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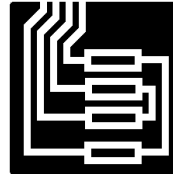
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General Dynamics F-111 Series - Archived 2/2007

Outlook

- Some modifications under way for RAAF F-111s
- RAAF F-111s are to remain in service until at least 2010

Note: Icons indicate area(s) of current and potential retrofit/modernization activity



Orientation

Description. Dual-seat, twin-engine multimission aircraft produced in various configurations, including a dedicated fighter, a fighter/bomber, and an electronic warfare platform.

Current Status. Series production was completed in 1976. Grumman EF-111 conversions were completed in 1985.

Total Produced. A total of 562 F-111s of all types was produced.

Application. F-111, tactical strike; EF-111, standoff electronic warfare.

Price Range. F-111 cost per aircraft, \$14.6 million (1973 figure). EF-111A modification: cost per aircraft, approximately \$21 million.

Contractors

Lockheed Martin Aeronautics Company, <http://www.lockheedmartin.com>, Lockheed Boulevard, Fort Worth, TX 76108 United States, Tel: + 1 (817) 777-2000, Fax: + 1 (817) 777-2115, Prime

Pratt & Whitney, <http://www.pratt-whitney.com>, 400 Main Street, East Hartford, CT 06108 United States, Tel: + 1 (860) 565-4321, Email: info@pw.utc.com (TF30 Turbofan)

NOTE(S): The Fort Worth unit of Lockheed Martin Aeronautics Company was formerly the Fort Worth Division of General Dynamics Corp, which produced the F-111.

Technical Data

(F-111)

	<u>Metric</u>	<u>U.S.</u>
Dimensions		
Length overall	22.40 m	73.47 ft
Height overall	5.22 m	17.12 ft
Wingspan, spread	19.20 m	62.98 ft
Wingspan, fully swept	9.74 m	31.95 ft
Weight		
Empty	21,537 kg	47,481 lb
Max TOW	45,359 kg	9,998 lb
Performance		
Max speed at height	Mach 2.5	
Range with max internal fuel	4,707+ km	2,540+ nm
Service ceiling	18,000+ m	59,040+ ft
Propulsion		
Two Pratt & Whitney TF30-P-100 turbofans		
Thrust (each), with afterburning	111.5 kN	25,067 lbst

Armament. One M61 multibarrel 20mm gun and/or bombs can be carried in an internal weapons bay. Three “wet” attachment points are under each wing. The F-111 can carry AIM-9L/M Sidewinder air-to-air missiles, Durandal runway cratering bombs, and Gator mine systems.



GENERAL DYNAMICS F-111

Source: U.S. Air Force

Program Review

Background. Submitted by General Dynamics Corp, the F-111 design was the winner in U.S. Defense Secretary Robert McNamara's Tactical Fighter, Experimental (TFX) competition of the early 1960s. The original concept of the TFX involved a multimission aircraft for quantity procurement by both the Air Force and the Navy. The Pentagon authorized work on an F-111A version for the Air Force and an F-111B variant for the Navy.

Early indications were that a sizable foreign market would develop for the F-111. However, rising development costs and changing political considerations forced the cancellation of a 50-unit British order in 1968. Australia ordered 24 F-111Cs in 1963, but deliveries were delayed due to extensive modifications and rising costs. No other export orders materialized.

Avionics Modernization Program. The U.S. Air Force F-111 Avionics Modernization Program (AMP) was designed to improve the reliability and maintainability of all F/EF-111 models. This effort involved the integration of off-the-shelf technology rather than the development of new equipment. The following systems were upgraded: the inertial navigation system, the terrain following radar, the attack radar, the Doppler radar, and controls and displays. NAVSTAR Global Positioning System (GPS) equipment was installed (the GPS modification was funded separately from the main AMP).

