= Bell Boeing V @-@ 22 Osprey =

The Bell Boeing V @-@ 22 Osprey is an American multi @-@ mission , tiltrotor military aircraft with both vertical takeoff and landing (VTOL) , and short takeoff and landing (STOL) capabilities . It is designed to combine the functionality of a conventional helicopter with the long @-@ range , high @-@ speed cruise performance of a turboprop aircraft .

The V @-@ 22 originated from the United States Department of Defense Joint @-@ service Vertical take @-@ off / landing Experimental (JVX) aircraft program started in 1981 . The team of Bell Helicopter and Boeing Helicopters was awarded a development contract in 1983 for the tiltrotor aircraft . The Bell Boeing team jointly produce the aircraft . The V @-@ 22 first flew in 1989 , and began flight testing and design alterations ; the complexity and difficulties of being the first tiltrotor intended for military service in the world led to many years of development .

The United States Marine Corps began crew training for the Osprey in 2000 , and fielded it in 2007 ; it supplemented and then replaced their Boeing Vertol CH @-@ 46 Sea Knights . The Osprey 's other operator , the U.S. Air Force , fielded their version of the tiltrotor in 2009 . Since entering service with the U.S. Marine Corps and Air Force , the Osprey has been deployed in transportation and medevac operations over Iraq , Afghanistan , Libya and Kuwait .

= = Development = =

= = = Origins = = =

The failure of the Iran hostage rescue mission in 1980 demonstrated to the United States military a need for " a new type of aircraft , that could not only take off and land vertically but also could carry combat troops , and do so at speed . " The U.S. Department of Defense began the Joint @-@ service Vertical take @-@ off / landing Experimental (JVX) aircraft program in 1981 , under U.S. Army leadership .

The defining mission of the Marine Corps has been to perform an amphibious landing , and they were particularly interested in the JVX program . They realized that a concentrated strike force was vulnerable to a single nuclear weapon , airborne solutions with good speed and range allowed for significant dispersal ; and their CH @-@ 46s were wearing out ; without replacement , the threat of a merger between the Marine Corps and the Army lingered , similar to President Truman 's proposal following World War II . The OSD and Navy administration were against the tiltrotor project , but congressional pressure eventually proved persuasive .

The U.S. Navy and Marine Corps were given the lead in 1983 . The JVX combined requirements from the U.S. Marine Corps , Air Force , Army and Navy . A request for proposals (RFP) was issued in December 1982 for preliminary design work . Interest was expressed by Aérospatiale , Bell Helicopter , Boeing Vertol , Grumman , Lockheed , and Westland . Contractors were encouraged to form teams . Bell partnered with Boeing Vertol to submit a proposal for an enlarged version of the Bell XV @-@ 15 prototype on 17 February 1983 . Being the only proposal received , a preliminary design contract was awarded on 26 April 1983 .

The JVX aircraft was designated V @-@ 22 Osprey on 15 January 1985 ; by that March , the first six prototypes were being produced , and Boeing Vertol was expanded to deal with the project workload . Work has been split evenly between Bell and Boeing . Bell Helicopter manufactures and integrates the wing , nacelles , rotors , drive system , tail surfaces , and aft ramp , as well as integrates the Rolls @-@ Royce engines and performs final assembly . Boeing Helicopters manufactures and integrates the fuselage , cockpit , avionics , and flight controls . The USMC variant of the Osprey received the MV @-@ 22 designation and the U.S. Air Force variant received CV @-@ 22 ; this was reversed from normal procedure to prevent Marine Corps Ospreys from having a conflicting designation with aircraft carriers (CV) . Full @-@ scale development of the V @-@ 22 tilt @-@ rotor aircraft began in 1986 . On 3 May 1986 , the Bell Boeing partnership was awarded a $ 1 @.@ 714 billion contract for V @-@ 22 aircraft by the U.S. Navy . At this point , all

four U.S. military services had acquisition plans for V @-@ 22 versions .

The first V @-@ 22 was rolled out with significant media attention in May 1988 . The project suffered several blows . That year , the U.S. Army left the program , citing a need to focus its budget on more immediate aviation programs . In 1989 , the project survived two separate votes in the Senate that could have resulted in cancellation . Despite the Senate 's decision , the Department of Defense instructed the U.S. Navy not to spend more money on the V @-@ 22 . When the V @-@ 22 's projected development budget greatly increased in 1988 , Defense Secretary Dick Cheney tried to remove funding from 1989 to 1992 in an effort to cancel it . He was eventually overruled by Congress , which provided unrequested funding for the program . Multiple studies of alternatives found the V @-@ 22 provided more capability and combat effectiveness with similar operating costs . The Clinton Administration was supportive of the V @-@ 22 and helped it attain funding .

= = = Flight testing and design changes = = =

The first of six MV @-@ 22 prototypes first flew on 19 March 1989 in the helicopter mode , and on 14 September 1989 in fixed @-@ wing mode . The third and fourth prototypes successfully completed the Osprey 's first sea trials on USS Wasp in December 1990 . The fourth and fifth prototypes crashed in 1991 ? 92 . From October 1992 ? April 1993 , Bell and Boeing redesigned the V @-@ 22 to reduce empty weight , simplify manufacture , and reduce production costs . This redesigned version became the V @-@ 22B model . V @-@ 22 flights resumed in June 1993 after safety improvements were incorporated in the prototypes . Bell Boeing was awarded a contract for the engineering manufacturing development (EMD) phase in June 1994 . The prototypes also received changes to better match the B @-@ model configuration . Flight testing at the stage focused on expanding the flight envelope , measuring flight loads , and supporting the EMD redesign . This and further flight testing with the early V @-@ 22s continued into 1997 .

Flight testing of four full @-@ scale development V @-@ 22s began in early 1997 when the first pre @-@ production V @-@ 22 was delivered to the Naval Air Warfare Test Center , Naval Air Station Patuxent River , Maryland . The first EMD flight took place on 5 February 1997 . Testing fell behind schedule . The first of four low rate initial production aircraft , ordered on 28 April 1997 , was delivered on 27 May 1999 . Osprey number 10 completed the program 's second sea trials , this time from USS Saipan in January 1999 . During external load testing in April 1999 , Boeing used a V @-@ 22 to lift and transport the light @-@ weight M777 howitzer .

