



V-22 Osprey Guidebook



2011/2012

Message from the Commandant of the Marine Corps



As we consider the likely challenges of the next two decades, one thing remains clear: America needs an expeditionary force in readiness that is prepared to respond to any crisis. We are a maritime Nation with global responsibilities, requiring ready, sea-based forces organized, trained, and equipped to conduct operations in the littorals - from humanitarian assistance to major combat and “such other duties as the President may direct.” This has been, and will remain, the primary role of the Marine Corps in providing for the Nation’s defense.

To a Marine, the term ‘Expeditionary’ is more than a slogan; it is our state of mind. It drives the way we organize our forces, how we train, and what kind of equipment we buy. Future conflicts arising from a complex security environment will require a multi-capable, combined arms force, comfortable operating at the high and low ends of the threat spectrum, or in the shaded areas where they overlap.

The V-22 is ideally suited for this wide range of scenarios, and has proven itself across the range of military operations since its fleet introduction in 2007. The incredible effectiveness and survivability of this versatile aircraft have been demonstrated again and again, from land-based operations in Iraq and Afghanistan to sea-based operations in Haiti and Libya. The Osprey is providing our commanders unprecedented agility and operational reach. As we continue to transition our aviation platforms in the years ahead, the V-22’s revolutionary capability will remain a cornerstone of the Marine Air Ground Task Force.

Semper Fidelis



JAMES F. AMOS
General, U.S. Marine Corps
Commandant of the Marine Corps

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MV-22B
United States Marine Corps



CV-22
US Special Operations Command

EXECUTIVE SUMMARY

The V-22 Osprey is the world's first production tiltrotor aircraft. Unlike any aircraft before it, the V-22 successfully blends the vertical flight capabilities of helicopters with the speed, range, altitude, and endurance of fixed-wing transports. This unique combination provides an unprecedented advantage to warfighters, allowing current missions to be executed more effectively, and new missions to be accomplished that were previously unachievable on legacy platforms. Comprehensively tested and in full rate production, the V-22 provides strategic agility, operational reach, and tactical flexibility – all in one survivable, transformational platform.

Mission and Description

The V-22 Osprey Program is charged by the Department of Defense (DoD) with developing, testing, evaluating, procuring and fielding a tiltrotor Vertical/Short Takeoff and Landing (V/STOL) aircraft for Joint Service application with the Navy being the lead. The V-22 program is designed to provide an aircraft to meet the amphibious/vertical assault needs of the United States Marine Corps (USMC), the strike rescue needs of the Navy, and the special operations needs of the United States Special Operations Command (USSOCOM). The MV-22B variant is replacing the CH-46E. The CV-22 variant provides a new capability and will augment the MC-130 in the USAF/USSOCOM inventory for special operations infiltration, exfiltration, and resupply missions.

The V-22's tiltrotor technology is revolutionizing military air transport in a manner not seen since the introduction of helicopters more than 50 years ago.

USMC – 360 MVs

- Amphibious Assault
- Sustained Land Operations
- Self-Deployment



USSOCOM – 50 CVs

- Long-Range Special Operations
- Contingency Operations
- Evacuations and Maritime Special Operations



USN – 48 HVs

- Combat Search And Rescue
- Fleet Logistic Support
- Special Warfare



Marine Corps Vision & Strategy 2025

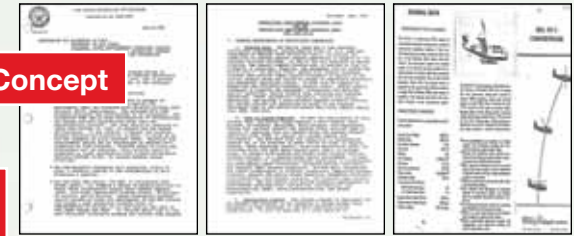


“Though our Corps has recently proven itself in ‘sustained operations ashore,’ future operational environments will place a premium on agile expeditionary forces, able to act with unprecedented speed and versatility in austere conditions against a wide range of adversaries...”

– Marine Corps Vision and Strategy 2025

The long-held vision of tiltrotor capabilities and the advantage that the V-22 could bring to our forces has faced challenges throughout the development and production of the aircraft. The strategic discipline, commitment, and perseverance of the government/industry partnership, have brought this aircraft to the field, where it is transforming aviation.

From Concept

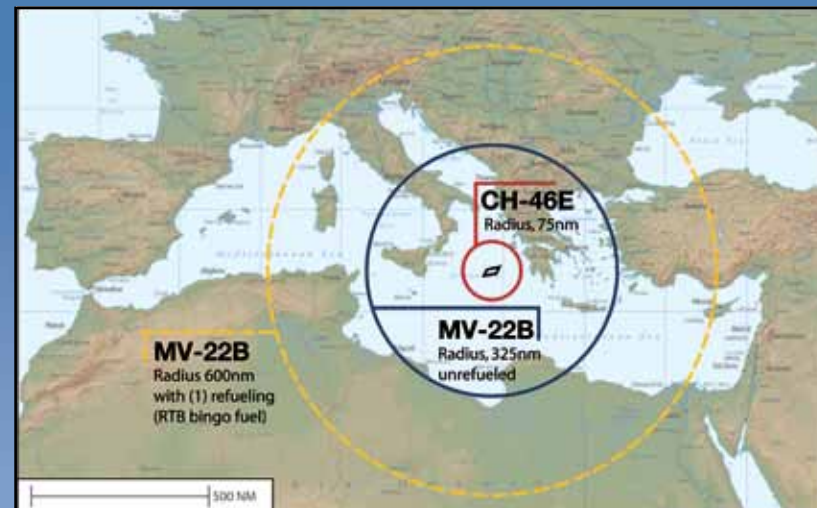


To Development and Testing

| Critical Operational Issue | 2005 Operational Evaluation | | |
|----------------------------|--|----------------------------------|----------------------------|
| | Parameter | Threshold | Result |
| Assault Support | Amphibious Pre-Assault/Raid | 200 NM (KPP) | 230 NM |
| | Amphibious Ext Lift | 10,000 lbs for 50 NM (KPP) | 9,800 for 50 NM |
| | Land Assault External Lift | 50 NM (KPP) | 69 NM |
| | Cruise Airspeed | 240 KTS (KPP) | 255 KTS |
| | Troop Seating | 24 Combat Troops (KPP) | 24 Combat Troops |
| Self Deployment | Self-deployment | 2100 NM (KPP) | 2660 NM |
| Survivability | Ballistic Tolerance | 12.7mm @ 90% velocity (KPP) | Satisfactory (BLRIP-LFT&E) |
| Interoperability | Top Level Information Exchange Requirement (IER) | All top-level requirements (KPP) | Satisfactory |

To Reality





Enhanced capability provides

- Expanded battlespace maneuver
- Complications to the enemy's defense
- Increased stand-off lowers seabasing risk
- Exponential operational impact
- Unprecedented survivability in assault support aircraft
- Tactical agility of a rotorcraft with the performance of a turboprop aircraft

Mission Profile

- Without Mission Auxiliary Tanks System (MATS)
 - Approx 4.0 hrs max endurance
 - Approx 700 nm max range in 3.0 hrs
- Ceiling 24,700'
- 325 nm combat radius
 - 24 passengers
- 600 nm combat radius with 1 aerial refuel
 - 24 passengers
- Additional fuel options: up to 3 MATS tanks
 - 1 MATS tank, 14 passengers, 3.5 hrs endurance
 - 2 MATS tanks, 6 passengers, 4.2 hrs endurance
 - 3 MATS tanks, 0 passengers, 4.9 hrs endurance



MV-22B



Since the MV-22B reached initial operational capability in June 2007, followed by the CV-22 in March 2009, Ospreys have been combat deployed across the globe in support of contingency operations.

In February 2011, the V-22 program exceeded 100,000 total flight hours since program inception. The Osprey has been one of the safest rotorcraft ever fielded by the DOD. For the Marines, over the last ten years the MV-22B has the lowest class "A" mishap rate of any currently fielded tactical rotorcraft.

CV-22



The following section briefly describes operational employment examples of the USMC MV-22B and AFSOC CV-22.

MV-22B MISSION SNAPSHOT

Afghanistan

Operation Enduring Freedom

November 2009 to Present



During Operation Enduring Freedom, the MV-22B established its presence in an historic 10-aircraft, 510-mile, single-leg transit from amphibious shipping. All aircraft arrived safely at their new base two hours and 15 minutes after takeoff.

The MV-22B has been utilized with great success in direct action missions in OEF. Using its speed and range to ingress from unexpected directions, and capitalizing on its low aural signature to approach unnoticed, the Osprey has been a key factor in giving our forces a tremendous tactical advantage.

For example, in January 2010 a Taliban leader in the Marine's Area of Operations (AO) had been working with an Improvised Explosive Device (IED) maker. Intel sources had been tracking his movements as he arrived at one of two locations every day around the same time.

Mission Execution: At L-hour, in a bold daylight raid, 4 MV-22Bs hit two separate Landing Zones (LZs) simultaneously. Leveraging the aircraft's precision navigation capability, L-hour was made exactly on time, and the aircraft landed within 50' of the target buildings. On short final, 30-40' from landing, Osprey aircrews "saw the surprise in a local national's face as he did a 'jump stutter step' because he had just noticed us." Upon landing, the assault element debarked. The target was in the vicinity of a bazaar, was tracked, and subsequently captured.

