V22 Osprey Guidebook

2013/2014

Message from the Commandant of the Marine Corps

Marines have played a storied role throughout the history of our nation. While warfare has evolved, the fundamentals of conflict and uncertainty remain. History has shown that crises usually come with little or no warning, stemming from the same conditions of complexity and chaos we observe across the world today. In the unstable regions of the world, where we see the clash of dissimilar interests, social unrest and violent extremism combined with natural disasters, competition for resources and the proliferation of advanced weaponry, crises are imminently possible. These factors require a force that is poised to respond at a moment's notice to buy time for strategic decision-making. America's Expeditionary Force in Readiness – the U.S. Marine Corps – is that force.

The Marine Corps remains partnered with the U.S. Navy in a state of persistent forward presence aboard amphibious warships as part of our posture of global readiness. These forces are prepared to execute short-notice, expeditionary operations ranging from humanitarian aid and disaster relief to stability operations and major combat. With the sea as maneuver space, our Nation's expeditionary naval forces can readily influence events in the littoral area or ashore. Our unique and close relationship with the Navy in operating forward maximizes operational reach and surprise while creating options for the larger joint force where none previously existed.

As we enter the second century of Marine Aviation, we must continue to evolve and modernize to maintain our tactical and operational advantages. The MV-22 Osprey is an integral part of that ongoing transformation. Since its introduction to the operational forces in 2007, this tilt-rotor platform has been indispensable, increasingly allowing forward deployed forces to conduct operations at the time and place of their choosing. The Osprey's revolutionary and unprecedented capabilities in speed, range and lift capacity give our commanders far greater tactical and operational reach than was previously available. Now recognized as the safest and most survivable assault support aircraft in operation, the agile, adaptable, rugged and tremendously capable Osprey is what Marines always knew it would be…an invaluable asset to the joint force, our Corps and our Nation's defense

Semper Fidelis

JAMES F. AMOS
General, U.S. Marine Corps

Message from the Commander of Air Force Special Operations Command

Many of the missions Air Force Special Operations Forces are expected to conduct and support require us to place the Joint Force on the objective, support the force while employed, and safely recover the force, often in a dynamic environment where opportunities are fleeting and minutes matter.

The CV-22 provides joint force commanders with an incredibly efficient and effective rapid global response, supporting long-range infiltration, exfiltration, and resupply of Special Operations Forces in hostile or denied territories and politically sensitive environments. Its unique capabilities, along with advanced tactics, techniques, and procedures, have significantly enhanced specialized air mobility reach and agility, and extended the commanders' battle space in austere environments such as Afghanistan, Iraq, and Africa. Since the first operational deployment in July 2009, our CV-22s have flown more than 3,300 hours, executed 2,738 missions, delivered in excess of 733 tons of cargo, and infiltrated over 14,000 personnel.

The CV-22 has proven its value to the warfighter and the joint force commanders on the battlefield. And, as Air Force Special Operations Command anticipates the demands of the future operating environment and focuses on continuous improvement of our specialized air mobility, the CV-22 will persist in providing swift, agile airpower, enabling timely response to combatant commander requirements for many years to come.

Any Time, Any Place

ERIC E. FIEL
Lieutenant General, USAF

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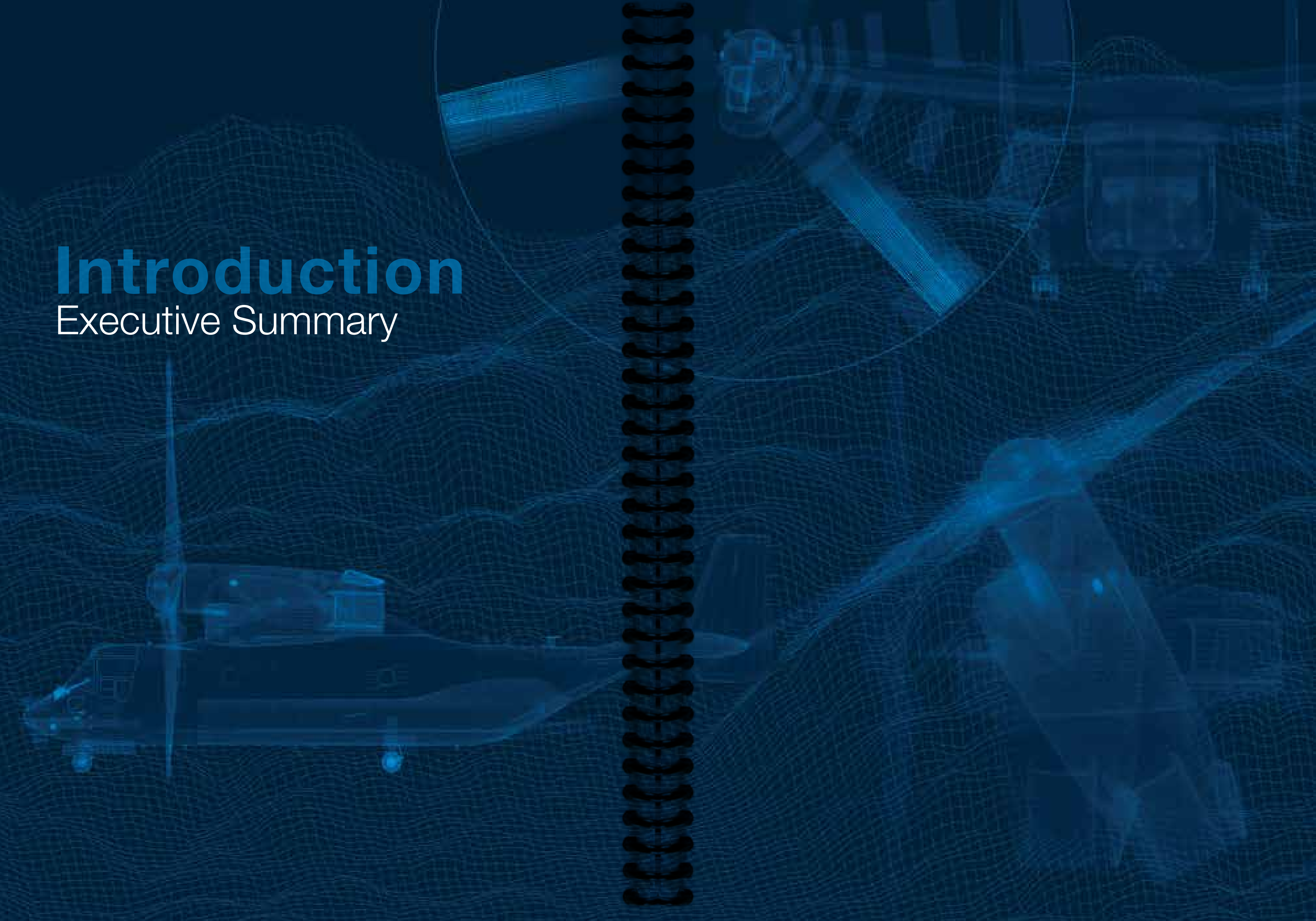
Executive Summary