In 2000 , there were two further fatal crashes , killing a total of 19 marines , and the aircraft was again grounded while the cause of these crashes was investigated and various parts were redesigned . By 2012 , changes had been made to the V @-@ 22 's hardware , software , and procedures in response to hydraulic fires in the nacelles , vortex ring state control issues , and opposed landings .

The V @-@ 22 completed its final operational evaluation in June 2005 . The evaluation had included long range deployments , high altitude , desert and shipboard operations , and was deemed successful . The problems identified in various accidents had reportedly been addressed .

U.S. Naval Air Systems Command worked on software upgrades to increase the maximum speed from 250 knots (460 km / h ; 290 mph) to 270 knots (500 km / h ; 310 mph) , increase helicopter mode altitude limit from 10 @,@ 000 feet (3 @,@ 000 m) to 12 @,@ 000 feet (3 @,@ 700 m) or 14 @,@ 000 feet (4 @,@ 300 m) , and increase lift performance . Implementation of these upgrades began in September 2011 and proved largely effective .

In October 2015 , NAVAIR tested rolling landings and takeoffs on a carrier , preparing for Carrier onboard delivery .

= = = Controversy = = =

The V @-@ 22 's development process has been long and controversial , partly due to its large cost increases , some of which are caused by the requirement to fold wing and rotors to fit aboard ships . The development budget was first planned for $ 2 @.@ 5 billion in 1986 , which increased to a

projected $ 30 billion in 1988 . By 2008 , $ 27 billion had been spent on the program and another $ 27 @.@ 2 billion was required to complete planned production numbers . Between 2008 and 2011 , the estimated lifetime cost for maintaining the V @-@ 22 grew by 61 percent , mostly allocated to maintenance and support .

Its [The V @-@ 22 's] production costs are considerably greater than for helicopters with equivalent capability ? specifically , about twice as great as for the CH @-@ 53E , which has a greater payload and an ability to carry heavy equipment the V @-@ 22 cannot ... an Osprey unit would cost around $ 60 million to produce , and $ 35 million for the helicopter equivalent .

In 2001 , Lieutenant Colonel Odin Lieberman , commander of the V @-@ 22 squadron at Marine Corps Air Station New River , was relieved of duty after allegations that he instructed his unit to falsify maintenance records to make the aircraft appear more reliable . A total of three USMC officers were later implicated as having played a role in the falsification scandal .

In October 2007 , Time Magazine ran an article condemning the V @-@ 22 as unsafe , overpriced , and completely inadequate ; the Marine Corps responded by arguing that parts of the article 's data were dated , obsolete , inaccurate , and reflected expectations too high for any new field of aircraft . In 2011 , it was reported by the controversial defense industry supported Lexington Institute that the average V @-@ 22 mishap rate per flight hour over the past 10 years was approximately half of the average accident rate for the USMC fleet ; the V @-@ 22 's accident rate was the lowest of any Marine rotorcraft . In 2011 Wired Magazine reported that the safety record was achieved by excluding ground incidents ; the USMC responded that MV @-@ 22 reporting were to the same standards as other aircraft in the Department of the Navy .

By 2012 , the USMC reported fleetwide readiness rate had risen to 68 percent ; however , the DOD 's Inspector General later found 167 of 200 reports had " improperly recorded " information . Captain Richard Ulsh blamed these errors on incompetence and said that they were " not malicious " or deliberate . The required mission capable rate was 82 % , but the average was 53 % from June 2007 to May 2010 . In 2010 , Naval Air Systems Command aimed for an 85 % reliability rate by 2018 . From 2009 to 2014 , readiness rates rose 25 percent to the " high 80s , " while cost per flight hour had dropped 20 percent to $ 9 @,@ 520 through a rigorous maintenance improvement program that focused on diagnosing problems before failures occur . As of 2015 , although the V @-@ 22 requires higher maintenance and has lower availability (62 %) than traditional helicopters , it also has a lower incidence rate . The average cost per flight hour is US $ 9 @,@ 156 , whereas the CH @-@ 53E cost about $ 20 @,@ 000 per flight hour in 2007 . V @-@ 22 ownership cost was $ 83 @,@ 000 per hour in 2013 .

While technically capable of autorotation if both engines fail in helicopter mode , a safe landing is difficult ; in 2005 , a director of the Pentagon 's testing office stated that in a loss of power while hovering below 1 @,@ 600 feet (490 m) , emergency landings " ... are not likely to be survivable . " V @-@ 22 pilot Captain Justin " Moon " McKinney stated that : " We can turn it into a plane and glide it down , just like a C @-@ 130 . " A complete loss of power requires both engines to fail , as one engine can power both proprotors via interconnected drive shafts . Though vortex ring state (VRS) contributed to a deadly V @-@ 22 accident , flight testing found the aircraft to be less susceptible to the condition than conventional helicopters . A GAO report stated that the V @-@ 22 is " less forgiving than conventional helicopters " during this phenomenon . Several test flights to explore the V @-@ 22 's VRS characteristics were canceled . The USMC trains pilots in the recognition of and recovery from VRS , and has instituted operational envelope limits and instrumentation to help pilots avoid VRS conditions .

= = = Production = = =

On 28 September 2005 , the Pentagon formally approved full @-@ rate production for the V @-@ 22 , with planned rate increase from 11 a year to between 24 and 48 a year by 2012 . Of the 458 total planned , 360 are for the U.S. Marine Corps , 50 for the Air Force , and 48 for the Navy at an average cost of $ 110 million per aircraft , including development costs . The V @-@ 22 had an incremental flyaway cost of $ 67 million per aircraft in 2008 , The U.S. Navy had hoped to shave

about $ 10 million off that cost after a five @-@ year production contract in 2013 . The cost for each CV @-@ 22 was $ 73 million in the FY 2014 budget .

