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MASTER OF MILITARY STUDIES

BUILDING A BETTER ACE: RESTRUCTURING THE MARINE EXPEDITIONARY UNIT'S AIR COMBAT ELEMENT IN THE MV-22 ERA

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Executive Summary

Title: Building a Better ACE: Restructuring the Marine Expeditionary Unit's Air Combat Element in the MV-22 era.

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Thesis: In order to enhance the Marine Expeditionary Unit's aviation capabilities as its assault support assets transition from the venerable CH-46E to the revolutionary MV-22, the Air Combat Element should be restructured to deploy with additional conventional medium-lift helicopter assets.

Discussion: The role of the Marine Expeditionary Unit (MEU) as an immediate regional crisis responder requires that it be properly equipped to execute all of its mission essential tasks. It is possible that aviation capability gaps may emerge as the Air Combat Element (ACE) transitions its medium-lift aircraft from the CH-46E to the MV-22. Through the years, the CH-46E has proven its ability to adequately support a wide variety of assault support missions. The MV-22 is a vast improvement over the 40 year-old CH-46E, but the unique design that gives the MV-22 its advantages may also make it less capable than traditional helicopters at some missions. The MEU could benefit from the MV-22 without compromising existing capabilities by permanently adding conventional medium-lift helicopters to its ACE.

Conclusion: Adding a permanent conventional medium-lift helicopter detachment to future MEUs would increase capabilities without compromising operations. This small detachment would consist of four aircraft aboard a LPD class ship, the Expeditionary Strike Group's (ESG) secondary aviation platform. This detachment would supplement MV-22 assault support missions, conduct routine ship-to-ship transportation and VERTREP, provide the MEU with an autonomously deployable CASEVAC asset capable of self-defense, and be pre-positioned for immediate on-demand split-ESG operations. This low-cost solution is immediately available to every MEU through remaining Sea Knight squadrons that have yet to be transitioned to the Osprey. Standing up and manning a medium-lift squadron to support this model appears achievable; an abundance of CH-46E helicopters and aircrew will remain in the community even after the MV-22 transition. This revolving MEU detachment is supportable through the end of the Sea Knight's service life in 2017. If this new restructured model proves beneficial, then the concept can be easily extended past 2017 with the purchase of relatively low-cost SH-60 helicopters. The proposed restructuring of the ACE would provide the MEU commander with additional aviation capabilities, greater mission flexibility, and increased support to the Marine.

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Preface

This paper attempts to make a bias-free and objective assessment of how to best support the MEU as it transitions from the CH-46E Sea Knight to the MV-22 Osprey. The Osprey is indisputably a step in the right direction for the future of Marine aviation. This paper is not intended to call out any deficiencies with the program, nor does it advocate for one airframe or another. Rather, it evaluates how retaining a conventional medium-lift capability within the MEU might compliment the Osprey.

This topic has been of interest to me since the announcement that the MV-22 would finally become an operational reality. The concept originated as wishful thinking about the best twilight tour for the Sea Knight. The idea evolved as a way to employ the CH-46E through its remaining years by supplementing the Marine Expeditionary Unit after the MV-22 transition. The unique specifications and requirements of the MV-22 seemed to justify the theory that the MEU should retain a conventional medium-lift helicopter capability. Over time, a concept that was born out of a humorous anecdote developed into a seemingly plausible and achievable way to increase MEU aviation capabilities.

I would like to thank LtCol. Michael A. Wall for his contributions with special thanks to Dr. Mark A. Jacobsen for his mentorship, guidance, and flexibility. I would especially like to thank my wife for her support, patience, and encouragement throughout this endeavor.

INTRODUCTION

The CH-46E Sea Knight may not be dead just yet. The role of the Marine Expeditionary Unit (MEU) as an immediate regional crisis responder requires that it be properly equipped to execute each of its 23 mission essential tasks.[1] The MEU's Air Combat Element (ACE) is about to transition from the 40 year-old CH-46E to the modern MV-22 Osprey. While the Osprey is a vast improvement over to the aging Sea Knight, the unique design that gives the MV-22 its advantages may also make it less capable than traditional helicopters at some missions. MEUs should deploy with the most capable set of assets for every mission it is required to perform.[2] Replacing the CH-46E with the MV-22 means certain aviation aspects have improved, but it does not mean that ACE mission set is more robust. In order to bridge possible capability gaps between MEUs utilizing the CH-46E and those employing the revolutionary MV-22, each MEU ACE should be restructured to deploy with additional conventional medium lift helicopters.

MEDIUM-LIFT AIRFRAME CAPABILITIES ANALYSIS

Much has been written about the significant value that the MV-22 will add to Marine Corps aviation missions, but discussion about possible incompatibilities seems conspicuously absent. The Osprey has been heralded as aircraft that can do everything the legacy CH-46E can do. Marine Corps Commandant General James Conway said the MV-22's mission profile is "exactly that of the aircraft it is replacing."[3] General Conway went further to say that the Osprey is "doing everything those airplanes [CH-46Es] do except three times faster."[4] Such praise suggests that the MV-22 is able to conduct every mission at least as well as the helicopter it is replacing. By implication, the MV-22 must meet or exceed the standard of its predecessor for all specified and non-specified tasks, routine missions, and Standard Operating Procedures (SOP) as

outlined in Marine Corps Order 3120.9B, *Policy for MEU(SOC).*[5] Due to the unique nature of helicopter aerodynamics, there is no single aircraft that is a perfect fit for every mission, and the MV-22 is no exception.[6]

In current combat commitments, deployed MV-22s are stationed at established operating bases and fly in a reduced-threat environment maneuvering between permanent airfields and improved landing zones.[7] In this predictable setting, the airframe excels as an assault support platform. In contrast to current land-based operations, the dynamic shipboard environment may have an entirely different impact on the way the Osprey executes missions. The first MV-22 MEU deployment aboard ship is scheduled to begin in just months.[8] From theoretical employment to operational deployment, the MV-22's daily performance of all MEU Mission Essential Tasks will soon be analyzed. From these results, lessons will be learned about how to best employ the Osprey within each mission profile. These techniques will produce new SOPs and Techniques, Tactics, and Procedures (TTP) meant to maximize the aircraft's potential and mitigate any limitations or restraints.[9] In order to understand where capability gaps may exist between current and future medium-lift aircraft, a statistical comparison is useful.

	MV-22[10]	CH-46E[11]
Empty weight (lbs)	33,140	**16,100***
Max weight (vertical take off)	52,870	**24,300**
Max internal lift (lbs)	**20,000**	6,200*
Max speed at sea level (knots)	**275**	145
Max range amphib ops (nm)	**515**	90
Length / width / area	57'4" (excluding probe) / 83'4" / 4777 sq.ft.	**84'4"x51' / 4,300 sq.ft.**
Folded length / width / area	62'7" x 18'5" / 1,152 sq.ft.	**45'8" x 14'9" / 673 sq.ft.**
Internal dimensions / volume	24'2 x 5'11" x 6' / 858 cu.ft.	24'2" x 6' x 6' / 869 cu.ft.
Seat capacity / standard load	**24 / 15-18**	18 / 8-12
Min required landing size / area	57'4" x 50'11" below 20'11" / 2,919 sq.ft.	**45'8" x 14'9" below 11'8" / 673 sq.ft.**
Armament	M-240G tail gun	**2 x XM-218 (.50 cal), M-240G tail gun**
Average Cost	110 million[12]	**N/A (not in production)**
Bolded numbers are better		
* Based on the average weight of 12 CH-46Es from an operational squadron[13]		

Table 1. Marine medium-lift comparative analysis

Increased speed, improved range, and greater lift capacity are the three most coveted factors in enhancing a rotor-driven airframe's capabilities. As Table 1 shows, the MV-22 excels at all three, but these factors alone do not qualify an aircraft as imminently capable to conduct every mission. By comparison, the CH-46E has only marginal relative advantages in seemingly insignificant categories. Yet, when the total of each advantage is applied in whole to MEU missions and shipboard operations, some benefits of conventional helicopters become apparent.

