designated Thunder, for the country's next fighter buy. According to Israeli and Pentagon, sources, Israel will get a better version of the F-15E than Saudi Arabia was allowed to buy last year. Cost estimate for the 21 aircraft is \$1.76 billion.

In November 1995 Israel firmed up options on four more F-15Is. Israel also received used USAF Lockheed F-16s. The first Israeli F-15I flew in September 1997, and was presented to Israel in November.

Korea: Fourth Export Customer and Production Line Savior

In April 2002 the Republic of Korea became the fourth F-15 export

customer, thereby saving the production line from imminent doom. After a hard fought competition (the runner up was Dassault's Rafale), the country ordered 40 F-15K models worth an estimated \$4 billion. Deliveries began in late 2005 and were completed in October 2008.

South Korea has chosen the General Electric F110 engine, a first for the F-15, for the first 40 planes. These were license produced by Samsung Techwin, which built Pratt F100s for the country's F-16 fleet. Korea is also getting the APG-63(V)1 (without AESA), and Lockheed Martin's TigerEyes targeting system. The K model is also the first F-15 with a Harpoon/SLAM missile capability.

In April 2008 South Korea added 21 planes to its order, for a total of 61. The first of these flew in April 2010. The first three arrived in September 2010, and the last was delivered in April 2012. This batch uses Pratt & Whitney F100-PW-229-EEP engine.

Singapore Signs for 24, And More Covertly

In September 2005 Singapore selected the F-15SG for its A-4 replacement requirement. The order included 12 firm and eight option planes, with the firm aircraft scheduled for delivery in 2009. They also selected GE F110 engines and the APG-63 (V)3 AESA radar.

In October 2007 Singapore exercised its options and added another four firm orders, raising the total order to 24 planes.

The first five SGs arrived in Singapore in April 2010. The last of the 24 were delivered in October 2012.

From there, Singapore ordered more SGs, but nobody knows how many. In August 2014, Boeing registered eight more with the FAA, and these have already been delivered. There is some evidence that another eight have been acquired, raising the total to 40. There was some confirmation of this in March 2016 when Singapore announced that a second F-15 squadron had been established.

New Saudi Deal for 84 F-15SAs

In 2010 and 2011, plans for another Saudi F-15 buy began to take shape, and a firm contract was signed

in December 2011. This followed a letter of agreement Defense Secretary Robert Gates had delivered to Saudi Arabia during his visit there in April. The order covers 84 aircraft valued at \$11.4 billion.

The aircraft will be equipped with Raytheon's APG-63(V)3 AESA radar and GE F110-129 turbofans. The planes will also come with Lockheed Martin's AAS-42 TigerEye IRST, among other advanced equipment.

The F-15SA is also the first version of the Eagle with a fly-by-wire flight control system and the first with BAE System's digital electronic warfare system (DEWS), replacing the previous Northrop Grumman ALQ-135 system.

Saudi Arabia has also signed for an upgrade package that will bring its 68 older F-15Ss to the new SA configuration. That includes new GE engines.

The first F-15SA made its first flight in February 2013. Deliveries were to run between 2015 and 2019. However, even though aircraft had been built, actual deliveries did not begin until December 2016, with the arrival in Saudi Arabia of two remanufactured jets and two new SAs.

Foreign User Upgrades

Saudi MSIP, Re-Engining

The first Saudi upgrade program was basically the MSIP. It involved the addition of the AN/APG-70 radar, an upgraded central computer system, and replacement of the armament control system.

In mid-1998, the Saudis began an upgrade program designed to bring their F-15S fleet to almost-F-15E standard. This program provided the Saudis with weapons retrofit kits, allowing three bomb racks to be fitted to each conformal fuel tank.

In September 2007 the RSAF also announced a re-engining program that will see 70 F-15Ss getting F110 engines. Most of the work will be performed in-country. With the sec-

ond batch of engines ordered in September 2008, the RSAF has ordered 156 F110s.

In April 2012 the RSAF also signed for Lockheed Martin Sniper targeting pods for its F-15Ss, along with IRSTs and new datalinks. At the same time BAE Systems was given a contract for digital electronic warfare systems (DEWS) and common missile warning systems (CMWS). All told, this new F-15S upgrade was worth over \$1 billion.

Israeli Upgrades

Between 1995 and 2005 Israel upgraded about 50 F-15B/Ds through the Baz 2000 program. This added new EW suites, mission computers, GPS-based nav systems, and other features.

In 2001 Israel began production of its Avionics Upgrade Program (AUP) package for its A/B/C/D fleet. This \$100 million effort gave these types greater commonality with the F-15I fleet. The upgrade was completed in 2004 and focuses on avionics and precision weapons, but not radars. It is broadly modeled on the USAF MSIP effort.

