



# V-22 Osprey 2010 Guidebook





## Message from the Commandant

Marines take extraordinary pride in the comment attributed to journalist Richard Harding Davis, "The Marines have landed, and the situation is well in hand." Our history has repeatedly validated that statement. Our training and organization ensure our fellow Americans that they should never doubt the outcome when Marines are sent to do our Nations work. Our confidence comes

from the selfless sacrifices we witness every day by the courageous young men and women who volunteer to serve. We must ensure we continue to provide the tools they need to get the job done.

Our Marines deserve the very best equipment we can give them – and the V-22 is exactly that. The Osprey is not a one-for-one replacement for any of our current, aging helicopters. The capability this aircraft represents does not just deliver Marines and equipment faster; it changes the entire calculus of planning and fighting at the tactical and operational level for our joint force and MAGTF commanders. None of us knows what the 2025 battlefield will look like. What we do know is what the Marine Corps will look like: It will be fast, light, agile, expeditionary and lethal. The Osprey is now and will be a cornerstone of that force.

Since 2001, the Marine Corps has been fighting shoulder to shoulder alongside our joint and allied partners overseas, supporting an extremely high operational tempo in two theaters while growing our force, introducing new aircraft and systems, and looking beyond the current fight. As we continue to shape naval aviation in the years ahead, the Osprey will be a key component of our future warfighting vision.

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

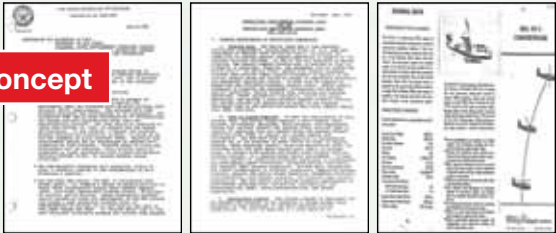


**“Though our Corps has recently proven itself in ‘sustained operations ashore,’ future operational environments will place a premium on agile expeditionary forces, able to act with unprecedented speed and versatility in austere conditions against a wide range of adversaries...”**

**– 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

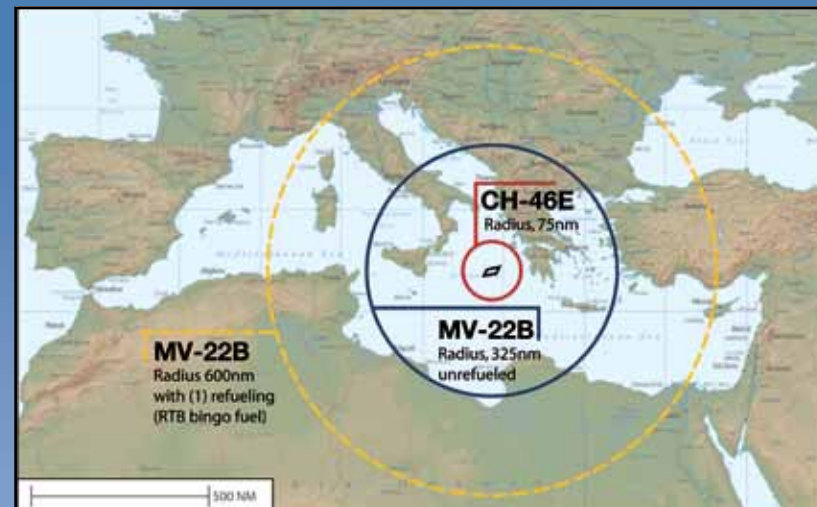
**To Reality**





### 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 MISSION SNAPSHOT CV-22

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.



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

# MV-22B MISSION

## 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**

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).

Jan 2010: The superior speed, range, and low acoustic signature of the MV-22B enabled a bold daylight raid against insurgents. The aircraft approached undetected until just before landing, with absolute tactical surprise that caught the enemy completely off guard.

Range capability unprecedented for a rotorcraft enabled the MV-22B to facilitate movement of government and tribal leaders across the breadth of Afghanistan.

# HAITI SNAPSHOT

## Haiti

### Operation Unified Response

Jan 2010



**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 rations, rice, 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

## Shipboard Operations

### 22 Marine Expeditionary Unit

May to November 2009

#### 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.

The MV-22B also proved to be a lifesaver, by flying an urgent ship to shore CASEVAC into Jordan, covering 147 miles in 37 minutes - a feat not possible with legacy aircraft.

"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."

– USS Bataan Corpsman



"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





# 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 tactics that 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

## CASEVAC

**25 Dec 07:** Urgent CASEVAC patient required transport from 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

## 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.

## 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



**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 flown in Iraq and Afghanistan 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. 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.



