

= McDonnell Douglas AV @-@ 8B Harrier II =

The McDonnell Douglas (now Boeing) AV @-@ 8B Harrier II is a single @-@ engine ground @-@ attack aircraft that constitutes the second generation of the Harrier Jump Jet family . Capable of vertical or short takeoff and landing (V / STOL) , the aircraft was designed in the late 1970s as an Anglo @-@ American development of the British Hawker Siddeley Harrier , the first operational V / STOL aircraft . Named after a bird of prey , it is primarily employed on light attack or multi @-@ role missions , ranging from close air support of ground troops to armed reconnaissance . The AV @-@ 8B is used by the United States Marine Corps (USMC) , the Spanish Navy , and the Italian Navy . A variant of the AV @-@ 8B , the British Aerospace Harrier II , was developed for the British military , while another , the TAV @-@ 8B , is a dedicated two @-@ seat trainer .

The project that eventually led to the AV @-@ 8B 's creation started in the early 1970s as a cooperative effort between the United States and United Kingdom (UK) , aimed at addressing the operational inadequacies of the first @-@ generation Harrier . Early efforts centered on a larger , more powerful Pegasus engine to dramatically improve the capabilities of the Harrier . Due to budgetary constraints , the UK abandoned the project in 1975 .

Following the withdrawal of the UK , McDonnell Douglas extensively redesigned the earlier AV @-@ 8A Harrier to create the AV @-@ 8B . While retaining the general layout of its predecessor , the aircraft incorporates a new wing , an elevated cockpit , a redesigned fuselage , one extra hardpoint per wing , and other structural and aerodynamic refinements . The aircraft is powered by an upgraded version of the Pegasus , which gives the aircraft its V / STOL ability . The AV @-@ 8B made its maiden flight in November 1981 and entered service with the USMC in January 1985 . Later upgrades added a night @-@ attack capability and radar , resulting in the AV @-@ 8B (NA) and AV @-@ 8B Harrier II Plus , respectively . An enlarged version named Harrier III was also studied , but not pursued . The UK , through British Aerospace , re @-@ joined the improved Harrier project as a partner in 1981 , giving it a significant work @-@ share in the project . After corporate mergers in the 1990s , Boeing and BAE Systems have jointly supported the program . Approximately 340 aircraft were produced in a 22 @-@ year production program that ended in 2003 .

Typically operated from small aircraft carriers , large amphibious assault ships and simple forward operating bases , AV @-@ 8Bs have participated in numerous military and humanitarian operations , proving themselves versatile assets . US Army General Norman Schwarzkopf named the USMC Harrier II as one of the seven most important weapons of the Gulf War . The aircraft took part in combat during the Iraq War beginning in 2003 . The Harrier II has served in Operation Enduring Freedom in Afghanistan since 2001 , and was used in Operation Odyssey Dawn in Libya in 2011 . Italian and Spanish Harrier IIs have taken part in overseas conflicts in conjunction with NATO coalitions . During its service history , the AV @-@ 8B has had a high accident rate , related to the percentage of time spent in critical take @-@ off and landing phases . USMC and Italian Navy AV @-@ 8Bs are to be replaced by the Lockheed Martin F @-@ 35B Lightning II , with the former expected to operate its Harriers until 2025 .

= = Development = =

= = = Origins = = =

In the late 1960s and early 1970s , the first @-@ generation Harriers entered service with the Royal Air Force (RAF) and United States Marine Corps (USMC) , but were handicapped in range and payload . In short takeoff and landing configuration , the AV @-@ 8A (American designation for the Harrier) carried less than half the 4 @,@ 000 lb (1 @,@ 800 kg) payload of the smaller A @-@ 4 Skyhawk , over a more limited radius . To address this issue , in 1973 Hawker Siddeley and McDonnell Douglas began joint development of a more capable version of the Harrier . Early efforts concentrated on an improved Pegasus engine , designated the Pegasus 15 , which was being

tested by Bristol Siddeley . Although more powerful , the engine 's diameter was too large by 2 @. @ 75 in (70 mm) to fit into the Harrier easily .

In December 1973 , a joint American and British team completed a project document defining an Advanced Harrier powered by the Pegasus 15 engine . The Advanced Harrier was intended to replace the original RAF and USMC Harriers , as well as the USMC 's A @-@ 4 . The aim of the Advanced Harrier was to double the AV @-@ 8 's payload and range , and was therefore unofficially named AV @-@ 16 . The British government pulled out of the project in March 1975 owing to decreased defense funding , rising costs , and the RAF 's insufficient 60 @-@ aircraft requirement . With development costs estimated to be around £ 180 ? 200 million (1974 British pounds) , the United States was unwilling to fund development by itself , and ended the project later that year .

Despite the project 's termination , the two companies continued to take different paths toward an enhanced Harrier . Hawker Siddeley focused on a new larger wing that could be retrofitted to existing operational aircraft , while McDonnell Douglas independently pursued a less ambitious , though still expensive , project catering to the needs of the US military . Using knowledge gleaned from the AV @-@ 16 effort , though dropping some items ? such as the larger Pegasus engine ? McDonnell Douglas kept the basic structure and engine for an aircraft tailored for the USMC .

= = = Designing and testing = = =

As the USMC wanted a substantially improved Harrier without the development of a new engine , the plan for Harrier II development was authorized by the United States Department of Defense (DoD) in 1976 . The United States Navy (USN) , which had traditionally procured military aircraft for the USMC , insisted that the new design be verified with flight testing . McDonnell Douglas modified two AV @-@ 8As with new wings , revised intakes , redesigned exhaust nozzles , and other aerodynamic changes ; the modified forward fuselage and cockpit found on all subsequent aircraft were not incorporated on these prototypes . Designated YAV @-@ 8B , the first converted aircraft flew on 9 November 1978 , at the hands of Charles Plummer . The aircraft performed three vertical take @-@ offs and hovered for seven minutes at Lambert ? St. Louis International Airport . The second aircraft followed on 19 February 1979 , but crashed that November due to engine flameout ; the pilot ejected safely . Flight testing of these modified AV @-@ 8s continued into 1979 . The results showed greater than expected drag , hampering the aircraft 's maximum speed . Further refinements to the aerodynamic profile yielded little improvement . Positive test results in other areas , including payload , range , and V / STOL performance , led to the award of a development contract in 1979 . The contract stipulated a procurement of 12 aircraft initially , followed by a further 324 .

