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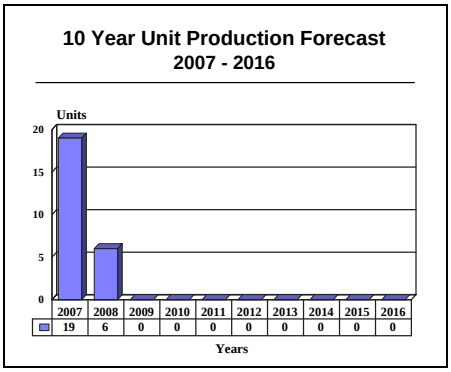
Boeing/BAE Systems Harrier II - Archived 02/2008

Outlook

- British RAF Harrier GR7s and GR7As are being modified to the new GR9 and GR9A configurations
- A further upgrade for RAF Harriers is contemplated



Orientation

Description. Single-engine, single- and twin-seat, transonic, V/STOL (vertical/short takeoff and landing) ground attack aircraft.

Sponsor. The U.S. Naval Air Systems Command, Washington, DC, USA (AV-8B), and the U.K. Ministry of Defence, London, U.K. (Harrier GR5/GR7). For the Harrier II Plus, the sponsors were the governments of Italy, Spain, and the U.S.

Status. New production has been completed. New production included 232 AV-8Bs, 24 TAV-8Bs, 62 Harrier GR5s, 34 Harrier GR7s, 13 Harrier T10s, 12 EAV-8Bs, and 51 Harrier II Plus aircraft.

Total Produced. Boeing/McDonnell Douglas and BAE produced 428 Harrier II aircraft.

Application. Close air support; tactical ground attack.

Price Range. Remanufactured Harrier II Plus, $25 million in 2003 U.S. dollars.

AV-8B HARRIER II

Source: Boeing

Boeing/BAE Systems Harrier II

Contractors

Prime

BAE Systems Air Systems	http://www.baesystems.com, Warton Aerodrome, Preston, PR4 1AX Lancashire, United Kingdom, Tel: + 44 772 633333, Fax: + 44 772 634724, Email: media@baesystems.com, Prime
Boeing Integrated Defense Systems	http://www.boeing.com, PO Box 516, St Louis, MO 63166 United States, Tel: + 1 (314) 232-0232, Fax: + 1 (314) 777-1096, Prime

Subcontractor

Raytheon Space & Airborne Systems	http://www.raytheon.com/businesses/rsas, 2000 East El Segundo Blvd, El Segundo, CA 90245 United States, Tel: + 1 (310) 647-1000, Fax: + 1 (310) 647-0734, Email: SAS_Comms_PA@raytheon.com (APG-65)
Rolls-Royce plc	http://www.rolls-royce.com, 65 Buckingham Gate, London, SW1E 6AT United Kingdom, Tel: + 44 20 7222 9020, Fax: + 44 20 7227 9178 (Pegasus Turbofan)

NOTE(S): APG-65 applies to Harrier II Plus.

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Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 22 Commerce Road, Newtown, CT 06470, USA; rich.pettibone@forecast1.com

Technical Data

(AV-8B Harrier II)

Design Features. The Harrier II is a shoulder-wing monoplane. The composite wing is canted downward. The tail section employs a single swept vertical stabilizer and twin swept, downward-canted horizontal stabilizers. The aircraft rides on bicycle-type landing gear with wheel-equipped wing-mounted outriggers.

Design changes in the AV-8B Harrier II from the older AV-8A Harrier I include an entirely new supercritical wing, extensive use of carbon-epoxy composite material, increased internal fuel volume, six underwing hardpoints (compared to four on the AV-8A), an improved engine air intake, lift improvement devices, and leading-edge root extensions. Also included are new electrical and hydraulic systems, as well as a new avionics suite for improved navigation and more accurate weapons delivery.