Later that day, a resupply mission was conducted by a pair of MV-22Bs into the LZ, now controlled by friendly forces. In the words of the Forward Air Controller (FAC) on the ground, "the two MVs came out of the sun and we couldn't see or hear them until they were right on top of us... less than 30 seconds out."

Missions that could not be executed using conventional rotorcraft have become commonplace, greatly enhancing the Commander's ability to influence the Area of Responsibility (AOR).

These examples, and countless others like it, show the tremendous performance of both the MV-22B and the Marines who operate and maintain the aircraft.

MV-22B MISSION SNAPSHOT

Amphibious Operations Marine Expeditionary Units

May 2009 to Present

MV-22B met all Amphibious Based Mission Requirements

The MV-22B excelled in contingency missions with greater speed, range, payload, and endurance than any other rotorcraft. This increased flexibility to amphibious shipping and allowed further standoff distances from the shore. In addition, long-range ship-to-shore logistics support benefited from the aircraft's transformational capabilities.



“There is a whole new generation of Marines getting very comfortable with seeing the MV-22B and working with it. Once you start using the asset, you really start to understand what you can do with the improved response time and range.”

– MEU Commander

“The V-22 can reach the fight and be effective in the fight like no other aircraft that has ever been embarked on these ships. And in doing so, it enhances the ship’s ability to contribute to those missions.”

– USS Bataan Commanding Officer



MV-22B MISSION SNAPSHOT

Amphibious Operations Operation Odyssey Dawn

March 2011



*USS Kearsarge MV-22B
flight deck operations*



26 Marine Expeditionary Unit Tactical Recovery of Aircraft and Personnel (TRAP)

On 22 March 2011, while in support of Operation Odyssey Dawn, an F-15E went down over Libya due to mechanical issues. Both aircrew were able to safely eject. What rapidly followed was a textbook example of the agility, flexibility, and effectiveness of what not only the MV-22B brings to the fight, but what the Navy Marine Corps team provides the Nation. Namely, an expeditionary force in readiness ready and able to respond where and when needed.

Tactical Recovery of Aircraft and Personnel, or TRAP, is a mission to which the MV-22B is ideally suited. Less than two hours after the F-15E crew ejected, 2 MV-22Bs, along with other elements of the TRAP package including AV-8B Harriers, CH-53E Super Stallion helicopters, and a 46 Marine Quick Reaction Force, were ready to launch from the USS Kearsarge, approximately 133 nm away from the downed aircrew.

Quickly covering the distance to the objective, the Ospreys, supported by the Harriers and other assets overhead, were able to land, rapidly recover one of the downed crew, and depart. Within a half hour of their departure, the Ospreys and the rescued pilot were safely back aboard Kearsarge. The second aircrew was safely recovered shortly thereafter via other means. In this instance, as it has in countless others, the MV-22B's speed, precision navigation, and ability to land virtually anywhere gave the Marines the necessary capability to quickly and successfully perform this critical mission.



USS Kearsarge AV-8B and CH-53E flight deck operations

Haiti

Operation Unified Response

Jan 2010



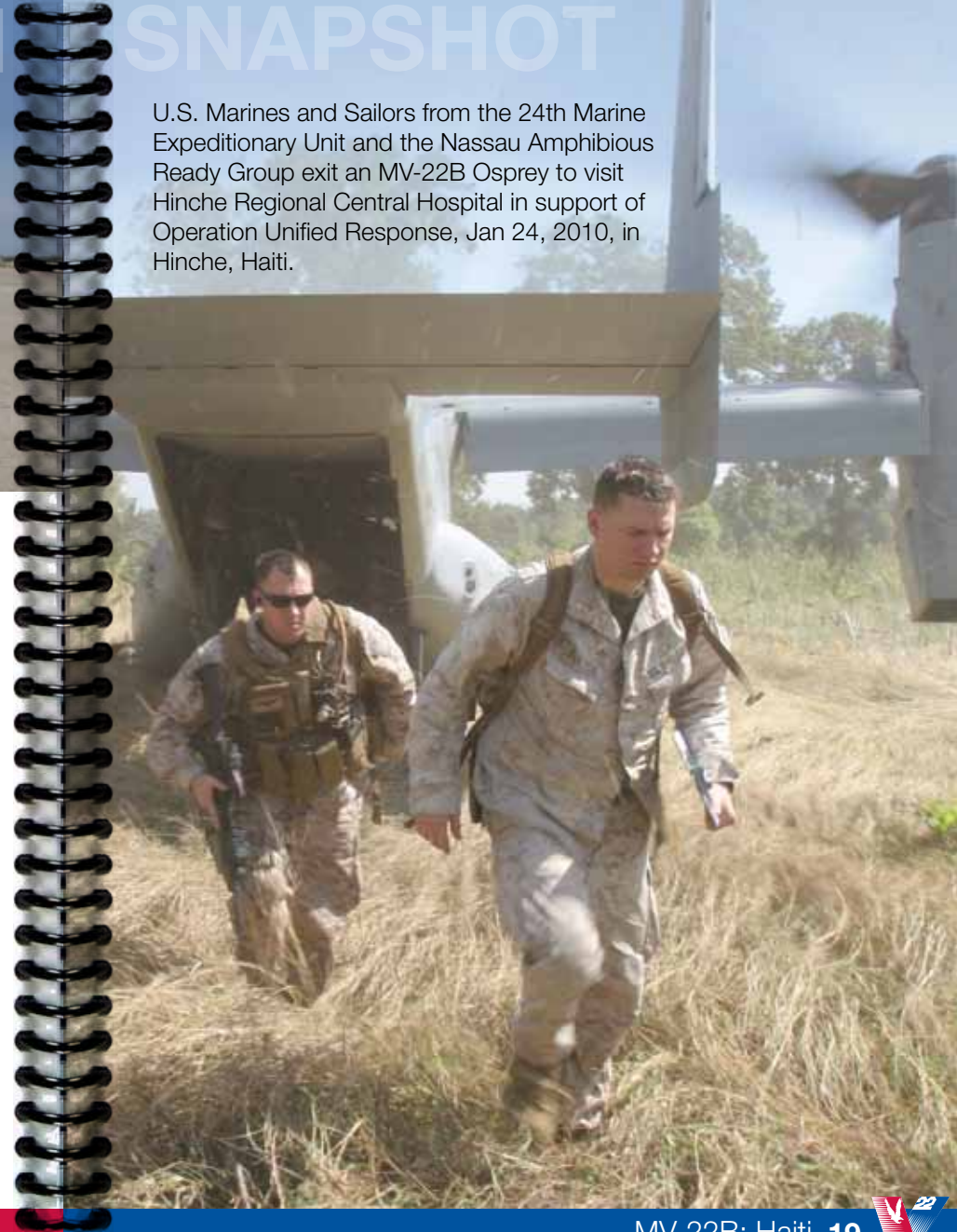
U.S. Marines and Sailors from the 24th Marine Expeditionary Unit and the Nassau Amphibious Ready Group exit an MV-22B Osprey to visit Hinche Regional Central Hospital in support of Operation Unified Response, Jan 24, 2010, in Hinche, Haiti.

MV-22B speed and range made it the platform of choice for a variety of missions

- Long-range logistics runs to Guantanamo Bay, Cuba (over 200nm) to pick up supplies for distribution
- Movement of 492 personnel for site assessments at remote sites for JTF-Haiti
- Movement of personnel for presence and security at multiple sites
- Movement of water and nearly 13,000 lbs of food and medical supplies.

“The overall advantage for using the Osprey is the efficiency with which we can get all of this done... The speed of the Osprey allows us to land multiple teams in areas all throughout northern Haiti, leave them there with enough time to get a good assessment and retrieve all these teams before nightfall — only using two Ospreys.”

– **Capt. Robert Shuford**
24th Marine Expeditionary Unit



MV-22B MISSION SNAPSHOT

Operation Iraqi Freedom

October 2007 to April 2009

In its combat debut, the MV-22B's speed and range immediately provided an operational reach that revolutionized assault support capability.

Often the aircraft of choice for missions where speed, range, and survivability were critical, the MV-22B was widely lauded as an assault support platform.

During consecutive Operation Iraqi Freedom deployments over a period of 18 months, three Marine Medium Tiltrotor Squadrons (VMMs) logged

- More than 6,000 sorties
- Nearly 10,000 flight hours
- More than 45,000 passengers moved
- More than 2.2 million pounds of cargo moved

The MV-22B broadened the ground commander's area of influence for boots on the ground.

The MV-22B flew into every threat zone, performing every available assault support mission, including

- Raids, assaults, Aero Scout, VIP, general support, MEDEVAC, Tactical Recovery of Aircraft and Personnel (TRAP), Rapid Ground Refueling (RGR)
- MV-22B speed and range enabled Iraqi government officials to make frequent visits to remote areas, spreading the influence of Iraqi governance.

No combat losses were incurred during this deployment, thanks to the aircraft's inherent survivability and performance characteristics which keep the aircraft out of range of small arms and RPGs for most of the flight.

"Turns Texas into Rhode Island."

– **BGen Alles**, CG ACE MNF-W

"I could dominate [Al Anbar Province], because I had V-22s...I couldn't do what I did with just helicopters."

