

United States Marine Corps  
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**TITLE:**

The Multipurpose Black Hawk Utility Helicopter: Rotary-wing Versatility Required for  
U.S. Marine Corps Enhanced Company Operations.

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**AUTHOR:** Major Wade J. Dunford, USMC

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Mentor and Oral Defense Committee Member: Mark Jacobsen  
Approved: Mark Jacobsen  
Date: 11 March 2009

Oral Defense Committee Member: Bradford Wilkerson  
Approved: [Signature]  
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## EXECUTIVE SUMMARY

**Title:** The Multipurpose Black Hawk Utility Helicopter: Rotary-wing Versatility Required for U.S. Marine Corps Enhanced Company Operations.

**Author:** Major Wade J. Dunford, United States Marine Corps

**Thesis:** The Black Hawk utility helicopter provides the multi-function capability and tactical flexibility required to support the U.S. Marine Corps' Enhanced Company Operations.

**Discussion:** In August of 2008, the Commandant committed the Marine Corps to developing and implementing the Enhanced Company Operations (ECO) concept. This concept seeks to distribute forces beyond mutual support of one another and focuses on the infantry company as the smallest unit capable of sustained dispersed operations.

Through analysis of Marine Corps operations and Warfighting Functions, ECO will utilize the Marine Air-Ground Task Force (MAGTF) construct, comprised of a Command Element (CE), Ground Combat Element (GCE), Logistics Combat Element (LCE), and Aviation Combat Element (ACE). Because ECO is designed to be highly versatile and capable across multiple functional areas, it will require an ACE that is equally adaptive and effective.

In order to maintain the agility and responsiveness of the ECO company-sized MAGTF, yet still provide the full rotary-wing Functions of Marine Aviation, a single, highly effective, multi-functional, rotary-wing aircraft is required to serve as the primary asset of the ACE. Though current rotary-wing aircraft will have certain roles in supporting ECO, the Sikorsky Black Hawk utility helicopter demonstrates the versatility, functionality, and capability required by the U.S. Marine Corps' Enhanced Company Operations concept.

**Conclusion:** The Sikorsky Black Hawk utility helicopter is the aircraft that provides the multi-function capability and tactical flexibility required to support the U.S. Marine Corps' Enhanced Company Operations.

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## ACRONYMS

AAW	Antiair Warfare
ACE	Aviation Combat Element
AFCS	Advanced Flight Control System
AMCIT	American Citizen
AS	Assault Support
ASE	Aircraft Survivability Equipment
CAS	Close Air Support
CASEVAC	Casualty Evacuation
CE	Command Element
CEFS	Crashworthy External Fuel System
CSAR	Combat Search and Rescue
DAS	Deep Air Support
DFD	Dual-Function Display
DO	Distributed Operations
ECO	Enhanced Company Operations
ESSS	External Stores Support System
FAC(A)	Forward Air Controller (Airborne)
FARP	Forward Arming and Refueling Point
FLIR	Forward Looking Infrared
GCE	Ground Combat Element
GPS	Global Positioning System
GSE	Ground Support Equipment
HMH	Marine Heavy Helicopter Squadron
HMLA	Marine Light Attack Helicopter Squadron
HMM	Marine Medium Helicopter Squadron
HMMWV	High Mobility Multipurpose Wheeled Vehicle
HUMS	Health and Usage Monitoring System
LCE	Logistics Combat Element
MAGTF	Marine Air Ground Task Force
MCDP	Marine Corps Doctrinal Publication
MCWL	Marine Corps Warfighting Lab
MEB	Marine Expeditionary Brigade
MEDEVAC	Medical Evacuation
MEF	Marine Expeditionary Force
METL	Mission Essential Task List
MEU	Marine Expeditionary Unit
MFD	Multi-Function Display
MOOTW	Military Operations Other Than War
NTIS	Navigational Thermal Imaging System
NTS	Night Targeting System
OAS	Offensive Air Support
PGM	Precision Guided Munitions
SAR	Search and Rescue
SATCOM	Satellite Communication

SPMAGTF	Special Purpose Marine Air Ground Task Force
STOL	Short Takeoff and Landing
STOM	Ship-to-Objective Maneuver
TAC(A)	Tactical Air Coordinator (Airborne)
TCN	Third-Country National
TRAP	Tactical Recovery of Aircraft and Personnel
TSS	Target Sighting System
UTTAS	Utility Tactical Transport Aircraft System
VERTREP	Vertical Replenishment
VMM	Marine Tiltrotor Squadron
VTOL	Vertical Takeoff and Landing

## PREFACE

In an effort to demonstrate the usefulness of the Sikorsky Black Hawk helicopter to the Marine Corps' Enhanced Company Operations concept, a logical analysis of several areas will be conducted. These areas include:

1. The MAGTF Concept and Enhanced Company Operations.
2. Rotary-wing Aviation Functions, Warfighting Functions, and Enhanced Company Operations.
3. Capabilities and Roles of Current U.S. Marine Corps Rotary-wing Aircraft in Support of Enhanced Company Operations.
4. Capabilities and Roles of the Black Hawk Utility Helicopter.

Thorough analysis of each of these subtopics will also demonstrate the importance of the MAGTF construct to the ECO concept, emphasize the universal rotary-wing Marine aviation and warfighting functions, and discuss current aircraft capabilities and roles. Furthermore, a scenario-based vignette will provide a real-world account of rotary-wing aviation in support of ECO. Doing so will ultimately demonstrate the necessity, versatility, and functionality of the Sikorsky Black Hawk helicopter as an asset to the Aviation Combat Element in support of the company-sized MAGTF, capable of performing all helicopter mission essential tasks, as required by the rotary-wing functions of Marine aviation.

## – INTRODUCTION

In April 2005, the Commandant of the Marine Corps, General Michael W. Hagee, published a paper, *A Concept for Distributed Operations*, where he outlined a new operating approach based on a future of irregular and asymmetrical warfare. In order to combat an enemy that is small, mobile, and adaptive, the Commandant envisioned decentralizing and dispersing platoons and squads beyond mutual support. This dispersion would enhance maneuver in a vast battle space and require extensive command and control capability, advanced logistical systems, access to joint fires, and would center on well equipped units with junior leaders making decisions at the lowest levels.<sup>1</sup>

Through 2007, the Marine Corps Warfighting Laboratory's (MCWL) focus was on the Distributed Operations (DO) concept at the platoon and squad level. With projects like SQUAD FIRES and COMBAT HUNTER, the DO concept proved to be successful. However, working groups at the 1<sup>st</sup> MEF Tactical Capabilities for Irregular Warfare Conference were unanimous in their belief that the "find, fix, and engage" irregular warfare capabilities rested at the company level.<sup>2</sup>

In August of 2008, the Commandant of the Marine Corps, General James T. Conway, published another concept paper, *A Concept for Enhanced Company Operations*, which portrayed the infantry company as the smallest tactical formation that could carry out sustained independent operations on a distributed battlefield. Built on the DO concept, Enhanced Company Operations (ECO) centers on a company-sized MAGTF.<sup>3</sup> Implementation of the ECO company-sized MAGTF concept is the challenge before us. In addition to educational, doctrinal, and structural changes that will take place within the Marine Corps, there will also be physical and philosophical transitions in how we support and equip units on the distributed battlefield.