	Metric	U.S.
Dimensions		
Length overall	14.12 m	46.33 ft
Height overall	3.55 m	11.65 ft
Wingspan	9.25 m	30.33 ft
Wing area	21.4 sq m	230 sq ft
Weight		
Operating weight empty	6,336 kg	13,968 lb
Max fuel	7,180 kg	15,829 lb
Max TOW		
CTO	14,515 kg	32,000 lb
SL VTO, ISA(a)	9,342 kg	20,595 lb

	Metric	U.S.
Performance		
Max Mach number in level flight at SL	Mach 0.88	Mach 0.88
STOL T-O run, ISA(b)	524 m	1,720 ft
Unrefueled ferry range(c)	3,641 km	1,965 nm
g limits	+8/-3	+8/-3

Propulsion

AV-8B	(1)	Rolls-Royce Pegasus 11-21 vectored thrust turbofan rated 95.42 kN (21,450 lbst). U.S. military designation is F402-RR-406A. From December 1990, AV-8Bs used one Pegasus 11-61 (U.S. designation F402-RR-408) rated 105.9 kN (23,800 lbst).
Harrier GR5/GR7	(1)	Rolls-Royce Pegasus Mk 105 vectored thrust turbofan rated 95.6 kN (21,500 lbst).

Armament

Two underfuselage gun/ammunition packs, with a five-barrel 25mm cannon based on the GE GAU-12/U (with 300 rounds) on the AV-8B, or two 25mm Royal Ordnance cannon (derived from the 30mm Aden) on the Harrier GR7. The AV-8B has six underwing weapons stations; the GR7 has eight. A single stores mount is located on the fuselage centerline. Weapons capability includes two or four AIM-9L Sidewinder, Magic, or AGM-65E Maverick missiles; general-purpose bombs; 12 cluster bombs; 10 Paveway laser-guided bombs; eight fire bombs; 10 rocket pods; or (in addition to the underfuselage gun packs) two underwing gun pods. RAF aircraft have Sidewinder air-to-air missiles on additional stations, ahead of the outrigger wheel fairings.

The Harrier II Plus has eight underwing weapons stations. It has the capability to carry a variety of missiles, including AMRAAM, Sea Eagle, Sparrow, and Harpoon.

Crew

The AV-8B, EAV-8B, and Harrier GR5/GR7 seat one; the TAV-8B and Harrier T10 trainer variants seat two in tandem.

(a)With the Pegasus 11-61 engine.
(b)At maximum takeoff weight.
(c)With four 300-U.S. gallon external tanks; tanks dropped.

Variants/Upgrades

AV-8B. Standard production version for the U.S. Marine Corps. Approximately 100 are night-attack-capable.

EAV-8B. Single-seat Spanish version. Twelve were produced.

TAV-8B. Tandem-seat training variant.

Harrier GR5. Initial British version, almost identical to the AV-8B. Sixty-two were produced.

Harrier GR7. Night attack version of the GR5. Thirty-four new-build GR7s were produced. In addition, all existing GR5s were converted to the GR7 standard.

Harrier T10. Two-seat trainer version based on the TAV-8B airframe. Thirteen were produced.

Harrier II Plus. Powered by an uprated Pegasus 11-61 engine, the Harrier II Plus is equipped with a Raytheon APG-65 radar and a new, larger leading-edge root extension (LERX) for higher turn rates. This aircraft began as a private initiative between McDonnell Douglas (which has since merged with Boeing) and British Aerospace (now called BAE Systems) in 1987. The U.S., Italy, and Spain joined together in 1990 on an effort to integrate the APG-65 into the Harrier II. Prototype first flight occurred in September 1992; a total of 24 USMC AV-8Bs procured in FY91 (three of which went to Italy) were completed to this standard. The initial production aircraft was delivered in April 1993. Six more new-production Harrier II Plus aircraft were procured in FY92 for the USMC.

In addition, the Marines remanufactured 74 of their existing AV-8Bs to the Plus configuration. Boeing delivered the 74th and final remanufactured USMC Harrier II Plus in October 2003. This marked the end of the USMC's Harrier II Plus remanufacturing program.

Boeing also converted five Spanish Navy EAV-8Bs to the Harrier II Plus standard. All five aircraft were upgraded to the new configuration and redelivered to the Spanish Navy by the end of 2003, with the final redelivery occurring in December of that year.