On 15 April 2010 , the Naval Air Systems Command awarded Bell Boeing a $ 42 @.@ 1 million contract to design an integrated processor in response to avionics obsolescence and add new network capabilities . By 2014 , Raytheon will provide an avionics upgrade that includes Situational awareness and Blue Force Tracking . In late 2009 , a contract for Block C upgrades upon the V @-@ 22 was awarded to Bell Boeing . In February 2012 , the Marine Corps received the first Block C Ospreys ; these aircraft feature a new radar , along with additional mission management and electronic warfare equipment . Marines investigate options in 2015 to upgrade all V @-@ 22s to C models in order to boost availability .

On 12 June 2013 , the U.S. DoD awarded a $ 4 @.@ 9 billion contract to Bell and Boeing for 99 V @-@ 22s in production Lots 17 and 18 , including 92 MV @-@ 22s for the Marine Corps . Work is expected to be completed in September 2019 . A provision gives NAVAIR the option to order 23 more Ospreys . The combined cost of the June 2013 contract and other associated contracts for the order totaled $ 6 @.@ 5 billion .

In 2013 , the U.S. was reportedly hoping to sell up to 100 V @-@ 22s internationally with up to 15 interested nations identified ; prospective customers included Israel , the United Arab Emirates , and Japan . In 2013 , Bell began to lay off workers on the V @-@ 22 production line following the implementation of defense cuts , which had reduced the US order to about half the originally planned number of aircraft . Production rate went from 40 in 2012 to 22 planned for 2015 . Manufacturing robots have replaced older automated machines for increased accuracy and efficiency in production . Large parts are held in place by suction cups and measured electronically . Raw materials arrive frozen .

In March 2014 , Air Force Special Operations Command (AFSOC) issued a Combat Mission Need Statement to develop armor to protect V @-@ 22 passengers . NAVAIR worked with a Florida @-@ based composite armor company and the Army Aviation Development Directorate to develop and deliver the Advanced Ballistic Stopping System (ABSS) by October 2014 . Costing $ 270 @,@ 000 , the ABSS consists of 66 plates fitting along interior bulkheads and deck , adding 800 lb (360 kg) to the aircraft 's weight , affecting payload and unrefueled range . So it can be installed or removed when needed in hours and partially assembled in pieces for partial protection of specific areas . As of May 2015 , 16 kits had been delivered to the USAF .

In 2015 , Bell @-@ Boeing set up the V @-@ 22 Readiness Operations Center (VROC) at Ridley Park , Pennsylvania to gather information from each aircraft to improve fleet performance in a similar manner as the F @-@ 35 's Autonomic Logistics Information System (ALIS) .

= = Design = =

= = = Overview = = =

The Osprey is the world 's first production tiltrotor aircraft , with one three @-@ bladed proprotor , turboprop engine , and transmission nacelle mounted on each wingtip . It is classified as a powered lift aircraft by the Federal Aviation Administration . For takeoff and landing , it typically operates as a helicopter with the nacelles vertical and rotors horizontal . Once airborne , the nacelles rotate forward 90 ° in as little as 12 seconds for horizontal flight , converting the V @-@ 22 to a more fuel @-@ efficient , higher speed turboprop aircraft . STOL rolling @-@ takeoff and landing capability is achieved by having the nacelles tilted forward up to 45 ° . Other orientations are possible . It has a ferry range of over 2 @,@ 100 nmi . Its operational range is 1 @,@ 100 nmi .

Composite materials make up 43 % of the airframe , and the proprotor blades also use composites . For storage , the V @-@ 22 's rotors fold in 90 seconds and its wing rotates to align , front @-@ to @-@ back , with the fuselage . Due to the requirement for folding rotors , their 38 @-@ foot diameter is 5 feet less than optimal for vertical takeoff , resulting in high disk loading . Most missions use fixed wing flight 75 % or more of the time , reducing wear and tear and operational costs . This

fixed wing flight is higher than typical helicopter missions allowing longer range line @-@ of @-@ sight communications for improved command and control .

Heat from the V @-@ 22 's engines can potentially damage the flight decks of ships . Naval Air Systems Command (NAVAIR) devised a temporary fix of portable heat shields placed under the engines , and determined that a long @-@ term solution would require redesigning decks with heat resistant coating , passive thermal barriers , and ship structure changes . Similar changes are required for F @-@ 35B operations . In 2009 , DARPA requested solutions for installing robust flight deck cooling . A heat @-@ resistant anti @-@ skid material called Thermion has been tested on USS Wasp .

= = = Engines = = =

The V @-@ 22 's two Rolls @-@ Royce AE 1107C engines are connected by drive shafts to a common central gearbox so that one engine can power both proprotors if an engine failure occurs .

In September 2013 , Rolls @-@ Royce announced it had increased the AE @-@ 1107C engine 's power by 17 percent via the adoption of a new Block 3 turbine , an increase in fuel valve flow capacity , and accompanying software updates . The upgrade should increase the reliability in high @-@ altitude , high @-@ heat conditions and boost maximum payload limitations from 6 @,@ 000 ft to 8 @,@ 000 ft . A Block 4 upgrade is reportedly being examined , which may increase power by up to 26 percent , producing close to 10 @,@ 000 hp , and improve fuel consumption .

In August 2014 , the U.S. military issued a request for information (RFI) for a potential drop @-@ in replacement for the AE @-@ 1107C engines . Submissions must have a power rating of no less than 6 @,@ 100 shp (4 @,@ 548 @.@ 78 kW) at 15 @,@ 000 rpm , operate at up to 25 @,@ 000 ft (7 @,@ 600 m) at up to 130 degrees Fahrenheit (54 @.@ 4 degrees Celsius) , and fit into the existing nacelles on the wings with minimal structural or external modifications . In September 2014 , the US Navy was considering contracting for an alternative engine supplier in order to reduce costs . In the V @-@ 22 program , the Navy purchases engines separately from the aircraft themselves . The General Electric GE38 has been considered as a replacement , providing commonality with the CH @-@ 53K King Stallion .

= = = Proprotors = = =

Either engine can power both proprotors through the wing driveshaft . However , the V @-@ 22 is generally not capable of hovering on one engine . If a proprotor gearbox fails that proprotor cannot be feathered , and both engines must be stopped before an emergency landing . The aircraft 's autorotation characteristics are poor partly because the rotors have low inertia .