Executive Summary

MV-22, United States Marine Corps

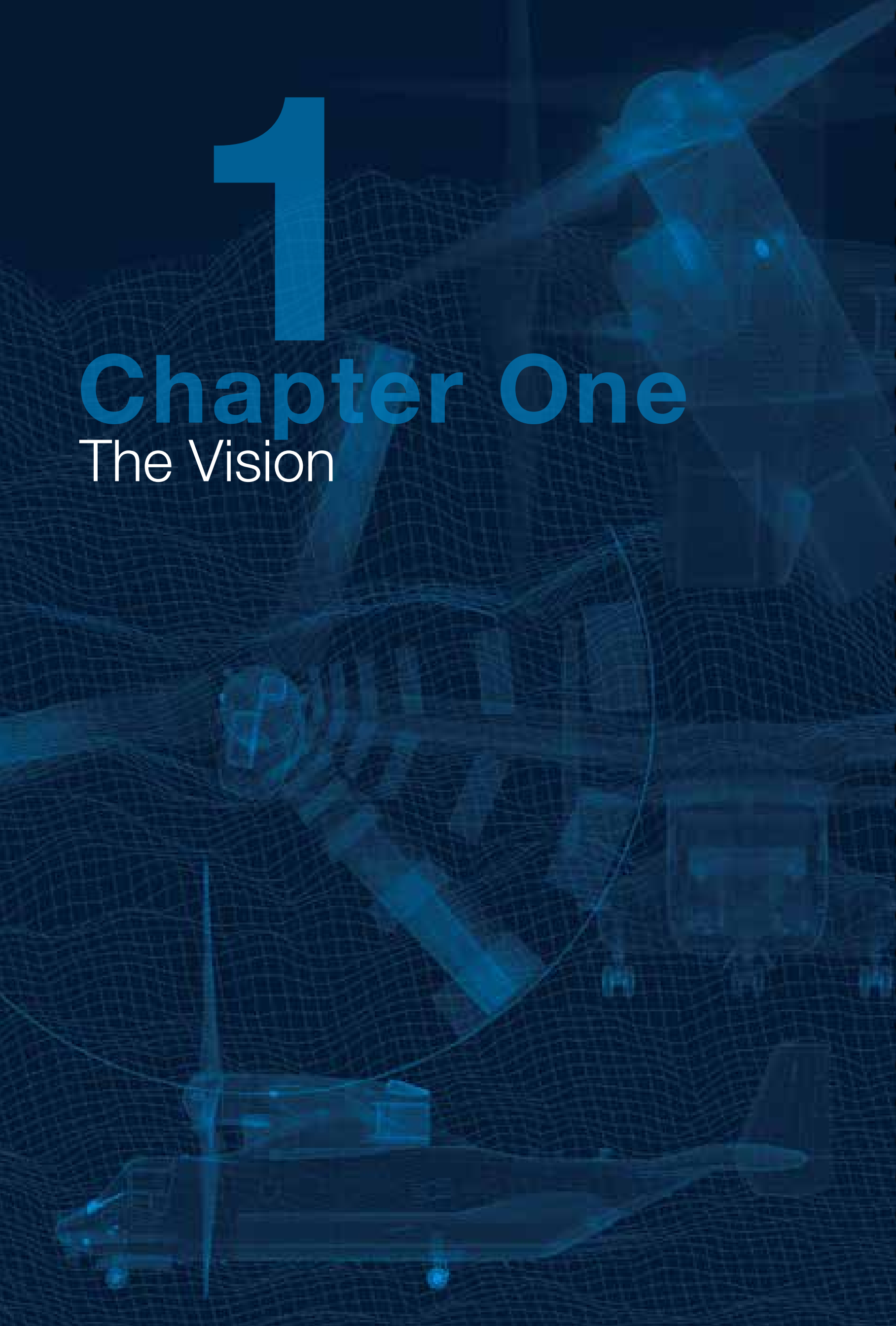
CV-22, US Special Operations Command

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-22 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 continues to revolutionize military air transport in a manner not seen since the introduction of helicopters more than 50 years ago.



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Chapter One
The Vision

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.

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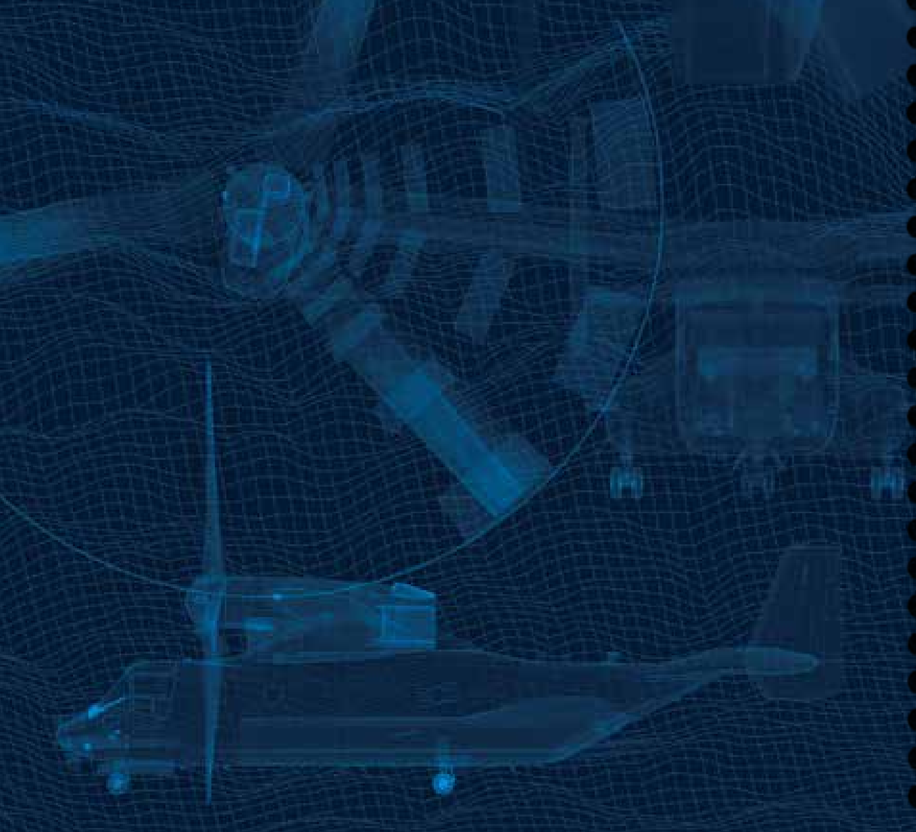
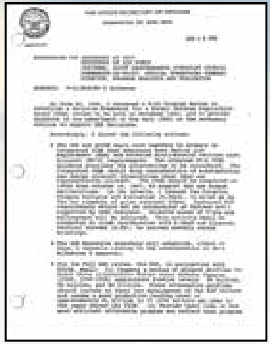
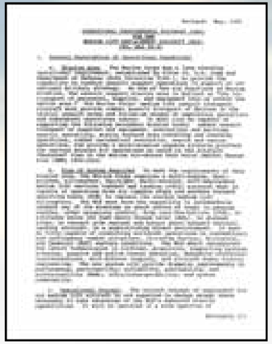
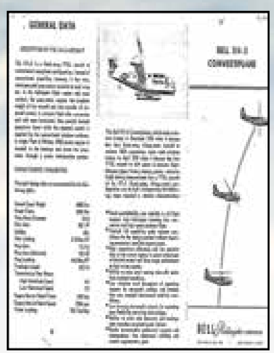
Chapter Two
The Program