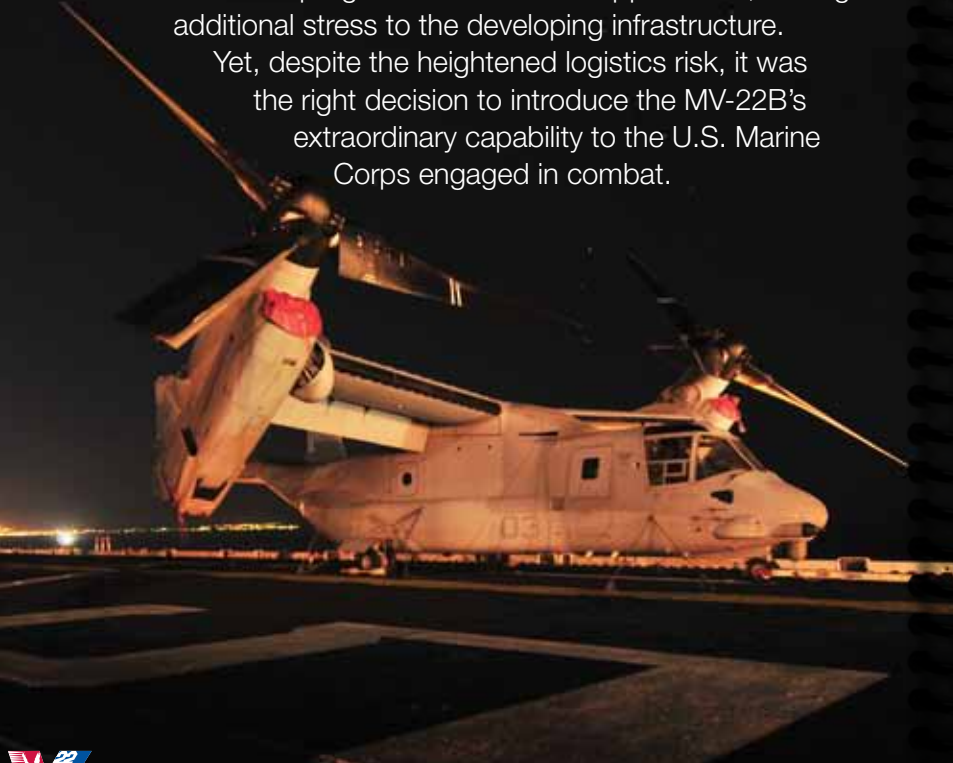
# Readiness Plan

## 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). 2010 finds one Marine tiltrotor squadron conducting high-intensity combat operations in Afghanistan while a second performs contingency operations with the MEU, such as the humanitarian assistance/disaster relief operations in Haiti. The Air Force is poised for another combat operation in support of National objectives.

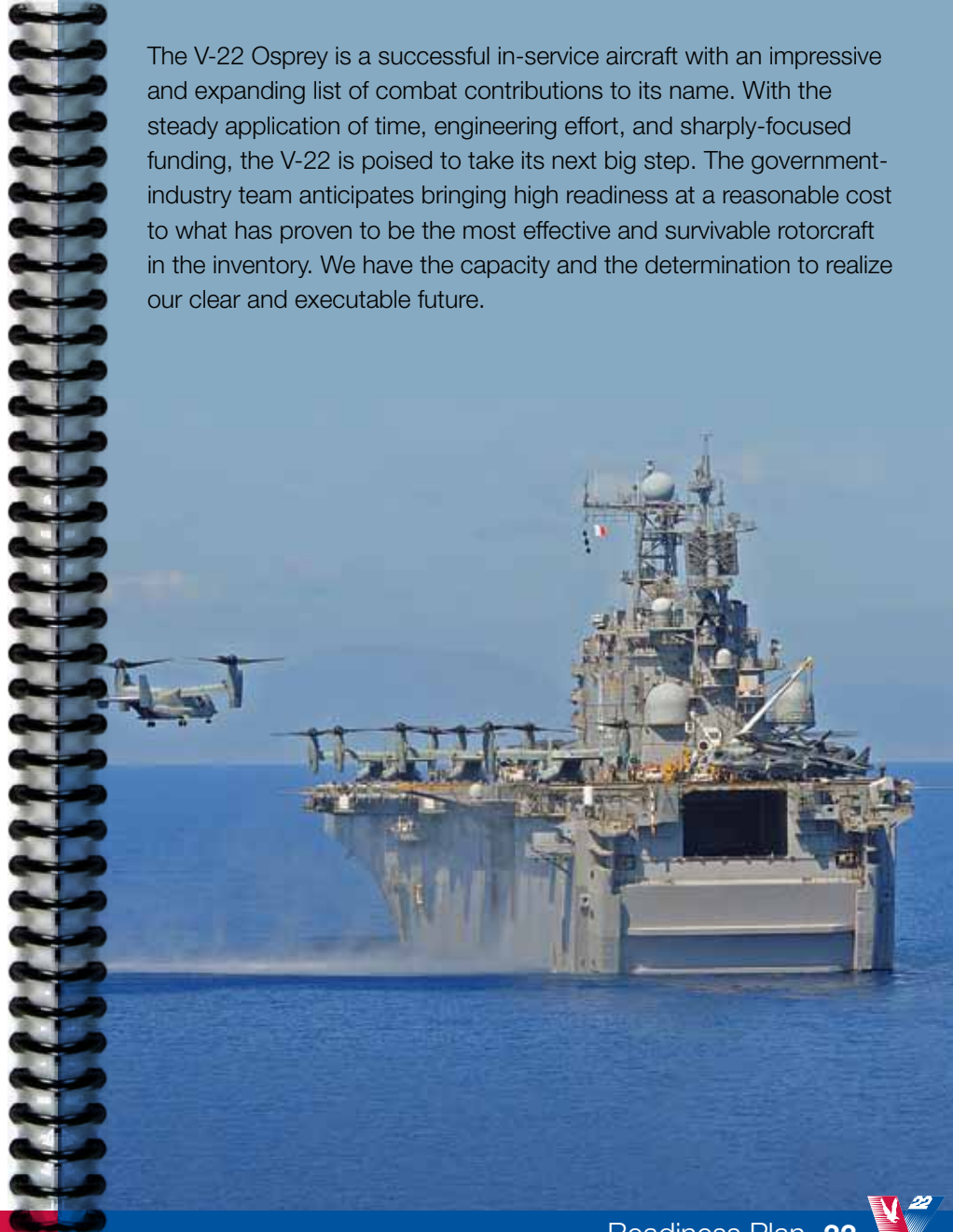
Since June 2007 when the USMC achieved the Initial Operational Capability of the V-22, the transition of tactical helicopter units to tiltrotor squadrons has continued at the rate of two squadrons per year. Cognizant of the contribution their preeminent assault support capability would make to the warfighter, the USMC deployed its Marine medium tiltrotor squadrons without delay 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 superior performance continues to the present, where we find the USMC preparing to transition its eighth operational squadron and AFSOC its second.