The V @-@ 22 has a maximum rotor downwash speed above 80 knots , more than the 64 knots lower limit of a hurricane . The rotorwash usually prevents usage of the starboard door in hover , instead the rear ramp is used for rappelling and hoisting . Boeing has stated the V @-@ 22 design loses 10 percent of its vertical lift over a tiltwing design when operating in helicopter mode because of airflow resistance due to the wings , but that the tiltrotor design has better short takeoff and landing performance . A V @-@ 22 must maintain at least 25 ft (7 @.@ 6 m) of vertical separation between each other to avoid their rotor wake , which can cause turbulence and potentially lead to a loss of control .

= = = Avionics = = =

The V @-@ 22 is equipped with a glass cockpit , which incorporates four Multi @-@ function displays (MFDs , compatible with night @-@ vision goggles) and one shared Central Display Unit (CDU) , to display various images including : digimaps , imagery from the Turreted Forward Looking Infrared System primary flight instruments , navigation (TACAN , VOR , ILS , GPS , INS) , and system status . The flight director panel of the Cockpit Management System (CMS) allows for fully coupled (autopilot) functions that take the aircraft from forward flight into a 50 ft (15 m) hover with

no pilot interaction other than programming the system . The glass cockpit of the canceled CH @-@ 46X was derived from the V @-@ 22 . The fuselage is not pressurized , and personnel must wear on @-@ board oxygen masks above 10 @,@ 000 feet .

The V @-@ 22 has triple @-@ redundant fly @-@ by @-@ wire flight control systems . The aircraft also has computerized damage control that automatically isolates damaged elements . With the nacelles pointing straight up in conversion mode at 90 ° the flight computers command the aircraft to fly like a helicopter , with cyclic forces being applied to a conventional swashplate at the rotor hub . With the nacelles in airplane mode (0 °) the flaperons , rudder , and elevator fly the aircraft like an airplane . This is a gradual transition and occurs over the rotation range of the nacelles . The lower the nacelles , the greater effect of the airplane @-@ mode control surfaces . The nacelles can rotate past vertical to 97 @.@ 5 ° for rearward flight . The V @-@ 22 can use the " 80 Jump " orientation with the nacelles at 80 ° for takeoff to quickly achieve high altitude and speed . Aspects of the V @-@ 22 's flight are automated and simplified by the control system such that the V @-@ 22 can hover (in low wind) with no hands on the controls . According to some who have flown the aircraft , former fixed @-@ wing pilots may be preferable because they (unlike those with helicopter experience) are not trained to constantly adjust the controls while hovering .

= = = Armament = = =

The Osprey can be armed with one 7 @.@ 62 × 51mm NATO (.308 in caliber) M240 machine gun or .50 in caliber (12 @.@ 7 mm) M2 machine gun on the loading ramp , that can be fired rearward when the ramp is lowered . A .50 in GAU @-@ 19 three @-@ barrel Gatling gun mounted below the V @-@ 22 's nose was studied for future upgrade . BAE Systems developed a belly @-@ mounted , remotely operated gun turret system for the V @-@ 22 , named the Interim Defense Weapon System (IDWS) . The IDWS is remotely operated by a gunner inside the aircraft , who acquires targets via a separate pod using color television and forward looking infrared imagery . The IDWS was installed on half of the first V @-@ 22s deployed to Afghanistan in 2009 , but found limited use due to its 800 lb (360 kg) weight and restrictive rules of engagement .

There were 32 IDWSs available to the Marine Corps in June 2012 . The system had not been fired in combat as V @-@ 22s were routinely escorted by helicopter gunships and close air support aircraft , allowing them to focus on their transport role ; squadrons also often flew without the belly gun , as the added weight reduced its cargo @-@ carrying capacity . The Osprey 's speed means it can outrun supporting conventional helicopters , requiring a self @-@ defense capability on long @-@ range missions and operate independently . The infrared gun camera has proven valuable for reconnaissance and surveillance . Other weapons are being studied to provide an all @-@ quadrant defensive weapon system including nose guns , door guns , and nonlethal countermeasures to work with the current ramp @-@ mounted machine gun and the IDWS .

In 2014 , the USMC revealed plans for new V @-@ 22 weapons " to increase all @-@ axis , stand @-@ off , and precision capabilities " , which may be potentially operated by additional crew members . Armament increases are for enhanced offensive capabilities to special purpose Marine rapid crisis response task forces , rather than as an attack platform . The V @-@ 22 could be adapted for various precision weapons , including the AGM @-@ 114 Hellfire , AGM @-@ 176 Griffin , Joint Air @-@ to @-@ Ground Missile , and GBU @-@ 53 / B SDB II . Fuselage @-@ based hardpoints would be used to clear the proprotors . In November 2014 , Bell and Boeing conducted self @-@ funded weapons tests using a V @-@ 22 equipped with a small pylon on the front port @-@ side fuselage and the AN / AAQ @-@ 27A EO camera replaced with an L @-@ 3 Wescam MX @-@ 15 sensor / laser designator . 26 unguided Hydra 70 rockets , two guided APKWS rockets , and two Griffin B missiles were fired over five flights . The USMC and USAF seek a traversable nose @-@ mounted weapon connected to a helmet @-@ mounted sight ; recoil would complicate integrating a desired forward @-@ facing gun . A weapons pylon on either side of the fuselage can carry 300 lb (140 kg) of munitions .

= = = Refueling capability = = =

Boeing is developing a roll @-@ on / roll @-@ off aerial refueling kit , which would give the V @-@ 22 the ability to refuel other aircraft . Having an aerial refueling capability that can be based off Wasp @-@ class amphibious assault ships would increase the striking power of Marine F @-@ 35Bs , as they would not rely on refueling assets that could only be based on full @-@ sized Nimitz @-@ class aircraft carriers or from land bases . The roll @-@ on / roll @-@ off kit can also be applicable to intelligence , surveillance , and reconnaissance functions . Boeing funded a non @-@ functional demonstration on a VMX @-@ 22 aircraft ; a prototype kit was successfully tested with an F / A @-@ 18 on 5 September 2013 .