WEIGHT AND DIMENSIONS

The increased width of a folded MV-22 (3'8" wider and 229 square feet larger than a CH-46E) becomes a significant issue on a floating landing deck with limited space. Flight decks on Amphibious Assault Ships (LHA/LHD) will become increasingly crowded with the addition of MV-22s. On the largest amphibious decks there is an aft aircraft staging area (aft slash) typically reserved for two CH-53E Super Stallions and all six AV-8B Harriers, and a forward aircraft staging area (forward slash). The 284 foot-long forward slash is reserved for attack helicopters, two CH-53Es, both Navy SH-60s, and all medium lift-helicopters. A squadron of twelve MV-22s, twenty-five percent wider than CH-46Es, will take up an additional 2,748 square feet of deck space. Any decrease in deck space makes maneuvering aircraft and readying them for launch more difficult. Decreased deck space becomes critical when considering attaching additional aircraft to the MEU ACE.

The increased gross weight of twelve MV-22s, when compared to twelve CH-46Es, becomes another important shipboard issue. Naval ships simply cannot hold an unlimited amount of weight. Replacing a squadron of Sea Knights with Ospreys displaces an additional shipboard load of 102 tons. This weight must be reclaimed elsewhere, either by decreasing tactical vehicle/cargo loads, or by the ship itself taking less fuel. Either way, the Marine contingent

aboard becomes less combat capable or the ship must slow more often to refuel during underway replenishments (UNREP). A ship that must refuel more often may cause the MEU to be less responsive to arising global crises. Positioning additional aircraft on an LHA/LHD would simply amplify these effects.

The Osprey's increased operating dimensions and landing footprint become important when addressing ship support operations. Currently the MV-22 can land on all Amphibious Readiness Group (ARG) ships: LHA/LHDs, Amphibious Transport Dock Ships (LPD), and Dock Landing Ships (LSD). The ARG has recently converted to the Expeditionary Strike Group (ESG) deployment concept. The ESG deploys with additional Navy ships like Guided Missile Cruisers (CG), Guided Missile Frigates (FFG), and Coast Guard Cutters.[14] In addition, Fleet Replenishment Oiler ships (T-AO) support each ESG/ARG for UNREP and Vertical Replenishment (VERTREP). The V-22 has not yet been certified to operate on additional ESG ships or T-AO ships.[15] In addition, the CH-53E cannot land on some of the smaller air capable ships like CGs, FFGs, and DDGs.[16] If the Osprey and CH-53E are unable to land on these ships, only two Navy SH-60s and four Marine UH-1N Hueys would be capable to support them. While the Huey is able to execute some assault support missions, its limited capabilities make it unsuitable to conduct sustained lift operations.[17] Therefore, the SH-60s would be the sole provider of aviation support to 33 percent of the ESG. The disparity between required missions and assets available would drastically increase the SH-60s workload, crippling its ability to accomplish its primary airborne Search and Rescue (SAR) mission. Furthermore, it would make VERTREP difficult to complete across all ESG/ARG shipping within the standard VERTREP window. Additional medium-lift helicopters certified to operate on each air-capable ship would mitigate these problems.

MV-22s deployed with the MEU may suffer from some shipboard maintenance incompatibilities. Each ship in the ARG appears to have some intricacies making MV-22 maintenance more challenging. The LSD has two standard flight spots; however, it is common to fill the forward spot with equipment and containers. If an aircraft is forced to land aboard a LSD in this configuration, there is limited means to conduct basic organizational-level maintenance.[18] The older *Austin* class LPD can land one MV-22 and has crane support, but the MV-22 cannot fit in the hangar. The new *San Antonio* class LPD allows for two MV-22s to land simultaneously and stowage of a single MV-22 in the hangar. As of 2003, *San Antonio* class LPDs contained no crane for organizational-level maintenance, and the dimensions of the hangar were too small to allow engine nacelle movement required for some engine maintenance. The LHA/LHD hangar deck, where engine exchange and intermediate-level maintenance occurs, is too short to allow the MV-22 to manually position the engine nacelles upright presenting some maintenance challenges. Existing medium-lift helicopters are capable of full maintenance operations on all three ships.

SELF DEFENSE AND ARMED ESCORT

Currently, the MV-22 will be the only front-line combat aircraft without any means of forward firing armament. To address this issue, an attachable all-quadrant gun pack is being fielded.[19] This bolt-on addition weighs in excess of 700 pounds and takes up the space of "three Marines, fully combat loaded."[20] In addition, the gun pack is mounted at the bottom of the airframe and must be retracted during the terminal landing phase. It is during the terminal landing phase that aircraft-delivered suppressive fire is most critical. With the gun retracted, the MV-22 has no ability to suppress the enemy during ingress. This presents undue risk for commanders who must employ the MV-22 into a known threat environment without offensive

air support.

In any threat environment, Ospreys would need to be escorted into the objective area via attached or detached escort.[21] If rotary-wing attack helicopters are utilized as escorts, the MV-22 can outrange and outrun them all, even the updated UH-1Y Super Huey and AH-1Z Super Cobra. During attached operations the MV-22 must operate in helicopter mode, eliminating the Osprey's speed advantage. Attack helicopters conducting detached escort arrive in the objective area prior to the Osprey, effectively compromising surprise.

Fixed wing aircraft are available to conduct route reconnaissance prior to a heliborne assault; however, any clandestine operation or mission that seeks to surprise the enemy may preclude their use. In addition, it would be very difficult for fixed-wing aircraft to suppress or neutralize small enemy units in close proximity to the MV-22 while the Osprey is in the terminal phase of landing.[22] In this scenario, coordinating fixed-wing engagement timing to prevent fratricide may prove to be too difficult or risky.

CONFINED AREA LANDINGS

A significant capability of medium lift helicopters is their ability to land in small spaces, doctrinally termed Confined Area Landings (CAL). In all cases, the MV-22 needs a larger landing zone to conduct CALs due to its unconventional shape and subsequent increased landing footprint. The overall size of the MV-22 is nearly identical to the CH-46E when landing between objects greater than ten feet tall (the MV-22 requires an additional 477 square feet). When landing around obstacles shorter than ten feet, the MV-22 needs an additional 2,246 square feet of landing space, nearly three times as much as a CH-46E (Appendix A. Figures 2-5).

Furthermore, the CH-46E benefits from a landing technique known as a "main mount" (Figure 1). This technique requires that only the aft landing gear need to touch down in order to lower the ramp and debark personnel or equipment. This method of hovering while debarking significantly decreases required Landing Zone (LZ) size, enables access to sloped or restrictive terrain normally untenable by a conventional landing, and facilitates a quicker takeoff.[23] Due to a smaller footprint, the number of potential landing zones for the CH-46E is greatly increased. With more landing zone choices available, Marines have greater mission flexibility for heliborne insertion and extraction. Simply, larger aircraft need larger zones to land, thus decreasing the number of available or accessible zones. Future operating areas may be mountainous, wooded, or canopied jungle regions where adequate landing zones are scarce. These landing environments reduce suitable Landing Zones (LZ), especially for larger aircraft, which may prove problematic for MV-22 vertical-lift support. The MV-22 has greater range and speed then the CH-46E. These advantages will allow the Osprey to fly to suitable LZs at greater distances from the objective area. While this may mitigate objective area threats and increase the number of LZs available to the Osprey, an important consideration is that smaller zones closer to the objective may help the assault force conduct efficient direct action missions, increase surprise during raids, or expedite movement-to-contact.

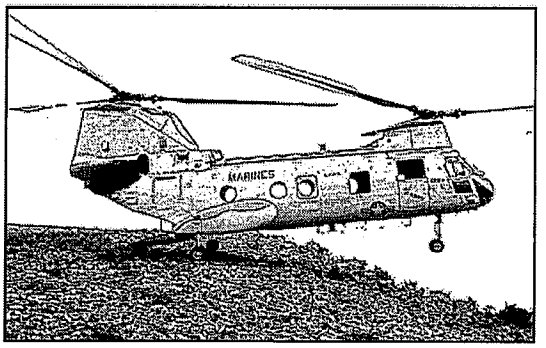

Figure 1. CH-46E conducting a main mount

CASEVAC AND MEDEVAC

By definition, Medical Evacuation (MEDEVAC) is the movement of a patient to a care facility, and Casualty Evacuation (CASEVAC) is the movement of a casualty from a combat

zone to a patient treatment facility. CASEVAC aircraft "have medical corpsmen on hand who are trained to treat trauma patients, can load patients rapidly, and are capable of defending the aircraft from enemy fire upon withdrawal."[24] CASEVAC aircraft are not identified with the universal Red Cross medical symbol and may have armament for offensive and preemptive suppressive use. In contrast, MEDEVAC aircraft are typically identified by the Red Cross symbol and therefore do not take part in any type of offensive engagement, although they can carry weapons for self-defense.[25] MEDEVAC missions are generally intra-theater administrative flights which move stabilized casualties to different level treatment facilities.[26] The unique mission capabilities of the MEU require that Marine Corps aircraft perform both CASEVAC and MEDEVAC missions, often with the same aircraft.