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

Program of Record

USMC - 360 MVs

- Amphibious Assault
- Sustained Land Operations
- Self-Deployment

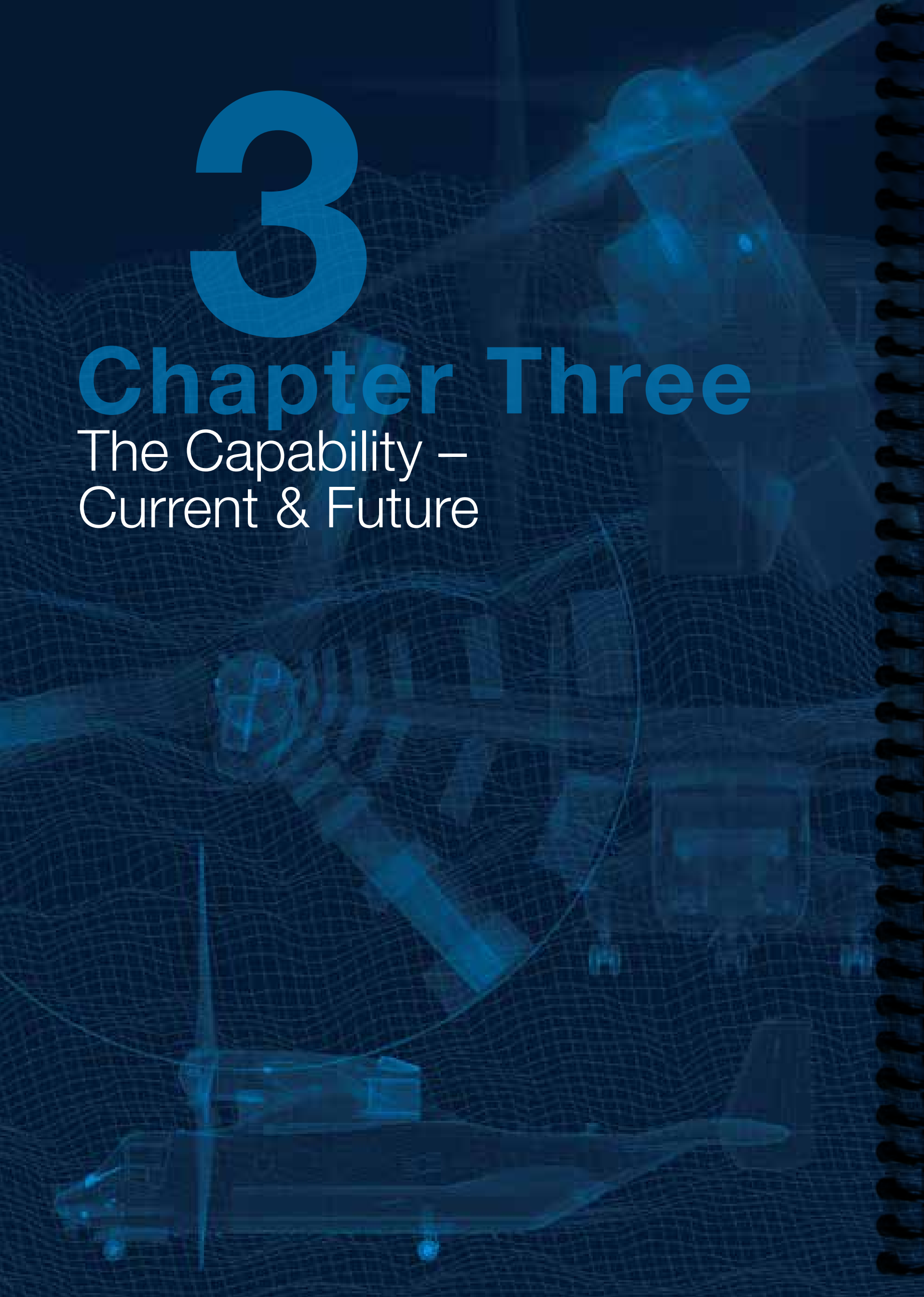
Program of Record
USSOCOM - 50 CVs

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

Program of Record

USN - 48 MVs

- Fleet Logistics Support
- Special Warfare
- Combat Search and Rescue



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Chapter Three
The Capability – Current & Future

USMC MV-22 BASING

MCAS New River
MCAS Miramar
MCAS Futenma

AFSOC CV-22 BASING

Hurlburt AFB
Cannon AFB
Kirtland AFB

Fleet Expansion

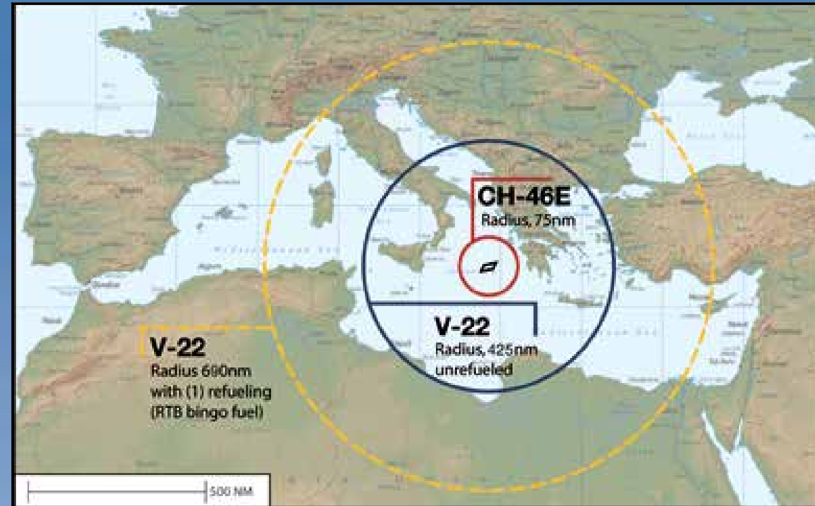
2013
HMX-1 Quantico, VA
Okinawa
Mildenhall, UK

2014
MCAS Kaneohe, Hawaii
MCAS Pendleton

Tactical, Operational, and Strategic Reach

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

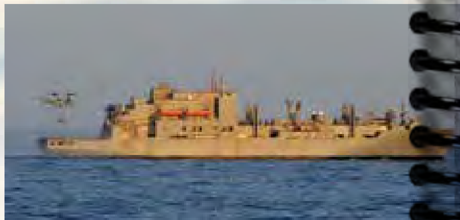


Mission Profile

- Without Mission Auxiliary Tanks System (MATS)
  - Approx 5.0 hrs max endurance
  - Approx 900 nm max range in 4.3 hrs
- Ceiling 24,700'
- 420 nm combat radius
  - 24 passengers
- 690 nm combat radius with 1 aerial refuel
  - 24 passengers
- Additional fuel options: up to 3 MATS tanks point to point with no loiter enroute
  - 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

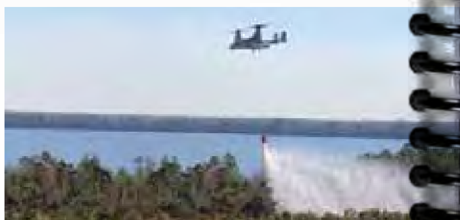
Expanding the Capability

The growing USMC and AFSOC global fleet highlights the V-22's operational capability and flexibility



- V-22 transfers an AV-8B engine from the USNS Wally Schirra (T-AKE 8)

- V-22 hovers over USS Wyoming (SSBN 742) while performing simulated MEDEVAC operations



- V-22 conducting firebucket operations

- Flight Deck Certification USS Chester Nimitz (CVN-68)

- VMM-261 MV-22 and AV-8B Harriers assigned to 24th MEU in formation after aerial refueling training

Rescue at Sea Proof of Concept

- Simulated MEDEVAC by a V-22 from an SSBN at sea
- Non-stop, round trip flight from Cannon AFB, NM to USS Wyoming (SSBN 742) off the east coast utilizing aerial refueling
- 2600 nm roundtrip / 11.5 total hours / 5.5 hours to the SSBN
- Demonstrates the operational reach and unique capability