Specifically, a realignment of the MAGTF Aviation Combat Element (ACE) must take place to enhance the company's air support through more efficient, timely, and tailored means, and must link effectively with, and integrate access to, all aviation functions. Current ECO concepts leave critical gaps in rotary-wing attack, utility, and assault support aviation functions by focusing primarily on the success of the MV-22 Ospreys' range and speed, while relegating all other helicopter support functions to the theoretical use of unmanned air vehicles.<sup>4</sup>

The ECO concept will decentralize leadership and distribute military operations to the company level, but should not do so at the expense of the Marine Corps' MAGTF concept. Emphasis will now be placed on the company-sized MAGTF and the ACE that supports it. Current rotary-wing capabilities restrict the warfighting versatility and agility of ECO, requiring multiple types and numerous quantities of aircraft to support all functions of aviation, serving only to complicate ACE operations, maintenance support, supply, and logistics. Now, more than ever, the U.S. Marine Corps needs a helicopter that possesses the versatility to operate across the functional spectrum of all current Marine Corps rotary-wing aviation assets. The Sikorsky Black Hawk helicopter provides the multi-function capability and tactical flexibility required to support the U.S. Marine Corps' Enhanced Company Operations.

#### – THE MAGTF CONCEPT AND ENHANCED COMPANY OPERATIONS

##### The U.S. Marine Corps MAGTF

The Marine Corps is known for its employment of combined-arms warfighting and task-organizes its forces as a Marine Air-Ground Task Force (MAGTF). The MAGTF concept includes, just as the name implies, a balance of air and ground forces organized under one commander, tailored in size and capabilities based on a specific mission. The MAGTF is designed to rapidly deploy by air, land, or sea and provides forces to naval, joint, and

multinational commanders that are ready to fight, prevent conflicts, or control crises. Each MAGTF has four elements: the Command Element (CE), the Ground Combat Element (GCE), the Aviation Combat Element (ACE), and the Logistics Combat Element (LCE). The most robust MAGTF is the Marine Expeditionary Force (MEF), based around the infantry division and air wing, and serves as the Marine Corps principal warfighting organization. The Marine Expeditionary Brigade (MEB) is centered on the infantry regiment and air group. The most commonly utilized and smallest standing MAGTF is the Marine Expeditionary Unit (MEU), tailored around the infantry battalion and a reinforced squadron, and is continuously forward-deployed to provide immediate crisis response and power projection.<sup>5</sup> The fourth type of MAGTF is the Special Purpose MAGTF (SPMAGTF). A SPMAGTF is a non-standing MAGTF temporarily formed to accomplish a specific mission when either a standing MAGTF unit is not suitable or a standing MAGTF is not readily available. A SPMAGTF can come in any size but is generally smaller than a MEU and can be task-organized from deployed or non-deployed forces.<sup>6</sup>

#### ECO and the MAGTF

With the introduction and evolution of the Enhanced Company Operations concept, the Commandant of the Marine Corps states that “we should ensure we have the means to organize, train, and employ smaller MAGTF’s built around company-sized ground combat elements by providing responsive C2I, air, and logistics resources.”<sup>7</sup> Knowledge of the U.S. Marine Corps MAGTF concept and the understanding that ECO will tailor MAGTF’s around company-sized elements may lead to a new, named type of MAGTF, one echelon below a MEU. Or perhaps the standing MAGTF constructs will remain as they are and the ECO MAGTF will simply function as a SPMAGTF, either pulled from non-deployed forces or from a forward deployed MEU,

MEB, or MEF. Regardless of how ECO will be specifically organized, trained, and employed, ECO will be structured according to the MAGTF concept, consisting of command, ground, aviation, and logistic elements.

For the Marine Air-Ground Task Force (MAGTF) to reap the benefits of ECO, it will require modification to its training, organization, equipping, - and perhaps, most of all, thinking - in order to fully exploit the capability...and the same development process that "enhances" the company, must ensure concomitant improvements are made to the MAGTF.<sup>8</sup>

As indicated by the Commandant, each element of the MAGTF, including the Aviation Combat Element, will require modifications and improvements in order to maximize the intended versatility, flexibility, and agility of ECO. Just as the infantry company reorganizes and trains specifically for ECO, and just as the infantry company acquires lighter, multi-functional, and highly technological equipment in support of their mission, so will the ACE. Due to the asymmetric, irregular world the U.S. Marine Corps operates in, Enhanced Company Operations will soon become the primary means by which combat operations, peacekeeping missions, and nation-building endeavors are performed around the globe. In order to efficiently and effectively adapt to transitions in ACE tasks and missions, Marines need a helicopter robustly capable of supporting all rotary-wing aviation and warfighting functions.

#### - ROTARY-WING AVIATION FUNCTIONS, WARFIGHTING FUNCTIONS, AND ENHANCED COMPANY OPERATIONS

##### Rotary-wing Aviation Functions

U.S. Marine Corps aviation units are organized, trained, and equipped to provide a task-organized ACE for any size MAGTF.<sup>9</sup> The primary mission of the ACE is "full spectrum aviation support of the MAGTF during expeditionary operations and sustained operations ashore".<sup>10</sup> In order to provide this support, the ACE performs six functions: Offensive Air Support (OAS), Antiair Warfare (AAW), Assault Support, Air Reconnaissance, Electronic

Warfare, and Control of Aircraft and Missiles. Of the six functions of Marine Corps aviation all, but Electronic Warfare, are performed by current rotary-wing aircraft.<sup>11</sup> (See Appendix A) These capabilities are conducted with rotary-wing assets that are found in Marine Light Attack Helicopter (HMLA), Marine Medium Helicopter (HMM), Marine Heavy Helicopter (HMH), and Marine Medium Tiltrotor (VMM) Squadrons. The present ACE is comprised of rotary-wing assets from each of these squadrons, based on task-organization and mission requirements, and operates in general support of the MAGTF.