Like the CH-46E, the MV-22 can be configured with 12 litters,[27] making it well suited to perform both MEDEVAC and CASEVAC missions. The speed of the MV-22 is also a significant benefit in that it can range greater levels of medical treatment facilities within the first hour after a casualty, known as the "Golden Hour."[28] Doctrinally, a basic Level-I Shock Trauma Platoon (STP) is capable of stabilizing a casualty but lacks surgical support. STPs are positioned close enough to the Forward Edge of the Battle Area (FEBA) to be accessible within the Golden Hour. Level-II and Level-III surgical support is located in permanent or semi-permanent facilities at a distance from the FEBA. Using Operation Iraqi Freedom I (OIF-I) as an example, the CH-46E was employed as an autonomous dedicated CASEVAC asset between the FEBA and the STP. Typically, very few OIF-I CASEVAC missions received attached or detached escort. Sea Knight aircraft were able to consistently move injured Marines from the point of casualty to the STP within the first hour. Often, Level-II and Level-III facilities were too far for the CH-46E to range within the Golden Hour without degrading continuous CASEVAC support. In

these situations, MEDEVAC of stabilized casualties either fell to Army H-60 helicopters or by any opportune transportation.

While the MV-22 is perfectly suited for MEDEVAC missions, performing CASEVAC missions without a means of self-defense becomes extremely high-risk. Many OIF-I CASEVAC missions flown by CH-46E aircraft were flown to hostile combat zones with active enemy fire. As previously stated, a suppressive weapon system to ensure survivability during the terminal landing phase is essential. This requirement is even more critical during CASEVAC in order to ensure that the rescuer does not become the one in need of rescue. Without a way for the MV-22 to defend itself in a hostile environment, point-of-casualty pickup may incur excessive risk. If point-of-casualty pickup is not supportable for the MV-22, the casualty would need to be evacuated by ground to a LZ suitable for the MV-22. The manpower requirements to move each ground casualty movement and provide LZ security may seriously disrupt combat operational tempo.

BRIDGING THE GAP

To bridge any capability gaps that may arise as the MV-22 deploys with the MEU, each MEU ACE should deploy with a four-plane detachment of medium-lift conventional helicopters. This proposed detachment would reside on the LPD for the duration of each MEU. The typical configuration of aircraft deployed with a MEU ACE is a base squadron of twelve medium-lift helicopters reinforced with four heavy-lift helicopters, six light/attack helicopters, and six fixed-wing attack jets. All of these aircraft typically operate from LHA/LHD ships with limited flight deck space remaining for additional assets. Positioning the medium-lift helicopter detachment on the LPD would add aviation assets without sacrificing flight LHA/LHD deck space.

Like large-deck Naval aircraft carriers (CVN, LHA, LHD), the smaller LPD is one of the few ships in the Navy inventory that has its own air department. The LPD is not just an air-capable ship, it is designed and manned to support sustained air operations throughout the duration of a deployment.[29] Historically, four-plane detachments have utilized the LPD for extended periods, and the relationship has proved both successful and beneficial. [30]

A permanent medium-lift detachment on the LPD assures the MEU commander that a comprehensive split-ARG task force is immediately available for contingency operations. Split-ARG operations are pre-planned to the maximum extent possible in order to avoid difficult inter-ship transfer of assets while underway. Assets and equipment are most often moved between ships pier-side if split-ARG operations are anticipated. Historically, the reshuffling of assets would provide split-ARG assets at the expense of degrading LHA/LHD aviation capabilities. Planning for split-ARG operations in this manner is counter-intuitive. The split-ARG concept suggests that there may be instances where the MEU has more than one regional commitment simultaneously. In these instances, split-ARG operations should be immediately ready and available without having to compromise total force strength aboard the LHA/LHD. A permanent LPD-based medium-lift detachment would solve this problem by providing the MEU commander with pre-positioned aviation assets fully capable of supporting on-demand split-ARG operations.

Additional medium-lift helicopters deployed with the MEU can provide extended intra-ARG/ESG aviation support by staggering each ship's aviation hours of operation, known as "deck cycles."[31] A deck cycle is defined as the hours the flight deck is open for flight operations. By OPNAV directive, a daily deck cycle lasts no more than 10 hours.[32] If all aviation assets are staged on the same deck, then aviation support to the ESG/ARG ceases at the termination of

flight operations. By having a detachment on the LPD, deck cycles can be staggered so that additional aviation support is provided to ESG/ARG ships even when the LHA/LHD is not conducting flight operations.

A medium-lift detachment would provide additional administrative movement of passengers, mail, and cargo (PMC) and help facilitate Navy VERTREP. Currently, only two Navy SH-60 Sea Hawk aircraft are deployed with the ESG/ARG. These two aircraft are the only organic ESG/ARG aircraft certified to conduct airborne SAR.[33] Typically, one SH-60 is airborne during flight operations in order to provide immediate SAR support. On rare occasions when the Sea Hawk's role as a SAR platform is not needed, it can execute limited opportune administrative movement of PMC. By having a LPD detachment of CH-46Es conduct most inter-ship PMC, the Navy SH-60s can concentrate on their primary mission. In addition, this proposed model removes PMC requirements from the MV-22 and CH-53E, allowing these airframes to conduct additional tactical mission training resulting in enhanced combat proficiency.

A permanent CH-46E detachment aboard the LPD would have only minimal negative impact. In fact, the only real impact would be the ability of the *Austin* class LPD to support four H-1 or two SH-60 helicopters simultaneously. Older *Austin* class LPDs can support one MV-22, one CH-53E, four H-1s, two CH-46Es or two SH-60s during normal operations.[34] When an aviation detachment is aboard, only one of the two standard landing spots remains available. The ship can still land a single MV-22 or CH-53E, but is limited to two additional H-1s or a single CH-46E or SH-60. The adoption of the *San Antonio* class LPD will mitigate this problem. The new LPD's flight deck is 33 percent larger and would support two CH-53s, two MV-22s, four H-1s, four CH-46Es, or four SH-60s simultaneously.[35] LPD-17 *San Antonio* is currently

finishing its deployment with 26th MEU, and LPD-18 *New Orleans* began its maiden deployment on January 9, 2009.[36] The full complement of *San Antonio* class ships will be procured by 2012.[37] The increased deck space on the new LPD would further mitigate the impact of an additional medium-lift detachment.

One of the greatest benefits of an additional medium-lift capability on the MEU would free up the MV-22 to take advantage of its unique mission capabilities rather than dividing the Osprey between operational and administrative support missions. An additional medium-lift detachment would be able to provide support to the MEU and ARG/ESG while the MV-22 conducts over-the-horizon Ship-to-Objective Maneuver (STOM). For shore-based MEU operations, additional medium-lift assets can provide dedicated Tactical Recovery of Aircraft and Personnel (TRAP), CASEVAC or MEDEVAC assets capable of self-defense.

Currently, ESG/ARG ships must get close to shore to launch all operational amphibious vehicles and attack helicopters due to existing range and speed limitations. A ship in close proximity to the shore would facilitate medium-lift support to littoral regions and beyond without imposing additional restrictions. This would mean that medium-lift helicopters could execute autonomous TRAP, CASEVAC, or MEDEVAC from the point-of-casualty or objective area back to ESG/ARG shipping.

Long-range missions may require conventional helicopters to utilize a Forward Arming and Refueling Point (FARP). Current MEU attack helicopters have the shortest flight endurance at two-hours and will often require a FARP to be established to support operations ashore. If a MEU objective is distance greater than the combat radius of the aircraft, then a FARP must be established. Medium-lift aircraft can simply utilize the FARP established for attack helicopters; no additional special support operations are required.