Contractors for the AMP were as follows:

Lockheed Martin

Systems integration and modification kits; attack radar sets

Gould Inc

Combined altitude radar altimeter

Northrop Grumman

Systems integration and modification kits

Litton Industries

Inertial navigation system

Rockwell Collins

Integrated Communication Navigation Identification Set (ICNIS)

Astronautics Corp Kearfott

Weapons navigation computer; advanced micro-electric converter

Honeywell Defense Avionics Systems Division

Multifunction display set

Teledyne Inc

Doppler radar sets

Texas Instruments

Terrain following radar

TRW Inc

Software

AMP kit installations began in FY86 and have been completed. In 1983, General Dynamics was selected by the Air Force as AMP integrator for the FB-111A. Grumman was chosen as integrator for the F-111A, F-111E, and EF-111A in 1986. The F-111D was dropped from the program in March 1990, pending its retirement. Avionics modernization for the F-111F was conducted under the Pacer Strike effort. A Pacer Strike prototype flew for the first time in July 1992.

Rockwell was awarded a USAF contract with an initial value of \$69 million for Pacer Strike work in 1989. Rockwell's Autonetics Marine and Aircraft Systems Division acted as team leader on the Pacer Strike program. The division was also responsible for avionics and weapon delivery, development of the operational flight program upgrade, and integration and testing. Rockwell's North American Aircraft organization performed airframe modifications, and Rockwell Collins provided and supported the integration of the GPS equipment. TRW modified the ground equipment used for software development for the operational flight program. Although 58 modification kits were delivered, only 29 F-111Fs were modified.

Variants

F-111A. Initial version produced for the U.S. Air Force. It was powered by Pratt & Whitney TF30-P-3 engines (development models used TF30-P-1 engines). Production deliveries began in October 1967, and 159 were produced.

YF-111A. Two fighters were completed for a subsequently canceled British order under the F-111K

designation. They were used by USAF for research and development. These two aircraft are included in the F-111A production total.

F-111B. U.S. Navy version. It was powered by TF30-P-12 engines (development models used TF30-P-1 engines). The F-111B ran into trouble early in the program. It was too heavy for its role as a

carrier-based fleet defense fighter, and was unable to meet its performance requirement. Only seven were built, including five development aircraft. The effort was canceled in 1968.

F-111C. Strike aircraft built for Royal Australian Air Force. It was powered by TF30-P-3 engines, and equipped with Mk I electronics. Twenty-four were built. Four F-111As were later purchased from the USAF inventory and refurbished to the C configuration. In the early 1980s, RAAF F-111s were fitted with Ford Aeronutronic's AVQ-26 PAVE TACK target acquisition and tracking system.

RF-111C. Four F-111Cs modified by the Royal Australian Air Force to provide an increased tactical reconnaissance capability. These aircraft, designated RF-111C, are fitted with a Fairchild low-altitude panoramic camera, a Honeywell AAD-5 infrared line scanner, and a Cardion Electronics television/viewfinder.

F-111D. Improved version of the F-111A for the U.S. Air Force. It was equipped with the Mk II avionics package consisting of a digital computer, an APQ-30 attack radar, an inertial navigation system, Doppler navigation equipment, and head-up displays. The F-111D was powered by the uprated Pratt & Whitney TF30-P-9 engine.

The Mk II avionics proved to be extremely costly and troublesome. Only 96 F-111Ds were built.

F-111E. Waiting for the F-111D, the U.S. Air Force turned to the F-111E, fitted with the original Mk I avionics and the TF30-P-3 engines. A total of 94 F-111Es was manufactured.

F-111F. This variant contained an avionics suite less complex than the Mk II package but more advanced than F-111A/E avionics. The F-111F also used the improved TF30-P-100 engine. A total of 106 aircraft was built.

F-111G. Conversion of FB-111A (see below) from SAC to TAC service. It was used in a training role. Deliveries to TAC began in 1990. Conversion of 29 aircraft was completed before the program was terminated. This series was retired in July 1993. A total of 5,728 sorties and nearly 14,000 flight-hours were accumulated in training over 400 aircrews. The F-111G was replaced in the training role by the F-111E. Fifteen surplus F-111Gs were purchased by Australia in 1994.

In 1999, Australia purchased an additional 11 ex-USAF F-111Gs to use as spares sources for its F-111 fleet.

FB-111A. Strategic bomber version of the F-111. It was equipped with the Mk IIB avionics package and

TF30-P-7 engines. Deliveries of this variant began in 1969. A total of 76 aircraft was produced.