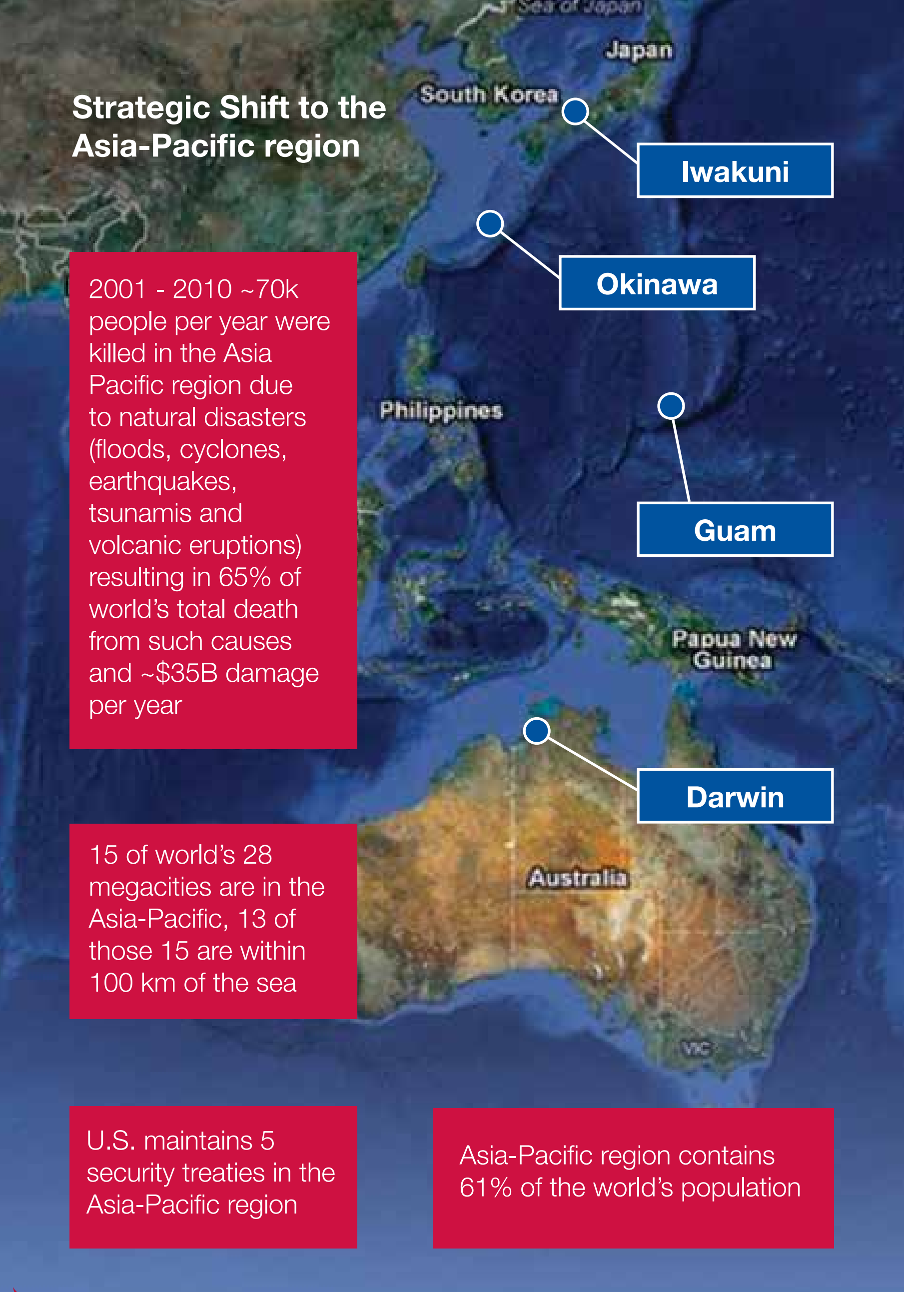
Strategic Shift to the Asia-Pacific region

2001 - 2010 ~70k people per year were killed in the Asia Pacific region due to natural disasters (floods, cyclones, earthquakes, tsunamis and volcanic eruptions) resulting in 65% of world's total death from such causes and ~$35B damage per year

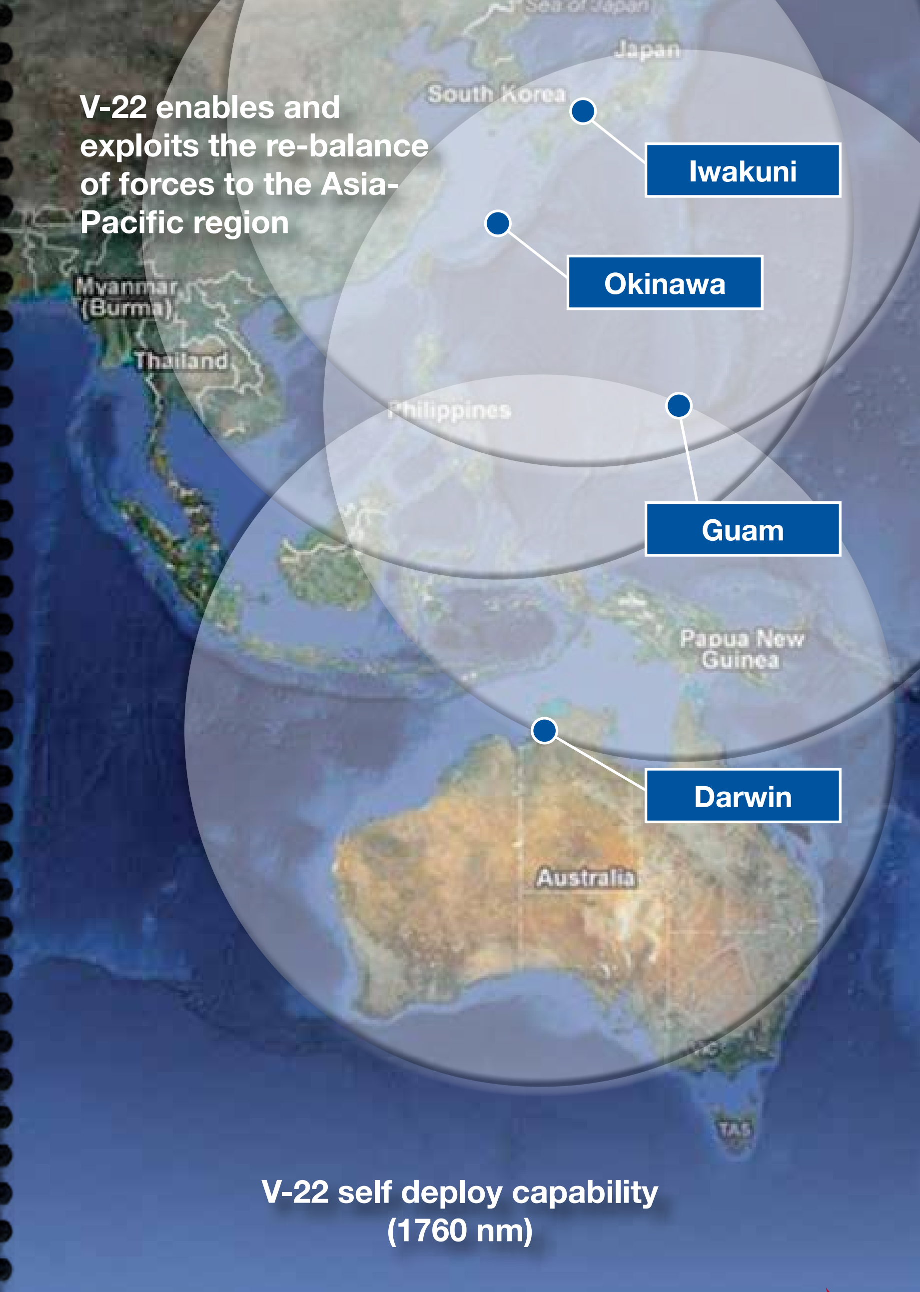
15 of world's 28 megacities are in the Asia-Pacific, 13 of those 15 are within 100 km of the sea

U.S. maintains 5 security treaties in the Asia-Pacific region

Asia-Pacific region contains 61% of the world's population



V-22 enables and exploits the re-balance of forces to the Asia-Pacific region



V-22 self deploy capability (1760 nm)

4 Chapter Four
The Missions

The USMC and AFSOC employ the MV-22 and CV-22 repectively around the world. The aircraft has made a tremendous impact, affording its customers unprecedented versatility and operational reach. This chapter looks at specific examples of both MV-22 and CV-22 employment

MV-22

Since the MV-22 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.

CV-22

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

MV-22 MISSION SNAPSHOT

Afghanistan
Operation Enduring Freedom
November 2009 to Present

During Operation Enduring Freedom, the MV-22 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.

To date, MV-22s in OEF have flown over 14,000 flight hours, carried over 148,000 passengers and over five million pounds of cargo.

The MV-22 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-22s 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-22s 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-22 and the Marines who operate and maintain the aircraft.