IMPLEMENTATION

This proposal should be easy to implement and relatively cost effective. It can be implemented immediately using existing West Coast Sea Knight squadrons. The CH-46E is currently the only conventional medium-lift helicopter in the Marine Corps' inventory. These aircraft are shipboard certified and ready to operate as detachments on each Osprey-based ACE. As West Coast squadrons eventually transition to the MV-22, a single CH-46E squadron would need to be established to consolidate the remaining active CH-46E aircraft and aircrew. To maximize support, a single Marine Medium Helicopter (HMM) command would be stationed in Hawaii that dual-hats as both a training and operational squadron. This solitary Sea Knight squadron would train replacement aircrew for the CH-46E, support Marines Corps training across the Hawaiian islands, maintain revolving four-plane detachments to each of the seven standing MEUs, and keep the CH-46E community operationally viable.

Establishing this proposed restructured ACE model would incur only minimal additional cost. Considering that the CH-46E is no longer in production, any airframe loss would be replaced by another airframe already procured. Today there are 112 CH-46Es attached to eight operational squadrons and one training squadron.[38] As these squadrons transition to the MV-22, each of these CH-46E airframes will be removed from active service, but still available for flight operations. If one of these dormant Sea Knight helicopters needed to be reintroduced to the operating forces, only small cost commitments would be necessary to prepare them for flight operations.[39] At current airframe loss rates, 112 remaining Sea Knight airframes would be more than enough aircraft to last though 2017, the end of the CH-46E service life.[40]

Under the one-squadron concept, a minimum of 42 aircraft would be needed; 16 for training flights and Marine Corps assault support, in addition to 28 for operational MEU

detachments. These 28 aircraft for MEU detachments would ensure that every MEU could receive a medium-lift detachment if all seven were to deploy simultaneously. Although the total number of aircraft seems dauntingly large, the squadron would only have five four-plane detachments fielded under normal conditions, a maximum commitment of 20 aircraft.[41]

As of February 2009, MV-22s have replaced five of the six East Coast CH-46E squadrons.[42] VMM-263 is undergoing workups in support of the 22nd MEU and will be the first squadron to operationally deploy Ospreys aboard Naval shipping.[43] The Department of Defense signed a bill in March 2008 that would deliver the last MV-22 to the Marine Corps by 2014. This "will allow the Marines to transition two CH-46E squadrons per year until they are replaced by Ospreys."[44] In the near term, West Coast CH-46E squadrons would be able to field detachments for the East Coast MEUs. With the imminent drawdown of U.S. forces in Iraq, Each West Coast CH-46E squadron's operational tempo will decrease as they return to their standard MEU rotation. In this system, four of the six West Coast Sea Knight squadrons will remain in the rotation for MEU deployments leaving two Sea Knight squadrons for contingency and general support missions. These two squadrons would be able to provide detachment support to the East Coast MEUs until West Coast squadrons begin their transition to the MV-22.

TRANSITION

A proposed one-squadron system supporting all seven MEUs is a four-phase plan:

1. Assign the West Coast's Third Marine Aircraft Wing (III MAW) CH-46E squadrons to support the East Coast II Marine Expeditionary Force (II MEF) MEUs while the remaining East Coast CH-46E squadrons transition to the Osprey.
2. Shift responsibility to field all MEU detachments to HMM(T)-164 in Camp Pendleton, CA as III MAW squadrons begin transitioning to the MV-22. Begin to reinforce HMM(T)-164

with additional CH-46E aircraft transferred from II MAW.

3. Move HMM(T)-164 to Hawaii to replace the CH-53D squadrons that will transition to the Osprey. CH-53D squadrons will move to the West Coast as they transition. This will streamline maintenance support for both the MV-22 and CH-46E by centralizing all MV-22 squadrons on the west coast and all Sea Knights in Hawaii.
4. Replace the CH-46E with another conventional medium-lift helicopter by 2017 to keep the conventional rotary-wing detachment aboard MEUs sustainable.

When discussing the CH-46E replacement of the CH-53Ds in Hawaii, it is important to understand that both airframes have similar capabilities (Table 2).[45] Like the CH-53D, the CH-46E can still range all of the Hawaiian Islands without refueling. The longest leg from Marine Corps Air Facility (MCAF) Kaneohe Bay, Oahu to any Hawaiian destination is the 200 nautical mile flight to the Pohalaku Training Area (PTA). The CH-46E can make this round trip-flight without refueling, but would need 3,600 pounds of fuel to do so. Carrying this much fuel would decrease the Sea Knight's internal lift capability to 2,400 pounds, equating to eight combat loaded Marines. A one-way flight from MCAF Kaneohe Bay to PTA would consume only 1,800 pounds of fuel, leaving 4,200 pounds for assault support. Carrying only enough fuel for a one-way flight would allow the CH-46E to lift 14 combat loaded Marines but would need to refuel. Conveniently located within PTA is the Bradshaw Army Air Field (AAF), where fuel is available on request. Flights destined for PTA would take enough fuel to make the flight and then refuel at Bradshaw AAF before departure. The CH-46E has proven that this system can work effectively; multiple Sea Knight squadrons were stationed at MCAF Kaneohe Bay until 1996.

	Cruise Speed (knots)	Fuel (hours)	Range	Troops / Seats
CH-46E	120	2.5	240	10 / 18
CH-53D	120	3.0	300	12 / 24

Table 2. CH-46E/CH-53D comparison

An unpopular topic for discussion is the potential for an over-water mishap. Ditching an aircraft in water usually results in loss of the airframe. Although the Marine Corps never plans for failure, the reality remains that long periods of over-water flight increases the potential for ditching. If the MV-22 replaces CH-53D squadrons at MCAF Kaneohe Bay as scheduled, it will be the only Marine Corps aircraft to support Marine battalions between the Hawaiian Islands. By logic, prolonged over-water flight in an Osprey will increase its risk of loss. While the loss of personnel is very real regardless of airframe, the Osprey's 110 million dollar price tag would make any MV-22 loss especially costly. In contrast, if CH-46Es were moved to MCAF Kaneohe Bay in place of the CH-53D and the MV-22, any loss of a Sea Knight helicopter would cost substantially less. In addition, the CH-46E has good auto-rotation qualities in relation to the Osprey, and has been proven to be reasonably survivable during water landings and ditching.[46] With the ability to remain afloat for up to two hours after entry into the water, the CH-46E may improve the chance of survival for passengers and aircrew in the event of an emergency.[47]

PERSONNEL

The proposed concept for a restructured ACE keeps the remaining CH-46Es aircrew operationally and tactically relevant. This is important as the end of the service life for the CH-46E approaches, especially at a time when Department of Defense funding is sure to decline. Newly designated helicopter pilots will be less willing to volunteer to fly for a squadron whose platform has no prolonged future. However, the Marine Corps will still need to field Sea Knight squadrons with pilots.

Addressing the issue of manning a squadron destined for replacement may seem daunting. In reality, the concept of manning a CH-46E squadron with a full complement of experienced aircrew and mechanics is already in place. Under the transition/conversion program, not all CH-

46E aircrew and maintenance personnel will stay with the squadron after the MV-22 transition is complete. In addition, the Marine Corps will continue to field newly designated pilots as replacement aircrew for the CH-46E platform in the near term. If a single-squadron model of CH-46Es is implemented, Sea Knight aircrew of various ranks and experience would be available. This squadron would be divided into two departments; an operational department for supporting Marine forces, and a training department for replacement aircrew. Although a larger squadron requires more personnel, the only manpower gap would occur within a year of the CH-46Es service life expiration. Eventually, the Marine Corps Manpower Branch will need to slate all new pilots for the MV-22 to ensure future community staffing goals are met.

As of 2012, all newly designated pilots who are selected for the CH-46E community should be offered a minimum three-year CH-46E tour with an option to transition to MV-22s. This would ensure that new pilots would not be stove-piped into the CH-46E community - a potential career dead-end. It would also ensure an adequate number of pilots man new MV-22 squadrons as CH-46E squadrons complete their Osprey transition, and remaining Sea Knight aircraft leave operational service (Table 3).