– **MGen Kelly**, CG MNF-W



MV-22B MISSION SNAPSHOT

Saving Lives

As one of the core tasks inherent to Assault Support, Casualty Evacuation (CASEVAC) is a uniquely demanding mission. When a patient needs to be transported to receive critical care, the “tyranny of distance” presents a formidable obstacle. Typically, the point of injury occurs far from established transportation hubs and services; therefore, the movement options are limited to whatever assets are on hand. For those in reach of a V-22, the range and speed options become exponentially greater. Recent examples of long range CASEVAC made possible by the V-22 are provided here.

2010

During their most recent deployment, the USS Kearsarge based 26 MEU conducted a long range CASEVAC. While conducting split Amphibious Group operations, with assets ashore assisting Pakistani Humanitarian Assistance/Disaster Relief efforts following devastating floods, the balance of the aviation assets operated afloat off the Horn of Africa supporting other operations. During this period, a patient aboard Kearsarge required medical support beyond the ship’s capability. The nearest facility that could provide the required services was 500 nm away in Mombasa, Kenya. A section of MV-22Bs was tapped to perform the CASEVAC mission, because, in the words of the MEU Commander, **“The V-22 is the only aviation asset that can bridge the long ship-to-shore expanse.”** The patient was successfully moved to the required level of care thanks to the Osprey.

2009

26 Marine Expeditionary Unit
The MV-22B flew a ship-to-shore urgent CASEVAC into Jordan, covering **147 miles in 37 minutes – a feat not possible with legacy aircraft.** In the words of a USS Bataan corpsman, “If it hadn’t been for the Osprey, there’s no way we could have gotten the patient to where she needed to be to receive the care that ultimately saved her life.”

2007

An urgent CASEVAC required patient transport from outlying Forward Operating Base Mudaysis to Al Asad (80 nautical miles, one way)

“Golden Hour” Preserved

In a scenario that conventional assault support assets could not execute, the MV-22B launched from Al Asad, flew to Mudaysis, performed pickup, and returned to Al Asad in under one hour.

Economy of Force: A Classic Example

To match this response time using conventional assets, helicopters would have to be staged and ready at the pickup point, along with associated security, maintenance, and fuel requirements.



CV-22 MISSION SNAPSHOT

Personnel Recovery Mission

June, 2010



Long Range, High Speed, High Altitude, Vertical Lift Exfiltration

On 1 June 2010 a coalition helicopter conducting a special operations raid was disabled on a target near Kunduz, Afghanistan.

Stranded in the open, the aircrew and ground party were under small arms and mortar fire.

Other theater aircraft made multiple rescue attempts, but none were successful due to rugged mountainous terrain and a severe dust storm.

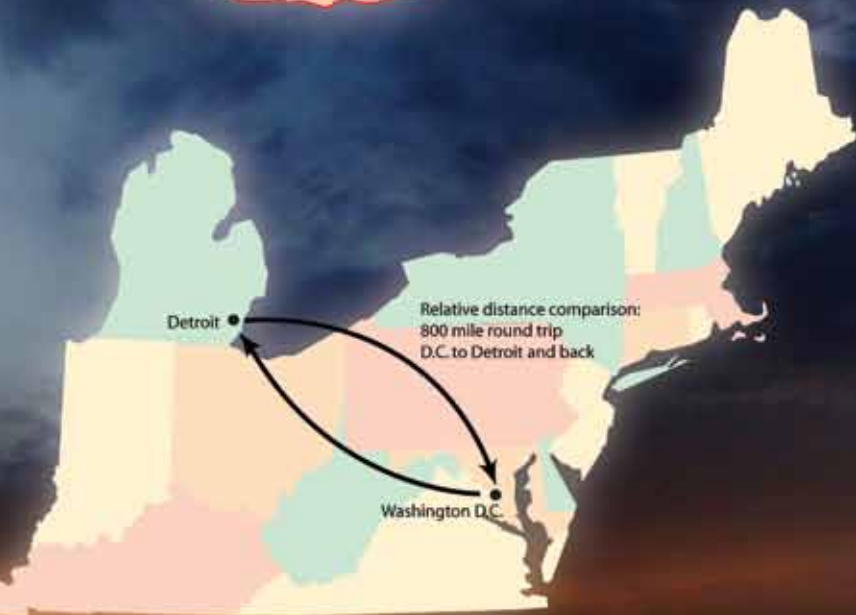
Two 8th Special Operations Squadron CV-22 aircraft based at Kandahar launched within two hours of notification and flew a direct route at 15000 feet over the Hindu Kush mountain range. Using their advanced navigation and sensor suite, the flight was able to continue its mission through periods of very low visibility.

32 U.S. personnel were recovered from the target area.

The CV-22s accomplished the round trip flight from Kandahar in less than 4 hours without requiring additional fuel.

“Thanks for picking us up when no one else could.”

-Ground Force Commander



CV-22 MISSION

Operation Enduring Freedom March – October 2010

SNAPSHOT

Operation Enduring Freedom Casualty Evacuation (CASEVAC)



Five CV-22s and crews from the 8th Special Operations Squadron were deployed for the first CV operations in support of Operation Enduring Freedom in March, 2010. Their primary mission was to conduct infiltration and exfiltration of special operations forces. During the six month deployment, the squadron executed 68 direct action assault force INFIL/EXFIL missions. In this assault role, the aircraft delivered 4,069 assaulters, enabling the capture of 231 suspected terrorists. In the combat support role, over 87,000 pounds of cargo and 760 personnel were delivered.

After the completion of an assault mission, CV-22s were re-tasked with an urgent CASEVAC of an injured Afghan soldier who sustained a critical head injury. All other aviation assets were on stand down due to the poor visibility, less than a mile, around the surrounding airfields. The lead CV-22 performed a low visibility approach to the CASEVAC location. Once the casualty was loaded onboard, the formation proceeded directly to Kandahar. With the new flight control software, the crews were able to fly at 260 KCAS. The unique combination of speed, range, VTOL, and TF/TA radar made the CV-22 the perfect platform for this mission. The casualty was successfully stabilized and survived.

CV-22 MISSION

Operation Iraqi Freedom

July – November 2009



In July 2009, six CV-22 aircraft from the 8th Special Operations Squadron (SOS) departed Hurlburt Field, FL, for their first operational deployment to Iraq. The CV-22s conducted a successful 7,000 nautical mile self-deployment in support of Operation Iraqi Freedom. The aircraft completed the transatlantic crossing in 7 days while completing three aerial refuelings along the way. While deployed the CV-22's primary mission was to conduct long-range infiltration, exfiltration and resupply missions for special operations forces.

During the deployment, the squadron executed and completed 45 direct action assault force INFIL/EXFIL missions and 123 combat service support missions, delivered over 30,250 pounds of cargo, and transported over 2,349 passengers. The CV-22s also supported the Iraqi Special Operations Forces (ISOF) in several operations to apprehend suspected terrorists. Although the new aircraft was flown by U.S. Air Force personnel, the troops and mission were led by the elite ISOF soldiers.

The CV-22 has proven its value to the warfighter and commanders on the battlefield. The exceptional range, speed and versatility this aircraft brings to the fight is unmatched by conventional helicopters.

SNAPSHOT

Humanitarian Relief

SOUTHCOM June 2009



While deployed to SOUTHCOM in support of ongoing operational missions, three CV-22 aircraft from the 8th SOS contributed air power to a large scale humanitarian relief effort to the country of Honduras. Taking advantage of the CV-22's unique payload and flight capabilities, the aircraft and crews made three different deliveries of critical items to a small remote northeastern village. In total, approximately 43,000 pounds of goods were delivered. These goods had been waiting to be delivered for some time, and with the CV's unique lift-off/landing capabilities the much needed items, such as non-perishable food, hospital beds, and textbooks were finally delivered to the remote village.

The CV-22 Osprey's power, range and speed bring unique capabilities to a very broad spectrum of humanitarian relief, as proven in this and other documented V-22 relief efforts.

Exercise Flintlock 09

October – November 2008



Four CV-22 aircraft from the 8th Special Operations Squadron (SOS), Hurlburt Field FL successfully completed their first self-deployment mission. The deployment covered some 5,300 nautical miles across the Atlantic Ocean to Bamako, Mali in support of Exercise FLINTLOCK-09. The exercise is a regularly scheduled training exercise in the Trans-Sahara region designed to build relationships and to enhance African nations' ability to patrol and control their sovereign territory.

The exercise included personnel from 15 countries and the CV-22 served as a platform for multinational training. Specifically, the aircraft was used to transport Malian and Senegalese special operations forces (SOF) and leadership teams throughout the vast exercise region. The primary mission for the CV-22 was long range vertical lift, inserting SOF teams so they could practice ground maneuvers, then return in order to extract the teams.

The CV-22 proved to be a game changer during this exercise. Because of its long range capability, the teams were able to traverse the vast distances of the African continent in less time than a conventional helicopter. Taking advantage of the aircraft's unique tiltrotor capabilities, missions over 500 nautical miles were routinely completed, infiltrating small teams and bringing them back without having to aerial refuel, and all within a four-hour window. This mission would have taken the MH-53 two to three times as long to complete.