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, over 50% of which have occurred in the last two years. This rapid increase in aircraft utilization has led to a renewed focus on meeting unforeseen challenges while continuing to complete complicated mission requirements. As a new aircraft in its first few years of Fleet operations, the V-22 program has put a priority on reviewing and improving its aircraft readiness and operating costs. This natural transition of focus occurs while tactical V-22 squadrons are continuously deployed, sometimes with two squadrons forward simultaneously.

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 has a coordinated strategy to solve these issues which is spiral in nature and will provide incremental improvements over time. The team is executing this strategy, having improved many aspects of maintainability, component reliability, and overall affordability. With the commitment of funds in January 2010, we are now accelerating the incorporation of these improvements onto fleet aircraft. Successful component modification, improved maintenance and diligent supply support practices are intended to reduce component removals and increase component availability. 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.

The V-22 Osprey is a successful in-service aircraft with an impressive and expanding list of combat contributions to its name. With the steady application of time, engineering effort, and sharply-focused funding, the V-22 is poised to take its next big step. The government-industry team anticipates bringing high readiness at a reasonable cost to what has proven to be the most effective and survivable rotorcraft in the inventory. We have the capacity and the determination to realize our clear and executable future.





# 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

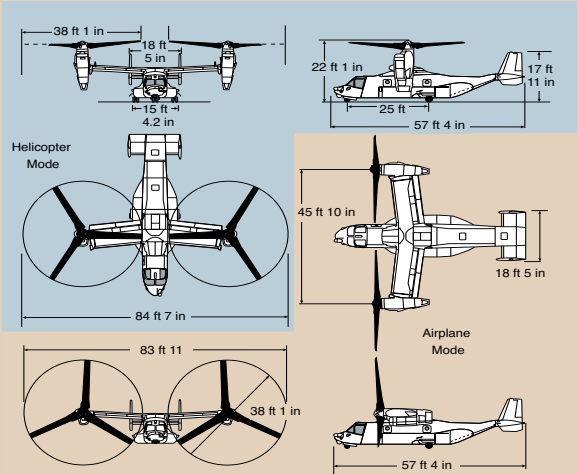
MV-22, gallons (liters) . . . . . 1,721 (6513)  
CV-22, gallons (liters) . . . . . 2,025 (7667)

## Engines

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

## Crew

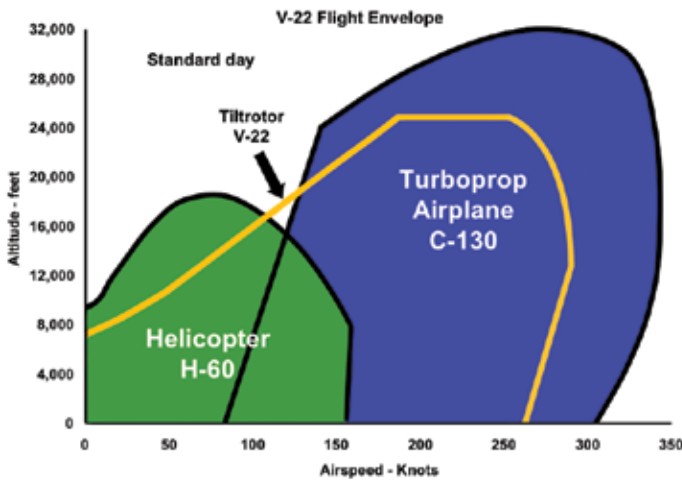
Cockpit – crew seats . . . . . 2 MV/3 CV  
Cabin – crew seat/troop seats . . . . . 1/24



# 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: 250+ 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 benefitted the V-22 structural design.