Year / Pilot Class	2012	2013	2014	2015	2016	2017	2018
2012	CH-46E	CH-46E	CH-46E	MV-22			
2013		CH-46E	CH-46E	MV-22	MV-22		
2014			46/60	SH-60	SH-60	MV-22	
2015				SH-60	SH-60	SH-60	MV-22

Table 3. Recommended new pilot transition/conversion manpower flow

LIFE AFTER SERVICE LIFE

The Service Life Extension Program has pushed the CH-46E's operational service until 2017. However, the Sea Knight will be removed from active Marine Corps inventory as early as

2015, assuming the MV-22 can be delivered to squadrons as scheduled.[48] Once the last CH-46E squadron has been transitioned, the advantages of having a true medium-lift helicopter to augment the MEU will disappear. Unless the Marine Corps can procure a conventional medium-lift helicopter replacement for the CH-46E, MEUs will lose the additional aviation support. MEU commanders will have to re-apportion standing missions within the ACE, or increase platform workload in order to maximize capabilities. Currently, the Marine Corps has no published plan for a new medium-lift rotary-wing platform in the near or long term.[49]

Procurement of a replacement conventional medium-lift helicopter would enable the MEU to keep the proposed restructured ACE model, and further enhance its capabilities past 2017. The most obvious solution is to transition the last squadron of CH-46Es to the SH-60 Sea Hawk. The Sea Hawk is a more capable platform than the Sea Knight and would be able to perform all the conventional gap-filler missions of a CH-46E. Furthermore, the SH-60 can be easily reconfigured for tactical or shipboard missions. The Sea Hawk is able to provide the MEU with an organic SAR and Combat Search and Rescue (CSAR) capability. Incorporating the SH-60 into the MEU would have even greater benefits as the Sea Hawk shares inter-service parts commonality among the Army, Navy, and Air Force. This common inter-service parts structure would facilitate a more robust, responsive, and cost effective maintenance program.

The SH-60 cost per aircraft is around 10.2 million dollars.[50] At this price, the Marine Corps could buy 42 Sea Hawk helicopters for 428 million dollars, a price less than the cost of four new MV-22s. Procurement for these helicopters could be completed before the Sea Knight is retired from active service (Appendix B. Table 4).

CONCLUSION

The MV-22 is more than just an evolutionary step ahead of the current Marine Corps' medium lift helicopter. It is a revolutionary capability with seemingly limitless potential. But for all its allure and enhanced mission capabilities, it may not adequately support every existing conventional helicopter mission profile. The Marine Corps should not simply conduct a one-for-one replacement of CH-46Es with MV-22s on MEU deployments. Rather, the Marine Corps should reconsider the composition of the MEU ACE to ensure adequate and competent airframes exist for the variety of missions the MEU performs. If the MV-22 is not the perfect platform for certain missions, conventional rotary-wing aircraft may be able to bridge the gap. As presented, an additional four-plane medium-lift helicopter detachment would significantly increase the MEU's readiness and mission capabilities with almost no negative impact. The CH-46E is a suitable interim solution while the aircraft still remains in active service.

Having a conventional medium-lift helicopter detachment assigned to each MEU would ensure that all mission-essential tasks remain thoroughly supportable, by simultaneously increasing total aircraft to compliment the MV-22. This detachment would be easy to implement and provide relevance to CH-46E aircrew that are "dying on the vine." By centralizing the entire Sea Knight community in Hawaii, CH-46Es could focus on training and operational readiness while supporting Marines across the Islands and all seven standing MEUs. This reorganization would be cost effective, and available immediately. The proposed restructuring of the ACE should be considered for employment as a valid way to increase future MEU capabilities. It should remain an enduring practice for all deploying MEUs in order to increase global crisis and regional response capabilities while simultaneously meeting challenges outlined in the Marine Corps' *Vision and Strategy 2025.*

Endnotes

[1] Commandant of the Marine Corps, *Policy for Marine Expeditionary Unit (Special Operations Capable)(MEU(SOC))*, MCO 3120.9B w/ch. 1, 3-5, http://www.marines.mil/news/publications/Documents/MCO%203120.9B%20W%20CH%201.pdf (accessed January 28, 2009).

[2] The Aviation Combat Element is the sole provider of Marine tactical aviation for all MEU and MEU(SOC) deployments. A standard ACE is built around a Medium-lift helicopter squadron of 12 CH-46E Sea Knights or MV-22B Ospreys, with detachments of four CH-53Es Super Stallions, four AH-1W Cobras, two UH-1N Hueys, and six AV-8B Harriers. This configuration can be reconfigured to task organize for unique deployment needs.

[3] Rotor & Wing, "Rotorcraft Report," *Rotor & Wing* 42, no. 1 (January 2008): 10.

[4] Ibid.

[5] Commandant of the Marine Corps, *Policy for Marine Expeditionary Unit (Special Operations Capable)(MEU(SOC)),* 3-5.

[6] When the MV-22 operates in helicopter mode, it is subject to aerodynamic principles unique to helicopters. Issues that effect various rotary-wing flight regimes include but are not limited to: ground vortex; vortex ring state; translational lift; dissymmetry of lift; phase lag; transverse flow and coning; blade twist; and center of gravity. All of these aerodynamic principles effect each phase of flight, and put unique constraints and restraints on individual helicopters based on their design. No two helicopters perform identically. More can be read about this topic in the Introduction to Helicopter Aerodynamics Workbook (CNATRA P-401) published by the Naval Air Training Command and can be found online at: https://www.cnatra.navy.mil/pubs/folder5/TH57/P-401.pdf

[7] MV-22 is operating between established Forward Operating Bases (FOB), and does not conduct day flights into Baghdad. The Associated Press, *Iraq | www.azstarnet.com* ®. October 21, 2008. http://www.azstarnet.com/sn/fromcomments/263354.php (accessed March 10, 2009).

[8] United States Marine Corps, *22nd Marine Expeditionary Unit,* March 3, 2009. http://192.156.19.109/22ndmeu/index.htm (accessed March 5, 2009).

[9] Both Standard Operating Procedures and Techniques Tactics and Procedures are developed over time through experience and observance. As quoted in Naval Air System Commands' *NATOPS Flight Manual Navy Model CH-46E* Letter of Promulgation, "Since aviation is a continuing, progressive profession, it is both desirable and necessary that new ideas and new techniques be expeditiously evaluated and incorporated if proven to be sound."

[10] All MV-22 specifications retrieved from NAVAIR website. Naval Air Systems Command, *V22 Osprey Web,* February 20, 2009, http://www.navair.navy.mil/v22/?fuseaction=aircraft.main (accessed February 28, 2009).

[11] United States Navy, *NATOPS Flight Manual Navy Model CH-46E* (Patuxent River: Naval Air Systems Command, 2006), 4-1 to 4-19.

[12] According to Mark Thompson, the Pentagon estimates that that 458 contracted V-22's for all the services will cost $55 billion, or $119 million per aircraft. Mark Thompson, "V-22 Osprey: A Flying Shame," *Time* 170, no. 15 (October 8, 2007): 34-44. The Congressional Research Service published a marginally more conservative number of $110 million per aircraft in a January 2009 report. Christopher Bolkcom, *V-22 Osprey Tilt-Rotor Aircraft.* CRS Report for Congress RS31384 (Washington DC: Congressional Research Service, January 2, 2009), 13.

[13] HMM-165 average weight and balance computations for 12 CH-46Es, as of June 2008.

[14] A Coast Guard Cutter is any vessel operated by the United States Coast Guard that is greater than 65' in length. United States Coast Guard. *USCG: About Us - Aircraft & Cutters.* November 03, 2008. http://www.uscg.mil/datasheet/#cutters (accessed March 06, 2009).

[15] Aircraft Division, Naval Air Warfare Center, *Shipboard Aviation Facilities Resume* (Lakehurst: Naval Air Systems Command, 2006), 172.

[16] Ibid.

[17] Although the Huey can conduct passenger, cargo, and mail operations in addition to supporting vertical replenishment, the aircraft only seats up to six and can only carry 4,500 pounds in fuel and cargo. If the Huey were to assume the inter-ARG passenger, mail, and cargo missions that the CH-46E currently conducts, the amount of sorties required would double. United States Navy. "The US Navy -- Fact File, "*The Official Website of the United States Navy,* February 18, 2009. http://www.navy.mil/navydata/fact_display.asp?cid=1200&tid=100&ct=1 (accessed March 12, 2009).

[18] Organizational-level maintenance is maintenance that can be conducted by members of the squadron without the need for specialized maintenance technicians or equipment utilized at higher echelon facilities. Organizational-level maintenance consists of craning engines, replacing rotor heads, troubleshooting, and replacing avionics, etc.

[19] Michael Hoffman, "All-Quandrant Gun Set for Osprey Installation," *Air Force Times* 69, no. 25 (January 7, 2009): 19.

[20] Matt Hillburn, "Osprey Bulks Up," *Seapower* 51, no. 6 (June 2008): 22.