CV-22 Responds

Rescue Request



On October 6th, 2007, the 58th Special Operations Wing (Kirtland AFB) was contacted by civil authorities and the Air Force Rescue Center to help locate a missing aircraft. The CV-22 from the 71st SOS joined two HH-60G helicopters and an MC-130P in the search, becoming the first Osprey tiltrotor aircraft to conduct a real-world search and rescue mission. The downed aircraft was located in the San Juan Mountain range at elevations over 11,000 feet. Because of the speed, range, and ability to fly at higher altitudes, the CV-22 was the first aircraft to arrive at the crash site.

Setting the Record Straight Misconceptions & Statements of Fact

Throughout its development, fielding, and early operational employment, inaccurate “urban legends” have persisted. The following section offers ground truth on these issues.



Myth: The V-22 can't operate in the heat

Fact: VMM-162 completed all mission tasks in Iraq throughout the summer of 2008, when ambient temperatures ranged well above 120 degrees F. It operated in dust storms with ¼-mile visibility when other rotorcraft could not. During their deployment, VMM-162s flew 2,371 hours, carried 12,841 passengers, and transported more than 407,000 pounds of cargo.

Myth: The V-22 can't operate in cold environments

Fact: The V-22 can operate in temperatures as low as -54 degrees C (-65 degrees F) and demonstrated protracted cold-weather capability during operational test in Nova Scotia and Minnesota.

Myth: The V-22 has an abnormal mishap rate

Fact: The V-22 experienced a mishap rate of 77.3 prior to fleet introduction. By comparison, the CH-53E rate was 159.0 and the F-14A rate was 78.7, normalized to a rate per 100,000 hours.

Myth: The V-22 has an abnormally low readiness rate at this stage of its lifecycle

Fact: All newly introduced aircraft face readiness challenges early in the operational phase of their life cycle. V-22 readiness rates are on par with other types of aircraft at similar periods, and a clear roadmap exists, developed by the government-industry team to increase readiness levels.

Myth: The V-22 was “protected” and “babied” during Operation Iraqi Freedom

Fact: The MV-22B and CV-22 flew into all threat zones in Iraq, including “black zones”—the most dangerous areas. It performed extremely well across the full range of assault support missions, including raids and heliborne assault, exceeding the capabilities of legacy helicopters in speed, agility, and survivability.

Myth: The V-22 hasn’t been combat tested

Fact: Every mission that was flown in Iraq, and every mission being flown today in Afghanistan was and is a combat mission. A combination of performance and tactics unique to the MV-22B keep the aircraft outside much of the threat envelope—including small arms, RPGs, and shoulder-fired surface-to-air missiles (MANPADS)—during transit. During ingress and egress, when the aircraft must penetrate the threat envelope, the speed, agility, and low aural signature of the MV-22B combine to reduce exposure to threats and improve survivability. Ballistic tolerance, proven during Live Fire Test and Evaluation, protects crew and passengers in case of engagement. Hydraulic and flight control redundancy, widely separated engines, robust single-engine flyaway capability, and the extensive combat experience of the MV-22B community combine to make this the most survivable rotorcraft in history.



Myth: The V-22 can’t operate on ship

Fact: VMM-263 safely and successfully conducted the first MV-22B shipboard deployment aboard USS Bataan with the 22nd Marine Expeditionary Unit in 2009. Three successive MEUs have proven that the the aircraft can operate seamlessly with Harrier and helicopter patterns.

Myth: V-22 exhaust damages the flight decks of Navy ships

Fact: When the MV-22B nacelles are positioned vertically for takeoff, the engine exhaust gases are directed toward the flight deck. As a precautionary measure, flight deck portable heat shields were utilized aboard LSD and LPD class ships during the first MV-22B shipboard deployment. Subsequent testing and analysis determined that instead of these heat shields, a nacelle modulation technique was a more suitable and effective method to protect the flight deck. This nacelle modulation, wherein the nacelles are periodically rotated a small number of degrees, prevents heat build up in the deck plating and thus negates any chance of damage.



Myth: The V-22 can't land in the desert

Fact: Unlike any other aircraft in the inventory, the V-22 has systems that allow it to land in total brown-out conditions. The flight control system can automatically hold the aircraft position over the ground; or pilots can reference the exact drift information and fly the aircraft manually to the deck without looking outside. The ability of the V-22 to operate in brown-out conditions far exceeds that of legacy aircraft.

Myth: The V-22 is unsafe because it can't autorotate

Fact: The V-22 is a tiltrotor and does not rely on autorotation for a survivable power-out landing. The wide separation of the engines and the ability to drive both rotors with one engine make a power-out landing extremely unlikely. However, if required, the V-22 can glide for a predictable run-on landing in airplane mode, much like a turboprop.

Myth: The V-22 can't operate in high-threat environments

Fact: A high-threat environment is one in which integrated air defenses—such as networks of radar-guided surface-to-air missiles, along with a robust command and control network to direct those systems—are present and operating. We do not operate any of our assault-support platforms in that kind of environment without appropriate reduction or mitigation provided by attack platforms.

The V-22 has operated successfully in low- and medium-threat environments where small arms, RPGs, and shoulder-launched heat-seeking missiles are present.

Myth: Excessive V-22 downwash prohibits hoisting, fastrope, and over water hover work

Fact: Recognizing the rotor downwash of the V-22 is similar to that of the CH-53E, and after incorporating lessons learned from previous Operational Test periods, procedures have been developed to effectively mitigate downwash effects on personnel working below or in the vicinity of the aircraft as well as personnel exiting the aircraft via fastrope, rappel, or helocast operations. These procedures are safe, effective, and in use today.



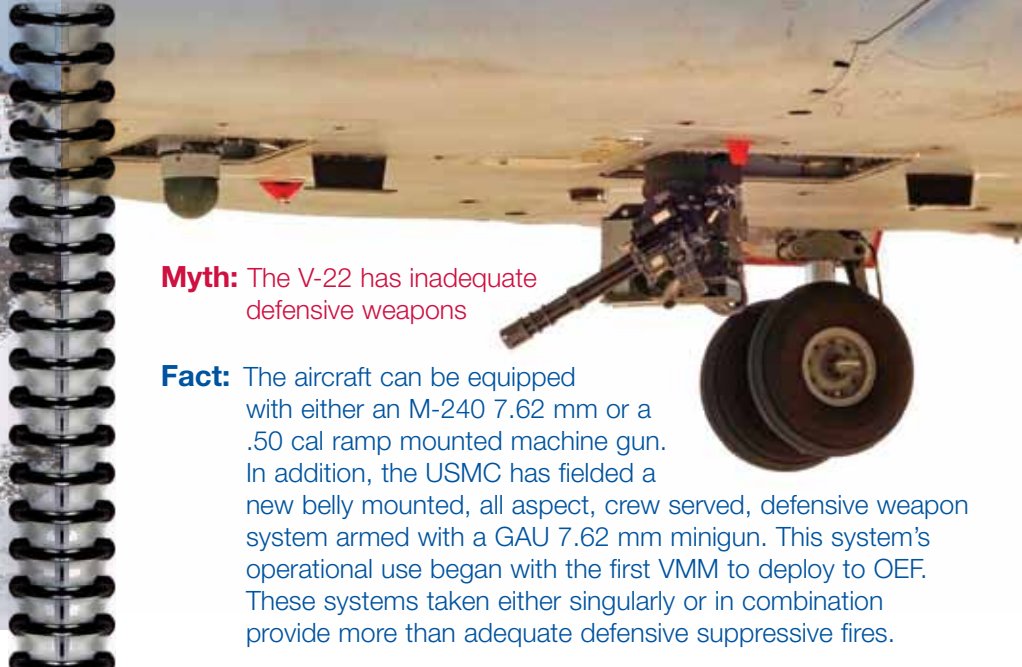


Myth: The V-22 is not maneuverable

Fact: The V-22 has excellent low-speed maneuverability. With abundant excess power and cyclic-, collective-, and vector-thrust control, it is very maneuverable and agile across its entire flight envelope. The unique ability to transition rapidly (in less than 30 seconds) to airplane mode is perhaps the greatest contributor to V-22 performance and survivability.

Myth: The V-22 can't operate above 8,000 feet

Fact: The V-22 consistently operates above 10,000 ft as part of its normal transit flight profile. The V-22 can operate in airplane mode up to 25,000 ft. In helicopter mode, at 10,000 ft Density Altitude, the V-22 can carry 3000 lbs (that's the equivalent of 10 passengers) with a 70 nautical mile range post-pickup. Although all rotorcraft have diminished capability as altitude increases, the ability of the V-22 greatly exceeds the capability of the medium lift aircraft it replaces.



Myth: The V-22 has inadequate defensive weapons

Fact: The aircraft can be equipped with either an M-240 7.62 mm or a .50 cal ramp mounted machine gun. In addition, the USMC has fielded a new belly mounted, all aspect, crew served, defensive weapon system armed with a GAU 7.62 mm minigun. This system's operational use began with the first VMM to deploy to OEF. These systems taken either singularly or in combination provide more than adequate defensive suppressive fires.