In early 2015 Israel announced that Raytheon's APG-82(V)1 AESA radar would be fitted to the F-15I fleet. It will also receive new weapons and updated avionics.

Japanese Upgrades

Japan has modified its F-15J fleet with engine upgrades, bringing the F100s to F100-220E (E = Equivalent) standard, with a digital engine

control system. Another program, begun in 1997, involves radar and computer upgrades, bringing the APG-63 radar to (V)1 standard. The radar modification program will cost about ¥2 billion (\$19.2 million) per aircraft. This upgrade also includes EW suite improvements, including an ALQ-8 ECM system.

The first modified planes were delivered in December 2000, while test

flights with the upgraded radar began in 2003. The upgraded F-15s will serve as escorts for F-2 squadrons. Plans call for 26 upgrades in the current five-year budget period, with two funded in 2004 and six in 2005, and the ultimate goal is to improve radars on 80 F-15s. As of 2014, the number is still unclear, with the upgraded model now known as the F-15MJ. This will include a new EW

suite, the AAM--4 and -5 missiles, and other improvements. One option considered was the APG-63(V)3 AESA radar, but the (V)1 mechanically scanned version was chosen instead.

In 2007 Japan decided to convert an unknown number of F-15Js to reconnaissance duties. These use Lockheed Martin Phoenix Eye SAR pods.

Funding History

RDT&E (\$ mns)	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18*
PE# 0207134F F-15E Squadrons/Programs	203.8	240.0	201.0	184.7	102.3	227.1	233.9	210.0	356.7	320.3
PE# 0207171F F-15 EPAWSS	—	—	—	—	—	—	—	174.4	256.7	209.8
Procurement (\$ mns)	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18*
Air Force Aircraft Procurement BA 5: Modification of Aircraft										
F-15	49.2	152.1	303.8	255.6	190.2	346.6	498.3	596.9	105.7	417.2
Air Force Aircraft Procurement BA 7: Aircraft Support Equipment and Facilities										
F-15 Post Production Supp.	20.1	15.7	17.5	2.1	2.4	2.4	1.1	3.2	3.0	20.0
National Guard and Reserve Equipment BA 5: Modification of In-service Aircraft										
Air National Guard										
F-15	22.3	—	—	22.5	53.6	37.6	232.3	166.2	0.6	1.7
FMS (\$ mns)	FY87	FY88	FY89	FY90	FY91	FY92	FY93	FY94	FY95	FY96
Foreign Procurement Funding via FMS										
Fighter Aircraft F-15A#	329.7	—	—	—	—	—	—	—	—	—
(quantity)	(25)	—	—	—	—	—	—	—	—	—
Fighter Aircraft F-15C#	1,400.3	332.0	—	545.5	—	—	—	—	—	—
(quantity)	(67)	(9)	—	(20)	—	—	—	—	—	—
Fighter Aircraft F-15D#	694.4	112.6	133.9	109.7	—	—	—	—	—	—
(quantity)	(35)	(3)	(5)	(4)	—	—	—	—	—	—
Fighter Aircraft F-15S/I	—	—	—	—	—	—	4,787.2	839.6	—	166.5
(quantity)	—	—	—	—	—	—	(72)	(21)	—	(4)
Japan (¥ billions)	FY87	FY88	FY89	FY90	FY91	FY92	FY93	FY94	FY95	FY96
Procurement										
Fighter F-15J/DJ	106.1	94.3	n/a	n/a	112.0	n/a	n/a	n/a	n/a	n/a
(quantity)	(12)	(12)	(11)	(10)	(8)	(7)	(4)	(4)	(5)	(4)

*budget request
#through FY87.

Teal Group Evaluation

A Remarkable Ability to Cheat Death

The F-15 has been among the most successful US fighter programs, and one of Boeing's most lucrative McDonnell legacy programs. The

first two sales to Korea were hugely important. The large revenue stream attached helped justify Boeing's McAir acquisition, and saved the company from its post-JSF loss dollars. The first sale came with

heavy-handed lobbying, but it affirmed the US's reliance on its superpower status as a way to sell weaponry.

Even better news: the F-15K, and its cousins the F-15SG and F-15E+

Super Eagle, rejuvenated the product, with new systems, weapons, and sensors. And the F-15K was not an orphan plane. It gave this veteran jet another two decades on the market, a fact confirmed by 2005's Singapore victory. Both customers increased their orders, to 61 and 32, respectively.

And this year, Qatar joined the club, taking production into the 2020s. Our forecast assumes they get 36, but they are approved for up to 72.

The reborn F-15 has been very bad news for the Rafale and Eurofighter. It's a heavyweight strike platform that kept the high end of the market (other than Egypt, and perhaps India) largely in US hands until F-35 arrives. However, South Korea's rejection of the Silent Eagle proposal killed that idea.