#### Warfighting Functions

The U.S. Marine Corps conducts combined-arms operations utilizing the MAGTF concept, while planning for and executing warfighting based on six functional areas: Command and Control, Maneuver, Fires, Intelligence, Logistics, and Force Protection. (See Appendix A) Exercising the warfighting functions through the ability to direct synchronized fire and maneuver, operating on accurate intelligence, and supported by dependable logistics under a veil of strong force protection allows “the commander (to) achieve unity of effort and build sustained combat power”<sup>12</sup> during expeditionary and sustained combat operations. Knowledge of the five rotary-wing functions of Marine aviation, and their relationship to the six warfighting functions, suggests how the U.S. Marine Corps will equip the ACE that supports the company-sized ECO MAGTF.

#### Rotary-Wing Aviation Functions, Warfighting Functions, and ECO

Just as a MAGTF will always plan for and execute combat operations with thorough consideration and implementation of the six warfighting functions, an ACE will always organize and employ its aviation assets while incorporating the six functions of Marine aviation. Success of the MAGTF concept, and the ACE, are based on task-organized, deployable, and

technologically equipped units, capable of exploiting their respective warfighting and aviation functions. With the introduction of ECO as the new company-sized MAGTF, each of the six warfighting functions will remain crucial at the company level. The rotary-wing functions of Marine aviation will be more critical than ever to a company operating in a dispersed, fluid environment, beyond the mutual support of adjacent ground units. Current Marine Corps rotary-wing aviation assets are task focused and are neither the most effective nor efficient means of supporting ECO, requiring up to four different types of aircraft, along with additional numbers for redundancy, to support a single company-sized MAGTF mission. Though existing Marine Corps aircraft retain valuable roles in supporting ECO, consolidation of all rotary-wing aviation functions into one highly capable aviation platform will prove critical in achieving continuous, compatible, proportional, timely, and adaptable rotary-wing support to the ECO MAGTF.

– CAPABILITIES AND ROLES OF CURRENT U.S. MARINE CORPS ROTARY-WING  
AIRCRAFT IN SUPPORT OF ENHANCED COMPANY OPERATIONS

Current and forthcoming U.S. Marine Corps aircraft will undoubtedly provide critical capabilities to ECO and the Mission Essential Task Lists (METL) of Marine Corps rotary-wing aviation squadrons are directly tied to these individual types of aircraft. Analysis of the roles and capabilities of the AH-1W Super Cobra, CH-53E Super Stallion, MV-22B Osprey, and the UH-1N Huey will identify strengths and weaknesses each of these airframes possess in their support of the ECO MAGTF. The CH-46E Sea Knight and the CH-53D Sea Stallion will not be reviewed because of their scheduled replacement by the MV-22B Osprey. Also, where data exists, the CH-53K Super Stallion, AH-1Z Viper (Zulu Cobra), and UH-1Y Venom Huey aircraft upgrades will be considered, as each of these helicopters is scheduled to enter operation over the next decade. Appendix B depicts a comparison of functions and capabilities among the aforementioned aircraft.

### AH-1W/Z Cobra Capabilities and Limitations

The mission of the Marine Light Attack Helicopter (HMLA) Squadron AH-1W Super Cobra is to “provide attack helicopter fire support and fire support coordination during amphibious operations and subsequent operations ashore.”<sup>13</sup> The AH-1W supports this mission through its OAS capability to provide and coordinate CAS for ground forces and escorted convoys, its ability to seek out and destroy enemy armor and aviation targets through DAS and AAW, and its capability to operate from naval amphibious shipping and shore bases “at night, in adverse weather conditions, under instrument flight conditions”.<sup>14</sup> The AH-1W has a cruise speed of 120 knots and a range of 250 nautical miles. It has a crew of two and can carry 2,250 pounds of ordnance, including a 3-barreled 20mm cannon with a 750 round capacity, options for 2.75 inch rockets in 7 or 19 shot launchers, up to eight 5 inch Zuni rockets, up to eight wire-guided TOW antitank missiles, up to eight laser guided Hellfire missiles, and up to two AIM-9 Sidewinder anti-aircraft missiles. The Cobra employs a Night Targeting System (NTS), Forward Looking Infrared (FLIR), and laser range-finding and designation capabilities to further enhance its lethality in combat operations.<sup>15</sup>

The forthcoming upgrade to the AH-1W is the AH-1Z Viper (Zulu Cobra). The AH-1Z provides upgrades in just about every aspect of the aircraft, increasing main and tail rotor blades from two to four, upgrading to a “glass cockpit” comprised of many Multi-Function Displays (MFD) and Dual-Function Displays (DFD), enhanced engines and transmissions, and upgraded weapons and targeting systems to include additional wing stores to hold 16 Hellfire missiles and the advanced Target Sighting System (TSS). Most performance parameters remain about the same, while bringing more firepower, technology, and aircraft survivability to the fight. There is

also a significant potential cost benefit in operating and support expenses because 84% of the AH-1Z's components are common with the new UH-1Y utility helicopter.<sup>16</sup>

Limitations of the Cobra as a conventional attack helicopter are very few, especially with system upgrades available in the AH-1Z. But it cannot carry troops, supplies, or even additional ordnance for rearming. The Cobra must return to base or rely on a Forward Arming and Refueling Point (FARP) for fuel and reload of ordnance. This greatly increases the logistical requirements for an AH-1W operating over 100 nautical miles from base, and often, a Cobra must depart the engagement area to rearm at a FARP, even though it has fuel remaining.<sup>17</sup> An AH-1W utilizes skids as landing gear, which has some negative effects on its shipboard and shore-based ground handling. Also, the new four-bladed AH-1Z can only fold two of its main rotor blades, effectively reducing its width, but not its length, for storage aboard naval ships and requires removal of rotor blades for transport aboard Air Force C-5 or C-17 aircraft.<sup>18</sup>

#### AH-1W/Z Cobra's Role in Support of ECO

The AH-1W Super Cobra and the AH-1Z Viper will be critical rotary-wing assets in support of ECO when the mission dictates heavy kinetic offensive or defensive operations, dedicated air reconnaissance, or deterrence through heavy show of force. Because of the potential firepower and sensors required in some situations, the company-sized MAGTF ACE will, from time to time, be task-organized to include attack helicopters. The AH-1W/Z will self-deploy by way of amphibious shipping, and use FARP's when required, in order to get to long-range objective areas, or can deploy via Air Force Strategic Airlift if there are airfields capable of supporting large transport aircraft. During military operations other than war (MOOTW), when aviation functions such as OAS and AAW are minimal, maintaining an attack helicopter in general support of a company-sized MAGTF creates excessive logistical and service

requirements that are otherwise unproductive. In this scenario, fixed-wing OAS and AAW may prove to be a more cost and resource effective solution.