The high @-@ speed version of the hose / drogue refueling system is designed to be deployed at 185 kn (213 mph ; 343 km / h) and function at up to 250 kn (290 mph ; 460 km / h) . Onboard tanks and a roll @-@ on / roll @-@ off bladder can contain up to 12 @,@ 000 lb (5 @,@ 400 kg) of fuel . The operator must open the ramp to extend the refueling hose , then raise the ramp once extended , with the top ramp door left open . The V @-@ 22 could refuel rotary @-@ wing aircraft , but it would require a separate drogue used specifically by helicopters and a partially converted nacelle . Bell and Boeing are hoping for funding for additional testing to include contact between the refueler and receiver and eventually the passage of fuel . Since many Marine Corps ground vehicles can run on aviation fuel , a refueling V @-@ 22 could also service them . In late 2014 , it was stated that such tankers could be operational by 2017 .

While the Navy has not declared a firm interest to use the V @-@ 22 Aerial Refueling System (VARS) on its planned COD fleet , on 22 February 2016 Boeing confirmed that it expects to sign a development contract with the US Marine Corps (USMC) for the VARS system in the first quarter of 2016 . Boeing had conducted an internally financed proof of concept for the roll @-@ on / roll @-@ off capability , with the anticipated USMC contract providing funds to " productionise the kit " . VARS would become operational in FY 2018 and would allow the Osprey to become the USMC 's recovery tanker ; when aircraft land on USMC amphibious ships , they sometimes need additional fuel while they wait for available deck space .

= = Operational history = =

= = = U.S. Marine Corps = = =

Since March 2000 , VMMT @-@ 204 has conducted Marine Corps crew training for the V @-@ 22 . On 3 June 2005 , Marine Corps helicopter squadron Marine Medium Helicopter 263 (HMM @-@ 263) stood down to transition to the MV @-@ 22 . On 8 December 2005 , Lieutenant General James Amos , commander of II Marine Expeditionary Force , accepted delivery of the first fleet of MV @-@ 22s , delivered to HMM @-@ 263 . The unit reactivated on 3 March 2006 as the first MV @-@ 22 squadron , redesignated as VMM @-@ 263 . On 23 March 2007 , HMM @-@ 266 became Marine Medium Tiltrotor Squadron 266 (VMM @-@ 266) at Marine Corps Air Station New River , North Carolina .

The MV @-@ 22 reached initial operational capability (IOC) with the U.S. Marine Corps on 13 June 2007 . The Osprey has been replacing the CH @-@ 46 Sea Knight since 2007 ; the Sea Knight was retired in October 2014 . On 10 July 2007 , an MV @-@ 22 landed aboard the Royal Navy aircraft carrier HMS Illustrious , the first time a V @-@ 22 had landed on a non @-@ U.S. vessel .

On 13 April 2007 , the Marine Corps announced the first V @-@ 22 combat deployment at Al Asad Airbase , Iraq . On 17 September 2007 , 10 MV @-@ 22Bs of VMM @-@ 263 left for Iraq aboard USS Wasp . The decision to use a ship instead of self @-@ deploying was made because of concerns over icing during the North Atlantic portion of the trip , lack of available KC @-@ 130s for mid @-@ air refueling , and the Wasp 's availability .

On arrival , they were used in Iraq 's western Anbar province for cargo and troop movements , as well as riskier " aero @-@ scout " missions . General David Petraeus , the top U.S. military

commander in Iraq , used one to visit troops around Iraq on Christmas Day 2007 ; as did then @-@ presidential candidate Barack Obama during his 2008 tour of Iraq . Obtaining spare parts proved problematic . By July 2008 , the V @-@ 22 had flown 3 @,@ 000 sorties totaling 5 @,@ 200 hours in Iraq . General George J. Trautman , III praised the V @-@ 22 's increased speed and range over legacy helicopters , stating that " it turned his battle space from the size of Texas into the size of Rhode Island . " Through 2009 , V @-@ 22s had been fired upon several times by man @-@ portable air @-@ defense systems , and small arms with none lost to enemy fire .

A Government Accountability Office study reported that by January 2009 , 12 MV @-@ 22s were operating in Iraq and they completed all assigned missions ; mission capable rates averaged 57 % to 68 % , and an overall full mission capable rate of 6 % . The report also stated that the aircraft had shown weakness in situational awareness , maintenance , shipboard operations and transport capability . The study concluded that " ... deployments confirmed that the V @-@ 22 ? s enhanced speed and range enable personnel and internal cargo to be transported faster and farther than is possible with the legacy helicopters it is replacing . "

The MV @-@ 22 deployed to Afghanistan in November 2009 with VMM @-@ 261 , and saw its first offensive combat mission , Operation Cobra 's Anger , on 4 December 2009 . Ospreys assisted in inserting 1 @,@ 000 Marines and 150 Afghan troops into the Now Zad Valley of Helmand Province in southern Afghanistan to disrupt Taliban communication and supply lines . On 18 February 2011 , Marine Commandant General James Amos indicated MV @-@ 22s deployed to Afghanistan had surpassed 100 @,@ 000 flight hours and were noted as " the safest airplane , or close to the safest airplane ? in the Marine Corps inventory .

In January 2010 , the MV @-@ 22 was sent to Haiti as part of Operation Unified Response relief efforts after the earthquake there , the type 's first humanitarian mission . In March 2011 , two MV @-@ 22s from Kearsarge participated in a mission to rescue a downed USAF F @-@ 15E crew member during Operation Odyssey Dawn . On 2 May 2011 , following Operation Neptune 's Spear , the body of Osama bin Laden , founder of the al @-@ Qaeda terrorist group , was flown by a MV @-@ 22 to the aircraft carrier Carl Vinson in the Northern Arabian Sea , prior to his burial at sea .

In 2013 , several MV @-@ 22s received communications and seating modifications to support the Marine One presidential transport squadron due to the urgent need for CH @-@ 53Es in Afghanistan . On 11 August 2013 , two MV @-@ 22s from Marine Helicopter Squadron One (HMX @-@ 1) made their debut ferrying Secret Service agents , White House staff , and press members from CGAS Cape Cod to Martha 's Vineyard during the President 's vacation . In May 2010 , Boeing announced plans to submit the V @-@ 22 for the VXX presidential transport replacement .