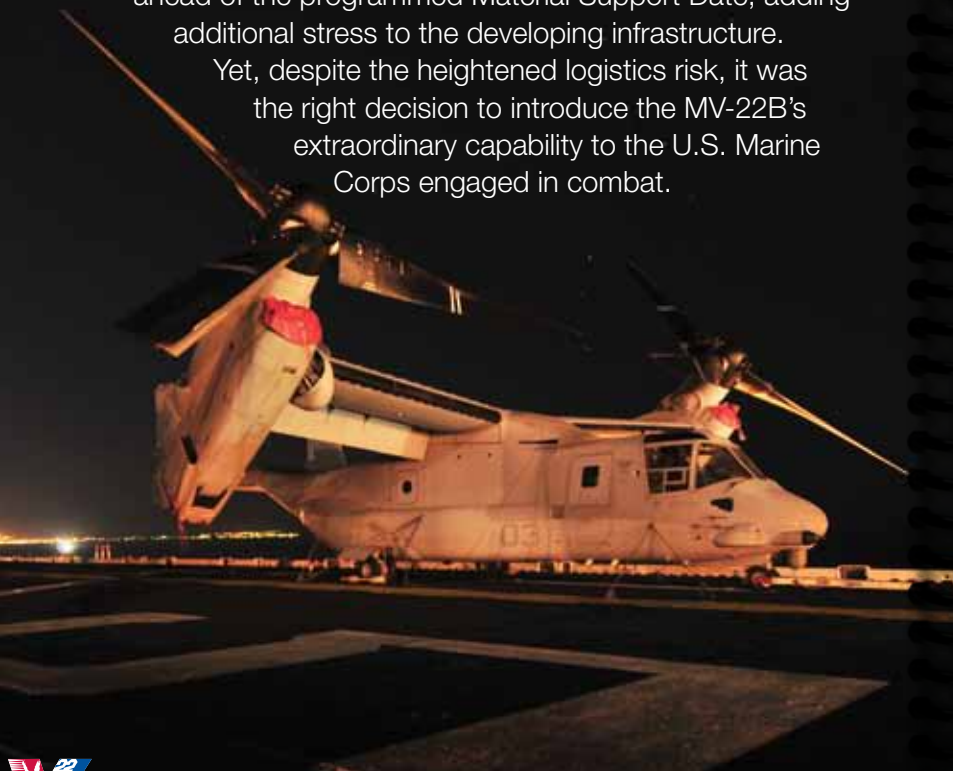
Readiness Plan

Early readiness rates

Readiness of newly introduced aircraft typically trends downward after Initial Operational Capability (IOC) until the logistics infrastructure matures sufficiently to support the aircraft in the field. This is particularly true for aircraft, such as the V-22, that represent a significant leap in technology. The CH-46, CH-53, F/A-18, AV-8B, and others all experienced this trend upon introduction.

Fleet introduction of the Osprey was accelerated one year ahead of the programmed Material Support Date, adding additional stress to the developing infrastructure.

Yet, despite the heightened logistics risk, it was the right decision to introduce the MV-22B's extraordinary capability to the U.S. Marine Corps engaged in combat.



Executing Missions, Improving Readiness

The proven and versatile V-22 Osprey tiltrotor aircraft is today transforming the way the USMC and AFSOC execute missions around the globe. The two services now have numerous consecutive and highly-successful deployments to their credit, covering Operation Iraqi Freedom, Operation Enduring Freedom, South America, Africa, and amphibious operations with Marine Expeditionary Units (MEUs). 2011 finds one Marine tiltrotor squadron conducting high-intensity combat operations in Afghanistan while a second performs contingency operations with the MEU. The Air Force is poised for another combat operation in support of National objectives.

Since June 2007 when the USMC achieved the Initial Operational Capability of the V-22, the transition of tactical helicopter units continued at the rate of two squadrons per year. Cognizant of the contribution their preeminent assault support capability would make to the warfighter, the USMC deployed its Marine medium tiltrotor squadrons without delay after transition to Operation Iraqi Freedom, Operation Enduring Freedom, and the MEUs. The Air Force Special Operations Command joined this record with CV-22 deployments that began in 2008. Enabling a concurrent aggressive deployment schedule and steady transition is an active streak since August 2007 of production aircraft delivered by Bell-Boeing on time or ahead of schedule.

This intense period of deployments and transition was performed against a backdrop of steadily increasing aircraft production, expanding Marine and Air Force transitions, and a rapidly burgeoning record of flight hours. In fact, nearly 50% of program flight hours have accrued in the last two years.

While V-22 wartime operational performance has been exceptional, readiness and operating costs are two remaining issues facing the V-22 program. The government-industry team is executing a coordinated strategy to solve these issues which is spiral in nature and is providing incremental improvements over time. This effort has and continues to yield multiple benefits. Improved maintenance practices, streamlined supply support, and more efficient contracting efforts are responsible for increased readiness and lower operating costs.

While simultaneously maintaining an emphasis on its hard-won production excellence and these initial readiness advances, government and industry partners are engaged in the next iteration which aims to raise parts production capacity to meet demonstrated demand while designating additional candidates for potential redesign and retrofit. Both a clear path and demonstrable progress exist in our effort to make the V-22 as ready and affordable as it is effective and survivable.



General Characteristics

Performance @ 47,000 lb

Max cruise speed -
 (MCP) Sea Level (SL), kts (km/h) 262 (485)
 Max RC, A/P mode SL, fpm (m/m) 3,200 (975)
 Service Ceiling, ISA, ft (m) 25,000 (7620)
 OEI Service Ceiling ISA, ft (m), 10,300 (3139)
 HOGE ceiling, ISA, ft (m) 5,400 (1,646)

Weights

Takeoff, vertical, max, lb (kg) 52,600 (23859)
 Takeoff, short, max, lb (kg) 57,000 (25855)
 Takeoff, self-deploy, lb (kg) 60,500 (27443)
 Cargo hook, single, lb (kg) 10,000 (4536)
 Cargo hook, dual capability, lb (kg) 15,000 (6804)

Fuel Capacity

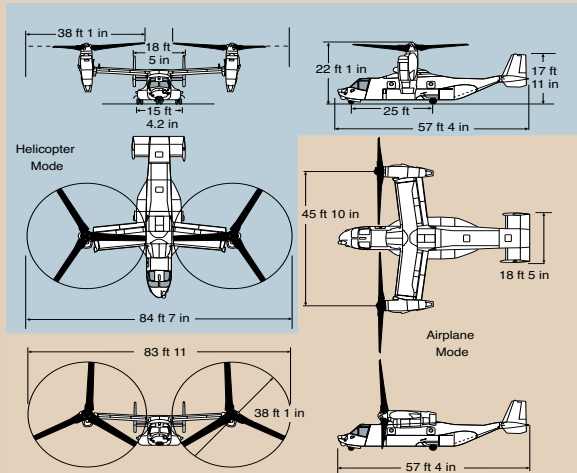
MV-22, gallons (liters) 1,721 (6513)
 CV-22, gallons (liters) 2,025 (7667)

Engines

Model AE1107C (Rolls-Royce Liberty)
 AEO VTOL normal power, shp (kW) 6,150 (4586)

Crew

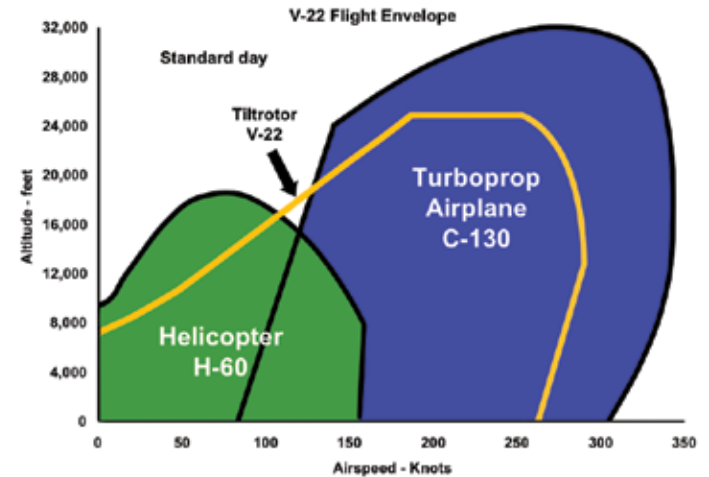
Cockpit – crew seats 2 MV/3 CV
 Cabin – crew seat/troop seats 1/24



Design Features

The V-22 has been designed to the most stringent safety, reliability, readiness, all-weather operations, survivability, crash worthiness, and performance requirements of any rotary wing aircraft ever built.

The V-22's self-deployability and large payload capacity over long distances position it to support numerous missions worldwide.



- Sustained cruise speed: 260+ knots
- Self-deploy worldwide
- Unrefueled radius of action: 500+ nmi
- Operate from amphibious ships
- Carry 15,000 lb external payload
- Vertical insertion/extraction

} Fixed-wing tactical transport
 } Helicopter assault transport

- High level of ballistic tolerance
- Cockpit integrated color displays, avionics to navigate worldwide, civil and military fields
- Fold/stow and corrosion protection to meet shipboard compatibility

Top Level V-22 Design Requirements

Airframe

Composite materials were a key technology that enabled the development of the V-22 and reduced cost and weight, improved reliability, and increased ballistic tolerance. The past two decades of extensive research and development on composite materials in the aerospace industry has directly benefited the V-22 structural design.