### CH-53E Super Stallion Capabilities and Limitations

The mission of the Marine Heavy Helicopter (HMH) Squadron CH-53E Super Stallion is to “provide assault helicopter transport of heavy weapons, equipment, and supplies during amphibious operations and subsequent operations ashore.”<sup>19</sup> The CH-53E supports this mission through its capability to lift 36,000 pounds, either as internal cargo or externally through a single or dual-point hook system. Whether externally lifting an M-198 Howitzer and its ammunition, two dual-slung HMMWV’s, or water and other supplies, the CH-53E has entered near “national-asset” status because of its incredible lift capability. It also has a sizable cabin capable of transporting up to 55 Marines into combat, palletized cargo, vehicles, or 2400 gallons of additional fuel for other helicopters or ground vehicles. With a cruise speed of 150 knots and a range of nearly 500 nautical miles un-refueled (unlimited through aerial refueling by KC-130 Hercules), the CH-53E has the ability to support the MAGTF, from amphibious shipping or shore bases, deep into inland locations.<sup>20</sup> It is currently the only U.S. Marine Corps helicopter capable of flying MV-22B distances by employing aerial refueling, though it cannot match the Osprey’s speed. The CH-53E has functioned very well in the high mountainous terrain of Afghanistan, as well as in the deserts of Iraq, and has full capability to “operate at night, in adverse weather conditions, under instrument flight conditions”.<sup>21</sup> The replacement aircraft for the CH-53E, the CH-53K, will have tremendous lift capability, with improvements in every airframe aspect from engines, transmissions, and avionic systems and these upgrades will reflect positively on operating parameters and statistics.

Despite its numerous capabilities, the CH-53E Super Stallion does have some limitations. Through its primary function of assault support, the CH-53E employs only defensive weapons and threat countermeasures, and has often been restricted from flight through or into certain hostile locations because of its size, heat signature, and perceived vulnerability. Also, because of the Super Stallion's dimensions and extreme rotor downwash, there are serious limitations on landing zone selection because of space issues and potential damage to property. Optimally, the CH-53E will either fly to the operational area or transit aboard naval amphibious shipping because transport aboard U.S. Air Force C-17 or C-5 aircraft requires an extensive breakdown and buildup effort that results in hundreds of maintenance man-hours. This, and other more routine maintenance, requires heavy Ground Support Equipment (GSE) that is also difficult to deploy to austere locations.

#### CH-53E Super Stallion's Role in Support of ECO

The CH-53E Super Stallion is an invaluable rotary-wing asset in support of certain aspects of ECO and the company-sized MAGTF. Based on task and mission, the ECO MAGTF ACE will certainly be organized to include the CH-53E on occasion, but on a daily basis, the Super Stallion is better served in a general support role of a larger MAGTF. The CH-53E's primary role in support of ECO will be to assist in the initial deployment of the company-sized MAGTF to its area of operation, through its heavy lift capability of vehicles and equipment, and then to continue logistical support of heavy cargo, as may be required from time to time. It is, however, not the most efficient helicopter for use in daily assault support operations in support of ECO, such as re-supply of platoons and smaller units or casualty evacuation (CASEVAC) missions. A CH-53E can certainly conduct these missions, but is not the most efficient choice as the primary aviation asset. The fuel, maintenance Marines, and GSE required to support a CH-

53E would increase the footprint of the company-sized MAGTF ACE, in terms of logistical and service requirements, to a point beyond the intended agility and economy of force of ECO.

### MV-22B Osprey Capabilities and Limitations

The mission of the Marine Medium Tilt-Rotor (VMM) Squadron and the MV-22B Osprey is to “provide transportation of combat troops, supplies, and equipment across the spectrum of expeditionary operations.”<sup>22</sup> The MV-22B Osprey, as the world’s first production tilt-rotor aircraft, accomplishes this mission through its ability to carry 24 combat loaded Marines, internally transport 20,000 pounds of cargo and vehicles, and externally lift 15,000 pounds of equipment with its single or dual-point cargo hook system. The MV-22B incorporates the latest aviation technology including fly-by-wire flight controls, GPS navigation with moving digital map system, imbedded satellite communication (SATCOM), and dual-digital avionics suites displayed on five MFDs.<sup>23</sup> Because the Osprey can take off and land like a conventional helicopter and fly at the speed, distance, and altitude of a fixed-wing aircraft, it can operate from naval amphibious shipping with ranges up to 1,100 nautical miles at speeds of 250 knots.<sup>24</sup> Through its aerial refueling capability, the Osprey can self-deploy anywhere in the world with the support of KC-130J Hercules tanker aircraft. Upon arrival at the objective area, the MV-22B can transition to helicopter mode and approach and land just as a conventional helicopter and do so “at night, in adverse weather conditions, under instrument flight conditions”.<sup>25</sup> The Osprey is changing the dynamics of U.S. Marine Corps assault support because of its range and speed, opening new doors on ship-to-shore and ship-to-objective maneuver (STOM) tactics and logistics in support of combat forces.

The MV-22B does have some distinct disadvantages at this phase of its operational usage. First, the Osprey only has a ramp-mounted defensive weapon capability, which is limited

to defending the rear hemisphere of the aircraft. Though manufacturers have advertised an option for a turret-mounted 20mm gun under the nose of the aircraft, it has yet to be fielded.<sup>26</sup> Critically, no rotary-wing aircraft can physically escort the Osprey at the speeds or distances at which the MV-22B can operate, requiring fixed-wing escorts. The AH-1W/Z can support the Osprey in the objective area but only after multiple FARP evolutions at any distance beyond 100 nautical miles. Also, the external lift capability of the Osprey is airspeed limited by the flight characteristics of the particular external load lifted. For that reason, a majority of its external lift operations are conducted strictly in helicopter mode, at conventional helicopter speeds and at conventional helicopter ranges, severely sacrificing all the beneficial advantages of the MV-22B.<sup>27</sup> Finally, the Osprey is still plagued by numerous aircraft maintenance, tactical employment, safety, and operational issues, resulting in continued criticism that has haunted the MV-22 program since its infancy.<sup>28</sup> The MV-22B has completed a positive first operational deployment to Iraq, which will certainly serve as a stepping-stone towards its overarching success.

#### MV-22B Osprey's Role in Support of ECO

The U.S. Marine Corps has big plans for the Osprey, and the military is willing to rewrite combat aviation tactics, techniques, and procedures based on the capabilities of the MV-22. ECO will disperse infantry companies well beyond mutual support of one another and by utilizing the Osprey, maneuver and logistical support for and between these companies will be very effective. However, in order to maintain the efficiency of ECO, the MV-22B cannot remain in general support of the ECO MAGTF but should only support as required by individual task or mission. The capabilities that set the Osprey apart from helicopters will be wasted when it is directly attached to a company-sized MAGTF for use in a small area of operation that can be

covered by a conventional rotary-wing asset. Also, as with the AH-1W/Z and CH-53E, the MV-22B cannot operate across the spectrum of rotary-wing functions of Marine Corps aviation, thereby resulting in its lack of versatility during certain evolutions that are OAS intensive. This results in logistical and service requirements that are beyond the design concepts of a highly task-organized and efficient ECO MAGTF.