Program Review

Background. In 1973-1974, the British and U.S. governments explored several proposals for an advanced Harrier design. The U.K. went on to develop the Sea Harrier, and McDonnell Douglas proceeded with development of the AV-8B. In the mid-1970s, McDonnell Douglas and the U.S. Marine Corps began modifying a pair of AV-8As to serve as YAV-8B prototypes. New production of the AV-8B for the USMC ended at 281 Harrier IIs, including four full-scale development (FSD) aircraft and 27 Harrier II Plus models.

Phase I of the FSD program began in April 1979, followed by construction of the first FSD aircraft, which flew in 1981. This was followed by three additional FSD aircraft. In August 1981, British Aerospace and McDonnell Douglas agreed to a joint Harrier II manufacturing program.

The U.K. initially ordered 62 Harrier GR5 models, but subsequently increased its order to 96 units with a buy of 34 new-production Harrier GR7s. Two GR5s were converted into GR7 development aircraft. Spain acquired 12 EAV-8Bs; delivery of these was completed in 1988. Italy took delivery of two TAV-8B trainers.

Harrier II Plus Program. A 1990 Memorandum of Understanding (MoU) among Italy, Spain, and the U.S. authorized radar integration and development for the new Harrier II Plus. In February 1992, the Italian government took the lead in signing an MoU covering production of the aircraft. The U.S. followed in March 1992, and Spain signed in December 1992.

In November 1992, the Italian government authorized the purchase of 13 Harrier II Plus aircraft. The contract, issued via the U.S. Navy, included a not-to-exceed price of $392 million. The contract also included an option, which was never exercised, for an additional eight aircraft. Alenia performed final assembly of the aircraft. Italy had earlier ordered three Harrier II Plus aircraft, all of which were delivered in 1994.

In March 1993, the Spanish government authorized the purchase of eight Harrier II Plus aircraft. The contract, also issued via the U.S. Navy, included a not-to-exceed price of $257 million. The first aircraft was delivered in January 1996. CASA performed final assembly of the aircraft.

Funding

U.S. FUNDING

	FY04 QTY	FY04 AMT	FY05 QTY	FY05 AMT	FY06 QTY	FY06 AMT	FY07 (Req) QTY	FY07 (Req) AMT
AV-8B Reman.	-	12.4	-	0.9	-	1.7	-	-
AV-8 Mods	-	64.0	-	33.9	-	34.4	-	20.5
AV-8B RDT&E	-	10.3	-	19.3	-	15.3	-	13.9

All $ are in millions.

Contracts/Orders & Options

Contractor	Award ($ millions)	Date/Description
Boeing	$14.0	Dec 2003 – Contract modification from U.S. Navy for upgrade of the AV-8B Harrier weapons systems for the U.S. Marine Corps.
Boeing	$11.1	Dec 2003 – Contract modification from U.S. Navy to exercise an option for the AV-8B Harrier Production Line Transition (PLT), which includes the efficient and orderly shutdown of the AV/TAV-8B production line and disposition of all special tooling, special test equipment, and other property accountable to AV/TAV-8B production contracts.

Contractor	Award ($ millions)	Date/Description
Boeing	$8.8	Dec 2005 – Contract modification from U.S. Navy to exercise an option for engineering, logistics and program management services that support the development and low-rate initial production of the Advanced Mission Computer and Displays system for the F/A-18 and AV-8B platforms.
Boeing	$39.6	Oct 2005 – Contract from U.S. Navy for upgrades for the AV-8B weapons system through a series of spiral System Configuration Set (SCS) developments. In addition, the contract provides for investigation and documentation of current system anomalies, design and integration of system upgrades to include avionics and weapons, and development verification and validation of support software associated with these upgrades.
Boeing	$10.2	Dec 2005 – Contract from U.S. Navy for AV-8B Harrier post-production support services, including engineering analysis, testing, suitability evaluations, effectiveness evaluations, configuration management support, and resolution of reliability, availability, and supportability problems.
Boeing	$9.5	Jun 2006 – Contract modification from U.S. Navy for AV-8B Harrier post-production support services, including engineering analysis, testing, suitability evaluations, effectiveness evaluations, configuration management support, and resolution of reliability, availability, and supportability problems.
Boeing	$10.2	Nov 2006 – Contract modification from U.S. Navy to exercise an option for AV-8B Harrier post-production support services, including engineering analysis, testing, suitability evaluations, effectiveness evaluations, configuration management support, and resolution of reliability, availability, and supportability problems.