# Multiservice Configurations

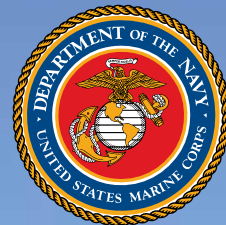
## MV-22B U.S. Marine Corps

**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



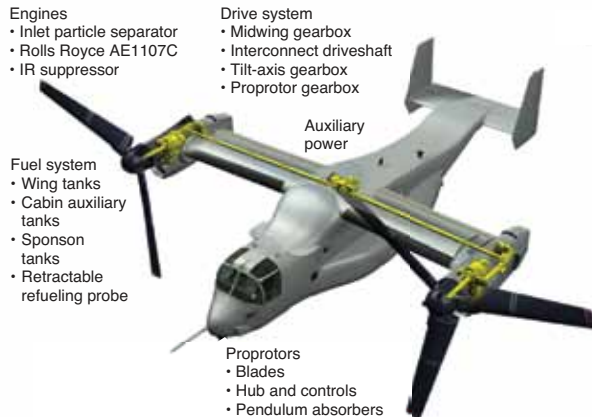
## Propulsion System

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

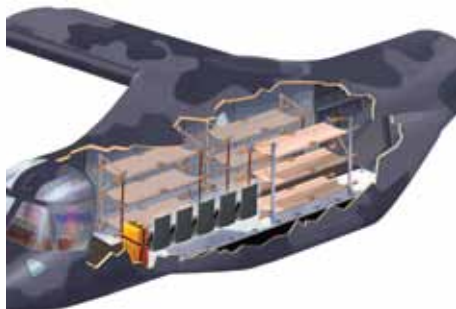
**The V-22 is designed to fulfill the multimission role with its large open cabin, rear loading ramp, and a variety of cabin and cargo systems.**

## 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/ft<sup>2</sup> 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*

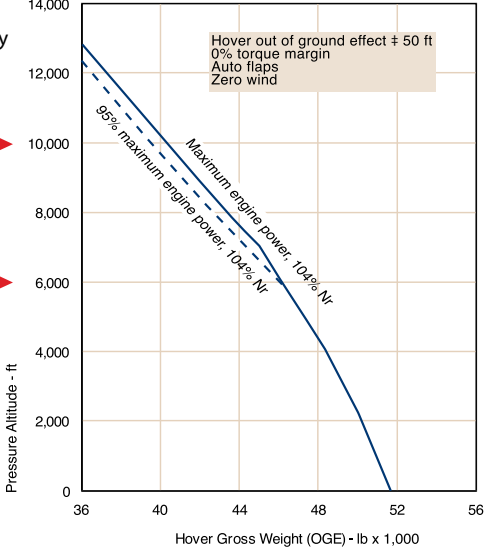
The V-22 is capable of sustained cruise speeds in excess of 275 kts and an unprecedented V/STOL aircraft mission radius. Standard day capabilities are shown in the figures below.

Hover Performance

Example HOGE  
Transport Capability

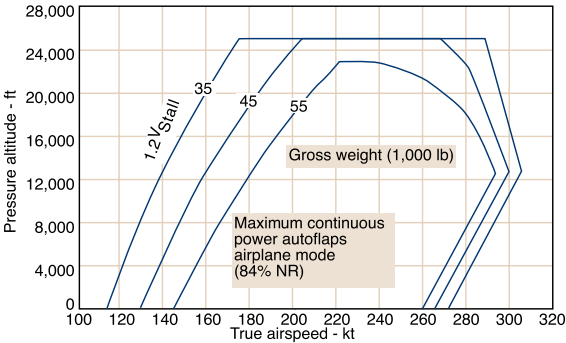
3000 lb, 70 nm  
payload at 10k'  
PA is 3,000 lbs with  
70 nm range post  
pickup/drop