#### UH-1N/Y Huey Capabilities and Limitations

The mission of the Marine Light Attack Helicopter (HMLA) Squadron UH-1N Huey is to “provide combat utility support... and fire support coordination during amphibious operations and subsequent operations ashore.”<sup>29</sup> As a utility helicopter, the Huey can operate across all five functions of Marine aviation that are supported by rotary-wing aircraft: OAS, AAW, Assault Support, Air Reconnaissance, and Control of Aircraft and Missiles. This versatility is reflected in the UH-1N’s ability to provide and control CAS, escort helicopter assets and ground vehicle convoys, transport small troop teams, supplies, and equipment, and operate from naval amphibious shipping “at night, in adverse weather conditions, and under instrument flight conditions.”<sup>30</sup> The twin-engine Huey, introduced in 1970, has a cruise speed of 110 knots, can carry 4-6 passengers or 1300 lbs of cargo, and has a mission-loaded range of 175 nautical miles. The UH-1N employs a combination of 2.75-inch rocket pods, GAU-16 .50 caliber machinegun, GAU-17 7.62mm mini-gun, or the M240 lightweight machinegun and a Navigational Thermal Imaging System (NTIS) FLIR to aid in air reconnaissance and target selection.<sup>31</sup>

The upgraded UH-1Y Venom brings many of the attributes found in the AH-1Z, as these aircraft maintain 84% compatibility among airframe components, avionics, rotor-systems, transmissions, engines, and “glass” cockpit controls and displays. There were no armament improvements to the UH-1Y and it retains the NTIS FLIR. The new twin 1800 shaft horsepower

General Electric engines and an increase to four main rotor and tail blades provide a cruise speed of 135 knots, over 125% more payload capability (including 4,000 pound external lift), and 50% increase in mission range of the UH-1N, to 260 nautical miles.<sup>32</sup>

The UH-1N does have severe limitations due to the weight of ordnance, cargo, and passengers, which grossly affect its speed, range and lift capability. The improved UH-1Y does address many of these shortfalls; however, the Venom's 130 nautical mile combat radius is well short of the range of the MV-22B Osprey and CH-53E Super Stallion. Because the UH-1Y will be called upon, just as the AH-1W/Z Cobra will, to provide long-range escort and objective area CAS, the Huey will also require numerous FARP evolutions just to support one ECO mission. The Huey also lacks provisions for external auxiliary fuel tanks, sacrificing already limited cabin space to internal auxiliary fuel bladders. Even with Venom upgrades, the Huey does not possess precision-guided munitions (PGM) like the AH-1Z, which will be critical on the modern battlefield where combat is waged near civilians and in extremely close proximity to friendly forces. Area fire weapons, such as 2.75-inch rockets, increase potential for collateral damage, intolerable in modern conflicts. The Huey also utilizes skids as landing gear, which negatively affects its shipboard and shore-based ground handling. Also, the new four-bladed UH-1Y can only fold two of its main rotor blades, effectively reducing its width, but not its length, for storage aboard naval ships and will require removal of rotor blades for transport aboard Air Force C-5 or C-17 aircraft.<sup>33</sup> Finally, the UH-1Y's external lift capability is limited to 4,000 pounds, well short of the minimum HMMWV weight of 5,200 pounds.<sup>34</sup>

#### UH-1N/Y Huey's Role in Support of ECO

The utility helicopter concept is perfect for support of all aviation functions in support of ECO. The UH-1N Huey will be able to support the company-sized ECO MAGTF in all

functional areas but will be severely limited in most of those functions. The Huey's inability to range distances capable by other rotary-wing aircraft will require an increase in logistical support, but once in the ECO area of operation, the UH-1N/Y will be versatile and adaptive to changing missions. The Huey will be able to serve as a command, control, and reconnaissance platform for ground forces, quickly transition into a non-precision CAS role, even providing FAC(A) coordination for joint fixed-wing aircraft, and then land at the point-of-injury to CASEVAC a wounded Marine. This multi-function capability will be in concert with the agile, autonomous concept of ECO, but because of previously mentioned limitations, all other U.S. Marine Corps rotary-wing assets will be required to augment the Huey's shortfalls.

#### – CAPABILITIES AND ROLES OF THE BLACK HAWK UTILITY HELICOPTER

##### Background

During the early 1970's, the U.S. Army initiated the Utility Tactical Transport Aircraft System (UTTAS) program, in an effort to find a replacement for its aging, but battle proven, UH-1 Huey helicopter fleet. During the UTTAS study, five helicopters from three manufacturers were evaluated, and in December 1976, the Sikorsky S-70 helicopter was awarded the contract. In October 1978, the U.S. Army received their first S-70, known as the UH-60 Black Hawk, and have successfully employed it for over thirty years.

The Black Hawk has evolved and been upgraded throughout the years, with over 3,000 Army Black Hawk, Navy Sea Hawk, Air Force Pave Hawk, and Coast Guard Jay Hawk tactical helicopters in service within the Department of Defense, and hundreds in civil and military uses in over 25 foreign countries. The Marine Corps considered purchasing the tactical Black Hawk helicopter on two occasions. Initially, the Marine Corps saw it as a replacement for the aging CH-46E Sea Knight medium lift helicopter, a competition that was awarded to the MV-22

Osprey because of the potential of its unconventional tilt-rotor technology. The second time, the Black Hawk challenged the aging UH-1N Huey utility helicopter, but the tactically proven UH-60 was spurned, once again, giving way to a more economical H-1 upgrade program that benefited both the AH-1W and the UH-1N.

The Department of Defense Program Analysis and Evaluation Office initially projected UH-1N upgrades at \$11.3 million per aircraft compared to \$14.3 million per aircraft for the UH-60 Black Hawk. After initial contracting, the UH-1Y evolved into a new-build program at \$19.4 million per aircraft but has survived several program cost reviews because of its 84% commonality with the AH-1Z. The proposed UH-60 Black Hawk currently costs \$18.6 million per aircraft and provides robust capabilities across the Marine Corps rotary-wing aviation functional spectrum.

The Marine Corps will exploit existing capabilities – “off-the-shelf” technology – to the greatest extent possible... in order to minimize research and development costs and fielding time<sup>35</sup>(and) the acquisition effort should balance the need for specialization with the need for utility in a broad range of environments.<sup>36</sup>

Contrary to doctrine, however, the Marine Corps did not commit to the joint advantages and proven tactical capabilities of the utility Black Hawk helicopter.

