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1. AGENCY USE ONLY (LEAVE BLANK)		2. REPORT DATE		3. REPORT TYPE AND DATES COVERED STUDENT RESEARCH PAPER AY 2011-2012	
4. TITLE AND SUBTITLE MAXIMIZING THE AVIATION COMBAT ELEMENT OF THE FUTURE				5. FUNDING NUMBERS N/A	
6. AUTHOR(S) Major Jon B. Livingston, USMC					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) USMC COMMAND AND STAFF COLLEGE 2076 SOUTH STREET, MCCDC, QUANTICO, VA 22134-5068				8. PERFORMING ORGANIZATION REPORT NUMBER NONE	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) SAME AS #7.				10. SPONSORING/MONITORING AGENCY REPORT NUMBER: NONE	
11. SUPPLEMENTARY NOTES NONE					
12A. DISTRIBUTION/AVAILABILITY STATEMENT NO RESTRICTIONS				12B. DISTRIBUTION CODE N/A	
ABSTRACT (MAXIMUM 200 WORDS) The introduction of MV-22Bs and F-35Bs to the ACE increases the aviation logistics footprint aboard ship and limits operational employment options by decreasing sortie generation rates and encroaching on the space available to conduct operational missions. Simply decreasing the numbers of aircraft assigned to the MEU will only serve to decrease sortie generation capability for the sake of space. Modifications to the ACE embarkation plans, aircraft support equipment, and aircraft maintenance capabilities aboard the LPD-17 class ship are required to increase sustainability for aviation assets shipboard operations.					
14. SUBJECT TERMS (KEY WORDS ON WHICH TO PERFORM SEARCH) Aviation Combat Element, ACE, MEU ACE, MEU Organization, ACE Organization, Aviation Logistics Footprint, Aviation Operations, Shipboard Operations, V-22, JSF, AIMD				15. NUMBER OF PAGES: 44	
				16. PRICE CODE: N/A	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED		18. SECURITY CLASSIFICATION OF THIS PAGE: UNCLASSIFIED		19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	
20. LIMITATION OF ABSTRACT					

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Command and Staff College
Marine Corps University
2076 South Street
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MASTER OF MILITARY STUDIES

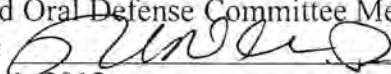
TITLE: Maximizing the Aviation Combat Element of the Future

SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF MILITARY STUDIES

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EXECUTIVE SUMMARY

Title: Maximizing the Aviation Combat Element of the Future

Author: Major Jon Livingston, United States Marine Corps

Thesis: Modifying the Marine Expeditionary Unit (MEU) Aviation Combat Element's (ACE) embarkation plans, aircraft support equipment, and aircraft maintenance capabilities aboard air capable ships will increase sustainability for aviation assets during disaggregated operations.

Discussion: The introduction of MV-22Bs and F-35Bs to the ACE increases the aviation logistics footprint aboard ship and limits operational employment options by decreasing sortie generation rates and encroaching on the space available to conduct operational missions. Simply decreasing the numbers of aircraft assigned to the MEU will only serve to decrease sortie generation capability for the sake of space.

The amount of hangar bay space allocated to ACE support and maintenance equipment is insufficient to embark all equipment items assigned to the squadron. The amount of equipment will also require an aircraft parking plan on the flight deck of the LHA/LHD, which necessitates multiple aircraft towing evolutions to launch and recover aircraft. These additional towing evolutions result in a reduction of sortie generation capability by increasing the time between aircraft launches to move aircraft into launch positions.

In addition to these limitations, the increased equipment footprint will prevent usage of the hangar bay for operational missions such as pre-staging of troops for disembarkation, staging of detainees, triage space for casualties, or the processing of noncombatants during noncombatant evacuation operations. The current ARG includes air-capable LPD class ships, which are not optimized for sustained aviation operations.