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



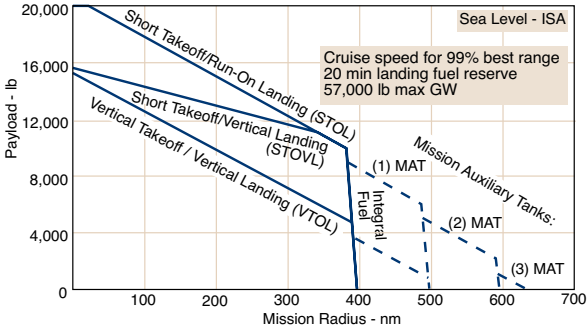
V-22 Standard Day Hover Envelope (OGE)

Cruise Flight Envelope

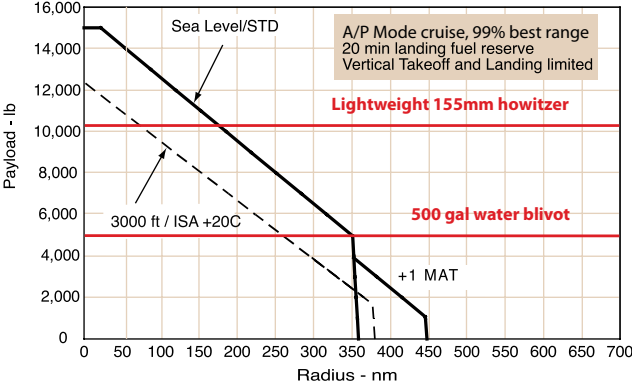


V-22 Airplane Mode Flight Envelope (Standard Day)

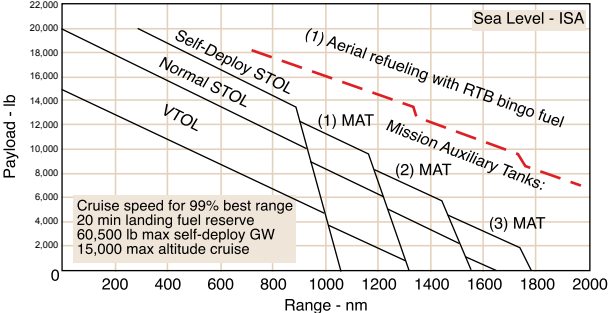
Internal Payload Mission



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.

### Speed and Range:

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

### 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



### IR Signature:

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

### Acoustic Signature:

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



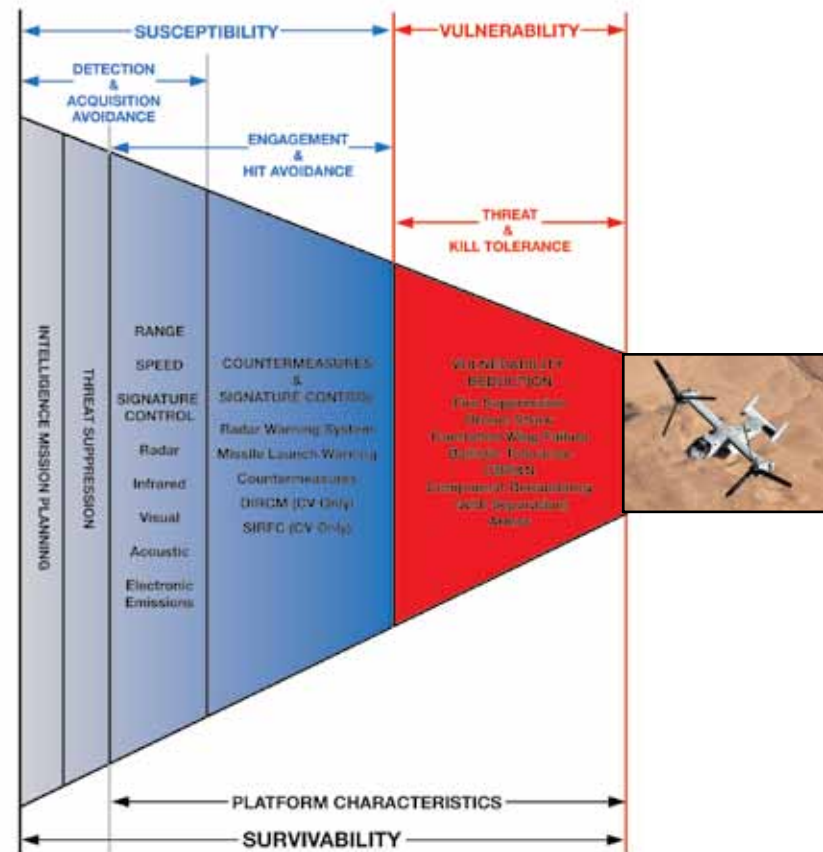
The V-22 reduces its susceptibility through the use of speed, range, altitude, situational awareness for the aircrew, the aircraft survivability suite sensors and countermeasures, as well as infra-red signature reduction.