Timetable

Month	Year	Major Development
	1973-1974	Joint U.S./U.K. studies of advanced Harrier
Nov	1978	First flight of modified YAV-8B prototype
Feb	1979	Second flight of modified YAV-8B prototype
Nov	1981	First AV-8B FSD aircraft flown
Jan	1984	First AV-8B handed over to USMC
Apr	1985	Harrier GR5 first flight
Jul	1987	Initial delivery of Harrier GR5
	1990	Multinational MoU authorizing radar integration and development for Harrier II Plus
Feb	1992	Italy signs Harrier II Plus production MoU
Mar	1992	U.S. signs Harrier II Plus production MoU
Sep	1992	First flight of Harrier II Plus prototype
Dec	1992	Spain signs Harrier II Plus production MoU
Mar	1993	First flight of production Harrier II Plus
Apr	1993	Initial delivery of production Harrier II Plus
Apr	1994	First flight of Harrier T10
Feb	1995	Harrier T10 deliveries begin
Dec	2003	Harrier II Plus remanufacturing program ends

Boeing/BAE Systems Harrier II

Worldwide Distribution/Inventories

Italy	15	Harrier II Plus
	2	TAV-8B
Spain	4	EAV-8B
	13	Harrier II Plus
U.K.	36	Harrier GR7/7A/9(a)
	5	Harrier T10
	1	Harrier T12
U.S.	154	AV/TAV-8B

(a)Approximately 30 more Harrier IIs (including some T10s) are in storage.

Forecast Rationale

With new Harrier II production coming to an end in the 1990s, focus turned to upgrades for the aircraft. However, all planned conversions of existing Harrier IIs to the Harrier II Plus standard have since been completed, and Boeing has been shutting down the production/remanufacturing line.

GR9 Program

In the U.K., though, BAE Systems is the prime contractor for a major modification program for British Royal Air Force (RAF) Harriers. This effort, which is called the GR9/T12 program, involves the upgrade of 60 RAF GR7s and GR7As and 10 RAF T10s. Work is scheduled to be completed by 2009.

Under the program, the 60 GR7/7As are undergoing an upgrade that will allow these aircraft to carry and integrate smart weapons such as the Brimstone anti-armor missile and precision-guided bombs, and support an enhanced integration of legacy weapons such as the AIM-9L Sidewinder and the Maverick. The program also includes the integration of High Order Language (Ada) software with a new open architecture mission computer, a MIL-STD-1760 Stores Management System, a new inertial navigation/global positioning system, a ground proximity warning system, upgraded displays, and an improved communications suite. Additionally, Raytheon is supplying the Successor Identification Friend or Foe (SIFF) system for the upgrade effort. New rear fuselages are being fitted on certain of the aircraft.

The GR9 upgrades are accomplished through an effort called the Joint Upgrade and Maintenance Program (JUMP), under which essential maintenance is performed along with the modifications.

The 60 aircraft to undergo the GR9 upgrade include 40 GR7s and 20 GR7As. The GR7As are GR7s that once received an engine upgrade taking their Pegasus Mk 105 engines to the Mk 107 (also known as the 11-61) standard. Engine modifications were performed by Rolls-Royce, and BAE Systems supplied aircraft modification kits. Upon receiving the engine modification, the GR7s were redesignated as GR7As.

Ten more GR7s are to receive the engine modification but will do so as part of the GR9 upgrade program. All 20 GR7As are also to eventually go through the GR9 program.