Between 1978 and 1980 , the DoD and USN repeatedly attempted to terminate the AV @-@ 8B program . There had previously been conflict between the USMC and USN over budgetary issues . At the time , the USN wanted to procure A @-@ 18s for its ground attack force and , to cut costs , pressured the USMC to adopt the similarly @-@ designed F @-@ 18 fighter instead of the AV @-@ 8B to fulfill the role of close air support (both designs were eventually amalgamated to create the multirole F / A @-@ 18 Hornet) . Despite these bureaucratic obstacles , in 1981 , the DoD included the Harrier II in its annual budget and five @-@ year defense plan . The USN declined to participate in the procurement , citing the limited range and payload compared with conventional aircraft .

In August 1981 , the program received a boost when British Aerospace (BAe) and McDonnell Douglas signed a Memorandum of Understanding (MoU) , marking the UK 's re @-@ entry into the program . The British government was enticed by the lower cost of acquiring Harriers promised by a large production run , and the fact that the US was shouldering the expense of development . Under the agreement BAe was relegated to the position of a subcontractor , instead of the full partner status that would have been the case had the UK not left the program . Consequently , the company received , in man @-@ hours , 40 percent of the airframe work @-@ share . Aircraft production took place at McDonnell Douglas ' facilities in suburban St. Louis , Missouri , and manufacturing by BAe at its Kingston and Dunsfold facilities in Surrey , England . Meanwhile , 75 percent work @-@ share for the engine went to Rolls @-@ Royce , which had previously absorbed Bristol Siddeley , with the remaining 25 percent assigned to Pratt & Whitney . The two companies planned to manufacture 400

Harrier IIs , with the USMC expected to procure 336 aircraft and the RAF , 60 .

Four full @-@ scale development (FSD) aircraft were constructed . The first of these (BuNo 161396) , used mainly for testing performance and handling qualities , made its maiden flight on 5 November 1981 , piloted by Plummer . The second and third FSD aircraft , which introduced wing leading @-@ edge root extensions and revised engine intakes , first flew in April the following year ; the fourth followed in January 1984 . The first production AV @-@ 8B was delivered to the Marine Attack Training Squadron 203 (VMAT @-@ 203) at Marine Corps Air Station Cherry Point (MCAS Cherry Point) on 12 December 1983 , and officially handed over one month later . The last of the initial batch of 12 was delivered in January 1985 to the front @-@ line Marine Attack Squadron 331 (VMA @-@ 331) . The engine used for these aircraft was the F402 @-@ RR @-@ 404A , with 21 @, @ 450 lb (95 @. @ 4 kN) of thrust ; aircraft from 1990 onwards received upgraded engines .

= = = Upgrades = = =

During the initial pilot conversion course , it became apparent that the AV @-@ 8B exhibited flight characteristics different from the AV @-@ 8A . These differences , as well as the digital cockpit fitted instead of the analog cockpit of the TAV @-@ 8A , necessitated additional pilot training . In 1984 , funding for eight AV @-@ 8Bs was diverted to the development of a two @-@ seat TAV @-@ 8B trainer . The first of the 28 TAV @-@ 8Bs eventually procured had its maiden flight on 21 October 1986 . This aircraft was delivered to VMAT @-@ 203 on 24 July 1987 ; the TAV @-@ 8B was also ordered by Italy and Spain .

With export interest from Brazil , Japan , and Italy serving as a source of encouragement to continue development of the Harrier II , McDonnell Douglas commenced work on a night @-@ attack variant in 1985 . With the addition of an infrared sensor and cockpit interface enhancements , the 87th production single @-@ seat AV @-@ 8B became the first Harrier II to be modified for night attacks , leaving the McDonnell Douglas production line in June 1987 . Flight tests proved successful and the night attack capability was validated . The first of 66 AV @-@ 8B (NA) s was delivered to the USMC in September 1989 . An equivalent version of the AV @-@ 8B (NA) also served with the RAF under the designation GR7 ; earlier GR5 aircraft were subsequently upgraded to GR7 standards .

In June 1987 , as a private venture , BAe , McDonnell Douglas , and Smiths Industries signed an MoU for the development of what was to become the AV @-@ 8B Plus , which saw the addition of radar and increased missile compatibility . The agreement was endorsed by the USMC and , after much consideration , the Spanish and Italian navies developed a joint requirement for a fleet of air @-@ defense Harriers . The United States , Spain , and Italy signed an MoU in September 1990 to define the responsibilities of the three countries and establish a Joint Program Office to manage the program . On 30 November 1990 , the USN , acting as an agent for the three participating countries , awarded McDonnell Douglas the contract to develop the improved Harrier . The award was followed by an order from the USMC in December 1990 for 30 new aircraft , and 72 rebuilt from older aircraft . Italy ordered 16 Harrier II Plus and two twin @-@ seat TAV @-@ 8B aircraft , while Spain signed a contract for eight aircraft . Production of the AV @-@ 8B Harrier II Plus was conducted , in addition to McDonnell Douglas ' plant , at CASA 's facility in Seville , Spain , and Alenia Aeronautica 's facility in Turin , Italy . The UK also participated in the program by manufacturing components for the AV @-@ 8B .