EF-111A. In January 1975, the U.S. Air Force awarded Grumman Corp, Bethpage, New York, an \$85.9 million contract to convert two F-111As to an EF-111A Raven electronic warfare configuration. Including these two prototypes, Grumman eventually converted 42 aircraft to the new standard. The EF-111As replaced the service's aging EB-66s. This effort involved installation of the Eaton AIL ALQ-99E tactical jamming system, the Lockheed Sanders ALQ-137 electronic countermeasures set, and the Dalmo Victor ALR-62 terminal threat warning system.

Exterior modifications to the aircraft included a 16-foot-long, canoe-shaped radome mounted beneath the fuselage to house the jamming transmitters of the ALQ-99E system. A new tail fin, topped with a pod, enclosed receiving antennas and associated equipment. The first production EF-111A was delivered to the Air Force in the fall of 1981.

Australian F-111 AUP. The Royal Australian Air Force has completed an avionics modification program for its F/RF-111Cs. The goal of the effort, known as the Avionics Update Program (AUP), was to raise the aircraft mean time between failure rate from 3.6 hours to 20.9 hours, as well as to ensure that the aircraft will remain operational beyond the year 2010. (However, the aircraft may now be withdrawn from service as early as 2010.)

The program mainly involved replacing the existing analog systems of the aircraft with digital equipment. The systems that were digitized included the attack and terrain following radars, the inertial navigation unit and its associated computer and displays, and the ballistics computing controls (with display system) for weapon delivery. Additions included a digital flight control system, GPS equipment, a high-frequency radio, secure voice communications, and a data transfer system. The upgrade was patterned after the U.S. Air Force's Avionics Modernization Program.

The Australian government awarded a \$160 million contract in 1990 for the program to a team led by Rockwell International Corp. However, Boeing later became responsible for the program, due to its acquisition of several Rockwell divisions. In addition to Boeing, the team included Marconi Aerospace Systems, Wayne, New Jersey; Smiths Industries, Grand Rapids, Michigan; Lockheed Martin Federal Systems, Owego, New York; and Lockheed Martin Data Systems, Sarasota, Florida. Honeywell, General Electric, and Texas Instruments were other suppliers.

Principal Australian companies involved included Hawker de Havilland for airframe modification design

and kit installations; Honeywell Ltd Australia for multifunction display sets, standard navigation sets, and maintenance training; British Aerospace Australia Ltd

for the mission computer's software development; and Hadland Photonics for an airborne video recorder system.

Funding

The U.S. Air Force last received funding for its EF-111 modifications line item in FY97.

Milestones

<u>Month</u>	<u>Year</u>	<u>Major Development</u>
Nov	1962	USAF awarded development contract to General Dynamics for TFX
Dec	1964	First flight of F-111A
May	1965	Initial flight of F-111B
Jul	1967	First flight of FB-111
Oct	1967	F-111A production deliveries begun
Jul	1968	F-111B canceled
May	1973	First flight of F-111F
Jan	1975	Grumman awarded EF-111A conversion contract
	1976	Production of airframes ceased
Mar	1977	First flight of EF-111A
Jul	1992	First flight of F-111F Pacer Strike prototype
Jul	1993	F-111G retired from USAF service
Jul	1996	F-111 retired from USAF service
May	1998	EF-111 retired from USAF service

Worldwide Distribution

<u>Region</u>	<u>Country</u>	<u>Total</u>	<u>Variant</u>	<u>Avg. Age (Yrs)</u>
<u>Australia/ New Zealand</u>	Australia	13	F-111C	33
		4	F-111C	37; converted in 1982
		7	F-111G	35; converted in 1990-91
		4	RF-111C	33; converted in 1979-80

Identified R&M Contractors

Electronics

BAE Systems Australia	http://www.baesystems.com.au , Taranaki Road, Edinburgh Parks, Edinburgh, 5111 SA, Australia, Tel: + 61 8 8480 8888, Fax: + 61 8 8480 8800, Email: media@baesystems.com , (NVG Compatible Lighting System Trial Modification)
Elta Systems Group	http://www.iai.co.il , 100 Yitzchak Hanasi Blvd, PO Box 330, Ashdod, 77102 Israel, Tel: + 972 8 857 2312, (Supplying Jamming Pods for RAAF F-111s)
Terma A/S	http://www.terma.com , Hovmarken 4, Lystrup, DK-8520 Denmark, Tel: + 45 8743 6000, Fax: + 45 8743 6001, Email: terma.dk@terma.com , (Supplying Electronic Warfare Management Systems for RAAF F-111s)