Several Japanese politicians and Okinawa residents opposed a V @-@ 22 deployment to Japan in July 2012 , mainly due to several high @-@ profile accidents . On 14 June 2013 , an MV @-@ 22 landed on the JDS Hy?ga off the coast of California , the first time a V @-@ 22 had landed on a Japan Maritime Self @-@ Defense Force vessel . In January 2014 , a MV @-@ 22 landed aboard the French Mistral @-@ class amphibious assault ship Dixmude . A Marine MV @-@ 22 landed on the ROKS Dokdo (LPH @-@ 6111) on 26 March 2015 , marking the first landing of an Osprey on a Republic of Korea Navy amphibious ship .

From 2 to 5 August 2013 , two MV @-@ 22s completed the longest distance Osprey tanking mission to date . Flying from Marine Corps Air Station Futenma in Okinawa alongside two KC @-@ 130J tanker aircraft , the Ospreys flew to Clark Air Base in the Philippines on 2 August , then to Darwin , Australia on 3 August , Townsville , Australia on 4 August , and finally rendezvoused with Bonhomme Richard on 5 August .

In 2013 , the USMC formed an intercontinental response force , the Special Purpose Marine Air @-@ Ground Task Force - Crisis Response - Africa (SPMAGTF @-@ CR @-@ AF) , equipped with V @-@ 22s outfitted with specialized communications equipment . In 2013 , following Typhoon Haiyan , 12 MV @-@ 22s of the 3rd Marine Expeditionary Brigade were deployed to the Philippines for disaster relief operations . The V @-@ 22 's capabilities were described as " uniquely relevant " , being able to fly faster and with greater payload while moving essential supplies to remote sites throughout the island archipelago .

The V @-@ 22 deployment to Afghanistan was set to conclude in late 2013 with the drawdown of

combat operations ; however VMM @-@ 261 was directed to extend operations for a new role , casualty evacuation , for which it was better suited than helicopters as its speed better enabled casualties to reach a hospital within the ' golden hour ' ; they were fitted with medical equipment such as heart @-@ monitors and basic triage supplies .

In 2014 , the SPMAGTF @-@ CR @-@ AF supported the time @-@ critical effort against the Ebola virus epidemic in Liberia , flying 1 @,@ 200 people and 78 @,@ 000 lb (35 t) of cargo in V @-@ 22s .

In November 2014 , three MV @-@ 22Bs were placed on alert at Al Jaber Air Base in Kuwait to be ready within 30 minutes to recover downed pilots during the Military intervention against ISIL . On 29 occasions between 1 November and 24 April 2015 , two Ospreys and a KC @-@ 130J aerial tanker assigned to this Tactical Recovery of Aircraft and Personnel (TRAP) mission spent 145 flight hours loitering , ready to perform rescue missions if required . The only pilot that was downed was a Jordanian , but he did not have a radio on him when he ejected and landed too close to ISIL forces .

= = = U.S. Air Force = = =

The Air Force 's first operational CV @-@ 22 was delivered to the 58th Special Operations Wing (58th SOW) at Kirtland Air Force Base , New Mexico on 20 March 2006 . This and subsequent aircraft became part of the 58th SOW 's fleet of aircraft used for training pilots and crew members for special operations use . On 16 November 2006 , the Air Force officially accepted the CV @-@ 22 in a ceremony conducted at Hurlburt Field , Florida . The Air Force first used the V @-@ 22 on a non @-@ training mission to perform search and rescue from Kirtland Air Force Base on 4 October 2007 .

The U.S. Air Force 's first operational deployment of the Osprey sent four CV @-@ 22s to Mali in November 2008 in support of Exercise Flintlock . The CV @-@ 22s flew nonstop from Hurlburt Field , Florida with in @-@ flight refueling . AFSOC declared that the 8th Special Operations Squadron reached Initial Operational Capability on 16 March 2009 , with six CV @-@ 22s in service .

In June 2009 , CV @-@ 22s of the 8th Special Operations Squadron delivered 43 @,@ 000 pounds (20 @,@ 000 kg) of humanitarian supplies to remote villages in Honduras that were not accessible by conventional vehicles . In November 2009 , the 8th SO Squadron and its six CV @-@ 22s returned from a three @-@ month deployment in Iraq .

In August 2012 , the USAF found that " CV @-@ 22 wake modeling is inadequate for a trailing aircraft to make accurate estimations of safe separation from the preceding aircraft . "

On 21 December 2013 , three CV @-@ 22s came under small arms fire while on a mission to evacuate American civilians in Bor , South Sudan during the 2013 South Sudanese political crisis . The three aircraft were damaged and four crew wounded ; the mission was aborted and the aircraft flew 500 mi (800 km) to Entebbe , Uganda . South Sudanese officials stated that the attackers were rebels . The CV @-@ 22s , of the 8th Special Operations Squadron , had flown to Bor over three countries across 790 nmi (910 mi ; 1 @,@ 460 km) . The formation was hit 119 times , causing flight control failures and hydraulic and fuel leaks on all three aircraft . Due to fuel leaks , multiple air @-@ to @-@ air refuelings were performed en route . Following the South Sudan incident , AFSOC developed optional armor floor panels for the V @-@ 22 .

On 3 July 2014 , V @-@ 22 aircraft carried Delta Force commandos to a campsite in eastern Syria where Islamic State militants had held American and other hostages . The commandos quickly eliminated the militants at the site , but found that the hostages had been moved elsewhere and returned home empty handed .

The Air Force is looking to configure the CV @-@ 22 to perform combat search and rescue in addition to its primary long @-@ range special operations transport mission . The Osprey would act as a complement to Air Force HH @-@ 60G Pave Hawk and planned HH @-@ 60W rescue helicopters , being employed in scenarios were its ability to cover more ground quickly would be better suited to search and rescue than more nimble but slower helicopters .

= = = Potential operators = = =

= = = = U.S. Navy = = = =

The United States Navy could potentially employ the V @-@ 22 in search and rescue , transport and anti @-@ submarine warfare roles . The V @-@ 22 program included Navy 48 HV @-@ 22s , but none were ordered at first . One proposal was to replace the C @-@ 2 Greyhound with the V @-@ 22 for Carrier Onboard Delivery duties . One specific advantage of the V @-@ 22 in this role is the ability to deliver supplies and people between non @-@ carriers ships beyond helicopter range . An MV @-@ 22 landed and refueled onboard Nimitz as part of an evaluation for COD in October 2012 . Further cargo handling trials took place in 2013 on Harry S. Truman .