During many MEU operations LPDs already embark aircraft detachments to facilitate both distributed and disaggregated ARG operations and to alleviate space constraints on the LHA/LHD during aggregated ARG operations. However, the lack of any Aircraft Intermediate Maintenance Division (AIMD) support aboard the LPD requires the LPD to stay in close proximity to the LHA/LHD because both replacement parts and certification equipment are currently only embarked on the LHA/LHD.

Conclusion: Modifications to the ACE embarkation plans, aircraft support equipment, and aircraft maintenance capabilities aboard the LPD-17 class ship are required to increase sustainability for aviation assets during shipboard operations.

PREFACE

The United States Navy and the Marine Corps provide a unique capability set to the nation's defense. As the United States refocuses defense priorities toward the Asia Pacific region, the Navy-Marine Corps team will, by virtue of those capabilities, play a vital role. The Marine Expeditionary Unit (MEU) is an integral portion of that capability, but there is definitely room for process improvement when looking at future requirements. Deployments aboard LHD-6 and LPD-7 opened my eyes to the daily physical grind and mental gymnastics performed by our Marines and Sailors who ensure the Geographic Combatant Commander has an expedient, effective, and vigilant MEU ready for tasking. This paper is dedicated to them and all of the times I've heard, "You know sir, I don't know why we don't just _____? It would make us so much more efficient!" This paper will combine previous research and conceptual development performed by naval service professionals across the country with lessons learned from several recent MEU deployments. The ultimate goal is to ensure that the upgraded aviation platforms are able to maximize their newly acquired capabilities across the ships of the Amphibious Readiness Groups to improve capacity.

I would like to express my gratitude to Colonel Eric Steidl, Major Douglas Sanders, Captain Douglas Pack, Lieutenant Michael Mullerheim, Master Gunnery Sergeant Daniel Clinger, and Master Sergeant Marney Adams. Additionally, the guidance and mentorship of Dr. Paul Gelpi and Lieutenant Colonel Jeffry Tlapa kept me "on course, on glide slope" during this research year. This paper would not have been possible without the graciously volunteered time and tutelage of all mentioned above.

INTRODUCTION

The Marine Corps is in the midst of a transition, which will replace every "legacy" aviation platform with an upgraded version of the same basic airframe or an entirely new aircraft to fill its current role. While the upgrades bring significant performance and capability improvements over the aircraft they are replacing, both the characteristics of the new aircraft and the manner in which Amphibious Readiness Groups are conducting operations have created operational limitations on the Aviation Combat Elements (ACE) of Marine Expeditionary Units (MEU). This paper will focus on the negative effects that the aircraft upgrades will have on MEUs in terms of physical space and weight gains levied on the ACE as a result of each transition. A discussion of the intricate engineering issues involved will be followed by several options for the commanders of MEUs, Amphibious Readiness Groups (ARG) and supporting establishments. The ultimate goal is a course forward which will enable MEU commanders to fully leverage their assigned capabilities against physical and fiscal constraints which define today's ARG.

A clearer view of future requirements will emerge from a synopsis of historical operations framed against current National Security Strategy and bound by the most recent Quadrennial Defense Review. An examination of amphibious shipping stability limitations will quantify the restrictions facing the ships of the 21st Century Marine Expeditionary Unit and reinforce the recommended course of action. The intent is to ensure that the ARG, the MEU, and its ACE assets are optimized to perform the most likely enhanced MAGTF operations. The result will be increased sustainability for aviation assets during disaggregated operations.

BACKGROUND

In September of 2011, Headquarters Marine Corps (HQMC) Aviation convened an internal operational planning team (OPT) to examine the composition of future Aviation Combat Elements (ACE) assigned to Marine Expeditionary Units. The OPT members were subject matter experts representing each ACE type/model/series (T/M/S) who reviewed the current table of organization for aircraft assignments to MEU commanders in order to validate or recommend changes to assignment tables. The OPT developed the following problem statement: “The current MEU ACE is not optimized to support the MEU in the 2015 and beyond operating environment because of myriad challenges, to include fiscal constraints, reductions in amphibious shipping, requirements for greater operational reach and tempo, and the need for timely fire support.”¹ Specific limitations contributing to this problem stem from the transition plan for the CH-46 to the MV-22, UH1-N to the UH-1Y, AH-1W to the AH-1Z, and AV-8B to the F-35B. Each of these upgrades and the fielding of a small tactical unmanned aerial system (STUAS) will affect the embarkation of the MEU ACE of the 21st Century.²