Production was authorized on 3 June 1992 . The maiden flight of the prototype (BuNo 164129) took place on 22 September , marking the start of a successful flight @-@ test program . The first production aircraft was delivered to St. Louis and made its initial flight on 17 March 1993 . Deliveries of new aircraft took place from April 1993 to 1995 . At the same time , the plan to remanufacture existing AV @-@ 8Bs to the Plus standard proceeded . On 11 March 1994 , the Defense Acquisition Board approved the program , which initially involved 70 aircraft , with four converted in financial year 1994 . The program planned to use new and refurbished components to rebuild aircraft at a lower cost than manufacturing new ones . Conversion began in April 1994 , and the first aircraft was delivered to the USMC in January 1996 .

= = = End of production and further improvements = = =

In March 1996 , the US General Accounting Office (GAO) stated that it was cheaper to buy Harrier II Plus aircraft outright than to remanufacture existing AV @-@ 8Bs . The USN estimated the cost for remanufacture of each aircraft to be US \$ 23 ? 30 million , instead of \$ 30 million for each new @-@ built aircraft , while the GAO estimated the cost per new aircraft at \$ 24 million . Nevertheless , the program continued and , in 2003 , the 72nd and last AV @-@ 8B to be remanufactured for the USMC was delivered . Spain also participated in the program , the delivery of its last refurbished aircraft occurring in December 2003 , which marked the end of the AV @-@ 8B 's production ; the final new AV @-@ 8B had been delivered in 1997 .

In the 1990s , Boeing and BAE Systems assumed management of the Harrier family following corporate mergers that saw Boeing acquire McDonnell Douglas and BAe amalgamate with other defense companies to form BAE Systems . Between 1969 and 2003 , 824 Harriers of all models were delivered . In 2001 , Flight International reported that Taiwan might meet its requirement for a short take off and vertical landing (STOVL) aircraft by purchasing AV @-@ 8Bs , outfitted with the F @-@ 16 Fighting Falcon 's APG @-@ 66 radar . A Taiwanese purchase would have allowed the production line to stay open beyond 2005 . Despite the possibility of leasing AV @-@ 8Bs , interest in the aircraft waned as the country switched its intentions to procuring the F @-@ 35 and upgrading its fleet of F @-@ 16s .

Although there have been no new AV @-@ 8B variants , in 1990 McDonnell Douglas and British Aerospace began discussions on an interim aircraft between the AV @-@ 8B and the next generation of advanced STOVL aircraft . The Harrier III would have presented an " evolutionary approach to get the most from the existing aircraft " , as many of the structures employed on the Sea Harrier and AV @-@ 8B would be used . The wing and the torsion box were to be enlarged to accommodate extra fuel and hardpoints to improve the aircraft 's endurance . Due to the increase in size , the wing would have had folding wingtips . To meet the heavier weight of the aircraft , Rolls @-@ Royce was expected to design a Pegasus engine variant that would have produced 4 @,@ 000 lbf (18 kN) more thrust than the latest production variant at the time . The Harrier III would have carried weapons such as AIM @-@ 120 AMRAAM and AIM @-@ 132 ASRAAM missiles . Boeing and BAE Systems continued studying the design until the early 2000s , when the project was abandoned .

In 2013 , the USMC was studying potential enhancements to keep the AV @-@ 8B Harrier IIs up to date until its planned retirement , such as a helmet @-@ mounted cueing system . It is also predicted that additional work on the aircraft 's radars and sensor systems may take place . The Marines Corps Harrier II fleet was planned to remain in service until 2030 , owing to delays with the F @-@ 35B and the fact that the Harriers have more service life left than USMC F / A @-@ 18 Hornets . However , by 2014 the USMC had decided to retire the AV @-@ 8B sooner because changing the transition orders of Harrier II and Hornet fleets to the Lightning II would save \$ 1 billion . Expected to become operational in 2015 , the F @-@ 35B will start to replace the AV @-@ 8B in 2016 , with the AV @-@ 8B expected to continue service until 2025 . Meanwhile , the AV @-@ 8B will receive revamped defensive measures , updated data @-@ link capability and targeting sensors , and improved missiles and rockets , among other enhancements .

= = Design = =

= = = Overview = = =

The AV @-@ 8B Harrier II is a subsonic attack aircraft of metal and composite construction that retains the basic layout of the Hawker Siddeley Harrier , with horizontal stabilizers and shoulder @-@ mounted wings featuring prominent anhedral (downward slope) . The aircraft is powered by a single Rolls @-@ Royce Pegasus turbofan engine , which has two intakes and four synchronized

vectorable nozzles close to its turbine . Two of these nozzles are located near the forward , cold end of the engine and two are near the rear , hot end of the engine . This arrangement contrasts with most fixed @-@ wing aircraft , which have engine nozzles only at the rear . The Harrier II also has smaller valve @-@ controlled nozzles in the nose , tail , and wingtips to provide control at low airspeeds .

The AV @-@ 8B is equipped with one centerline fuselage and six wing hardpoints (compared to four wing hardpoints on the original Harrier) , along with two fuselage stations for a 25 mm GAU @-@ 12 cannon and ammunition pack . These hardpoints give it the ability to carry a total of 9 @-@ 200 lb (4 @-@ 200 kg) of weapons , including air @-@ to @-@ air , air @-@ to @-@ surface , and anti @-@ ship missiles , as well as unguided and guided bombs . The aircraft 's internal fuel capacity is 7 @-@ 500 lb (3 @-@ 400 kg) , up 50 percent compared to its predecessor . Fuel capacity can be carried in hardpoint @-@ compatible external drop tanks , which give the aircraft a maximum ferry range of 2 @-@ 100 mi (3 @-@ 300 km) and a combat radius of 300 mi (556 km) . The AV @-@ 8B can also receive additional fuel via aerial refueling using the probe @-@ and @-@ drogue system . The British Aerospace Harrier II , a variant tailored to the RAF , uses different avionics , and has one additional missile pylon on each wing .