V @-@ 22 proponents said that it is capable of similar speed , payload capacity , and lift performance as the C @-@ 2 , and can also carry greater payloads over short ranges , up to 20 @,@ 000 lb , and can also carry suspended external loads . The C @-@ 2 can only land on carriers , requiring further distribution to smaller vessels via helicopters , while the Osprey has been certified for operating upon amphibious ships , aircraft carriers , and logistics ships . The V @-@ 22 could also take the roles of some helicopters , with a 600 lb hoist fitted to the ramp and a cabin configuration for 12 non @-@ ambulatory patients and five seats for medical attendants . Boeing designed a special frame for the V @-@ 22 to carry the Lockheed Martin F @-@ 35 's F135 engine to ships . Bell and Boeing have pitched the V @-@ 22 to the Navy as a platform for various missions , such as communications , electronic warfare , or aerial refueling ; the Navy has a known gap in tactical aerial refueling , currently handled by Marine KC @-@ 130s , Air Force KC @-@ 10 Extenders , and KC @-@ 135 Stratotankers with hose @-@ and @-@ drogue delivery systems .

On 5 January 2015 , the Navy and Marines signed a memorandum of understanding (MOU) to buy the V @-@ 22 for the COD mission , and was confirmed in the Navy 's FY 2016 budget . Initially designated HV @-@ 22 , four aircraft would be initially bought each year from 2018 ? 2020 . The Navy 's variant will incorporate an extended @-@ range fuel system , a high @-@ frequency radio for over @-@ the @-@ horizon communications , and a public address system to communicate with passengers . While the MV @-@ 22 has a range of 428 nmi (493 mi ; 793 km) when carrying 24 Marines , the Navy has a requirement for an 1 @,@ 150 nmi (1 @,@ 320 mi ; 2 @,@ 130 km) unrefueled range , which may lower passenger / payload capacity . In February 2016 , the Navy officially designated its V @-@ 22 COD variant as the CMV @-@ 22B . Although its primary mission is long @-@ range aerial logistics , other conceivable mission sets can include personnel recovery and special warfare . The Navy 's program of record originally called for 48 aircraft , but they later determined they only required 44 . Production of the CMV @-@ 22 will begin in FY 2018 and start deliveries in 2020 . The version will come equipped with extra fuel bladders to extend its range .

= = = = India = = = =

The Indian Aviation Research Centre (ARC) is interested in acquiring four V @-@ 22 Ospreys for the purposes of personnel evacuation in hostile conditions , logistic supplies , and deployment of the Special Frontier Force (SFF) on the border . India had seen the Osprey 's utility in relief operations of the April 2015 Nepal earthquake . The deal could be worth some $ 300 million . Elements of the Indian Navy have also looked at the V @-@ 22 rather than the E @-@ 2D for Airborne early warning and control to replace the short @-@ range Kamov Ka @-@ 31 .

= = = = Israel = = = =

Israel has shown interest in the V @-@ 22 . In 2009 , Israel reportedly favored the Sikorsky CH @-@ 53K over the V @-@ 22 . In 2011 , Israel was interested in using the V @-@ 22 to support special operations and search & rescue missions . In 2013 , Israel was reportedly interested in a possible lease of six to eight aircraft for special operations missions ; the type is not to act as a

replacement for existing rotorcraft .

On 22 April 2013 , an agreement was finalized to sell six V @-@ 22 to the Israel Air Force . Israeli aircraft were to be moved to the front of the production queue , jumping ahead of some USMC deliveries , and expected to arrive as early as 2015 . These aircraft are to be optimized for special operations and rescue missions . The initial order of six aircraft could cost up to $ 1 @.@ 13 billion , including additional equipment and support ; Israel is interested in doubling the purchase to 12 aircraft . In October 2014 , media reports indicated that Israel 's deferment or cancelling of its V @-@ 22 procurement due to budget restraints and changing policies . In December 2014 , the Letter of Agreement offering a $ 400 million discount and early delivery formally expired , the Defense Minister having decided to wait until elections in March 2015 to push for approval from a new cabinet .

= = = = Japan = = = =

In 2012 , former Defense Minister Satoshi Morimoto ordered an investigation of the costs of V @-@ 22 operations . The V @-@ 22 exceeds current Japan Self @-@ Defense Forces helicopters in terms of range , speed , and payload . The ministry anticipates deployments to the Nansei Islands and the Senkaku Islands , as well as in multinational cooperation with the U.S. Japan is considering plans to have V @-@ 22s in service in a maritime role by as early as 2015 . On 21 November 2014 , the Japanese Ministry of Defense officially decided to procure 17 V @-@ 22s , with deliveries planned from FY 2014 to FY 2019 . In January 2015 , Japan 's parliament approved a defense budget with funding for five V @-@ 22s .

= = = = South Korea = = = =

In February 2015 , the South Korean Army showed interest in the V @-@ 22 for delivering special forces to islands in the Yellow Sea near North Korean territory ; talks are to be held during 2015 on a possible Osprey buy .

= = = = United Arab Emirates = = = =

In May 2012 , it was reported that the United Arab Emirates was in the final negotiation stages to purchase several V @-@ 22s . The UAE intends to use the Osprey to support special forces . Both UAE and the Pentagon seek a $ 58 million unit cost . On 10 November 2015 , UAE selected an AW609 variant for search and rescue use and denies negotiations on the V @-@ 22 .

= = Variants = =

V @-@ 22A

Pre @-@ production full @-@ scale development aircraft used for flight testing . These are unofficially considered A @-@ variants after the 1993 redesign .

CV @-@ 22B

U.S. Air Force variant for the U.S. Special Operations Command (USSOCOM) . It conducts long @-@ range special operations missions , and is equipped with extra wing fuel tanks , an AN / APQ @-@ 186 terrain @-@ following radar , and other equipment such as the AN / ALQ @-@ 211 , and AN / AAQ @-@ 24 Nemesis Directional Infrared Counter Measures . The fuel capacity is increased by 588 gallons (2 @,@ 230 L) with two inboard wing tanks ; three auxiliary tanks (200 or 430 gal) can also be added in the cabin . The CV @-@ 22 replaced the MH @-@ 53 Pave Low .