Commonality among helicopters throughout the United States military, not just within one military branch, improves equipment, maintenance, and personnel interoperability in the joint environment and allows each service to tailor the H-60 Black Hawk to individual roles and functions. Not only is commonality important for operating forces, but it also reduces acquisition, service and logistical costs for the American taxpayer. The company-sized MAGTF will gain full rotary-wing aviation functionality at the cost of a single type helicopter, vice the combined operating and support costs currently required by utilizing all existing Marine Corps aircraft, effectively reducing ACE operating costs.

## Black Hawk Capabilities

The Black Hawk has adapted to missions across the entire rotary-wing aviation functional spectrum. Whether supporting Army Air Assault troops, Air Force Pararescuemen, Navy vertical replenishment (VERTREP), Coast Guard search and rescue (SAR), or while flying the President of the United States as "Marine One" for the Marine Corps, the Black Hawk has proven itself and continues to upgrade for the future. With a cruise airspeed of 150 knots, the latest UH-60 Black Hawk offers two 2000 shaft-horsepower digitally controlled General Electric engines, performance improving composite wide-chord, swept-tip rotor blades, on-board Health and Usage Monitoring System (HUMS), fully integrated Lockheed-Martin digital "glass" cockpit featuring four MFDs with GPS moving digital map, Forward Looking Infrared, enhanced Advanced Flight Control System (AFCS), secure communications including embedded SATCOM and data link, and weaponization modifications for defensive and offensive capabilities.<sup>37</sup> These features translate into rapid buildup of troops and equipment into the objective area, higher aircraft maintenance readiness, cutting edge safety features and communications capabilities, and overwhelming firepower.

Conventional wheeled landing gear simplifies shore-based and shipboard ground handling and Sea Hawk maritime features such as electronic rotor blade and tail-boom folding improve shipboard storage, reducing the Sea Hawk's length to 40 feet 11 inches, compared to 58 feet 4 inches for the UH-1Y. These features also allow for transport aboard the Air Force C-17 or C-5 without any maintenance requirements, resulting in a mission ready helicopter upon arrival, unlike all current Marine Corps aircraft that require considerable maintenance and functional check flights before becoming operationally ready. The Sea Hawk also incorporates

blade de-ice, engine anti-ice, and equipment for day and night all-weather flight.<sup>38</sup> (See Appendix C)

### Armed Capabilities of the Black Hawk

What makes the Black Hawk a true utility helicopter is its robust capability across the entire rotary-wing aviation function spectrum. The "Battle Hawk" version of the Black Hawk incorporates mission computers and armament that have, originally, only been available on dedicated attack helicopters. Through the External Stores Support System (ESSS), the Black Hawk can fully integrate weapons including up to 16 air-to-ground Hellfire missiles, two air-to-air Sidewinder missiles, 2.75inch rockets in 7, 12, or 19 shot launchers, and fixed-forward .50 and 7.62 caliber machineguns, all integrated with a helmet mounted sighting system. Machineguns can also be window mounted as crew-served defensive weapons, keeping doorways free for troop and cargo operations, and Aircraft Survivability Equipment (ASE) protects the Black Hawk through missile, radar, and laser warning and flare and chaff dispensing.<sup>39</sup>

With this weapons capability, the Black Hawk has the flexibility to provide armed reconnaissance in the deep battle space, in support of future operations. The Black Hawk can also conduct CAS and coordinate aviation fires as a FAC(A), for ground forces in the current objective area or along ground convoy routes. Because of its versatility against both ground and air threats, the Black Hawk is well suited as an attached escort platform for assault support helicopter flights into, through, and out of threat areas. The Black Hawk, utilizing its air-to-air PGM capability, can augment fixed-wing and rotary-wing dedicated air defense assets, specifically providing AAW functions to smaller bases and naval shipping beyond mutual support of overarching air defense structures. While providing the Marine aviation functions of

Offensive Air Support, Antiair Warfare, Control of Aircraft and Missiles, and Air Reconnaissance, the Black Hawk can either simultaneously serve as, or quickly adapt to, an Assault Support capability by inserting reconnaissance teams, supplies, or by carrying additional ordnance for reloading organic weapons during the mission.<sup>40</sup>

#### Assault Support Capabilities of the Black Hawk

The Black Hawk is a utility helicopter that has flawlessly functioned as an Assault Support platform since its introduction in 1978, providing maneuver and logistics in support of combat, MOOTW, and peacetime operations. As a primary lift asset for ground force maneuver, the Black Hawk can carry a crew of four (pilot, co-pilot, crew chief, and aerial gunner) along with 12 combat loaded troops, all in crash-attenuating seats and, depending on the mission and combat load, Black Hawks can carry up to 18 troops in a high-density configuration, with each passenger sitting on the floor of the helicopter. The Black Hawk, through visual reconnaissance, secure communications, and ability to operate in austere environments near supported units, will provide excellent command and control capability to ground commanders desiring a birds-eye view of the battlefield. The external rescue hoist supports over water or land based Search and Rescue (SAR) and Tactical Recovery of Aircraft and Personnel (TRAP) missions and the Black Hawk is widely utilized for CASEVAC missions, with provisions for 4-6 litter-bound patients and space for Navy Corpsman, nurses, and doctors to move around and function while providing critical care to the injured.

The 396-cubic feet of cabin space is accessed by two sliding doors, one on each side of the aircraft, through which two forklift-carried, standard warehouse pallets can be loaded. Once loaded, palletized cargo can be positioned via in-floor rollers and secured through numerous cabin tie-down points. A combination of 9,000 pounds of palletized or hand-loaded cargo can be

transported internally and externally through a cargo hook system.<sup>41</sup> With this lift capability, the Black Hawk helicopter can externally lift most variations of the HMMWV, including some “up-armored” versions, providing a ground transportation capability to ground forces that have deployed from naval shipping, when surface delivery is not possible.

The Black Hawk has an operating range of 250 nautical miles, which can be extended through either aerial refueling or use of auxiliary fuel tanks. Aerial refueling gives the Black Hawk unlimited range with support of a KC-130 Hercules tanker. Current Army and Air Force special operations Black Hawks utilize aerial refueling to support deployment to an area of operation, for combat operations including long-range insertion and extraction, and Combat Search and Rescue (CSAR). Without available tanker aircraft, the Black Hawk can utilize up to four ESSS mounted Crashworthy External Fuel System (CEFS) extended range fuel tanks, preserving valuable cabin space required by internal extended range fuel tanks. Each CEFS tank can carry 200 gallons of fuel, increasing total fuel load to 1160 gallons, resulting in autonomous flight operations at ranges up to 720 nautical miles.<sup>42</sup> Black Hawk utility helicopters, through aerial refueling and CEFS, maintain the ability to operate from naval amphibious ships in support of OMFTS and STOM, are capable of self-deploying beyond littoral regions deep into austere locations, and effectively bridge ECO dispersion gaps without a dependence upon logistically intensive FARP’s.