The Harrier II retains the tandem landing gear layout of the first @-@ generation Harriers , although each outrigger landing gear leg was moved from the wingtip to mid @-@ span for a tighter turning radius when taxiing . The engine intakes are larger than those of the first @-@ generation Harrier , and have a revised inlet . On the underside of the fuselage , McDonnell Douglas added lift @-@ improvement devices , which capture the reflected engine exhaust when close to the ground , giving the equivalent of up to 1 @-@ 200 lb (544 kg) of extra lift .

The technological advances incorporated into the Harrier II , compared with the original Harrier , significantly reduce the workload on the pilot . The supercritical wing , hands @-@ on @-@ throttle @-@ and @-@ stick (HOTAS) control principle , and increased engineered lateral stability make the aircraft fundamentally easier to fly . Ed Harper , general manager for the McDonnell Douglas Harrier II development program , summarized : " The AV @-@ 8B looks a lot like the original Harrier and it uses the same operating fundamentals . It just uses them a lot better " . A large cathode @-@ ray tube multi @-@ purpose display , taken from the F / A @-@ 18 , makes up much of the instrument panel in the cockpit . It has a wide range of functions , including radar warning information and weapon delivery checklist . The pilots sit on UPC / Stencel 10B zero @-@ zero ejection seats , meaning that they are able to eject from a stationary aircraft at zero altitude .

== Airframe ==

For the AV @-@ 8B , McDonnell Douglas redesigned the entire airframe of the Harrier , incorporating numerous structural and aerodynamic changes . To improve visibility and better accommodate the crew and avionics hardware , McDonnell Douglas elevated the cockpit by 10 @-@ 5 in (27 cm) and redesigned the canopy . This improved the forward (17 ° down) , side (60 °) , and rear visibility . The front fuselage is composed of a molded skin with an epoxy @-@ based core sandwiched between two carbon @-@ fiber sheets . To compensate for the changes in the front fuselage , the rear fuselage was extended by 18 in (46 cm) , and the taller vertical stabilizer of the Sea Harrier was used . The tail assembly is made up of composites to reduce weight .

Perhaps the most thorough redesign was of the wing , the objective being to match the performance of the cancelled AV @-@ 16 while retaining the Pegasus engine of the AV @-@ 8A . Engineers designed a new , one @-@ piece supercritical wing , which improves cruise performance by delaying the rise in drag and increasing lift @-@ to @-@ drag ratio . Made of composites , the wing is thicker and has a longer span than that of the AV @-@ 8A . Compared to the AV @-@ 8A 's wing , it has a higher aspect ratio , reduced sweep (from 40 ° to 37 °) , and an area increased from 200 sq ft (18 @-@ 6 m²) to 230 sq ft (21 @-@ 4 m²) . The wing has a high @-@ lift configuration , employing flaps that deploy automatically when maneuvering , and drooped ailerons . Using the leading edge root extensions , the new wing allows for a 6 @-@ 700 lb (3 @-@ 035 kg) increase in payload compared with the first @-@ generation Harriers after a 1 @-@ 000 ft (300 m) takeoff roll .

Because the wing is almost exclusively composite , it is 330 lb (150 kg) lighter than the AV @-@ 8A 's smaller wing .

The Harrier II was the first combat aircraft to extensively employ carbon @-@ fiber composite materials , exploiting their light weight and high strength ; they are used in the wings , rudder , flaps , nose , forward fuselage , and tail . Twenty @-@ six percent of the aircraft 's structure is made of composites , reducing its weight by 480 lb (217 kg) compared to a conventional metal structure .

= = = Differences between versions = = =

Most of the first " day attack " AV @-@ 8B Harrier IIs were upgraded to Night Attack Harrier or Harrier II Plus standards , with the remainder being withdrawn from service . The AV @-@ 8B cockpit was also used for the early trialing of Direct Voice Input (DVI) , which allows the pilot to use voice commands to issue instructions to the aircraft , using a system developed by Smiths Industries . The main attack avionics system in original aircraft was the nose @-@ mounted Hughes AN / ASB @-@ 19 angle @-@ rate bombing system . The system combined a TV imager and laser tracker to provide a highly accurate targeting capability . Defensive equipment include several AN / ALE @-@ 39 chaff @-@ flare dispensers , an AN / ALR @-@ 67 radar warning receiver , and an AN / ALQ @-@ 126C jammer pod .

The trainer version of the AV @-@ 8B is the TAV @-@ 8B , seating two pilots in tandem . Among other changes , the forward fuselage features a 3 ft 11 in (1 @-@ 19 m) extension to accommodate the second cockpit . To compensate for the slight loss of directional stability , the vertical stabilizer 's area was enlarged through increases in chord (length of the stabilizer 's root) and height . USMC TAV @-@ 8Bs feature the AV @-@ 8B 's digital cockpit and new systems , but have only two hardpoints and are not combat capable . Initial TAV @-@ 8Bs were powered by a 21 @-@ 450 lbf (95 @-@ 4 kN) F402 @-@ RR @-@ 406A engine , while later examples were fitted with the 23 @-@ 000 lbf (105 @-@ 8 kN) F402 @-@ RR @-@ 408A . In the early 2000s , 17 TAV @-@ 8Bs were upgraded to include a night @-@ attack capability , the F402 @-@ RR @-@ 408 engine , and software and structural changes .

Fielded in 1991 , the Night Attack Harrier was the first upgrade of the AV @-@ 8B . It differed from the original aircraft in having a forward looking infrared (FLIR) camera added to the top of the nose cone , a wide Smiths Industries head @-@ up display (HUD) , provisions for night vision goggles , and a Honeywell digital moving map system . The FLIR uses thermal imaging to identify objects by their heat signatures . The variant was powered by the F402 @-@ RR @-@ 408 engine , which featured an electronic control system and was more powerful and reliable . The flare and chaff dispensers were moved , and the ram air intake was lengthened at the fin 's base . Initially known as the AV @-@ 8D , the night @-@ attack variant was designated the AV @-@ 8B (NA) .