[21] Headquarters U.S. Marine Corps, *Assault Support*, MCWP 3-24 (Washington, DC: Headquarters U.S. Marine Corps, May 20, 2004), 3-6.

[22] Jesse A. Janay, "Taking A Hard Look at the MV-22 Osprey," *Marine Corps Gazette* 92, no. 2 (February 2008): 18.

[23] Due to helicopter aerodynamics, the main mount technique requires more power on landing but substantially less power on takeoff. This is contributed to a phenomenon known as ground effect. Ground effect occurs at a vertical distance from the ground equal to the diameter of the helicopter's rotor arc. For the MV-22 and the CH-46E helicopters enter ground effect at altitudes below 50 feet. Power required to takeoff and land is significantly reduced due to unique air circulation patterns while a helicopter is operating in ground effect. Because a main mount landing is typically conducted to a pinnacle, the terrain slopes away from the landing site thus reducing the benefits of ground effect during landing. However, during takeoff, the helicopter can simply lift and nose-over to fly down the slope, remaining in ground effect and building speed simultaneously.

[24] Sgt. M.P. Shelato, "Marine Corps CH-46's Vital to Casevac Missions in Iraq," *www.marines.mil*, July 30, 2003. http://www.marines.mil/units/marforpac/imef/Pages/2003/Marine%20Corps%20CH-46and%2039;s%20vital%20to%20casevac%20missions%20in%20Iraq.aspx (accessed February 24, 2009).

[25] Matthew R. Crouch, "The Future of Medium Lift," *Marine Corps Gazette* 91, no. 11 (November 2007): 79.

[26] Ibid.

[27] Naval Air Systems Command. *V22 Osprey Web.* February 20, 2009. http://www.navair.navy.mil/v22/?fuseaction=aircraft.main (accessed February 28, 2009).

[28] Shelato, "Marine Corps CH-46's Vital to Casevac Missions in Iraq."

[29] LPDs organic air department allow them to serve as the MEUs secondary aviation ship. United States Navy, "The US Navy -- Fact File," *The Official Website of the United States Navy,* February 6, 2009, http://www.navy.mil/navydata/fact_display.asp?cid=4200&tid=600&ct=4 (accessed February 28, 2009).

[30] Split-ARG operations usually consist of the LHA/LHD performing missions in one region while the LPD supports missions in another. The two regions are not mutually supportable by ARG shipping based on distance. Since the LPD is the only other ship in the ARG/ESG that has an organic air department comprised of trained Sailors that are capable of aircraft terminal control, refueling and maintenance, the LPD is most often the ship that is separated from the LHA/LHD flagship.

[31] Deck cycles are ten-hour periods in which flight operations are conducted. When all aviation assets are aboard the same ship, aviation support to other ARG/ESG ships cease once the deck cycle for that ship ends. With multiple ships offering the ability to conduct flight operations, the ships can coordinate a staggered deck cycles where aviation support across the MEU is still available after one of the decks flight windows closes.

[32] OPNAVINST C3501.104B delineates, "The ship can support 10 hours of flight operations per day when a Marine composite squadron or other aviation squadron of similar size is embarked."

[33] In order to be certified to perform airborne Search and Rescue missions, the aircraft must be configured with the appropriate gear (Doppler-hover radar, SAR baskets, operable external hoists), the aircrew must have completed and be proficient in SAR training, and there must be a rescue swimmer aboard the helicopter. Marine helicopters do not have all of these assets. While CH-46Es have filled the gap during periods of SH-60 unavailability (due to refueling requirements or maintenance issues), Marine helicopters are only able to put out a life raft for emergency situations.

[34] The *Austin* class LPD can support these aircraft when conducting flight operations utilizing only their two standard landing spots. Two additional CH-46Es or SH-60s can operate from the deck when the LPD allows expanded-spot operations. Expanded-spot operations do not allow these additional assets to operate simultaneously, the must stagger their take off and landing sequence.

[35] United States Navy, "The US Navy -- Fact File," *The Official Website of the United States Navy,* February 6, 2009, http://www.navy.mil/navydata/fact_display.asp?cid=4200 &tid=600&ct=4 (accessed February 28, 2009).

[36] United States Navy, "USS New Orleans (LPD-18) Official Command Website," *News,* March 09, 2009, http://www.new-orleans.navy.mil/Site%20Pages/news.aspx (accessed March 09, 2009).

[37] Ronald O'Rourke, *Navy LPD-17 Amphibious Ship Procurement: Background, Issues, and Options for Congress,* CRS Report for Congress RL34476 (Washington, DC: Congressional Research Service, May 6, 2008), 12.

[38] Based on a standard 12 plane squadron and 16 plane training squadron, not including CH-46E squadrons that have already transitioned to the MV-22 Osprey.

[39] Almost all CH-46Es have been updated with the latest technical directives (TD) and airframe changes (AFC) that make them ready for combat. TDs and AFCs are orders by Naval Aviation Systems Command to individual squadrons to update equipment or fix existing issues to ensure the safest, most combat ready aircraft. Any new TDs or AFCs that occur between the

times that a CH-46E is removed from the operating forces and when it returns must be complied with. Since there are no plans for major changes for the CH-46E before the end of its service life, any minor TDs or AFCs would be an inexpensive and quick fix.

[40] According to the Naval Safety Center's mishap rates for the CH-46E.

[41] At any given time there are three deployed MEUs (31st MEU, one West Coast MEU and one East Coast MEU). In addition, there are two MEUs in workups (one West Coast MEU and one East Coast MEU). These five MEUs would require a total force of 20 medium-lift helicopters.

[42] United States Marine Corps, *Official Website for MAG-29*, March 9, 2009, https://www.2maw.usmc.mil/MAG29/MAG29/default.asp (accessed March 9, 2009).

[43] United States Marine Corps, *22nd Marine Expeditionary Unit*, March 3, 2009, http://192.156.19.109/22ndmeu/index.htm (accessed March 5, 2009).

[44] Hillburn, "Osprey Bulks Up," 24.

[45] United States Navy, "The US Navy -- Fact File," *The Official Website of the United States Navy*, February 18, 2009, http://www.navy.mil/navydata/fact_display.asp?cid=1200&tid=200&ct=1 (accessed March 12, 2009).

[46] Compared to the CH-46E, the V-22's ability to make a successful auto-rotational landing is very low. "If the power is lost when a V-22 is flying like a helicopter below 1,600 feet, emergency landings are not likely to be survivable." Thompson, "V-22 Osprey: A Flying Shame," 41-42. According to a 2009 congressional report, the necessity that the V-22 is able auto-rotate is no longer a requirement. Bolkcom, *V-22 Osprey Tilt-Rotor Aircraft,* 8. See also Joseph Neff, "Eased Standards 'Fix' Osprey," *Raleigh News & Observer*, May 19, 2002, A1.

[47] "The helicopter has demonstrated the capability of remaining afloat for over two hours in two-foot waves with the rotors stopped. Starting or stopping rotors while afloat produces no adverse yawing tendency or appreciable change in helicopter heading." Naval Air Systems Command, *NATOPS Flight Manual Navy Model CH-46E*, 1-8.

[48] Lt.Gen. George Trautman III, *FY2009 Marine Aviation Plan* (Washington DC, 2008), 5.

[49] While the current UH-1N to UH-1Y, AH-1W to AH-1Z, and CH-53E to CH-53K conversions are underway, these upgraded airframes still not capable to match the MV-22s unique combination of speed and range.

[50] The cost of the Sea Hawk is different according to the model. The Sea Hawk costs between $5.9 and $10.2 million. Data is calculated using the most expensive model. United States Navy. "The US Navy -- Fact File," *The Official Website of the United States Navy*, February 20, 2009, http://www.navy.mil/navydata/fact_display.asp?cid=1200&tid=500&ct=1 (accessed February 28, 2009).