Collectively, these transitions include both space and weight increases, which will exceed the current operating limitations of Landing Helicopter Assault (LHA) and Landing Helicopter Dock (LHD) class amphibious assault ships. Compounding this issue, each upgrade T/M/S requires more and heavier support equipment than its predecessor. The aggregate space increase will exceed the space footprint allotted for ACE equipment on LHA-1 class and LHD-1 class amphibious assault ships.³ Because the equipment pieces are stored relatively high above the ship’s center of gravity, they threaten the vessel’s safe maneuvering limitations during underway operations.⁴ Additionally, the increase in aggregate footprint has severely limited the maneuvering space on the ship’s hangar and flight decks. As one recent MEU commander

phrased it: “The MV-22 ACE of today already exceeds the operational capacity to efficiently operate the entire ACE from the LHD.”⁵ With the addition of the F-35 and its equipment to the MEU, there will be even less space to park aircraft in the ship’s hangar. This will cause more aircraft to be parked on the flight deck, which will require a parking plan that places some aircraft in positions that will block the movement of other aircraft. The net result is a flight deck which requires multiple aircraft towing evolutions to launch a single aircraft. This is inefficient in terms time and ultimately leads to a reduced number of sorties which can be launched within the ship’s finite flight window.

Is there more floating real estate?

With an increasing amount of space required, one possible solution may be to add another amphibious assault ship to each ARG in order to increase the total real estate available for embarkation. There are 30 amphibious assault ships in the Navy's current inventory.⁶ The Navy’s *Annual Long Range Plan for Construction of Naval Vessels* (typically referred to as the “30 Year Plan”) states that the number will remain below the Navy’s 33 ship goal through 2015. While the inventory of amphibious ships is projected to exceed the Navy’s goal from 2017-2030, the 30 year plan forecasts inventory will again fall below that level after 2030.⁷ At no time does the Navy shipbuilding plan reach the Marine Corps’ requirement of 38 amphibious ships (see Table 1).⁸ The Marine Corps derived the 38 ship number from the requirement for “joint forcible entry operations,” which it sees as mission of a Marine Expeditionary Force consisting of two Marine Expeditionary Brigades (MEB) as outlined in *Marine Corps Vision and Strategy 2025*.⁹

Until a forcible entry operation is required, Marine Corps peacetime operations will hinge on presence and theatre security cooperation led by Marine Expeditionary Units on scheduled deployments. Of the current inventory of 30 ships, maintenance cycles will further decrease the number of deployable ships to 27 at any one time. To facilitate the 11th, 13th, and 15th MEUs through their dwell, work-up, and deployment cycle, the California based ARG requires 12 amphibious ships. To facilitate the 22, 24, and 26 MEUs through the same cycles the Norfolk based ARG requires 12 amphibious ships. To support the 31st MEU in Okinawa the Japan based ARG requires 3 ships. Because the maximum capacity narrowly meets the minimum requirements, there are no additional ships available to increase the size of each ARG and the simultaneous sea based deployment of two MEBs will not be possible. While there will admittedly be four additional ships in the Navy inventory during the mid-term period of 2021-2030, those figures constitute a planned overlap of LSD class vessels intended to facilitate the transition from the LSD-41 class to the LSD(X) class. There will be no net gain in usable flight deck space during this period. The end result is a fleet of amphibious assault ships, which will be incapable of operating the entire ACE of the 21st Century solely from the deck of the LHA or LHD alone. Therefore, MEU commanders are faced with the challenging problem set of arranging their forces aboard ship in a way that facilitates operations while ensuring they are properly task organized aboard their individual embarked vessels to enable them to quickly react to any assigned mission.

Task organized for what?