MV @-@ 22B

U.S. Marine Corps variant . The Marine Corps is the lead service in the V @-@ 22 's development . The Marine Corps variant is an assault transport for troops , equipment and supplies , capable of operating from ships or expeditionary airfields ashore . It replaced the Marine Corps ' CH @-@ 46E and CH @-@ 53D fleets .

CMV @-@ 22B

U.S. Navy variant for the carrier onboard delivery (COD) role . Similar to the MV @-@ 22B but includes an extended @-@ range fuel system , a high @-@ frequency radio , and a public address system .

EV @-@ 22

Proposed airborne early warning and control variant . The Royal Navy studied this AEW variant as a replacement for its current fleet of carrier @-@ based Sea King ASaC.7 helicopters .

HV @-@ 22

The U.S. Navy considered an HV @-@ 22 to provide combat search and rescue , delivery and retrieval of special warfare teams along with fleet logistic support transport . It chose the MH @-@ 60S for this role in 2001 . Naval Air Systems Command 's 2011 / 2012 V @-@ 22 Osprey Guidebook lists the HV @-@ 22 for the U.S. Navy with the USAF and USMC variants .

SV @-@ 22

Proposed anti @-@ submarine warfare variant . The U.S. Navy studied the SV @-@ 22 in the 1980s to replace S @-@ 3 and SH @-@ 2 aircraft .

= = Operators = =

Japan
Japan Self @-@ Defense Forces (5 on order)
United States
United States Air Force7th Special Operations Squadron
8th Special Operations Squadron
20th Special Operations Squadron
71st Special Operations Squadron
418th Flight Test Squadron
United States Marine CorpsHMX @-@ 1 :
VMX @-@ 22
VMM @-@ 161
VMM @-@ 162
VMM @-@ 165
VMM @-@ 166
VMMT @-@ 204
VMM @-@ 261
VMM @-@ 263
VMM @-@ 264
VMM @-@ 266
VMM @-@ 363
VMM @-@ 365
VMM @-@ 561

= = Notable accidents = =

The V @-@ 22 Osprey has had seven hull @-@ loss accidents with a total of 36 fatalities . During testing from 1991 to 2000 , there were four crashes resulting in 30 fatalities . Since becoming operational in 2007 , the V @-@ 22 has had three crashes resulting in six fatalities , and several minor incidents . The aircraft 's accident history has generated some controversy over its perceived safety issues .

= = Aircraft on display = =

The third of six V @-@ 22A prototypes is on display at the American Helicopter Museum & Education Center in West Chester , Pennsylvania .

CV @-@ 22B 99 @-@ 021 ? National Museum of the United States Air Force at Wright @-@ Patterson AFB in Dayton , Ohio .

= = Specifications (MV @-@ 22B) = =

Data from Norton , Boeing , Bell guide , Naval Air Systems Command , and USAF CV @-@ 22 fact sheet

General characteristics

Crew : Four (pilot , copilot and two flight engineers / crew chiefs)

Capacity : 24 troops (seated) , 32 troops (floor loaded) , or

20 @,@ 000 lb (9 @,@ 070 kg) of internal cargo , or up to 15 @,@ 000 lb (6 @,@ 800 kg) of external cargo (dual hook)

1 × Growler light internally transportable ground vehicle

Length : 57 ft 4 in (17 @.@ 5 m)

Rotor diameter : 38 ft 0 in (11 @.@ 6 m)

Wingspan : 45 ft 10 in (14 m)

Width with rotors : 84 ft 7 in (25 @.@ 8 m)

Height : 22 ft 1 in / 6 @.@ 73 m ; overall with nacelles vertical (17 ft 11 in / 5 @.@ 5 m ; at top of tailfins)

Disc area : 2 @,@ 268 ft ² (212 m ²)

Wing area : 301 @.@ 4 ft ² (28 m ²)

Empty weight : 33 @,@ 140 lb (15 @,@ 032 kg)

Loaded weight : 47 @,@ 500 lb (21 @,@ 500 kg)

Max. takeoff weight : 60 @,@ 500 lb (27 @,@ 400 kg) (self @-@ deploy / long runway)

Maximum rolling takeoff weight : 57 @,@ 000 lb (STOL)

Maximum vertical takeoff weight : 52 @,@ 600 lb

Powerplant : 2 × Rolls @-@ Royce Allison T406 / AE 1107C @-@ Liberty turboshafts , 6 @,@ 150 hp (4 @,@ 590 kW) each

Performance

Maximum speed : 275 knots (509 km / h , 316 mph) at sea level / 305 kn (565 km / h ; 351 mph) at 15 @,@ 000 ft (4 @,@ 600 m)

Cruise speed : 241 kn (277 mph , 446 km / h) at sea level

Stall speed : 110 kn (126 mph , 204 km / h) in airplane mode

Range : 879 nmi (1 @,@ 011 mi , 1 @,@ 627 km)

Combat radius : 390 nmi (426 mi , 722 km)

Ferry range : 1 @,@ 940 nmi (2 @,@ 230 mi , 3 @,@ 590 km) with auxiliary internal fuel tanks

Service ceiling : 25 @,@ 000 ft (7 @,@ 620 m)

Rate of climb : 2 @,@ 320 ? 4 @,@ 000 ft / min (11 @.@ 8 m / s)

Glide ratio : 4 @.@ 5 : 1

Disc loading : 20 @.@ 9 lb / ft ² at 47 @,@ 500 lb GW (102 @.@ 23 kg / m ²)

Power / mass : 0 @.@ 259 hp / lb (427 W / kg)

Armament

1 × 7 @.@ 62 mm (0 @.@ 308 in) M240 machine gun or 0 @.@ 50 in (12 @.@ 7 mm) M2 Browning machine gun on ramp , removable

1 × 7 @.@ 62 mm (.308 in) GAU @-@ 17 minigun , belly @-@ mounted , retractable , video remote control in the Remote Guardian System [optional]

= = Notable appearances in media = =

(For V @-@ 22 appearances in fiction , and for fictional V @-@ 22 @-@ based aircraft , respectively .)