Appendix A

Technical Diagrams

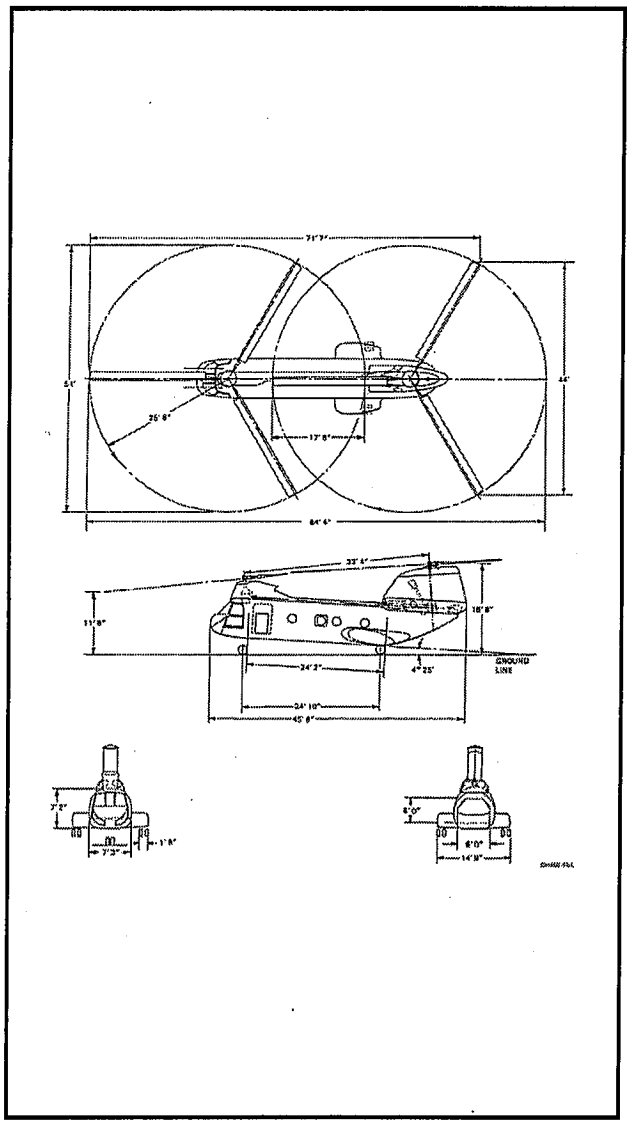

Figure 2. CH-46E dimensions

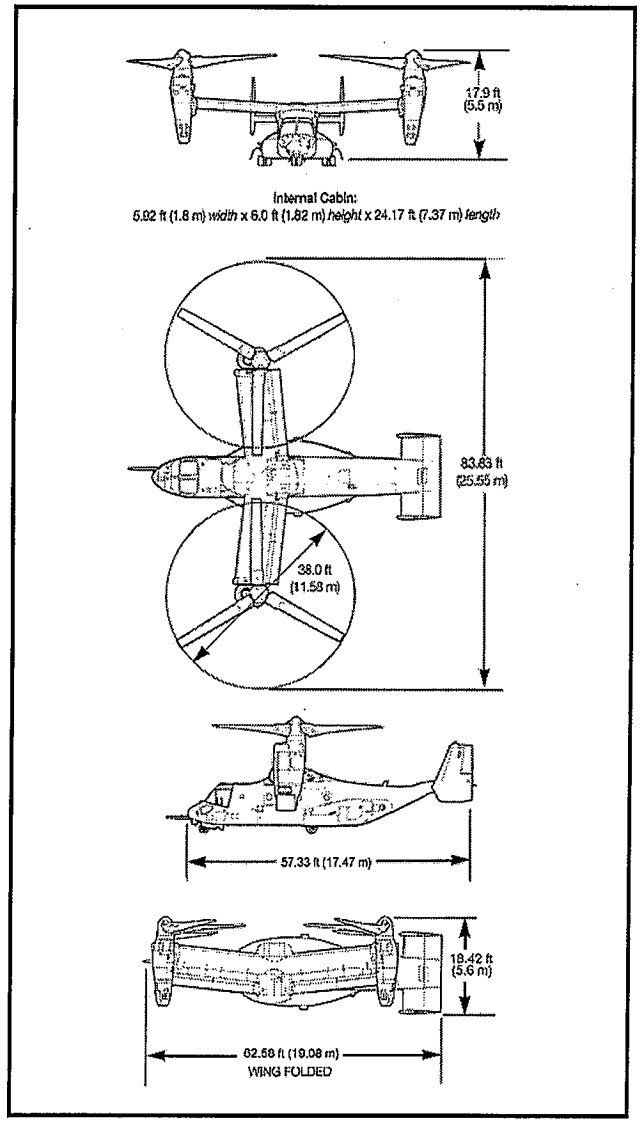

Figure 3. MV-22 dimensions

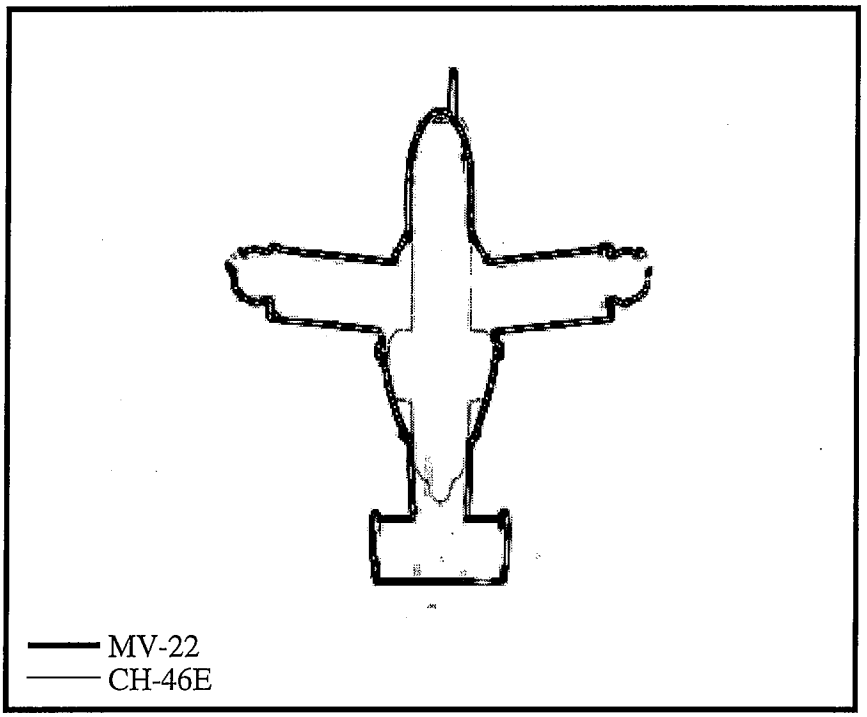

Figure 4. Landing footprint comparison

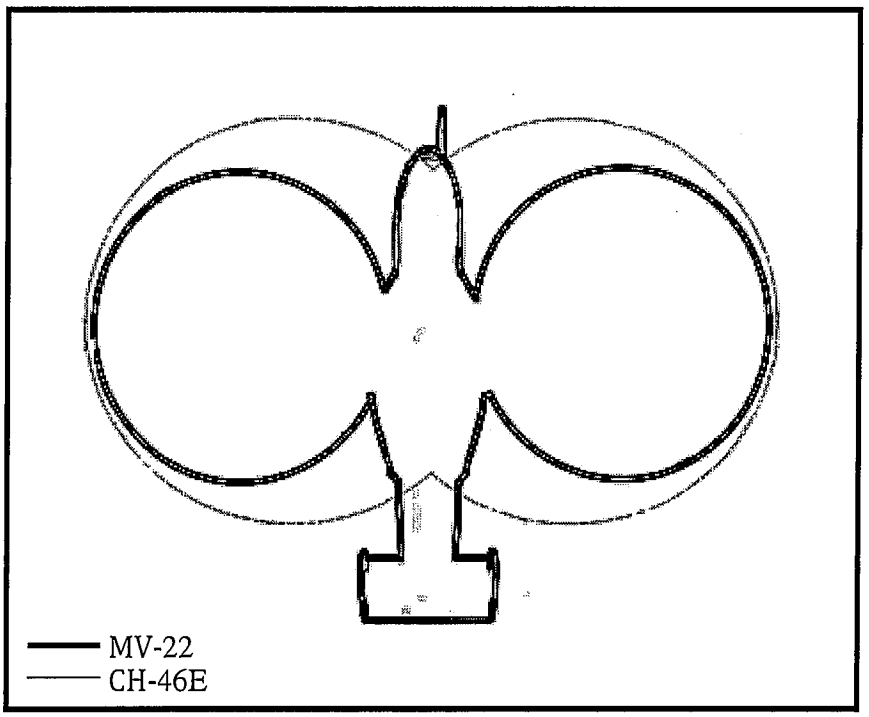

Figure 5. Minimum required landing zone comparison

Appendix B

Transition Schedule

Table 4 below provides a proposed Marine Expeditionary Unit Air Combat Element composition and airframe transition schedule through fiscal year 2020. It is based on projections for current airframe replacement/upgrades. The proposed schedule ensures has uninterrupted conventional medium-lift helicopter augmentation to the Marine Expeditionary Unit.