Those GR7s that retain their original Mk 105 engine are redesignated GR9s after modification. Those aircraft fitted with the Mk 107 engine, whether as part of the GR9 program or previously as part of the GR7A effort, will be called GR9As. Thus, when all is said and done, the RAF will have 30 GR9s and 30 GR9As.

The initial GR9 made its first flight in May 2003. Deliveries of GR9s to the RAF began in November 2005.

Meanwhile, 10 RAF Harrier T10 trainers are being modified to a configuration, called T12, that incorporates most of the GR9/9A modifications, though not the new weaponry. The trainers also retain their Mk 105 engines. The initial converted T12 made its first flight in January 2006.

As of September 2006, a total of one T12 and 24 GR9s were in RAF service.

Further RAF Harrier Upgrades

Beyond the GR9 program, a further upgrade for RAF Harriers is under consideration. This effort would

extend the service life of the aircraft beyond 2020. The program might include installation of a Link 16 datalink, improved defensive aids, a helmet-mounted cueing system, an updated reconnaissance pod, and the Advanced Short Range Air-to-Air Missile (ASRAAM). Current plans call for the GR9/9A to be retired in 2018, but the RAF could choose the keep the aircraft in service past this date.

Ten-Year Outlook

New Production

ESTIMATED CALENDAR YEAR PRODUCTION

			High Confidence Level			Good Confidence Level				Speculative			
Aircraft	**(Engine)**	**thru 06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**Total 07-16**
MCDONNELL DOUGLAS/BRITISH AERO (Co-Product)													
AV/TAV-8B HARRIER II	PEGASUS 11-21	196	0	0	0	0	0	0	0	0	0	0	0
AV/TAV-8B HARRIER II	PEGASUS 11-61	87	0	0	0	0	0	0	0	0	0	0	0
HARRIER GR5	PEGASUS 11-21 (MK 105)	62	0	0	0	0	0	0	0	0	0	0	0
HARRIER GR7(a)	PEGASUS 11-21 (MK 105)	34	0	0	0	0	0	0	0	0	0	0	0
HARRIER II EAV-8 (SPAIN)	PEGASUS 11-21 (MK 152-42)	12	0	0	0	0	0	0	0	0	0	0	0
HARRIER II PLUS (EXPORT)	PEGASUS 11-61	24	0	0	0	0	0	0	0	0	0	0	0
HARRIER T10	PEGASUS 11-21 (MK 105)	13	0	0	0	0	0	0	0	0	0	0	0
Total Production		428	0	0	0	0	0	0	0	0	0	0	0

(a)Prototypes were converted Harrier GR5s; not included in 34-unit buy.

Major Modifications

ESTIMATED CALENDAR YEAR PRODUCTION

			High Confidence Level			Good Confidence Level				Speculative			
Aircraft	**(Engine)**	**thru 06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**Total 07-16**
BAE SYSTEMS													
HARRIER GR7A/9A (MOD)(a)	PEGASUS 11-61 (MOD)	20	10	0	0	0	0	0	0	0	0	0	10
HARRIER GR9 (MOD)(b)	PEGASUS 11-21 (MK 105)	24	6	0	0	0	0	0	0	0	0	0	6
HARRIER T12 (MOD)(b)	PEGASUS 11-21 (MK 105)	1	3	6	0	0	0	0	0	0	0	0	9
Subtotal - BAE SYSTEMS		45	19	6	0	0	0	0	0	0	0	0	25
BOEING/BAE (Co-product)													
HARRIER II (REMAN)(c)	PEGASUS 11-61 (MOD)	79	0	0	0	0	0	0	0	0	0	0	0
Subtotal - BOEING/BAE (Co-Product)		79	0	0	0	0	0	0	0	0	0	0	0
Total Production		124	19	6	0	0	0	0	0	0	0	0	25

(a)Mod program - not new-production aircraft. Initial 20 conversions were to the GR7A standard. All 20 GR7As are to eventually become GR9As. This forecast line refers to the engine upgrade only.
(b)Mod program - not new-production aircraft.
(c)Mod program - not new-production aircraft. Total includes 74 for the USMC and five for Spanish Navy.