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 prop rotor 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 prop rotors 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**

## Susceptibility/Vulnerability Relationship "Kill Chain"

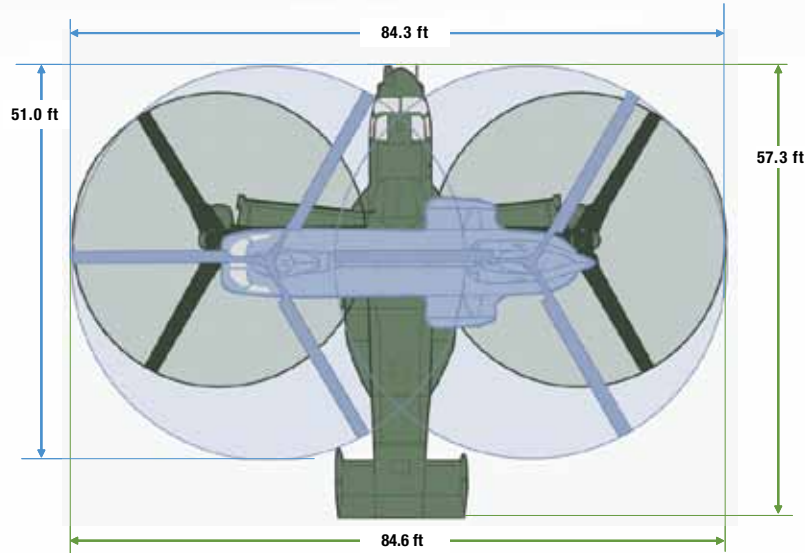


# Appendix 2

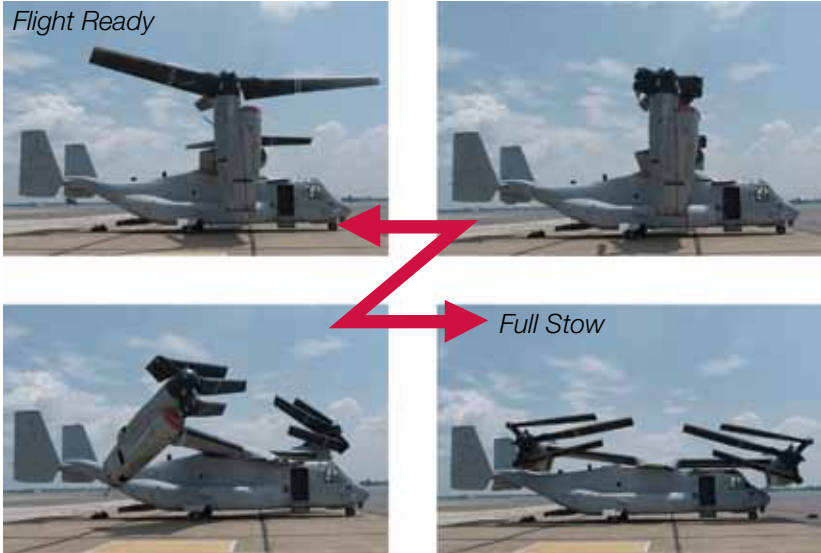
## Shipboard Compatibility

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 15ft 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 History & Development

Tiltrotor technology exploratory development began in 1950. It transitioned to military development in the mid-1980s, and has matured today into the V-22 Osprey tiltrotor aircraft.

Tiltrotor technology development has been as evolutionary as it has been revolutionary. Although various convertiplane concepts were explored during the late 1940s and early 1950s, the Bell XV-3 was the first tiltrotor that successfully converted from vertical to horizontal flight. The XV-3 (1958) 4,800-pound prototype used transmissions, driveshafts, gearboxes and electric motors inside the fuselage to tilt its wingtip mounted rotor systems. The XV-3 was powered by a 450 hp Pratt & Whitney R-985 radial, reciprocating engine, which was also located in the fuselage. The XV-3 made 250 test flights, including 110 full conversions from helicopter mode to airplane mode and back. The XV-3 demonstrated the feasibility of tiltrotor technology.

The XV-3 was flown well into the 1960s, to further the understanding of tiltrotor technology. Other turbine powered experimental convertiplanes followed in the 1960s, including the Hiller X-18, the

Curtiss Wright X-19 and the Bell X-22A, a four engine ducted fan built under a U.S. Navy contract to study the possibility of a Vertical and Short Takeoff and Landing tactical transport. All, including the XV-3, had limited payload and performance and were not considered suitable for operational service.



With the technical feasibility of tiltrotors established by the XV-3, the U.S. Army and NASA proposed developing a new turbine powered tiltrotor aircraft, the XV-15. In July 1972, Bell Helicopter was awarded a NASA contract to build and test two XV-15s. Each weighed 13,000 pounds and was powered by two 1,550 shaft horsepower Lycoming T53 turboshaft engines. The aircraft flew in helicopter mode in May 1978 and April 1979, respectively. On July 24, 1979, an XV-15 flew in airplane mode, achieving an altitude of 4,000 feet and airspeed of 160 knots. Later, the envelope was expanded to 21,000 feet altitude with cruise speeds reaching 300 knots. In 1981, an XV-15 dazzled a Paris Air Show audience that included Secretary of the Navy John Lehman, with a demonstration of takeoffs and landings, low-speed maneuvers, 360-degree turns and high-speed flyovers. The XV-15's Paris Airshow debut was the catalyst for the next generation of tiltrotors.