Multiservice Configurations

MV-22B U.S. Marine Corps

The V-22 is developed and produced utilizing incremental, time-phased upgrades (“Blocks”)

- Block A - Safe and operational
- Block B - Combat capability improvements plus enhanced maintainability
- Block C - Mission enhancements and upgrades

Inherent Features

- Composite/aluminum airframe
- Triple redundant fly-by-wire flight controls
- Rolls-Royce AE1107C engines
- Interconnect drive shaft
- 5000 psi hydraulic system
- 240 kVA electrical capacity
- Blade fold/wing stow
- Anti-ice and de-ice systems
- Vibration, structural life, and engine diagnostics
- Engine air particle separators
- Loading ramp
- Aerial refueling probe
- 5.7' W x 5.5' H x 20.8' L cabin
- Onboard oxygen and inert gas generating system (OBOGS/OBIGGS)



Mission Equipment

- Single and dual point external cargo hooks
- Advanced cargo handling system
- Fastrope
- Rescue hoist
- Paradrop static lines
- Ramp mounted defensive weapon system
- Up to three mission auxiliary fuel tanks
- Belly mounted, crew served all quadrant defensive weapon system

Avionics

- Dual avionics MIL-STD-1553B data buses
- Dual 64-bit mission computers
- Night Vision Goggle (NVG) compatible, multifunction displays
- Three inertial navigation systems
- Global positioning system
- Digital map system
- SATCOM
- VOR/ILS/ marker beacon
- Radar altimeter
- FM homing system
- Dual VHF/UHF/AM/FM radios
- Digital intercommunications system
- Turreted Forward Looking Infra-Red (FLIR) system
- Identification, Friend or Foe (IFF) transponder
- Tactical Air Navigation (TACAN) system
- Troop commander's communication station
- Flight incident recorder
- Missile/radar warning and laser detection

CV-22 U.S. Special Operations Command

The CV-22 is being developed and produced in parallel with the MV-22B configuration in incremental upgrades (“Blocks”)

- Block 0 - MV-22B Block A plus basic special operations capabilities
- Block 10 - MV-22B Block B plus improved special operation capabilities
- Block 20 - MV-22B Block C plus mission enhancements and upgrades

MV-22B Block B and CV-22 Block 10 have the same propulsion system, and a 90% common airframe. The primary differences are in the avionics systems.

CV-22 Unique Equipment

- Multimission Advanced Tactical Terminal (MATT) integrated with digital map, survivor locator equipment, and the electronic warfare suite
- Multimode Terrain Following/Terrain Avoidance (TF/TA) radar
- Advanced, integrated defensive electronic warfare suite
 - Suite of Integrated RF Countermeasures (SIRFC)
 - Directed IR Countermeasures (DIRCM)
- Additional tactical communications with embedded communication security
- Upgraded intercommunications
- Computer and digital map upgrades
- Flight engineer seating accommodation
- Crash position indicator



V-22 Top Tier Suppliers

| Supplier | System |
|---------------------|--|
| Bell Helicopter | Prime Contractor |
| Boeing | Prime Contractor |
| BAE | Flight control system |
| EFW | Digital map, MFD, DEU |
| Engineering Fabrics | Fuel cells |
| General Dynamics | Mission computer |
| Honeywell | ECS system and components, LWINS, VF generator, CDS, FDP, TCAS, SDC, IR suppressor, heat exchanger |
| ITT | AN/ALQ-211 (SIRFC) |
| Moog | Flight control actuators, vibration suppression actuators |
| MRA | Structural components |
| Northrop Grumman | DIRCM |
| Raytheon | FLIR, MMR, MAGR, IFF, mission planning, maintenance system |
| Rolls Royce | Engines |
| Smiths | Standby altimeter, AIU, rudder actuator, CF generator, flight incident recorder, lighting controllers, forward cabin control station, transmission blowers |
| Vought | Empennage, fiber placement skins |

Propulsion System

Two Rolls-Royce AE1107C Liberty engines provide the propulsion for the V-22. The AE1107C is a 6,150 shaft horsepower, two-spool, turboshaft, gas-turbine engine. The engines are located within the nacelles. The interconnect driveshaft provides safe one-engine-out flight in all modes of operation.

An Engine Air Particle Separator (EAPS) is integral to the engine installation and can be selected to manual pilot control or automatic.

Fire detection and extinguishing systems are provided in the engine compartments, wing bays and mid-wing areas.

A rotor brake assembly is integral to the mid-wing gearbox.



Structural Features

More than 43 percent of the V-22 airframe structure is fabricated from composite materials. The wing is made primarily with IM-6 graphite-epoxy solid laminates that are applied unidirectionally to give optimum stiffness. The fuselage, empennage, and tail assemblies have additional AS4 graphite fiber materials incorporated during their fabrication. Many airframe components such as stiffeners, stringers and caps, are co-cured with the skin panels. This technique provides subassemblies with fewer fasteners, thus fewer fatigue effects. The composite airframe delivers the necessary stiffness and light weight for V/STOL. It also provides additional resistance to environmental corrosion caused by salt water. The composite airframe is fatigue resistant and damage tolerant – a feature particularly desirable for ballistic survivability.



Cockpit and Avionics

The V-22 Integrated Avionics System (IAS) is a fully integrated avionics suite using a combination of off-the-shelf equipment and specially developed hardware and software. The functionality integrated into the IAS is as follows:

- **Controls and Displays**

Provides aircrew and maintenance personnel with the resources to monitor cockpit information and control aircraft functions.

- **Mission Computers**

Provides dual redundant processing and control for all functions of the IAS.

- **Navigation**

Provides primary navigation data. This data is gathered from the inertial navigation sensors and radio navigation sensors.

Navigation data includes: position, heading, altitude, geographic frame velocities, radar altitude, radio navigation (data such as distance and bearing to ground stations), and marker beacon station passage.

An optional enhanced suite can include Terrain Following/ Terrain Avoidance (TF/TA) Multimode Radar and Traffic Collision Avoidance System (TCAS).

- **Communications**

Provides for internal and external radio control and inter-communications, VHF/UHF radio communication, SATCOM, and IFF.

- **Turreted Forward Looking Infra-Red System**

Provides for reception of infrared energy and its conversion to video signals to assist the aircrew in piloting and navigation.

- **Dual Digital Map**

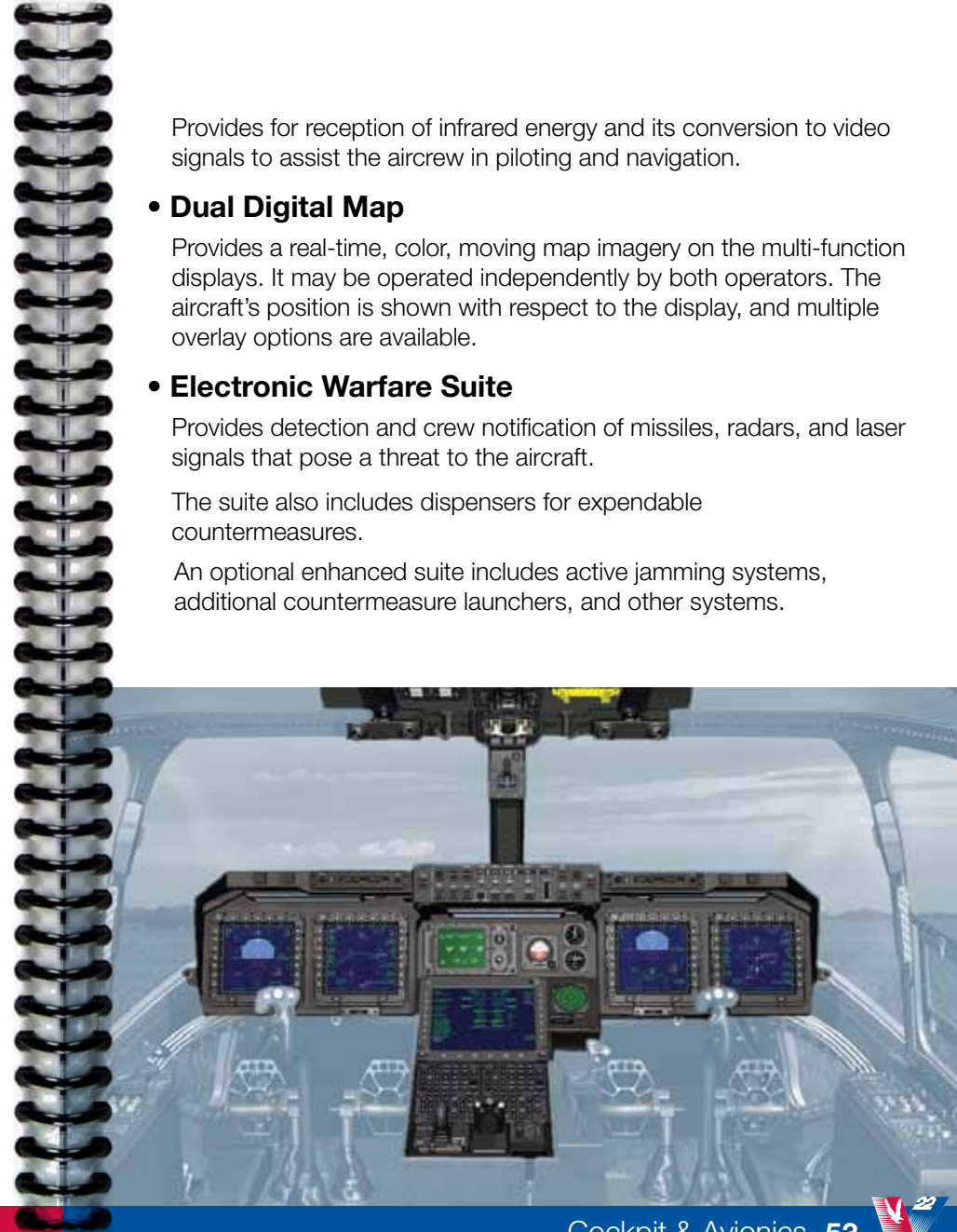
Provides a real-time, color, moving map imagery on the multi-function displays. It may be operated independently by both operators. The aircraft's position is shown with respect to the display, and multiple overlay options are available.