Amphibious Operations

Marine Expeditionary Units

May 2009 to Present

MV-22 met all Amphibious Based Mission Requirements

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

"There is a whole new generation of Marines getting very comfortable with seeing the MV-22 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 (LHD 5) Commanding Officer

MV-22 MISSION SNAPSHOT

Amphibious Operations

Operation Odyssey Dawn

March 2011

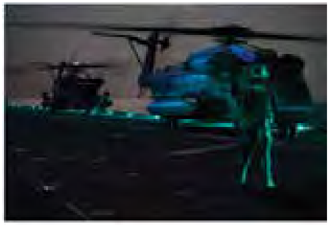

USS Kearsarge (LHD 3) MV-22 flight deck operations

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-22 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-22 is ideally suited. Less than two hours after the F-15E crew ejected, 2 MV-22s, 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 (LHD 3), 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-22's speed, precision navigation, and ability to land virtually anywhere gave the Marines the necessary capability to quickly and sucessfully perform this critical mission.



USS Kearsarge (LHD 3) AV-8B and CH-53E flight deck operations

Haiti
Operation Unified Response
January 2010

MV-22 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

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

Operation Iraqi Freedom

October 2007 to April 2009

In its combat debut, the MV-22'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-22 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-22 broadened the ground commander's area of influence for boots on the ground.

The MV-22 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-22 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*

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

The USS Kearsarge (LHD-3) 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-22s 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-22 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-22 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.

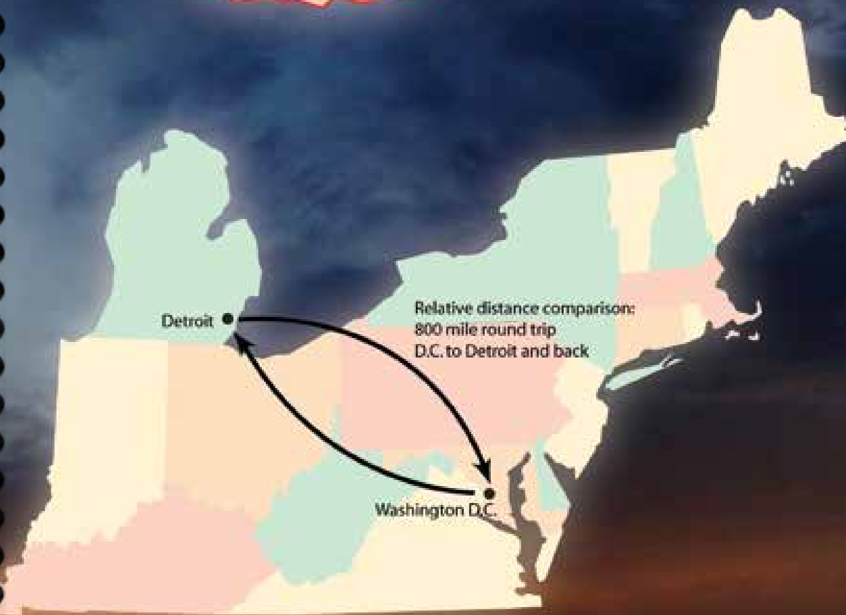
Other theater aircraft made multiple rescue attempts, but none were successful due to rugged mountainous terrain and a severe dust storm.

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



Operation Enduring Freedom

May 2011 - October 2012

Five CV-22s and crews from both the 8th Special Operations Squadron and the 20th Special Operations Squadron were deployed in support of Operations Enduring Freedom. Their primary mission was to conduct infiltration and exfiltration of special operations forces. During the 18-month deployment, the squadrons executed 224 INFIL/EXFIL missions. In this role, the aircraft delivered 11,531 assaulters enabling the capture of 725 suspected terrorists.

Operation Enduring Freedom

Casualty Evacuation (CASEVAC)

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.

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.

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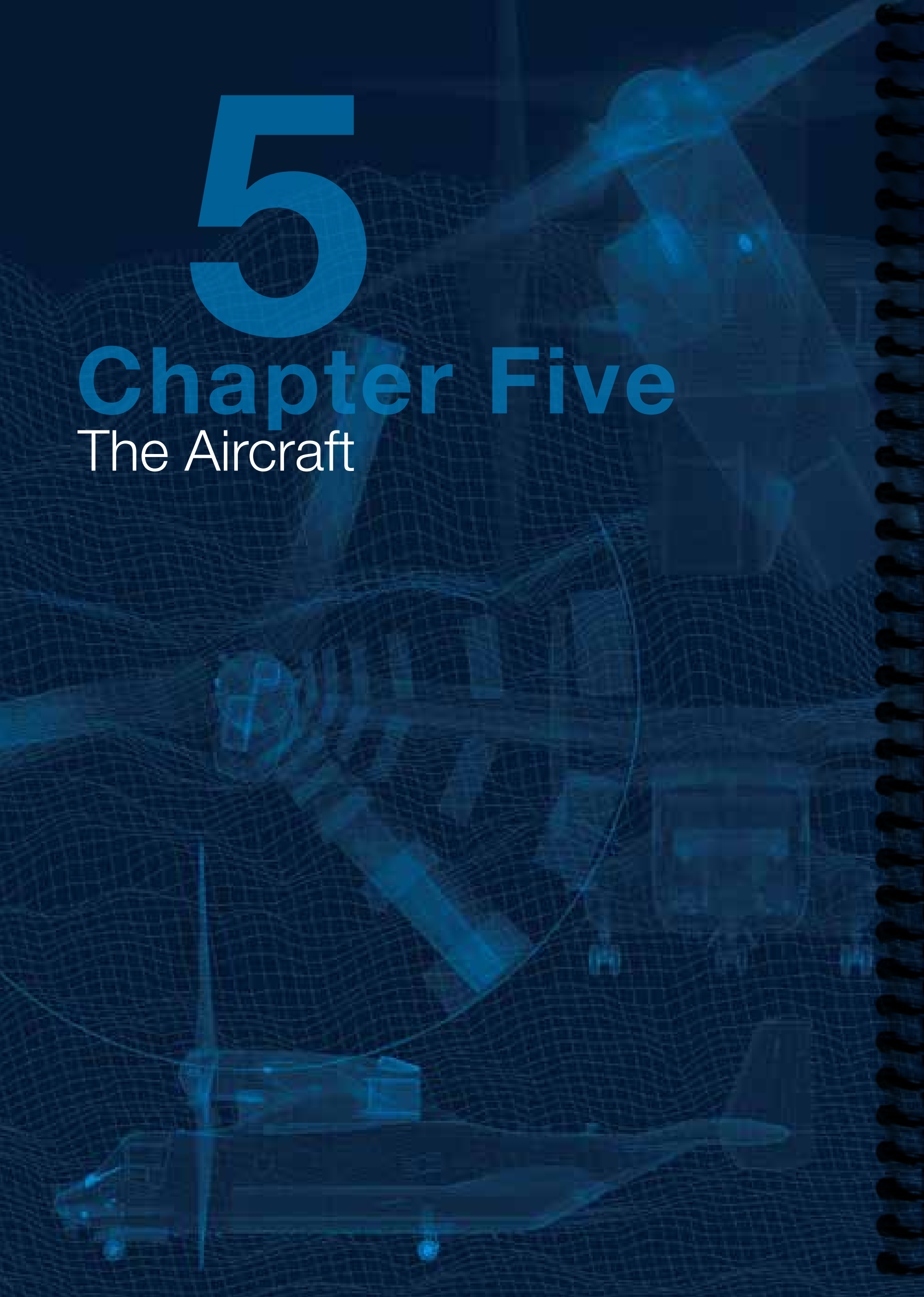
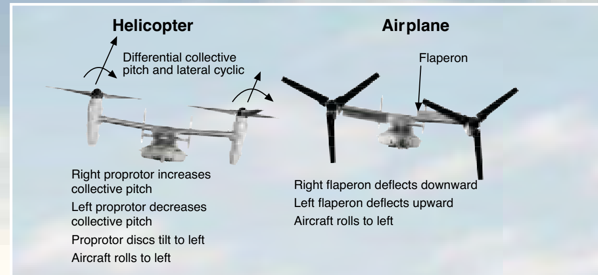
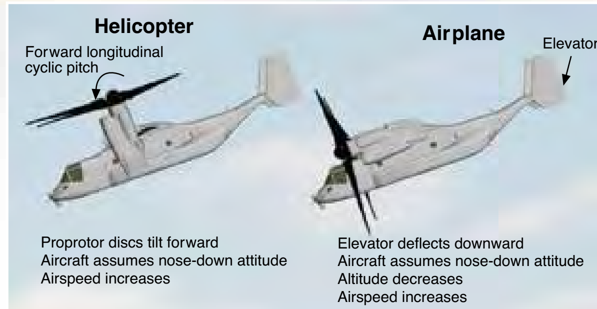
Chapter Five
The Aircraft