Right now, our forecast assumes that someone will buy 18 more F-15s, and these are in our Undetermined forecast line. If it isn't a follow-on Qatar buy, it could be more

for Saudi Arabia, or even for Singapore. But Israel, South Korea, and Japan have moved on to the F-35.

Back at Home: Upkeep for an Amazing Legacy

Today, the Air Force has 350 F-15Cs and 222 Es. The service has begun a "buy what you can" strategy, with money used for the 178 APG-63 (V)2/3 radar upgrades, F100-220E engine retrofits (now planned for 179 planes), ALQ-135 countermeasures, more JTIDS, and numerous other improvements. EPAWSS, a new EW system for much of the fleet, has emerged as one of the biggest programs.

Many C models will find themselves doing an attack mission, with appropriate upgrades. Many are gettingIRST pods. Many may get new wings. In the meantime, the Air Force is retiring about 170 C/Ds.

Ultimately, at least 100 Cs will get the (V)2/3 AESA radar (98 have been funded through FY 2017). These will stay in service through 2025 (and

probably 2030) as the core "Golden Eagle" force. So will 48 Air National Guard planes, which will also get the (V)3. With the F-22 dead, the Air Force can ask for F-15 AESA radar funding without any fear of it jeopardizing its highest priority.

As for the Strike Eagle, Boeing would like a full F-15E SLEP (probably based on the F-15K), which it may get. At the very least, it will get the new APG-82 AESA radar. This will add technology from the Super Hornet's AESA. The LANTIRN pod will be replaced by Sniper XR or Litening II. And GE is still pushing its F110 re-engining effort. But all of this depends on defense budget constraints, F-35 funding, and other factors.

Our Funding Forecast has lots of cash, including well over \$500 million for the radar work. And the 220+ F-15Es will stay in service through 2035, and probably beyond.

Funding Forecast

RDT&E (FY17\$ mns)	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27
PE# 0207134F F-15E Squadrons	320.3	251.0	209.0	255.0	245.0	210.0	160.0	130.0	125.0	155.0
PE# 0207171F F-15 EPAWSS	209.8	138.0	68.0	22.0	40.0	15.0	5.0	—	—	—
Procurement (FY17\$ mns)	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27
Air Force Aircraft Procurement BA 5: Modification of Aircraft										
F-15	417.2	587.0	785.0	840.0	556.0	380.0	325.0	300.0	250.0	205.0
National Guard and Reserve Equipment BA 5: Modification of In-service Aircraft										
Air National Guard										
F-15	10.0	26.0	52.0	29.0	29.0	110.0	240.0	280.0	250.0	220.0

Production Forecast

User (Variant)	Through 2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total
McDonnell Douglas/Boeing												
Israel (F-15A/B)	21	—	—	—	—	—	—	—	—	—	—	21
Israel (F-15C)	18	—	—	—	—	—	—	—	—	—	—	18
Israel (F-15D)	13	—	—	—	—	—	—	—	—	—	—	13
Israel (F-15I)	25	—	—	—	—	—	—	—	—	—	—	25
Japan (F-15J)	2	—	—	—	—	—	—	—	—	—	—	2
Japan (F-15DJ)	12	—	—	—	—	—	—	—	—	—	—	12
Qatar (F-15QA)	—	—	—	12	18	6	—	—	—	—	—	36
Republic of Korea (F-15K)	61	—	—	—	—	—	—	—	—	—	—	61

Saudi Arabia (F-15C)	55	—	—	—	—	—	—	—	—	—	—	55
Saudi Arabia (F-15D)	19	—	—	—	—	—	—	—	—	—	—	19
Saudi Arabia (F-15S)	72	—	—	—	—	—	—	—	—	—	—	72
Saudi Arabia (F-15SA)	51	15	15	3	—	—	—	—	—	—	—	84
Singapore (F-15SG)	32	—	—	—	—	—	—	—	—	—	—	32
USAF (F-15A)	365	—	—	—	—	—	—	—	—	—	—	365
USAF (F-15B)	59	—	—	—	—	—	—	—	—	—	—	59
USAF (F-15C)	409	—	—	—	—	—	—	—	—	—	—	409
USAF (F-15D)	61	—	—	—	—	—	—	—	—	—	—	61
USAF (F-15E)	236	—	—	—	—	—	—	—	—	—	—	236
Undetermined (F-15)	—	—	—	—	—	10	8	—	—	—	—	18
Subtotal	1,511	15	15	15	18	16	8	—	—	—	—	1,598
Mitsubishi Heavy Industries												
Japan (F-15J)	163	—	—	—	—	—	—	—	—	—	—	163
Japan (F-15DJ)	36	—	—	—	—	—	—	—	—	—	—	36
Subtotal	199	—	—	—	—	—	—	—	—	—	—	199
Total	1,710	15	15	15	18	16	8	—	—	—	—	1,797