The Harrier II Plus is very similar to the Night Attack variant , with the addition of an APG @-@ 65 multi @-@ mode pulse @-@ Doppler radar in an extended nose , allowing it to launch advanced beyond @-@ visual @-@ range missiles such as the AIM @-@ 120 AMRAAM . To make additional space for the radar , the angle @-@ rate bombing system was removed . The radars used were taken from early F / A @-@ 18 aircraft , which had been upgraded with the related APG @-@ 73 . In addition to the AIM @-@ 120 , the AV @-@ 8B Plus can also carry AGM @-@ 65 Maverick and AGM @-@ 84 Harpoon missiles . According to aviation author Lon Nordeen , the changes " had a slight increase in drag and a bit of additional weight , but there really was not much difference in performance between the [? 408 @-@ powered] Night Attack and radar Harrier II Plus aircraft " .

= = Operational history = =

= = = United States Marine Corps = = =

The AV @-@ 8B underwent standard evaluation to prepare for its USMC service . In the operational evaluation (OPEVAL) , lasting from 31 August 1984 to 30 March 1985 , four pilots and

a group of maintenance and support personnel tested the aircraft under combat conditions . The aircraft was graded for its ability to meet its mission requirements for navigating , acquiring targets , delivering weapons , and evading and surviving enemy actions , all at the specified range and payload limits . The first phase of OPEVAL , running until 1 February 1985 , required the AV @-@ 8B to fly both deep and close air support missions (deep air support missions do not require coordination with friendly ground forces) in concert with other close @-@ support aircraft , as well as flying battlefield interdiction and armed reconnaissance missions . The aircraft flew from military installations at Marine Corps Base Camp Pendleton and Naval Air Weapons Station China Lake in California , Canadian Forces Base Cold Lake in Canada , and MCAS Yuma in Arizona .

The second phase of OPEVAL , which took place at MCAS Yuma from 25 February to 8 March , required the AV @-@ 8B to perform fighter escort , combat air patrol , and deck @-@ launched intercept missions . Although the evaluation identified shortfalls in the design (subsequently rectified) , OPEVAL was deemed successful . The AV @-@ 8B Harrier II reached initial operating capability (IOC) in January 1985 with USMC squadron VMA @-@ 331 .

The AV @-@ 8B saw extensive action in the Gulf War of 1990 ? 91 . Aircraft based on USS Nassau and Tarawa , and at on @-@ shore bases , initially flew training and support sorties , as well as practicing with coalition forces . The AV @-@ 8Bs were to be held in reserve during the initial phase of the preparatory air assault of Operation Desert Storm . The AV @-@ 8B was first used in the war on the morning of 17 January 1991 , when a call for air support from an OV @-@ 10 Bronco forward air controller against Iraqi artillery that was shelling Khafji and an adjacent oil refinery , brought the AV @-@ 8B into combat . The following day , USMC AV @-@ 8Bs attacked Iraqi positions in southern Kuwait . Throughout the war , AV @-@ 8Bs performed armed reconnaissance and worked in concert with coalition forces to destroy targets .

During Operations Desert Shield and Desert Storm , 86 AV @-@ 8Bs amassed 3 @, @ 380 flights and about 4 @, @ 100 flight hours , with a mission availability rate of over 90 percent . Five AV @-@ 8Bs were lost to enemy surface @-@ to @-@ air missiles , and two USMC pilots were killed . The AV @-@ 8B had an attrition rate of 1 @. @ 5 aircraft for every 1 @, @ 000 sorties flown . US Army General Norman Schwarzkopf later named the AV @-@ 8B among the seven weapons ? along with the F @-@ 117 Nighthawk and AH @-@ 64 Apache ? that played a crucial role during the war . In the aftermath of the war , from 27 August 1992 , until 2003 , USMC AV @-@ 8Bs and other aircraft patrolled Iraqi skies in support of Operation Southern Watch . The AV @-@ 8Bs launched from amphibious assault ships in the Persian Gulf , and from forward operating bases such as Ali Al Salem Air Base , Kuwait .

In 1999 , the AV @-@ 8B participated in NATO 's bombing of Yugoslavia during Operation Allied Force . Twelve Harriers were split evenly between the 24th and 26th Marine Expeditionary Units (MEU) . AV @-@ 8Bs of the 24th MEU were introduced into combat on 14 April , and over the next 14 days flew 34 combat air support missions over Kosovo . During their six @-@ month deployment aboard USS Nassau , 24th MEU Harriers averaged a high mission @-@ capable rate of 91 @. @ 8 percent . On 28 April , the 24th MEU was relieved by the 26th MEU , based on USS Kearsarge . The first combat sorties of the unit 's AV @-@ 8Bs occurred two days later , one aircraft being lost . The 26th MEU remained in the theater of operations until 28 May , when it was relocated to Brindisi , Italy .

USMC AV @-@ 8Bs took part in Operation Enduring Freedom in Afghanistan from 2001 . The USMC 15th MEU arrived off the coast of Pakistan in October 2001 . Operating from the unit 's ships , four AV @-@ 8Bs began attack missions into Afghanistan on 3 November 2001 . The 26th MEU and its AV @-@ 8Bs joined 15th MEU later that month . In December 2001 , AV @-@ 8Bs began moving into Afghanistan to a forward base at Kandahar . More AV @-@ 8Bs were deployed with other USMC units to the region in 2002 . The VMA @-@ 513 squadron deployed six Night Attack AV @-@ 8Bs to Bagram in October 2002 . These aircraft each carried a LITENING targeting pod to perform reconnaissance missions along with attack and other missions , primarily at night .