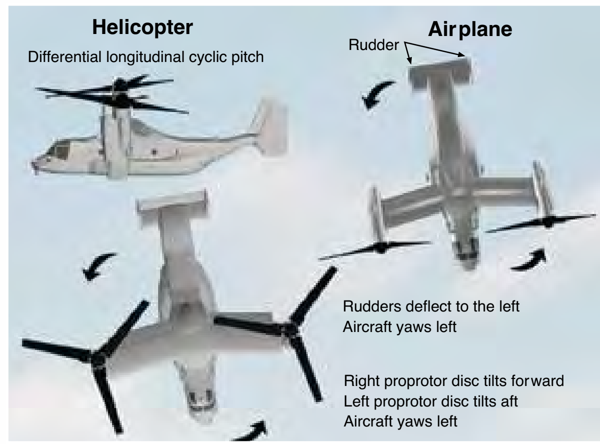
How it Flies



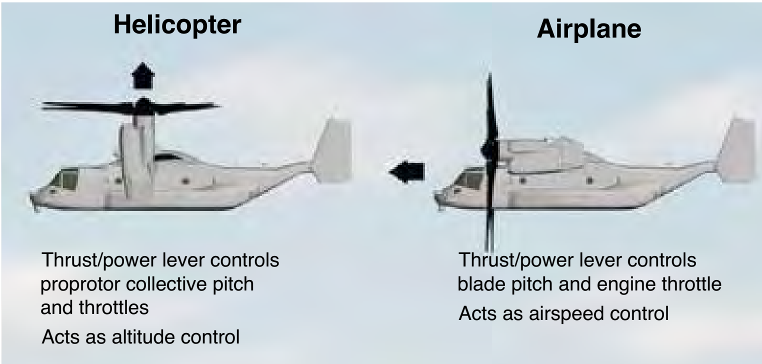
Lateral Control Input (Left Stick Shown)



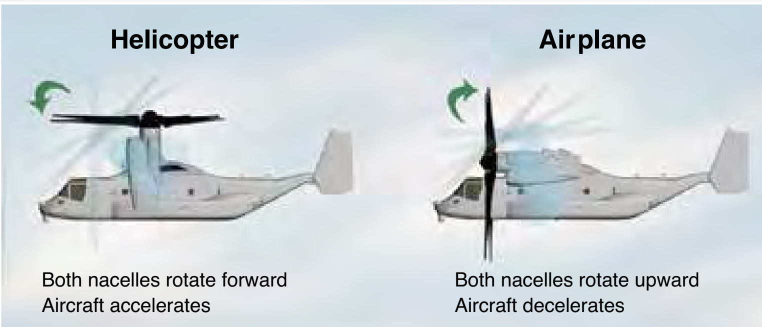
Longitudinal Control Input (Forward Stick Shown)



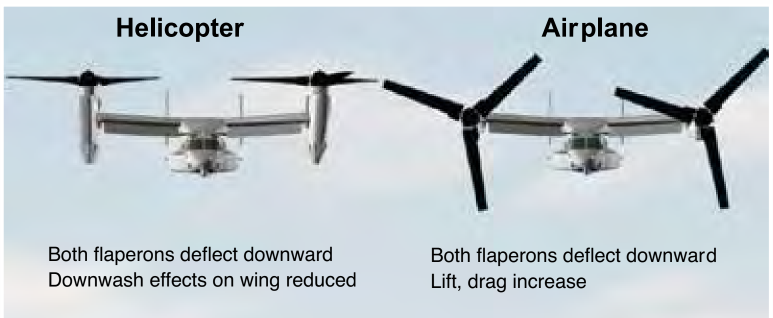
Directional Control Input (Left Pedal Shown)



Thrust/Power Input (Forward/Increase Shown)



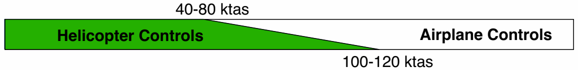
Nacelle Control Input



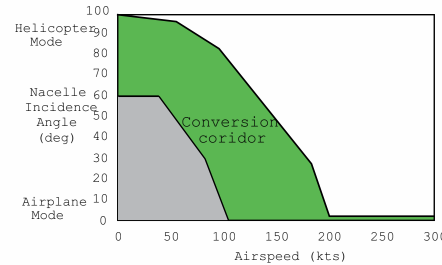
Flap Input

The V-22 can perform a complete transition from helicopter mode to airplane mode in as little as 16 seconds. The aircraft can fly at any degree of nacelle tilt within its conversion corridor at the range of permissible airspeeds for each angle of nacelle shift.

During vertical takeoff, conventional helicopter controls are utilized. As the tiltrotor gains forward speed between 40 to 80 knots, the wing begins to produce lift and the ailerons, elevators, and rudders become effective. The rotary-wing controls are then gradually phased out by the flight control system. At approximately 100 to 120 knots, the wing is fully effective and pilot control of cyclic pitch of the proprotors is locked out. The ability to operate in the realm between airplane and helicopter (VTOL) modes is what truly makes the V-22 a unique and capable aircraft. In conversion mode the flight control computers blend the control laws and program the flight control surfaces for optimum performance and response at intermediate airspeeds. This couples the efficiency of wing-borne flight with helicopter maneuverability.



The conversion corridor is very wide (approximately 100 knots) in both accelerating and decelerating flight. This wide corridor results in a safe and comfortable transition, free of the threat of wing stall.



Conversion Corridor

General Characteristics

Performance @ 47,000 lb

Max cruise speed -
(MCP) Sea Level (SL), kts (km/h). 266 (493)
Max RC, A/P mode SL, fpm (m/m). . .4,100 (1,250)
Service Ceiling, ISA, ft (m) 24,000 (7,315)
OEI Service Ceiling ISA, ft (m), ...9,500 (2,896)
HOGE ceiling, ISA, ft (m) 5,700 (1,737)

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) . . 12,500 (5,670)

Fuel Capacity

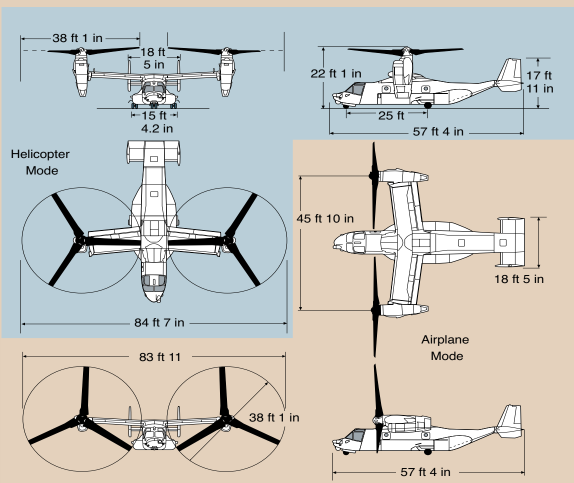
MV-22, gallons (liters). 1,721 (6513)
CV-22, gallons (liters) 2025 (7,667)

Engines. . . . .

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

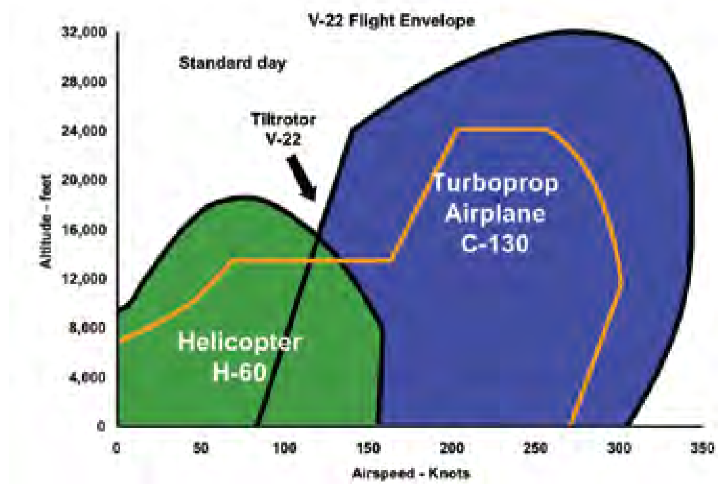
Crew

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



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

} Fixed-wing tactical transport

- Operate from amphibious ships
- Carry 12,500 lb external payload
- Vertical insertion/extraction

} 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.