## JVX

In December 1981, the Department of Defense formally began the Joint Services Advanced Vertical Lift Aircraft (JVX) Program to meet the needs of all four military services for a vertical takeoff and landing (VTOL), medium-lift, tactical transport aircraft. The need to replace the Services medium lift helicopters was well documented. U. S. Marine Corps CH-46E and CH-53D medium lift helicopters began military service in the early 1960s and were experiencing technical obsolescence, escalating maintenance costs, reduced reliability, availability and maintainability (RAM) and significant performance degradation. Current and projected CH-46E and CH-53D deficiencies included:

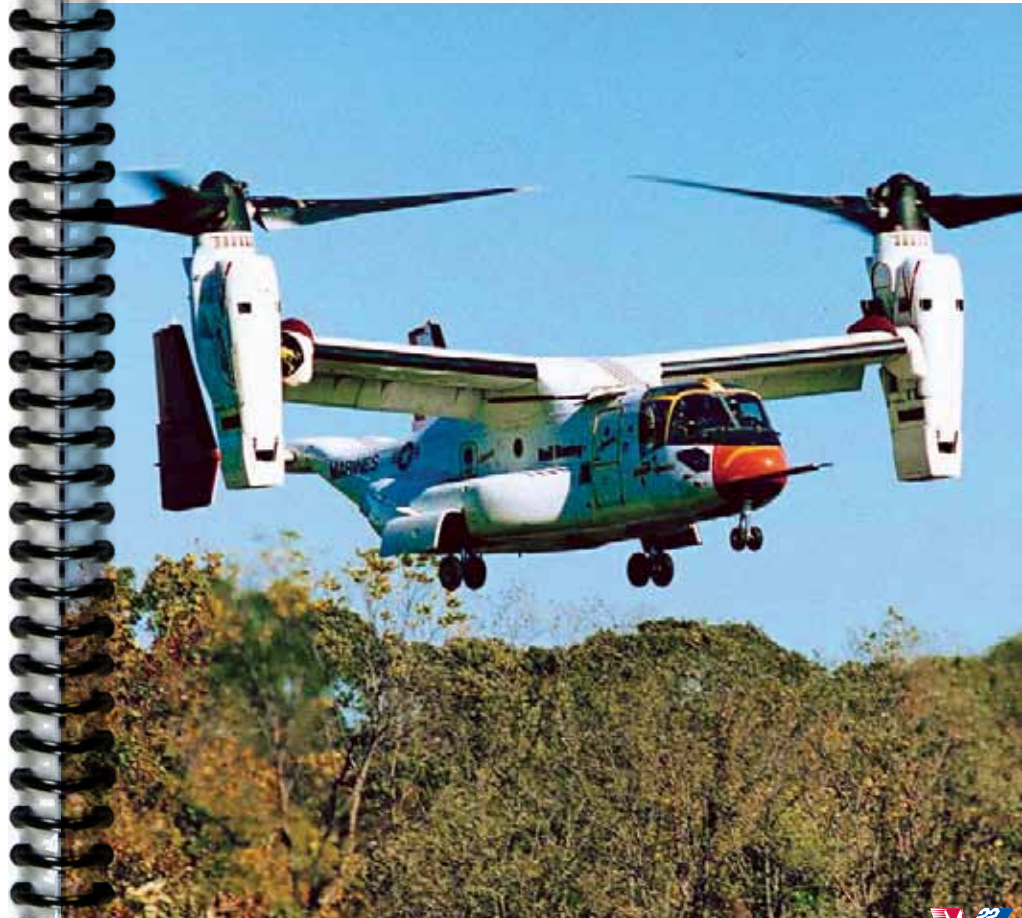
- Inadequate payload, range and airspeed
- Lack of ability to communicate, navigate and operate in adverse weather conditions, day or night
- No self-deployment or aerial refueling capability
- Insufficient threat detection and self-protection capabilities
- Unacceptably high maintenance and inspection rates
- Limited communication capability for embarked troop commanders

SOCOM uses a variety of fixed and rotary wing aircraft to perform special operations missions, the oldest of which were the MH-53J/M Pave Low II medium lift helicopters, with an average age of 30 years. The MH-53J/M lacked the self-deployment capability and performance required to maximize the probability of success for assigned clandestine missions. Current and projected SOCOM aircraft deficiencies include:

- Inadequate combat radius to execute multiple, concurrent major theater war and national missions without incurring additional support requirements, i.e., numerous in-flight refueling sorties and an increased operational signature
- Inadequate growth potential for emerging, self-protection avionics systems due to aircraft space and weight considerations

## V-22 Development

A two-and-a-half year preliminary design effort for JVX began in April 1983 to reduce program risk for full scale development. More than 8,600 hours of wind tunnel modeling were completed. A full scale composite fuselage section and a wing were built and static tested, and a large scale rotor performance test was conducted to verify performance estimates. In 1984, the government designated the JVX as the V-22, and shortly thereafter, Secretary of the Navy John Lehman named it the Osprey.