- **Electronic Warfare Suite**

Provides detection and crew notification of missiles, radars, and laser signals that pose a threat to the aircraft.

The suite also includes dispensers for expendable countermeasures.

An optional enhanced suite includes active jamming systems, additional countermeasure launchers, and other systems.

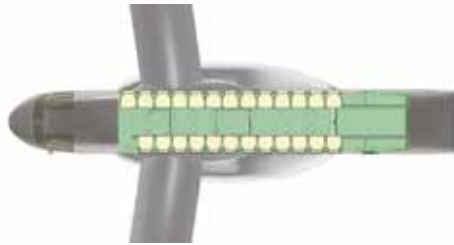


Payload Systems

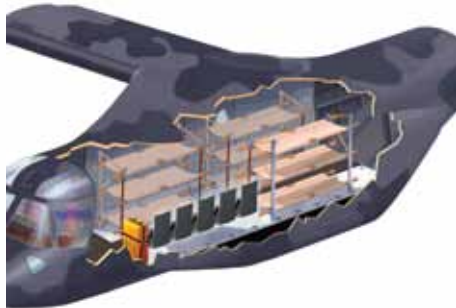
The V-22 is designed to fulfill the multimission role with its large open cabin, rear loading ramp, and a variety of cabin and cargo systems.

Personnel transport

- Crashworthy seats
 - Crew chief and 24 troops
 - Folding, removable seats for loading flexibility
 - Inboard facing
- Litter stanchions
 - Up to four stations of (3) litter positions each on MV-22B Block C for a total of 12 litters



Cabin Seating Arrangement



Typical CASEVAC Cabin Configuration



External Cargo and Air-drop Capability

Cargo

- External
 - (2) external cargo hooks
 - 10,000 lb single hook (forward or aft hook)
 - 15,000 lb dual-hook capacity
- Cabin accessible
 - Air-drop capability
- Internal
 - 300 lb/ft² floor loading capacity for up to 20,000 lb of internal cargo
 - Floor tie-down fittings within cabin and ramp
 - Flip, roller rails for cargo loading
 - 2,000 lb cargo winch, 150 ft cable
 - (2) 463L half-pallets, (4) 40 in x 48 in warehouse pallets, and other loading as available



Fast rope system at the rear cabin

Personnel Insertion/Extraction

The V-22 provides alternate means for personnel insertion and/or extraction when landing is not practical or desired.

The rescue hoist is an electrically driven system, capable of hoisting devices into the cabin like the stokes litter, two-man rescue team, forest penetrator, or a stokes litter with attached floatation device.

Optional fastrope equipment can be installed that provides for two fastropes in the cargo area. One mounting system is located above the end of the cargo ramp so that the rope can hang vertically at a nominal distance of 14 inches aft of the ramp floor; the second is located above the aft cargo hook bay.



Parachute operations have also been conducted with the V-22

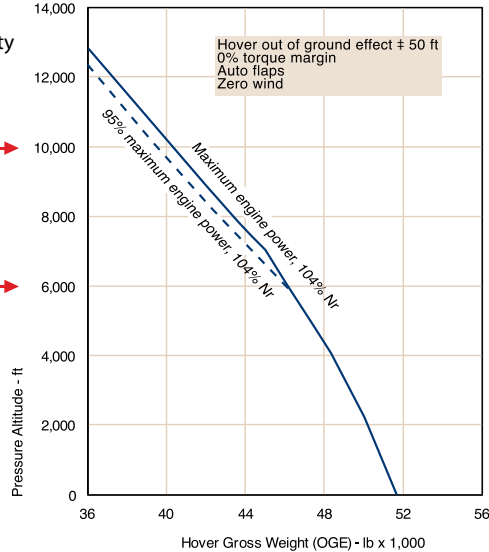
The V-22 is capable of sustained cruise speeds in excess of 275 ktas and an unprecedented V/STOL aircraft mission radius. Standard day capabilities are shown in the figures below.

Example HOGE
Transport Capability

3000 lb, 70 nm
payload at 10k'
PA is 3,000 lbs with
70 nm range post
pickup/drop

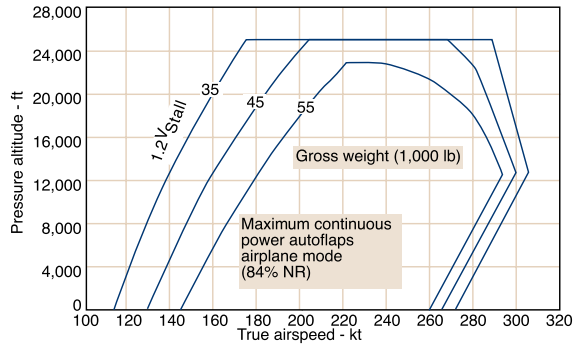
7500 lb, 200 nm
payload at 6k'
PA is 7,500 lbs with
200 nm range post
pickup/drop

Hover Performance



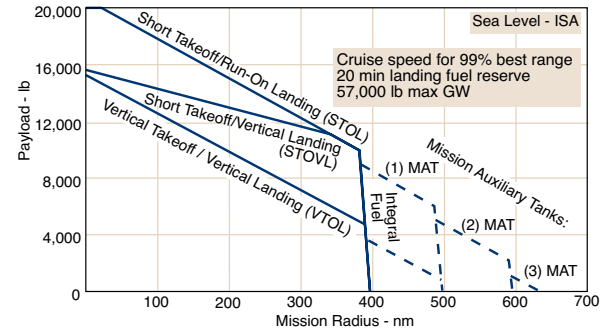
V-22 Standard Day Hover Envelope (OGE)

Cruise Flight Envelope

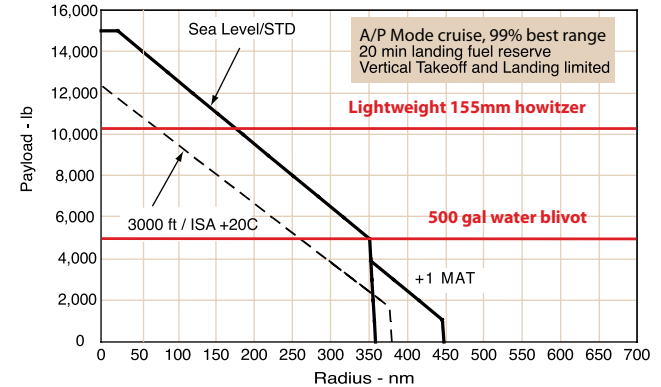


V-22 Airplane Mode Flight Envelope (Standard Day)

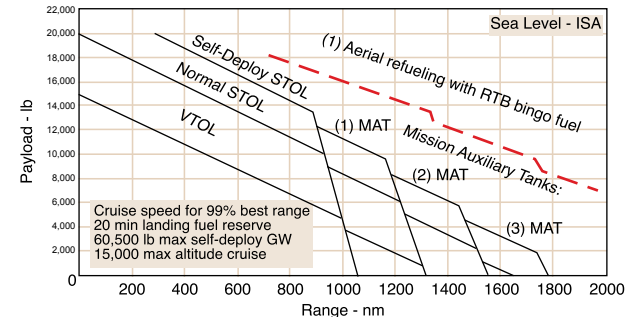
Internal Payload Mission



External Payload Mission



Self-Deployment Mission





Restricted Visibility Landings

The V-22 is capable of landing without visual reference to the ground via manual pilot control or automatic hovering autopilot functions.

Where sand or dusty conditions occur, the V-22 may conduct a Restricted Visibility Landing (RVL) based on cockpit instrumentation. The aircraft displays indicate attitude, altitude, drift vector, drift acceleration, and power settings, which allows the aircraft to use its INS systems to land in complete brown-out conditions. RVL landings may use a coupled hover approach from 50 ft to vertical landing, or pilots may manually fly to a no-hover direct landing.

Appendix 1 Survivability

Survivability is a function of three key elements: susceptibility, vulnerability, and crashworthiness. Susceptibility is the probability of being hit; vulnerability is the probability of surviving, if hit; and, crashworthiness is the probability the occupants will survive an emergency landing or ground impact without serious injury.

In any combat operation against a determined foe when assault support aircraft deliver supplies or troops to a contested area, there is the chance that hostile fire will impact the aircraft. Valuable lessons have been learned recently in the kinetic fight of Operation Enduring Freedom. Through the course of their operations, MV-22B's have taken surface to air fires on multiple occasions. No one can say with certainty how many "misses" there have been, but we do know that aircraft have received hits from various types of small arms fire on several occasions. Due to the robust ballistic tolerance of this airframe, in all instances the affected aircraft have been able to safely return to base with no injuries to embarked personnel or crewmembers. Moreover, in each instance the aircraft were repaired at the organizational (squadron) level and returned to the flight schedule in short order.