The aircraft participated in Operation Iraqi Freedom in 2003 , acting primarily in support of USMC ground units . During the initial action , 60 AV @-@ 8Bs were deployed on ships such as the USS Bonhomme Richard and Bataan , from which over 1 @, @ 000 sorties were flown throughout the war

. When possible , land @-@ based forward arming and refuelling points were set up to enable prompt operations . USMC commander Lieutenant General Earl B. Hailston said that the Harriers were able to provide 24 @-@ hour support for ground forces , and noted that " The airplane ... became the envy of pilots even from my background ... there 's an awful lot of things on the Harrier that I 've found the Hornet pilots asking me [for] ... We couldn 't have asked for a better record " .

USMC sources documented the Harrier as holding an 85 percent aircraft availability record in the Iraq War ; in just under a month of combat , the aircraft flew over 2 @, @ 000 sorties . When used , the LITENING II targeting pod achieved greater than 75 percent kill effectiveness on targets . In a single sortie from USS Bonhomme Richard , a wave of Harriers inflicted heavy damage on a Republican Guard tank battalion in advance of a major ground assault on Al Kut . Harriers regularly operated in close support roles for friendly tanks , one of the aircraft generally carrying a LITENING pod . Despite the Harrier 's high marks , the limited amount of time that each aircraft could remain on station , around 15 ? 20 minutes , led to some calls from within the USMC for the procurement of AC @-@ 130 gunships , which could loiter for six hours and had a heavier close air support capability than the AV @-@ 8B . AV @-@ 8Bs were later used in combination with artillery to provide constant fire support for ground forces during heavy fighting in 2004 around the insurgent stronghold of Fallujah . The urban environment there required extreme precision for airstrikes .

On 20 March 2011 , USMC AV @-@ 8Bs were launched from USS Kearsarge in support of Operation Odyssey Dawn , enforcing the UN no @-@ fly zone over Libya . They carried out airstrikes on Sirte on 5 April 2011 . Multiple AV @-@ 8Bs were involved in the defense of a downed F @-@ 15E pilot , attacking approaching Libyans prior to the pilot 's extraction by a MV @-@ 22 Osprey .

In addition to major conflicts , USMC AV @-@ 8Bs have been deployed in support of contingency and humanitarian operations , providing fixed @-@ wing air cover and armed reconnaissance . The aircraft served in Somalia throughout the 1990s , Liberia (1990 , 1996 , and 2003) , Rwanda (1994) , Central African Republic (1996) , Albania (1997) , Zaire (1997) , and Sierra Leone (1997) .

The AV @-@ 8B is to be replaced by the F @-@ 35B version of the Lockheed Martin F @-@ 35 Lightning II , which had been slated to enter service in 2012 . The USMC had sought a replacement since the 1980s , and has argued strongly in favor of the development of the F @-@ 35B . The Harrier 's performance in Iraq , including its ability to use forward operating bases , reinforced the need for a V / STOL aircraft in the USMC arsenal .

In November 2011 , the USN purchased the UK 's fleet of 72 retired BAe Harrier IIs (63 single @-@ seat GR.7 / 9 / 9As plus 9 twin @-@ seat T.12 / 12As) and replacement engines to provide spares for the existing USMC Harrier II fleet . Although the March 2012 issue of the magazine AirForces Monthly stated that the USMC intended to fly some of the ex @-@ British Harrier IIs , instead of using them just for spare parts , the Naval Air Systems Command (NAVAIR) has since stated that the USMC has never had any plans to operate those Harriers .

On 14 September 2012 , a Taliban raid destroyed six AV @-@ 8Bs and severely damaged two others while they were parked on the tarmac at Camp Bastion in Afghanistan 's Helmand Province . All of the aircraft belonged to VMA @-@ 211 . The two damaged AV @-@ 8Bs were flown out of Afghanistan in the hours after the attack . The attack was described as " the worst loss of U.S. airpower in a single incident since the Vietnam War . " The lost aircraft were quickly replaced by those from VMA @-@ 231 .

On 27 July 2014 , the USS Bataan began deploying USMC AV @-@ 8Bs over Iraq to provide surveillance of Islamic State (IS) forces . Surveillance operations continued after the start of Operation Inherent Resolve against IS militants . In early September 2014 , a USMC Harrier from the 22nd MEU struck an IS target near the Haditha Dam in Iraq , marking the first time a USMC unit dropped ordnance in the operation .

= = = Italian Navy = = =

In the late 1960s , following a demonstration of the Hawker Siddeley Harrier on the Italian Navy (Marina Militare) helicopter carrier Andrea Doria , the country began investigating the possibility of

acquiring the Harrier . Early efforts were hindered by a 1937 Italian law that prohibited the navy from operating fixed @-@ wing aircraft because they were the domain of the air force . In early 1989 , the law was changed to allow the navy to operate any fixed @-@ wing aircraft with a maximum weight of over 3 @,@ 300 lb (1 @,@ 500 kg) . Following a lengthy evaluation of the Sea Harrier and AV @-@ 8B , an order was placed for two TAV @-@ 8Bs in May 1989 . Soon , a contract for a further 16 AV @-@ 8B Plus aircraft was signed . After the TAV @-@ 8Bs and the first three AV @-@ 8Bs , all subsequent Italian Navy Harriers were locally assembled by Alenia Aeronautica from kits delivered from the U.S. The two @-@ seaters , the first to be delivered , arrived at Grottaglie in August 1991 . They were used for proving flights with the navy 's helicopter carriers and on the light aircraft carrier Giuseppe Garibaldi .

In early 1994 , the initial batch of US @-@ built aircraft arrived at MCAS Cherry Point for pilot conversion training . The first Italian @-@ assembled Harrier was rolled out the following year . In mid @-@ January 1995 , Giuseppe Garibaldi set off from Taranto to Somalia , with three Harriers on board , to maintain stability following the withdrawal of UN forces . The Harriers , flown by five Italian pilots , accumulated more than 100 flight hours and achieved 100 percent availability during the three @-@ month deployment , performing reconnaissance and other missions . The squadron returned to port on 22 March .