## V-22 Full Scale Development

Bell Boeing began Full Scale Development (FSD) in June 1985. The first FSD aircraft was rolled out on May 23, 1988, and flew on March 19, 1989. One month later in April 1989, the Administration decided that the V-22 was too expensive and requested no more funding for V-22 development or production, in effect cancelling the program. Congress, however, continued to fund the development program, while calling for an independent cost and operational effectiveness analysis (COEA) to evaluate the V-22 against conventional helicopters. The Institute for Defense Analysis (IDA) conducted this exhaustive assessment and concluded, as had several previous studies, that the V-22 was more cost and operationally effective than any alternative helicopters. Based on this study, Congress continued funding V-22 development. During FSD, Bell Boeing built six developmental V-22s, a ground test article and a full scale static test article. Five V-22s flew, accumulating 764 flight hours in 645 flights. The Osprey came full circle in October 1992, when Vice President Dan Quayle announced an Engineering and Manufacturing Development (EMD) contract award for four production representative V-22 aircraft.

## Engineering and Manufacturing Development

The \$2.3B Engineering and Manufacturing Development (EMD) program contract award called for Bell Boeing to modify two of the previous full scale development aircraft and to design, test, qualify and build four new production representative aircraft for Operational Evaluation testing. The EMD design effort incorporated fixes and lessons learned from the FSD contract phase to reduce weight and incorporate recurring unit cost reduction and producibility improvements. Tooling was designed and built to produce initial production lots. The first flight of EMD aircraft #7 occurred in December 1996. The EMD program was completed in 1999. During the EMD Flight Test Program, the V-22 achieved 275 knots in level flight, attained 25,000 feet altitude, flew at 60,500 pounds maximum gross weight and achieved 3.9 g's at 39,500 pounds.



# Low-rate Initial Production



In April 1997, the Under Secretary of Defense of Acquisition, Technology and Logistics approved V-22's entry into low rate initial production and delegated future production decisions to the Navy. Also in 1997 the Quadrennial Defense Review (QDR) restructured the V-22 program from a buy of 425 MV-22Bs for the Marine Corps, to 360. Because of the decrease in total numbers and the continued aging of the CH-46E/CH-53D fleets, the QDR also recommended accelerating production to a maximum rate of 30, vice 24 per year, to complete fielding in 2012, vice 2021.

Following two mishaps in 2000, at the suggestion of the Marine Corps Commandant, then Secretary of Defense Cohen established a panel to conduct an independent, high-level review of the V-22 program. The Panel was to assess the safety of the aircraft and recommend any proposed changes or corrective actions and report the results. Any milestone production decisions would be delayed until completion of the Review Panel's work.

The Panel's April 2001 report found no evidence of an inherent safety flaw in the V-22 tiltrotor concept, and recommended the program be continued.

The V-22 return to flight phase commenced in 2002. Proceeding under an incremental time-phased block procurement strategy, Block A aircraft began to be delivered to the fleet in 2003. Incorporating upgraded flight control software, improved hydraulics and wiring in the nacelles, and other reliability and maintainability enhancements, these aircraft now constitute the training squadron inventory.

## IOC and Initial deployments

The Corps established VMX-22 in August 2003 as its tiltrotor operational test squadron. Operational Evaluation was completed by VMX-22 in June 2005 and found the MV-22B operationally effective and suitable.

In Sep 2005, an Acquisition Defense Memorandum (ADM) approved Full Rate Production for the MV-22B and CV-22.

VMM-263, the first fleet tiltrotor squadron, stood up in March 2006, beginning the medium lift fleet transition from CH-46E to MV-22B. Initial Operational Capability (IOC) was reached in June 2007, and the first combat deployment of the MV-22B took place soon after in October 2007.

The MV-22B was continuously combat deployed to Operation Iraqi Freedom for 18 months from 2007 to 2009. In May 2009, the first MV-22B ship based MEU deployment began. Later that year in November, the MV-22B deployed to Operation Enduring Freedom.





## Appendix 4

# 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. In FY-09, the last remaining CH-46E HMM squadron stood down on the East Coast and the West Coast transition began in FY-10.



# Appendix 5

## 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.

Numerous major studies and analyses have shown that the V-22 is more cost and operationally effective than any helicopter (including compound/coaxial helicopter designs), or any combination of helicopters in the medium lift assault role. Compared to a range of current and advanced helicopter designs:

- 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 6

## 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/VIP



Disaster Relief



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