#### Vignette

##### *“The Black Hawk Helicopter In Support Of Enhanced Company Operations”*

*During the spring of 2017, the U.S. Marine Corps deployed Marine Expeditionary Team (MET) B/1/8, a company-sized MAGTF based on the Enhanced Company Operations concept. The MET CE was from 8<sup>th</sup> Marines, the GCE from Bravo Company, 1<sup>st</sup> Battalion, 8<sup>th</sup> Marines, the ACE consisted of an aviation detachment from MAG-29, and the LCE was detached from CLB 8. Having deployed via U.S. Air Force C-17 transport aircraft, the Marines of MET B/1/8 are now conducting security operations in Monrovia, Liberia. President Sirleaf, Liberia’s president, has*

*requested continued U.S. support as her country seeks to reestablish a once robust textile manufacturing industry that crumbled during devastating civil war a decade ago.*

*Prior to departure for Liberia, B/1/8 MET assessed their forthcoming mission and task organized accordingly. The ACE needed to perform primarily Assault Support functions but intelligence briefs indicated an increase in piracy around the coastal waters of Liberia and sporadic, disruptive, tribal conflicts that were interfering with the rebuilding of manufacturing infrastructure and port facilities. For this reason, the ACE also required an Offensive Air Support and Antiair Warfare capability, and deployed with four of the U.S. Marine Corps new UH-60 Black Hawk multi-mission utility helicopters.*

*14 July 2017 Operations in Liberia have been very successful. MET B/1/8 has worked closely with NGO's in the region, as well as Liberian and U.S. government officials. The Black Hawk helicopters have based out of Spriggs-Payne airport in Monrovia, and have been utilized to supply MET forces, provide MEDEVAC capability for the local hospital, for external transport of water and fuel to tribal communities in the deep interior of Liberia, and have provided armed escort for shipping to discourage piracy along the sea lanes and ports of Liberia. To date, three pirate vessels have been destroyed by Black Hawk employed PGM's.*

*21 July 2017 Despite success in Liberia, tensions have begun to rise in nearby Mali due to tribal and political struggles over trade and agriculture along the Niger River. The U.S. Embassy in Bamako, Mali has heightened alert levels and travel warnings with the U.S. Department of State and the 24<sup>th</sup> MEU(SOC), which is committed in the eastern Mediterranean Sea, has detached a company-sized MAGTF, MET G/3/6. MET G/3/6 started sailing for the west coast of Africa aboard the USS Mesa Verde, LPD-19, with two CH-53E Super Stallions and three UH-60 Black Hawks. Two MV-22B Osprey's from the 24<sup>th</sup> MEU(SOC) immediately departed for Rota, Spain to join up with a KC-130 tanker in preparation for the remaining 1800 mile flight to Senou International Airport in Bamako, Mali.*

*22 July 2017 Three MET B/1/8 UH-60's from Liberia, outfitted with CEFS range extension fuel tanks, self-deployed nearly 500 miles inland to Bamako, Mali in order to reinforce the U.S. Embassy with 36 Marines. Two Black Hawks remained in Mali for Air Reconnaissance and standby CASEVAC missions while one evacuated two critical wounded patients to Monrovia, Liberia.*

*24 July 2017 As the USS Mesa Verde passed through the Straits of Gibraltar, the MET G/3/6 UH-60's and GCE flew into Rota for C-17 transport direct to Bamako, Mali.*

*25 July 2017 Two Ospreys departed Rota, flew aboard the USS Mesa Verde for a top-off on fuel, and then joined their KC-130 for in-flight refueling to Bamako, arriving at 1200L. MET G/3/6 had arrived six hours before and was now providing ground and air security vicinity of the U.S. Embassy and other key government buildings, utilizing all three of their UH-60's.*

*With five armed UH-60 utility helicopters and two MV-22B Osprey's in Bamako, along with the entire GCE of MET G/3/6, and 36 Marines from MET B/1/8, officials hoped to thwart a potential coup. The KC-130 operated out of Roberts International Airport in Liberia, where the two CH-*

*53E Super Stallions from the USS Mesa Verde had just arrived. The CH-53E's lifted four HMMWV's to Mali that afternoon, utilizing aerial refueling from the KC-130. The USS Mesa Verde was scheduled to be off the coast of Liberia in 24 hours.*

*26 July 2017 Rioting is making travel in Bamako nearly impossible. One Marine convoy was ambushed and a UH-60 was diverted from a re-supply mission in order to provide CAS. The same helicopter CASEVACed two Marines and a civilian following the ambush. Mob violence was growing and unrest was at its peak and the U.S. Ambassador called for the evacuation of the embassy and over 160 American citizens (AMCIT) and 200 third-country nationals (TCN). MET G/3/6 had now transitioned to Non-Combatant Evacuation (NEO) operations, supported by MET B/1/8. UH-60 Black Hawks evacuated people from the embassy helicopter pad, which was too small for the Osprey, to Senou International Airport, where they were transferred to the KC-130 or CH-53E's for the flight to Roberts International Airport in Liberia. The Osprey's flew the sick and injured directly to the USS Mesa Verde, some 550 miles away, for medical care aboard ship.*

*27 July 2027 By sunset, all AMCITs, TCNs, and embassy staff had been evacuated to Liberia. MET G/3/6 and B/1/8 also retrograded all Marines and equipment to Liberia, to include five UH-60 Black Hawks, utilizing aerial refueling en-route. Preparations for MET G/3/6's return to the 24<sup>th</sup> MEU(SOC) were underway.*

#### - CONCLUSION

In August of 2008, General James T. Conway committed the Marine Corps to developing and implementing the Enhanced Company Operations concept. This concept seeks to distribute forces beyond mutual support of one another and focuses on the infantry company as the smallest unit capable of sustained dispersed operations. Through analysis of Marine Corps Operations and Warfighting Functions, ECO will utilize the MAGTF construct, comprised of a Command Element, Ground Combat Element, Logistics Combat Element, and Aviation Combat Element. Because ECO is designed to be highly versatile and capable across multiple functional areas, it will require an ACE that is equally adaptive and effective. In order to maintain the agility and responsiveness of the ECO MAGTF, yet still provide the full rotary-wing functions of Marine aviation, a single, highly effective, multi-functional, rotary-wing aircraft is required to serve as the primary asset of the ACE. The Sikorsky Black Hawk utility helicopter is the most

versatile, tactically flexible, and capable rotary-wing aircraft and is the perfect solution for the primary aviation support of the Marine Corps Enhanced Company Operations concept.