Multi-service Configurations

MV-22 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 32-bit mission computers
- Night Vision Goggle (NVG) compatible, multifunction displays
- Three inertial navigation systems
- Global positioning system
- Dual digital map system
- SATCOM
- VOR/ILS/ marker beacon
- Radar altimeter
- 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
- Weather radar
- Night Vision Goggle heads-up display

Multi-service Configurations

CV-22 U.S. Special Operations Command

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

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

MV-22 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
- Block 20 enhancements

V-22 Top Tier Suppliers

Supplier	System
Bell Helicopter	Prime Contractor
Boeing	Prime Contractor
BAE	Flight Control System, Low Probability of Intercept Altimeter (LPIA) and APX-123 IFF (MV-22), Defensive Weapon System
ESA	Digital map, Multi-Function Display (MFD), Display Electronics Unit (DEU) , NVG heads up display
Meggitt Polymers & Composites	Fuel cells, Electro-Thermal Ice Protection components
General Dynamics	Mission computer
Honeywell	Environmental Control System (ECS), Light Weight Inertial Navigation System (LWINS), Variable Frequency (VF) generator, Control Display Unit/Engine Instrument and Crew Alerting System (CDU/EICAS), Enhanced Standby Flight Instruments (ESFI), Flight Director Panel (FDP), Traffic Collision Avoidance System (TCAS), Shaft Driven Compressor (SDC), Infra-Red (IR) Suppressor, heat exchanger
ITT	AN/ALQ-211 (SIRFC)
Moog	Flight control actuators, vibration suppression components, Planetaries, Power Modules, Slip Rings
Middle River Aircraft Systems	Flaperons, Flap Seals, Cove Spars
Northrop Grumman	Directed Infra Red Counter Measures
Raytheon	Forward Looking Infrared Radar, Multi Mode Radar, APX-119 IFF (CV-22), mission planning
Robertson Fuel Systems	Mission Auxillary Tank System
Rockwell Collins	Radios, NAVAIDS
Rolls Royce	Engines
GE Aviation Systems	Interface Units, EAPS Actuator, Fire Door Actuator, CF generator, flight incident recorder, lighting controllers, forward cabin control station, oil cooling blowers, landing gear drag strut actuators, check valves
Triumph Aerostructures-Vought Integrated Programs Division	Empennage, fiber placement fuselage skins

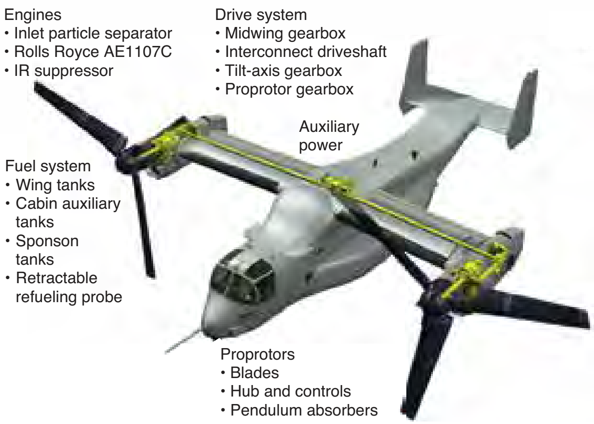
Propulsion System

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, GPS, 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.

  The CV-22 provides additional navigation capability, including 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.

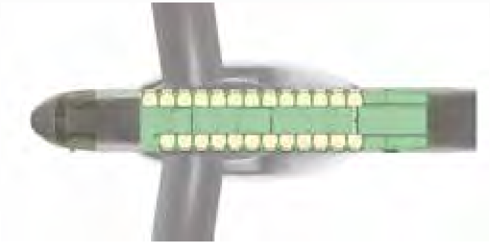
  An optional enhanced suite includes active jamming systems, additional countermeasure launchers, and other systems.

Payload Systems

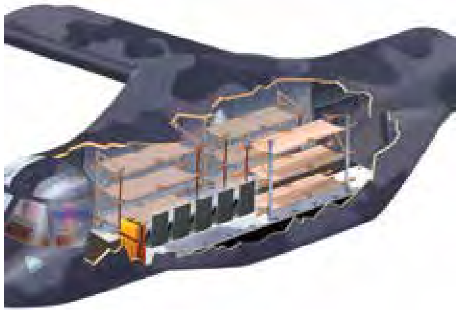
The V-22 is designed to fulfill the multimission role with its large open cabin, rear loading ramp, and a variety of cabin and cargo systems.

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-22 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)
- 12,500 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

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.

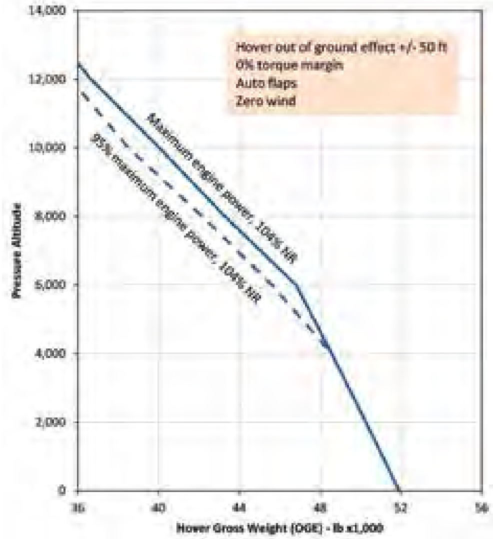
Optional fastrope equipment can be installed that provides for two fastropes in the cargo area. One mounting system is located above the end of the cargo ramp so that the rope can hang vertically at a nominal distance of 14 inches aft of the ramp floor; the second is located above the aft cargo hook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

Fast rope system at the rear cabin

Parachute operations have also been conducted with the V-22

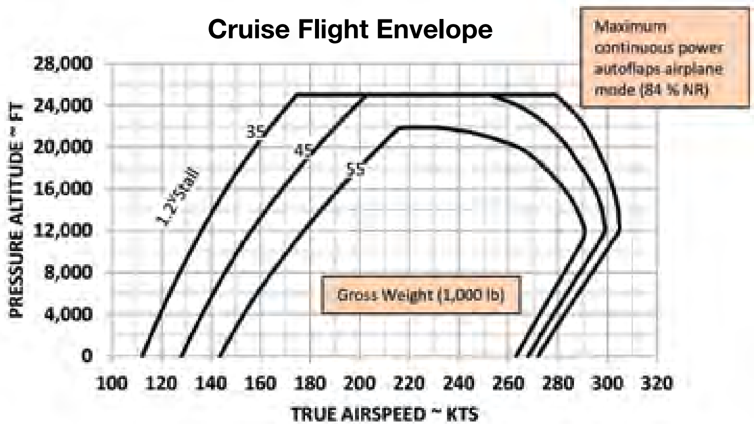
The V-22 is capable of sustained cruise speeds in excess of 260 ktas and an unprecedented V/STOL aircraft mission radius. Standard day capabilities are shown in the figures below.