What then are the most likely missions to be executed by Marine Expeditionary Units in the future? Which of those missions would carry with them the highest consequences of failure? Certainly the MEU ACE of the 21st Century should be right-sized to accomplish these

significant mission sets above others. A historical analysis of MEU operations created a baseline of expected mission types and associated mission essential tasks (METs) for future MEU operations. Research conducted by the Congressional Budget Office in 2011 looked at the "missions of expeditionary warfare forces" and concluded:

Between 1990 and mid-2010, amphibious forces conducted 107 separate operations. Of that total, 4 were categorized as assaults, 1 was a raid, 3 were demonstrations, 1 was a withdrawal, 78 were support to other operations, and 20 did not fit any of the five types of missions conforming to the Marine Corps doctrine.¹⁰

The Operational Planning Team at HQMC Aviation expanded the historical window from 1980 to 2010 and separated the missions beyond simple doctrinal terms into subsets of the MEU's Mission Essential Task List (METL). The METL contains the skill sets in which each MEU is required to demonstrate proficiency prior to deployment. Not surprisingly humanitarian assistance missions account for the largest percentage (28%) of missions followed closely by "Amphibious Operations", which account for 17%, then stability operations at 14%, and non-combatant evacuation operations at 10%. In total, these four mission essential tasks account for 70% of 258 MEU missions executed over the thirty year period (See Table 2).¹¹ The consulting firm Whitney, Bradley, and Brown Inc. conducted a review of the same tasks and ranked them according to lift footprint requirements. In most cases, the most likely missions tended to be the least stressful in terms of lift requirements with the exception of joint and combined operations and stability operations.¹² However, historical commitments alone are not representative of future requirements.

The President's National Security Strategy and the Secretary of Defense's recently published Priorities for 21st Century Defense each frame a clear niche within which the Marine Corps can expect to operate Marine Expeditionary Units. The Secretary calls for a "global

presence emphasizing the Asia-Pacific and the Middle East" through power projection.¹³ Of the ten primary missions of the U.S. Armed forces listed in those priorities, two fall squarely along the mission essential tasks of the Marine Expeditionary Unit: the conduct of stability and [limited] counterinsurgency operations and the conduct of humanitarian/disaster relief operations. In line with the Commandant's Strategy and Vision 2025 and the Marine Corps Operating Concepts, future MEU missions will be focused on humanitarian assistance, theatre cooperation and stability operations. Regardless of the mission types, by the very nature of the Amphibious Readiness Group, they will be heavily dependent on ship-to-shore movement of personnel and material.

How did the ships get so heavy?

Early amphibious assault class ships were designed and built in the 1970s and were engineered to run on navy distillate fuel (NDF). In 1975 the Navy shifted to diesel fuel marine (DFM), which is a more refined, cleaner burning fuel oil.¹⁴ The new DFM was lighter than NDF, which decreased the ship's overall displacement and simultaneously increased each ship's KG or height of the center of gravity above the ship's keel. The increase in KG meant that as the weight was removed from the ship's fuel tanks (located low in the ship's hull structure) a larger percentage of the ship's overall weight resided higher in the ship's mass, and therefore the ship was less stable.

Throughout the evolution of amphibious assault class ship design, the fuel oil swap was not the focus of engineering design changes because it only resulted in a KG increase of approximately three inches. That measurement was predicated on a crew practice called "dirty ballast." To compensate for the loss of low center of gravity weight as fuel oil was burned, the

ship was designed to ingest seawater into the tanks to replace the spent fuel and maintain ballast. However, dirty ballast was discontinued due to its effect on the environment when the seawater was pumped out to make room for fuel oil resupply. Compounding the issue of KG increase were the additions of multiple weapons systems for which the ships were not originally designed. The MK16 Phalanx Close in Weapon Systems (CIWS), Rolling Airframe Missile (RAM) Systems, SPS 48/49 Radar System, and Challenge Athena Radar System each served to increase the ships' KG distance.¹⁵

Each of these factors incrementally raised the ships' KG closer and closer to maximum allowable limitations. A series of tests conducted on LHA 1 class ships between 1985 and 1994 resulted in a decrease to the ships' stability status ratings. The increased weight and KG no longer allowed the ships to sustain the same level of theoretical damage and remain afloat.¹⁶ Ultimately, a revised liquid loading plan for LHA 1 class ships was adopted, which extended KG limitations without requiring the use of dirty ballast.