In 1999 , Italian AV @-@ 8Bs were used for the first time in combat missions when they were deployed aboard Giuseppe Garibaldi , which was participating in Operation Allied Force in Kosovo . Italian pilots conducted more than 60 sorties alongside other NATO aircraft , attacking the Yugoslav army and paramilitary forces and bombing the country 's infrastructure with conventional and laser @-@ guided bombs (LGB) .

In 2000 , the Italian Navy was looking to acquire a further seven remanufactured aircraft to equip Giuseppe Garibaldi and a new carrier , Cavour . Existing aircraft , meanwhile , were updated to allow them to carry AIM @-@ 120 AMRAAMs and JDAM guided bombs . From November 2001 to March 2002 , eight AV @-@ 8Bs were embarked aboard Giuseppe Garibaldi and were deployed to the Indian Ocean in support of Operation Enduring Freedom . The aircraft , equipped with LGBs , operated throughout January and February 2002 , during which 131 missions were logged for a total of 647 flight hours .

In 2011 , Italian Harriers , operating from Giuseppe Garibaldi , worked alongside Italian Eurofighters and aircraft of other nations during Operation Unified Protector , as part of the 2011 military intervention in Libya . They conducted airstrikes as well as intelligence and reconnaissance sorties over Libya , using the LITENING targeting pods while armed with AIM @-@ 120 AMRAAMs and AIM @-@ 9 Sidewinders . In total , Italian military aircraft delivered 710 guided bombs and missiles during sorties : Italian Air Force Tornados and AMX fighter bombers delivered 550 bombs and missiles , while the eight Italian Navy AV @-@ 8Bs flying from Giuseppe Garibaldi dropped 160 guided bombs during 1 @,@ 221 flight hours .

Italian Navy AV @-@ 8Bs are slated to be replaced by 15 (originally 22) F @-@ 35Bs , which will form the air wing of Cavour .

= = = Spanish Navy = = =

Spain , already using the AV @-@ 8S Matador , became the first international operator of the AV @-@ 8B by signing an order for 12 aircraft in March 1983 . Designated VA @-@ 2 Matador II by the Spanish Navy (Armada Española) , this variant is known as EAV @-@ 8B by McDonnell Douglas . Pilot conversion took place in the US . On 6 October 1987 , the first three Matador IIs were delivered to Naval Station Rota . The new aircraft were painted in a two @-@ tone matt grey finish , similar to US Navy aircraft , and deliveries were complete by 1988 .

BAe test pilots cleared the aircraft carrier Príncipe de Asturias ' for Harrier operations in July 1989 . The carrier , which replaced the World War II @-@ era Dédalo , has a 12 ° ski @-@ jump ramp . It was originally planned that the first unit to operate the aircraft would be the 8a Escuadrilla . This unit was disbanded on 24 October 1986 , following the sales of AV @-@ 8S Matadors to Thailand . Instead , 9a Escuadrilla was formed on 29 September 1987 , to become part of the Alpha Carrier Air

Group and operate the EAV @-@ 8B .

In March 1993 , under the September 1990 Tripartite MoU between the U.S. , Italy , and Spain , eight EAV @-@ 8B Plus Matadors were ordered , along with a twin @-@ seat TAV @-@ 8B . Deliveries of the Plus @-@ standard aircraft started in 1996 . On 11 May 2000 , Boeing and the NAVAIR finalized a contract to remanufacture Spanish EAV @-@ 8Bs to bring them up to Plus standard . Boeing said the deal required it to remanufacture two EAV @-@ 8Bs , with an option for another seven aircraft ; other sources say the total was 11 aircraft . The remanufacture allowed the aircraft to carry four AIM @-@ 120 AMRAAMs , enhanced the pilot 's situational awareness through the installation of new radar and avionics , and provided a new engine . Eventually , five aircraft were modified , the last having been delivered on 5 December 2003 .

Spanish EAV @-@ 8Bs joined Operation Deny Flight , enforcing the UN 's no @-@ fly zone over Bosnia and Herzegovina . Spain did not send its aircraft carrier to participate in the Iraq War in 2003 , instead deploying F / A @-@ 18s and other aircraft to Turkey to defend that country against potential Iraqi attacks . Starting in 2007 , Spain was looking to replace its Harrier IIs ? with the likely option being the F @-@ 35B . The Spanish government , in May 2014 however , announced that it had decided to extend the aircraft 's service life to beyond 2025 due to a lack of funds for a replacement aircraft .

Following the decommissioning of the Príncipe de Asturias in February 2013 , the sole naval platform from which Spanish Harrier IIs can operate is the Juan Carlos amphibious assault ship .

= = Variants = =

YAV @-@ 8B

Two prototypes converted in 1978 from existing AV @-@ 8A airframes (BuNos 158394 and 158395) .

AV @-@ 8B Harrier II sans suffix

The initial " day attack " variant .

AV @-@ 8B Harrier II Night Attack

Improved version with a forward @-@ looking infrared (FLIR) camera , an upgraded cockpit with night @-@ vision goggle compatibility , and the more powerful Rolls Royce Pegasus 11 engine . This variant was originally planned to be designated AV @-@ 8D .

AV @-@ 8B Harrier II Plus

Similar to the Night Attack variant , with the addition of an APG @-@ 65 radar . It is used by the USMC , Spanish Navy , and Italian Navy . Forty @-@ six new @-@ built aircraft were assembled from 1993 to 1997 .

TAV @-@ 8B Harrier II

Two @-@ seat trainer version .

EAV @-@ 8B Matador II

Company designation for the Spanish Navy version .

EAV @-@ 8B Matador II Plus

The AV @-@ 8B Harrier II Plus , ordered for the Spanish Navy .

Harrier GR5 , GR7 , GR9

See British Aerospace Harrier II .