Year / Aircraft	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
12	**MV-22B**	**MV-22B**	**MV-22B**	**MV-22B**	**MV-22B**	**MV-22B**	**MV-22B**	**MV-22B**	**MV-22B**	**MV-22B**	**MV-22B**
4	CH-53E	CH-53E	CH-53E	CH-53E	**CH-53K**	**CH-53K**	**CH-53K**	**CH-53K**	**CH-53K**	**CH-53K**	**CH-53K**
4	AH-1W	AH-1W	AH-1W	**AH-1Z**	**AH-1Z**	**AH-1Z**	**AH-1Z**	**AH-1Z**	**AH-1Z**	**AH-1Z**	**AH-1Z**
2	UH-1N	UH-1N	UH-1N	**UH-1Y**	**UH-1Y**	**UH-1Y**	**UH-1Y**	**UH-1Y**	**UH-1Y**	**UH-1Y**	**UH-1Y**
6	AV-8B	AV-8B	AV-8B	AV-8B	**F-35B**	**F-35B**	**F-35B**	**F-35B**	**F-35B**	**F-35B**	**F-35B**
4	CH-46E	CH-46E	CH-46E	CH-46E	CH-46E	CH-46E	CH-46E	**SH-60**	**SH-60**	**SH-60**	**SH-60**

Table 4. Proposed MEU Composition and Airframe Transition Schedule

Glossary

Abbreviations

AAF	Army Air Field
ACE	Air Combat Element
AFC	Airframe Change
ARG	Amphibious Readiness Group
CAL	Confined Area Landings
CASEVAC	Casualty Evacuation
CG	Guided Missile Cruiser
CSAR	Combat Search and Rescue
CVN	Nuclear Aircraft Carrier
ESG	Expeditionary Strike Group
FARP	Forward Arming and Refueling Point
FEBA	Forward Edge of the Battle Area
FFG	Guided Missile Frigate
FOB	Forward Operating Base
HMM	Marine Medium Helicopter Squadron
HMM(T)	Marine Medium Helicopter Training Squadron
III MAW	Third Marine Aircraft Wing
IIMEF	Second Marine Expeditionary Force
LHA	Amphibious Assault Ship
LHD	Amphibious Assault Ship
LPD	Transport Dock Ship
LSD	Dock Landing Ship
LZ	Landing Zone
MAGTF	Marine Air Ground Task Force
MAW	Marine Aircraft Winf
MCAF	Marine Corps Air Facility
MEDEVAC	Medical Evacuation
MEF	Marine Expeditionary Force
MEU	Marine Expeditionary Unit
MEU(SOC)	Marine Expeditionary Unit (Special Operations Capable)
OIF-I	Operation Iraqi Freedom I
OMTFS	Operational Maneuver from the Sea
PMC	Passengers, Mail, and Cargo
PTA	Pohalaku Training Area
SAR	Search and Rescue
SOP	Standard Operations Procedures
STOM	Ship-to-Objective Maneuver
STP	Shock Trauma Platoon
T-AO	Fleet Replenishment Oiler
TD	Technical Directive
TTP	Techniques, Tactics, and Procedures
UNREP	Underway Replenishment

Definitions

Amphibious Task Force (ATF) — A Navy task organization formed to conduct amphibious operations. The amphibious task force, together with the landing force and other forces, constitutes the amphibious force. [Joint Pub 1-02]

Aeromedical Evacuation (MEDEVAC). — The movement of patients under medical supervision to and between medical treatment facilities by air transportation. [Joint Pub 1-02]

Aviation Combat Element (ACE) — The core element of a Marine air-ground task force (MAGTF) that is task-organized to conduct aviation operations. The aviation combat element (ACE) provides all or a portion of the six functions of Marine aviation necessary to accomplish the MAGTF's mission. These functions are anti-air warfare, offensive air support, assault support, electronic warfare, air reconnaissance, and control of aircraft and missiles. The ACE is usually composed of an aviation unit headquarters and various other aviation units or their detachments. It can vary in size from a small aviation detachment of specifically required aircraft to one or more Marine aircraft wings. The ACE itself is not a formal command. [Joint Pub 1-02]

Casualty Evacuation (CASEVAC) — 1. The evacuation of wounded personnel by combatant military assets not dedicated to the medical mission. When performed by non-combatant aircraft, this mission is called aero medical evacuation (MEDEVAC). 2. The movement of the sick, wounded, or injured. It begins at the point of injury or the onset of disease. It includes movement both to and between medical treatment facilities. All units have an evacuation capability. Any vehicle may be used to evacuate casualties. If a medical vehicle is not used it should be replaced with one at the first opportunity. Similarly, aero medical evacuation should replace surface evacuation at the first opportunity. [CH-46E ANTTP] 3. The unregulated movement of casualties that can include movement both to and between medical treatment facilities. Also called CASEVAC. See also casualty; evacuation; medical treatment facility. [Joint Pub 1-02]

Combat Search And Rescue (CSAR) — The tactics, techniques, and procedures performed by forces to affect the recovery of isolated personnel during combat. [Joint Pub 3-50)

Forward Edge of the Battle Area (FEBA) — The foremost limits of a series of areas in which ground combat units are deployed, excluding the areas in which the covering or screening forces are operating, designated to coordinate fire support, the positioning of forces, or the maneuver of units. [Joint Pub 1-02]

Landing Zone (LZ) —A specified zone used for the landing of aircraft. [Joint Pub 1-02]

Marine Expeditionary Unit (MEU) —A Marine air-ground task force (MAGTF) that is constructed around an infantry battalion reinforced, a helicopter squadron reinforced, and a task-organized combat service support element. It normally fulfills Marine Corps forward sea-based

deployment requirements. The Marine expeditionary unit provides an immediate reaction capability for crisis response and is capable of limited combat operations. [Joint Pub 1-02]

Marine Expeditionary Unit (Special Operations Capable) (MEU(SOC))—The Marine Corps standard, forward-deployed, sea-based expeditionary organization. The MEU(SOC) is trained and equipped to conduct amphibious operations and a variety of specialized missions of limited scope and duration augmented by selected personnel. These capabilities include specialized demolition, clandestine reconnaissance and surveillance, raids, in-extremis hostage recovery, and enabling operations for follow-on forces. The MEU(SOC) is not a special operations force but, when directed by the National Command Authorities, the combatant commander, and/or other operational commander, may conduct limited special operations in extremis, when other forces are inappropriate or unavailable. [Joint Pub 1-02]

Medical Treatment Facility (MTF) — A facility established for the purpose of furnishing medical and/or dental care to eligible individuals. [Joint Pub 1-02]

Procedures — Standard, detailed steps that prescribe how to perform specific tasks. See also **tactics; techniques.** [CJCSI 5120.02]

Search And Rescue (SAR) — The use of aircraft, surface craft, submarines, and specialized rescue teams and equipment to search for and rescue distressed persons on land or at sea in a permissive environment. Also called **SAR.** See also **combat search and rescue; isolated personnel; joint personnel recovery center; personnel recovery coordination cell.** [Joint Pub 3-50]

Ship-to-Shore Movement — That portion of the assault phase of an amphibious operation which includes the deployment of the landing force from the assault shipping to designated landing areas. [Joint Pub 3-02]

Sortie — In air operations, an operational flight by one aircraft. [MCWP 3-2]

Tactical Recovery of Aircraft and Personnel (TRAP) — A Marine Corps mission performed by an assigned and briefed aircrew for the specific purpose of the recovery of personnel, equipment, and/or aircraft when the tactical situation precludes search and rescue assets from responding and when survivors and their location have been confirmed.
[Joint Pub 1-02]

Tactics — The employment and ordered arrangement of forces in relation to each other. See also **procedures; techniques.** [CJCSI 5120.02)]

Techniques — Non-prescriptive ways or methods used to perform missions, functions, or tasks. See also **procedures; tactics.** [CJCSI 5120.02]

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