Although the practice was no longer in use by Navy crews, LHD 1 class ships also incorporated the dirty ballast design. Due to weight increases throughout the life of these ships and the limitations imposed by dirty ballasting corrective measures, the LHD 1 class ships were labeled deficient in KG margin in the fall of 1995.¹⁷ Corrective measures were studied and a retrofit fuel compensating system was installed on LHA 1, LHD 1, and the newest LHD 5-6 class ships as well. Because the fuel compensating system was developed during the design phase of the LHD 7 class the design specifications for that ship were modified to include the compensation system prior to completion.¹⁸

Adding to the problem.

In 2006, with each class of amphibious assault ships already facing organic weight and stability issues, planners conducted a review of both weight and footprint considerations for a new fleet of aircraft upgrades which would replace the aging legacy platforms of the ACE. The old ACE consisted of several different aircraft mixes, which varied based on the ship upon which the ACE was embarked and the presence or absence of armored assets (main battle tanks and light armored vehicles) on the ship.¹⁹ Legacy aircraft will be swapped one-for-one within their respective squadrons, but some adjustments were required to accommodate differences in operational space between the LHA and LHD. By conventionally forming a reinforced squadron around the medium lift platform, the ACE of the 21st Century for squadrons embarked on an LHD would consist of a Medium Marine Tiltrotor Squadron with (12) MV-22s reinforced with (4)CH-53s, (7)H-1s, and (6) F-35s. Two MH-60s would also be embarked aboard the LHD separate from the ACE and operationally controlled by the Commander of the Amphibious Readiness Group. Because of the size constraint of the LHA, initial assessments of the logistic footprint for that ship included only (10)MV-22s and (3)H-1s. The fielding cycle for F-35s exceeded the planned service life of the last LHA so (6)AV-8Bs were assessed instead. Associated aviation support equipment (ASE) for each squadron configuration was loaded on the ships with the respective aircraft. The ASE included all “yellow gear” (servicing equipment) and a full allotment of repair parts as dictated by the aviation consolidated allowance list or AVCAL.

The resulting data proved that the embarkation of the “New ACE” (as it existed in 2006) would result in 70% of the nation’s large deck amphibious assault ships operating in a reduced stability status for the full range of environmental conditions in which they were tested.²⁰ These findings predicted that LHD 3 and 4 will be forced to operate above the allowable KG limit once

embarked with the MV-22 ACE and will increase their delta (Δ) as the F-35 and projected 2015 and 2024 GCE equipment sets are phased into inventory.²¹ The LHA class would be limited to (10) MV-22s due to footprint constraints; however, LHDs 1-7 would all be able to support the 2006 aviation logistics footprint of (12)MV-22s and (6)F-35s.²² With fiscal constraints looming over the Navy's amphibious assault ship acquisition programs, the only option to reduce stability risks would be the fuel oil compensation system modifications already in work. This compensation system was then incorporated into design characteristics for future LHD class ships.

Focusing on space.

As the MV-22 and F-35 programs matured in the 2007-2010 period, so did the size of their individual logistic footprints. The MV-22 conducted its first shipboard deployment aboard LHD 5 in May 2009, which helped to validate footprint requirements under operational conditions. In 2010 the Aviation/Ship Integration Branch at Naval Air Systems Command's (NAVAIR) conducted another operational logistics footprint assessment and discovered that since the 2006 study the amount of equipment and supplies to be embarked by the ACE had grown. A majority of the growth was a function of F-35 program maturity. Two of the largest space requirements that emerged were the F-35's Deployable Mission Rehearsal Trainers (DMRT) and the engine trailers and replacement system. The DMRT is a cockpit trainer used to allow pilots to rehearse missions and remain proficient at associated flight skills. The F-35 program currently calls for one complete spare engine assembly and another spare engine packaged as separate modules. These large components and the two engine trailers required to conduct a "roll-out / roll-in" engine swaps contribute significantly to the F-35s embarked aviation logistics footprint.