Speed and Range:

- Twice Legacy Speed
- 2–5 X Legacy Range
- Reduced Exposure Time
- Fly Around the Threat



IR Signature:

- Advanced IR Suppressors
- Cooled Nacelles
- No Exhaust on Airframe
- Low IR-Reflective Paint
- Low Secondary IR Sources

Ballistic Tolerance:

- Advanced Composite Construction
- Reduced Vulnerable area
- Fuel System Fire Protection
- Redundant Fly-by-Wire Controls
- Redundant Electrical Power
- Redundant Hydraulics
- Swashplate Actuator Armor
- Crewstation Armor

Acoustic Signature:

- Low Rotor Tip speed in Airplane Mode
- Low Noise at High Speed
- Unique Sound Propagation
-Up / Down / Sides
- Greatly Reduced Engagement Window

The V-22 reduces its susceptibility through the use of speed, range, altitude, situational awareness for the aircrew, the aircraft survivability suite sensors and countermeasures, as well as infra-red signature reduction.

Ballistic tolerance and system redundancy combine to reduce the Osprey's vulnerability. The V-22 capitalizes on the fatigue resistance and damage tolerant properties of composites which allow the V-22 to continue flight after sustaining impacts from projectiles. Cockpit seats are armored to withstand a 7.62mm small arms round. Fuel tanks are self-sealing and contain inert nitrogen gas to reduce the possibility of vapor ignition. The flight control system provides redundant flight control computers and hydraulic systems powered by redundant electrical subsystems. All major flight systems are physically separated to prevent loss of system functionality following loss of a single system. An emergency lubrication system provides 30 minutes of flight following loss of the primary proprotor transmission system.

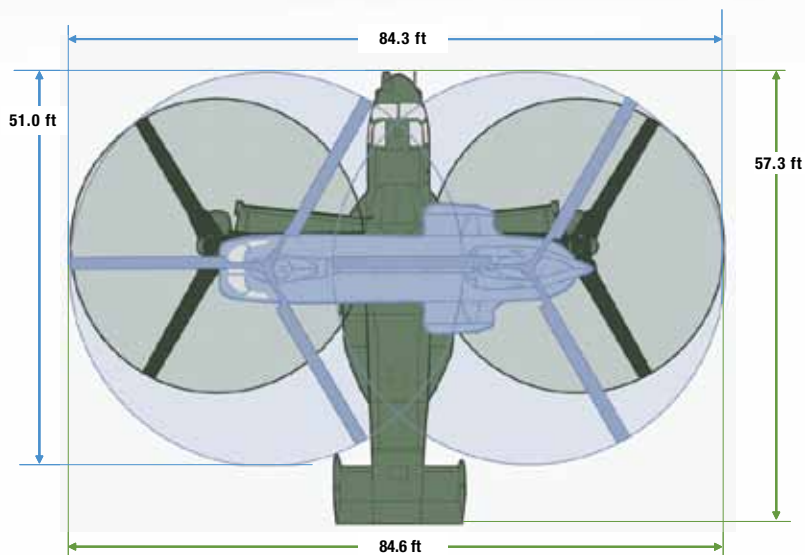
V-22 crashworthiness is a function of design. Heavy components, such as the engines and transmissions, are located away from the cabin and cockpit area. The proprotors are designed to fray or "broomstraw" rather than splinter on impact with the ground. The energy-absorbing landing gear system is designed to attenuate most of the energy for hard landings up to 24 fps. The wing is constructed to fail outboard of the wing/fuselage attachment in a manner that absorbs kinetic energy and ensures the cabin area will not be crushed, thereby protecting the occupants. An anti-plow bulkhead prevents the nose from digging in on impact, and the fuselage provides a reinforced shell that is designed to maintain 85% of its volume during a crash. Aircrew and embarked troops receive additional protection from crashworthy seats that stroke vertically to absorb energy.

The V-22 is the most survivable rotorcraft ever built

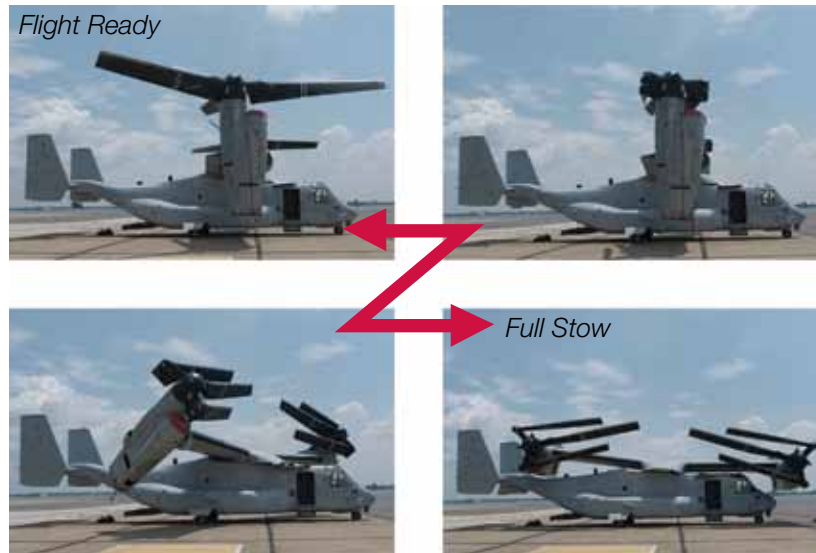
Appendix 2 Shipboard Compatibility

The V-22 Osprey is designed to a broad set of drivers, including the need to embark and operate from US Navy amphibious assault ships. The automatic blade fold/wing stow (BFWS) is a key feature of this shipboard compatibility. Full BFWS is accomplished in 90 seconds or less, and minimizes deck spotting, stowage, and hangar deck space required. Partial stow configurations for maintenance options are also accommodated.

Except as limited by deck strength or hangar size capability of the ship, the V-22 is designed to operate at the same level and class of flight operations as the H-46.



Comparison of V-22 and H-46 Spread Footprint



Blade Fold/Wing Stow Sequence

| V-22 Static Dimensions | | | |
|---------------------------------|--------|--------|--------|
| | | Feet | Meters |
| Rotors and Wing Spread | Width | 84'7" | 25.8 |
| | Length | 57'3" | 17.5 |
| | Height | 22'1" | 6.7 |
| Blades Folded, Wing Stow | Width | 18'11" | 5.8 |
| | Length | 63' | 19.20 |
| | Height | 18'3" | 5.5 |

The V-22 has been designed to permit timely spotting on shipboard flight decks and inside hangars. The aircraft can be positioned using standard spotting dollies connected to the nose landing gear for hangar spotting, or tow tractor with 8 or 15 ft tow bars primarily on the flight deck. Aircraft tiedown points are provided for securing the aircraft in up to 100 kt heavy weather conditions.

Appendix 3

USMC Medium Lift Transition

Transition Task Forces, chaired by HQMC Deputy Commandant for Aviation, oversees all Type/Model/Series transition plans.

The medium lift assault support fleet is transitioning from the CH-46E to the MV-22B. Beginning in 2003, this transition has been tracking to schedule and at the rate of two squadrons per year will be completed in 2017.

Squadron transitions from CH-46E to MV-22B take approximately 18 months from the time the HMM stands down to the time the newly formed VMM is ready to enter pre-deployment training.

V-22 deliveries are occurring on time and are supporting this transition. The East Coast transition is complete with 6 fully operational VMMs. The West Coast transition is underway.



Appendix 4

Studies and Analyses

The V-22 represents a revolutionary change in design and versatility. It brings capabilities not found in helicopters – a leap forward in speed, range and altitude performance.

The V-22 has been one of the most thoroughly studied aircraft in history. In fact, from 1984 to 2007, over 20 such studies comparing the V-22 to all currently available and proposed rotorcraft were conducted.

Every study showed the V-22 to be the most cost effective solution.

- The V-22 has superior speed, range and survivability:
 - Increases the tactical options available to the operational commander
 - Dramatically reduces the risk of friendly force casualties in post-assault ground operations
- When equal lift capability aircraft fleets are considered:
 - Significantly fewer V-22s were required to accomplish the specified missions
 - Likewise, proportionately fewer support assets and personnel were required
- When equal cost aircraft fleets are considered:
 - The V-22 fleet is more effective than any of the helicopter alternatives
 - Lower through-life costs for the tiltrotor
- For the same payload, range and cruise speed as the V-22, a compound or coaxial helicopter would require 20% more fuel and have a higher empty weight. Subsequently, the unit and operational cost of a comparable compound or coaxial helicopter would be far greater than the V-22.
 - In addition, it would be difficult to self deploy the desired 2,100 nm given the lower cruise efficiency associated with a compound or coaxial helicopter.
 - Furthermore, a compound or coaxial helicopter experiences significant vibrations in high speed flight, while the V-22 enjoys lower vibrations like other fixed wing turboprop aircraft.



Appendix 5

Current & Future Capabilities



Assault Support



Special Operations



External Loads



Personnel Infil/Exfil



Tactical Recovery of Aircrew and Personnel



CASEVAC



Aerial Refueling



Command and Control



Rapid Ground Refueling



Logistics Support



Executive/VP



Disaster Relief



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