Armament

Boeing Australia Limited	http://www.boeing.com.au, 363 Adelaide Street, PO Box 767, Brisbane, 4001 QLD, Australia, Tel: + 61 7 33063000, Fax: + 61 7 33063114, (Aircraft Modifications to Integrate AGM-142E on RAAF F-111Cs)
Precision Guided Systems US (PGSUS) LLC	Orlando, FL United States, (Supplying AGM-142E Air-to-Surface Missiles for RAAF F-111Cs)

Opportunities

The U.S. Air Force retired the F-111 fighter/attack aircraft in July 1996, and the EF-111 electronic warfare aircraft in May 1998. The Royal Australian Air Force (RAAF) is now the sole operator of the F-111, with 28 aircraft in its active fleet. The RAAF F-111s are planned to remain in service until at least 2010.

In August 2001, Boeing signed contracts worth \$326 million to provide support and upgrades for the RAAF's F-111s. The company will design, test, and incorporate upgrades for the aircraft under the F-111 Block Upgrade Program.

AIRFRAME

The RAAF's active fleet of 28 F-111s has been passing through a new test facility, called the Cold Proof Load Test facility, located at RAAF Base Amberley in Queensland. This is part of an effort to ensure the operational availability of the F-111s until their planned retirement date.

The facility was established to provide the environment, machinery, and controls that are required to demonstrate the F-111's structural integrity by proving the absence of metal flaws in its aerodynamic stress structure. If an aircraft does not suffer any damage during the test, it is cleared for 2,000 flight hours.

ELECTRONICS

EW Systems. In early 2000, the RAAF selected the Israeli company Elta and an Australian subcontractor, Vision Abell, to supply Elta EL/L-8222 electronic warfare jamming pods for the service's F-111s. The Elta pods include a digital RF memory and are software-reprogrammable. Vision Abell has since become part of Tenix Defence.

In late 1999, the RAAF awarded a \$4.2 million contract to the Danish company Terma to supply electronic warfare management systems (EWMS) for installation on F-111s. The EWMS will manage the F-111's EL/L-8222 jamming pod, ALR-62 radar warning receiver, and countermeasures dispenser system.

NVG Compatible Lighting System. In July 2003, BAE Systems Australia was awarded a contract by the British company Oxley Avionics to perform a trial modification of an RAAF F-111 cockpit and external lighting system to be NVG (night vision goggle) compatible. Under the contract, BAE will undertake the modification and installation of Oxley components.

The converted cockpit will enable the RAAF to develop requirements and procedures for a potential program to modify its entire fleet of F-111s.

ALR-2002. In September 2000, the BAE Systems ALR-2002 radar warning receiver completed its first series of test flights aboard an RAAF F-111. The ALR-2002 has been designed to meet the operational requirements of the RAAF's F/RF-111 strike aircraft, F/A-18 tactical fighters, and various transport aircraft and helicopters.

ARMAMENT

AGM-142E. RAAF F-111Cs are being equipped with AGM-142E standoff air-to-surface missiles. The AGM-142E is produced by PGSUS LLC, a joint venture of Rafael and Lockheed Martin. Aircraft modifications needed to integrate the AGM-142E weapon system are being incorporated by Boeing Australia Ltd.

Formal introduction of the AGM-142E into operational service is scheduled for early 2006.

FI's Opportunity Outlook

Program	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
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ELECTRONICS

EW Systems

In Progress +====> 28 F/RF-111 (Australia)

NVG Compatible Lighting System

In Progress +> 1 F-111 (Australia)

Speculative <=====> 27 F/RF-111 (Australia)

ALR-2002

Speculative <=====> 28 F/RF-111 (Australia)

Program	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
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ARMAMENT

AGM-142E

In Progress +> 17 F-111C (Australia)

Program	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
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