Hover Performance



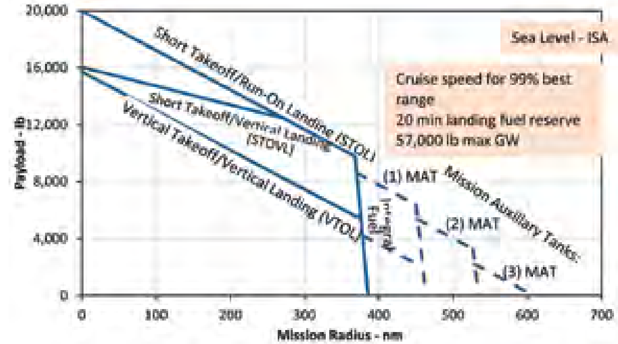
V-22 Standard Day Hover Envelope (OGE)

Cruise Flight Envelope

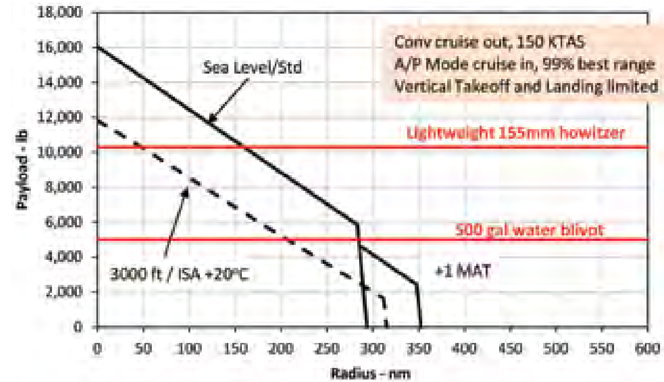


V-22 Airplane Mode Flight Envelope (Standard Day)

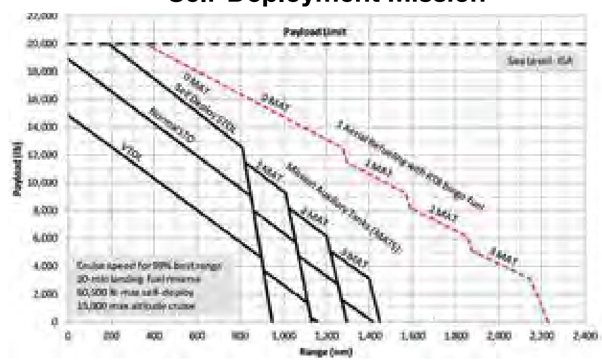
Internal Payload Mission



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 Inertial Navigation Systems to land in complete brown-out conditions. RVL landings may use a coupled hover approach from 30 ft to vertical landing, or pilots may manually fly to a no-hover direct landing.

Automated Logistics Environment (ALE)

Comprehensive Automated Maintenance Environment – Optimized (CAMEO)

The CAMEO system provides an adaptable, government-owned, open source, joint service, Automated Logistics Environment (ALE) and Condition-Based Maintenance (CBM+) capability, supporting continuous integration and automation of operational, maintenance, and logistical processes coupled with the technical data needed to improve aircraft readiness and reduce sustainment costs for the warfighter community.

Taking full advantage of the rich data set generated and collected by the Osprey, combined with historical maintenance and technical publication data the CAMEO suite provides maintainers, engineers, and analysts with relevant and accurate information for ease of maintenance to make the V-22 readily available for mission tasking.

CAMEO is fully operational on a variety of DOD networks including USMC Navy/Marine Corps Intranet (NMCI), USN NMCI, USAF, and IT-21.

Mediterranean Sea
(Feb. 22, 2010) Maintainers gather tools aboard the amphibious assault ship USS Nassau (LHA 4) after performing routine maintenance on an MV-22 Osprey.

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-22s 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 and its redundant systems, in all instances the affected aircraft have been able to continue safe flight to a secure area. Moreover, in each instance the aircraft were repaired at the organizational (squadron) level and returned to the flight schedule in short order.

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

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

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

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

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.

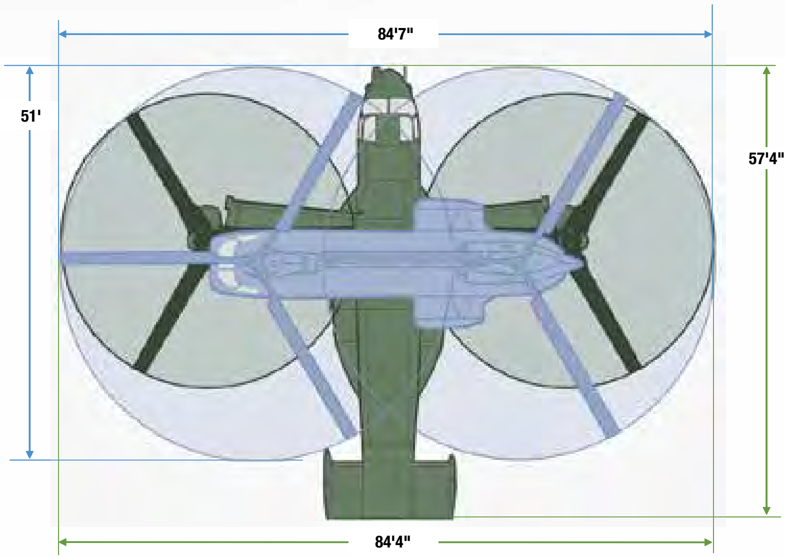
V-22 crashworthiness is a function of design. Heavy components, such as the engines and transmissions, are located away from the cabin and cockpit area. The proprotors are designed to fray or "broomstraw" rather than splinter on impact with the ground. The energy-absorbing landing gear system is designed 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. BFWS may be conducted with winds up to 45 kts from any direction.

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

V-22 Static Dimensions			
		Feet	**Meters**
Rotors and Wing Spread	Width	84’7”	25.8
	Length	57’4”	7.4
	Height	22’7”	6.9
Blades Folded, Wing Stow	Width	18’5”	5.6
	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 USMC Type/Model/Series transitions plans.

The medium lift assault support fleet is transitioning from the CH-46E to the V-22. 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 V-22 take approximately 18 months from the time the HMM squadron 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 six fully operational VMMs. The transition is underway on the West coast with three fully operational squadrons and two more in transition. Additionally, one VMM has stood up and is fully operationally capable in Okinawa, Japan.

In 2013 Marine Helicopter Squadron One (HMX-1) will take delivery of the first of twelve V-22s. These Ospreys will replace the CH-46E and will be used in the “greenside” support role.

Appendix 4
History and 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-22s 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-22 operationally effective and suitable.

In Sep 2005, an Acquisition Defense Memorandum (ADM) approved Full Rate Production for the MV-22 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-22. Initial Operational Capability (IOC) was reached in June 2007, and the first combat deployment of the MV-22 took place soon after in October 2007.

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

Appendix 5
Studies and Analyses

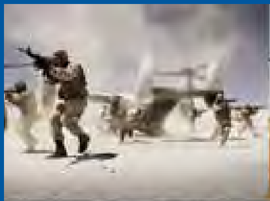
The V-22 represents a revolutionary change in design and versatility. It brings capabilities not found in helicopters – a leap forward in speed, range and altitude performance.

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.

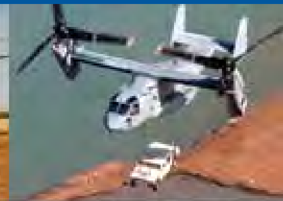
- The V-22 has superior speed, range and survivability:
  - Increases the tactical options available to the operational commander
  - Dramatically reduces the risk of friendly force casualties in post-assault ground operations
- When equal lift capability aircraft fleets are considered:
  - Significantly 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 6
Current & Future Capabilities



Assault Support

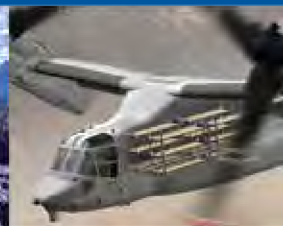
Special Operations



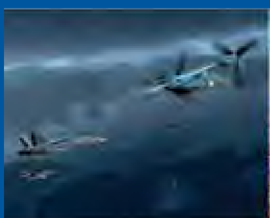
External Loads

Personnel Infil/Exfil

Tactical Recovery of Aircraft and Personnel



CASEVAC



Aerial Refueling

Command and Control

Rapid Ground Refueling

Logistics Support

Executive/VIP

Disaster Relief

www.navair.navy.mil/v22

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