## APPENDIX A

### ROTARY-WING AVIATION FUNCTIONS

#### Offensive Air Support

Offensive Air Support (OAS) “involves air operations that are conducted against enemy installations, facilities, and personnel in order to directly assist in the attainment of MAGTF objectives by destroying enemy resources or isolating enemy military forces”.<sup>43</sup> HMLA squadrons provide OAS through Close Air Support (CAS) and Deep Air Support (DAS) in support of the Maneuver, Fires, and Force Protection Warfighting Functions.<sup>44</sup>

#### Antiair Warfare

Antiair Warfare (AAW) “is the actions used to destroy or reduce the enemy air threat to an acceptable level”.<sup>45</sup> HMLA squadrons provide offensive and defensive AAW in support of the Fires and Force Protection Warfighting Functions.<sup>46</sup>

#### Assault Support

Assault Support (AS) “uses aircraft to provide tactical mobility and logistical support to the MAGTF”.<sup>47</sup> HMLA, HMM, HMH, and VMM squadrons provide AS through combat assault support, air delivery, air evacuation, and tactical recovery of aircraft and personnel (TRAP) in support of the Maneuver, Logistics, and Force Protection Warfighting Functions.<sup>48</sup>

#### Air Reconnaissance

Air Reconnaissance “employs visual observation and/or sensors in aerial vehicles to acquire intelligence information”.<sup>49</sup> All rotary-wing squadrons contribute to visual reconnaissance and HMLA squadrons provide visual and multi-sensor imagery reconnaissance in support of the Intelligence and Force Protection Warfighting Functions.<sup>50</sup>

#### Control of Aircraft and Missiles

Control of aircraft and missiles “integrates the functions of Marine aviation by providing the commander the ability to exercise command and control authority over Marine aviation assets”.<sup>51</sup> HMLA squadrons can provide air direction and air control of aircraft and missiles by functioning as airborne Forward Air Controllers (FAC(A)) or as airborne Tactical Air Coordinators (TAC(A)). They also provide an aviation platform and communications capabilities for use by ground commanders above the battle space. These capabilities support the Command and Control Warfighting Function.<sup>52</sup>

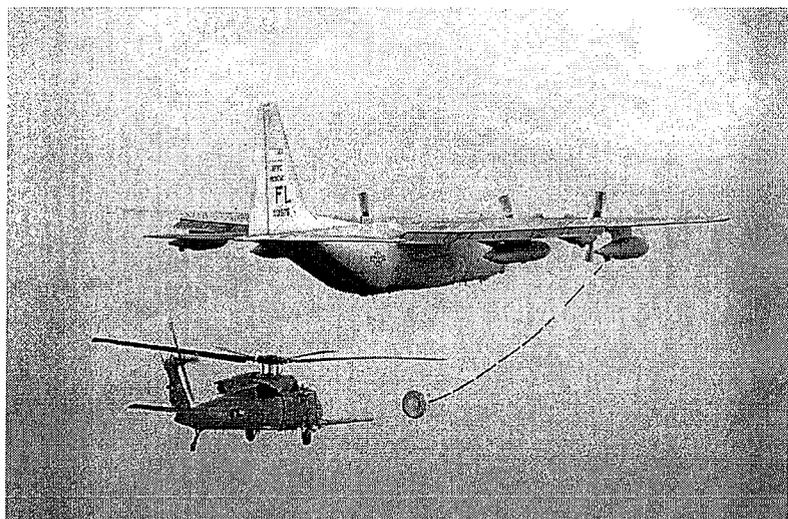
APPENDIX B

ROTARY-WING AIRCRAFT FUNCTIONS AND CAPABILITIES

	AH-1W/Z		CH-53E	MV-22B	UH-1N/Y		UH-60
Offensive Air Support	X				X		X
Antiair Warfare	X						X
Assault Support			X	X	X		X
Air Recon	X		X	X	X		X
Control of Aircraft and Missiles	X				X		X
	AH-1W	AH-1Z	CH-53E	MV-22B	UH-1N	UH-1Y	UH-60
Cruise Speed (kts)	120	135	150	250	110	135	150
Max Range (nm)	250	250	500	800 VTOL 1100 STOL	175	260	250
Max Range w/ External Auxiliary Fuel	N/A	N/A	N/A	N/A	N/A	N/A	720 nm
Aerial Refuel	N/A	N/A	YES	YES	N/A	N/A	YES
Internal Cargo (lbs)	N/A	N/A	32,250	20,000	1300	4,000	9,000
External Lift Cargo (lbs)	N/A	N/A	36,000	15,000	1300	4,000	9,000
Passengers	N/A	N/A	37-55	24	4-6	8	12-18
Weapons	20mm gun 2.75 & 5in rockets	20mm gun 2.75in rockets	3 x .50 cal machineguns	1 x .50 cal machinegun	GAU-16, GAU-17, M240 2.75in rockets	Same as UH-1N	GAU-16, GAU-17, M240 2.75in rockets
PGM's	8 x TOW 8 x Hellfire 2 x Sidewinder	16 x Hellfire 6 x Sidewinder	N/A	N/A	N/A	N/A	16 x Hellfire 2 x Sidewinder

APPENDIX C

SIKORSKY UH-60 BLACK HAWK PICTURES



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ENDNOTES

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<sup>8</sup> Commandant of the Marine Corps, *A Concept for Enhanced Company Operations*, 2.

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<sup>10</sup> *Ibid.*

<sup>11</sup> *Ibid.*, 2-1 – 2-2.

<sup>12</sup> Headquarters U.S. Marine Corps, *Marine Corps Operations*, A-1.

<sup>13</sup> *Ibid.*, 2-13.

<sup>14</sup> *Ibid.*

<sup>15</sup> TBD.

<sup>16</sup> Bell Helicopter, A Textron Company. *Bell AH-1Z Pocket Guide*. Marketing Publication Manager, Fort Worth, TX: [www.bellhelicopter.com](http://www.bellhelicopter.com), March 2006, 1-72.

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- <sup>35</sup> Headquarters U.S. Marine Corps, *Warfighting*, MCDP 1 (Washington, DC: U.S. Marine Corps, June 20, 1997), 65.
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<sup>41</sup> Ibid., 18.

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<sup>45</sup> Ibid., 2-2.

<sup>46</sup> Ibid., 3-1 – 3-2.

<sup>47</sup> Ibid., 2-3.

<sup>48</sup> Ibid., 3-1 – 3-2.

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