= = Operators = =

Italy

Italian Navy

Gruppo Aerei Imbarcati (1991 ? present)

Spain

Spanish Navy

9a Escuadrilla Aeronaves (1987 ? present)

United States

United States Marine Corps

VMA @-@ 211 " Wake Island Avengers " (1990 ? present)

VMA @-@ 214 " The Black Sheep " (1989 ? present)

VMA @-@ 223 " Bulldogs " (1987 ? present)

VMA @-@ 231 " Ace of Spades " (1985 ? present)

VMA @-@ 311 " Tomcats " (1988 ? present)

VMA @-@ 331 " Bumblebees " (1985 ? 1992)

VMA @-@ 513 " Flying Nightmares " (1987 ? 2013)

VMA @-@ 542 " Tigers " (1986 ? present)

VMAT @-@ 203 " Hawks " (1983 ? present)

United States Navy

VX @-@ 9 " The Vampires " (unknown)

VX @-@ 31 " Dust Devils " (unknown ? present)

= = Accidents = =

During its service with the USMC , the Harrier has had an accident rate three times that of the Corps ' F / A @-@ 18s . As of July 2013 , approximately 110 aircraft have been damaged beyond repair since the type entered service in 1985 , the first accident occurring in March that year . The AV @-@ 8 was dubbed a " widow maker " by some in the military . The Los Angeles Times reported in 2003 that the Harrier family had the highest rate of major accidents among military aircraft in service at that time , with 148 accidents and 45 people killed . However , Lon Nordeen notes that several other USMC single @-@ engine strike aircraft , like the A @-@ 4 Skyhawk and A @-@ 7 Corsair II , had worse accident rates .

Accidents have in particular been connected to the proportionate amount of time the aircraft spends taking off and landing , which are the most critical phases in flight . Further analysis shows that US Marine senior officers never understood the uniqueness of the aircraft , that the Harrier design was more complex , like that of helicopters . Cutbacks in senior maintenance personnel and pilot mistakes had a disastrous effect on the safety of the American @-@ operated AV @-@ 8B , which gained it a negative reputation in the US press that was not deserved .

= = Aircraft on display = =

AV @-@ 8B

BuNo 161396 ? National Museum of the Marine Corps , Triangle , Virginia .

BuNo 161397 ? Carolinas Aviation Museum , Charlotte , North Carolina .

= = Specifications (AV @-@ 8B Harrier II Plus) = =

Data from Nordeen , Boeing , and Airforce @-@ technology.com

General characteristics

Crew : 1 pilot

Length : 46 ft 4 in (14 @.@ 12 m)

Wingspan : 30 ft 4 in (9 @.@ 25 m)

Height : 11 ft 8 in (3 @.@ 55 m)

Wing area : 243 @.@ 4 sq ft (22 @.@ 61 m ²)

Airfoil : supercritical airfoil

Empty weight : 13 @,@ 968 lb (6 @,@ 340 kg)

Loaded weight : 22 @,@ 950 lb (10 @,@ 410 kg)

Max. takeoff weight : Rolling : 31 @,@ 000 lb (14 @,@ 100 kg)

Vertical : 20 @,@ 755 lb (9 @,@ 415 kg)

Powerplant : 1 × Rolls @-@ Royce F402 @-@ RR @-@ 408 (Mk 107) vectored @-@ thrust turbofan , 23 @,@ 500 lbf (105 kN)

Performance

Maximum speed : Mach 0 @ 9 (585 knots , 673 mph , 1 @ 083 km / h)

Range : 1 @ 200 nmi (1 @ 400 mi , 2 @ 200 km)

Combat radius : 300 nmi (350 mi , 556 km)

Ferry range : 1 @ 800 nmi (2 @ 100 mi , 3 @ 300 km)

Rate of climb : 14 @ 700 ft / min (75 m / s)

Wing loading : 94 @ 29 lb / (sq ft) (460 @ 4 kg / m²)

Armament

Guns : 1 × General Dynamics GAU @ 12 Equalizer 25 mm (0 @ 984 in) 5 @ barreled Gatling cannon mounted under @ fuselage in the left pod , with 300 rounds of ammunition in the right pod

Hardpoints : 6 × under @ wing pylon stations holding up to 9 @ 200 lb (4 @ 200 kg) of payload :

Rockets : 4 × LAU @ 5003 rocket pods (each with 19 × CRV7 or APKWS 70 mm rockets)

Missiles : Air @ to @ air missiles :

4 × AIM @ 9 Sidewinder or similar @ sized infrared @ guided missiles

6 × AIM @ 120 AMRAAM (on radar equipped AV @ 8B Plus variants)

Air @ to @ surface missiles :

6 × AGM @ 65 Maverick ; or

2 × AGM @ 84 Harpoon ; or

2 × AGM @ 88 HARM

Bombs : CBU @ 100 cluster bombs (CBUs)

Mark 80 series of unguided bombs (including 3 kg [6 @ 6 lb] and 14 kg [31 lb] practice bombs)

Paveway series of laser @ guided bombs (LGBs)

Joint Direct Attack Munitions (GBU @ 38 , GBU @ 32 , and GBU @ 54)

Mark 77 napalm canisters

B61 nuclear bomb

Others :

up to 4 × 300 / 330 / 370 US Gallon drop tanks (pylon stations No. 2 , 3 , 4 , & 5 are wet plumbed)

Intrepid Tiger II electronic jammer

Avionics

Raytheon APG @ 65 radar

AN / AAQ @ 28V LITENING targeting pod (on radar @ equipped AV @ 8B Plus variants)

= = Popular culture = =

As part of its 1996 Pepsi Stuff marketing campaign , Pepsi ran an advertisement promising a Harrier jet to anyone who collected 7 @ 000 @ 000 Pepsi Points , a gag that backfired when a participant attempted to take advantage of the ability to buy additional points for 10 cents each to claim a jet for US \$ 700 @ 000 . When Pepsi turned him down , a lawsuit ensued , in which the judge ruled that any reasonable person would conclude that the advertisement was a joke .