In August of 2010 the NAVAIR Aviation/Ship Integration branch published the results of the Amphibious Assault Ship Operational Logistics Footprint Assessment for the 2015 Marine Expeditionary Unit (MEU) Aviation Combat Element (ACE). The stated purpose of the assessment was to “[i]dentify the operational logistics footprint of the 2015 MEU ACE embarked on LHD-1, LHA-1, LHA-6, and LPD-17 class vessels.”²³ The study utilized scaled modeling at the Carrier Analysis Lab in Lakehurst, New Jersey to replicate the stowage and operational movement of all ACE assets both on the deck of and in the hangar areas of each class ship. The T/M/S of all aircraft, which would be fleet fielded in 2015 along with the requisite support equipment, AVCAL parts, and tools for each T/M/S were stowed. These items were termed “need to have items.”²⁴ The assessment team noted “[d]uring the 26-28 January 2010 spotting conference, aircraft placement and potential ACE reconfigurations were based on available logistics data vice an established ACE Air Plan or Concept of Operations (CONOPS).” This exercise only assessed the feasibility of best embarkation options for all equipment assigned to the 2015 MEU ACE and did not take into account a specific method of employing the equipment operationally – this was a study based solely on stowing the equipment within the allotted space and did not focus on the efficient operational employment of the equipment for specific missions.

Through a coordinated conference with stakeholders representing each embarked community and ship’s company, the assessment team identified items which were not essential for shipboard operations, or were redundant to the equipment of other T/M/S aircraft or the ship’s organic equipment. These items were all labeled “not essential” and space was not allotted to them in the exercise.²⁵ The problems to be solved were two fold. First, the team needed to find stowage space for the need to have items. Additionally, the aircraft stowage spots needed to be arranged to allow for maximum maneuver space (referred to as “operational

space”). Operational space allows the aircraft to be towed directly from its stowed position into a position from which it can be launched without the movement of any other aircraft. If two moves are required to make an aircraft operational then that aircraft is considered to be in a locked spot. Locked spot stowage was an important consideration due to the exponential man-hour requirement that the aircraft handlers would shoulder for the movement of each lock spot aircraft during a single flight operations cycle. The team then adjusted aircraft positions on each class of ship to maximize the stowage space available. By then arranging the representative cargo on a scaled model of the ship, they developed configurations which would maximize stowage and operational space. The assessment concluded with four courses of action (COA) as “potential risk mitigations strategies.”²⁶

COURSES OF ACTION

These courses of action used four aircraft scenarios provided by the Aviation Plans and Policies division of Headquarters Marine Corps. Each incorporated the removal of two MV-22B aircraft from the ACE. This was done to remain in-line with the number of aircraft currently assigned to MEU squadrons. The four courses of action are distinct in that they range from the fewest changes to the standard parking plan in COA 1 to the permanent relocation of an entire detachment of aircraft to the LPD in COA 4. Emphasis was placed on increasing operational footprint while minimizing operational impact of maintaining and employing the aircraft from the LHA/LHD.

The twelve aircraft configuration of the ACE aircraft had been refined and validated through four decades of operational experience utilizing the CH-46E helicopter which were capable of lifting 12 combat loaded Marines per sortie. With the transition from CH-46E to MV-

22 that variable changed. The MV-22 is capable of lifting 24 combat loaded Marines per sortie but is often filled with 18 Marines to allow room for combat gear and maintain the integrity of six man sticks. Despite the loss of (2)MV-22s, this increase in troop capacity and a cruise airspeed significantly faster than the CH-46s afforded the MAGTF commander a net gain in operational capacity to support a heliborne lift. While the procurement plan still calls for every Marine tiltrotor squadron to receive (12)MV-22s, all MEU ACEs to date have deployed with only (10)MV-22s.²⁷

The reduction of (2)MV-22s significantly improved the crowded footprint aboard the ARG, but it did not solve the problem. The four remaining COAs each required additional changes to the standing configuration (See Table 3). After action reports from previously deployed MEUs, and the Commandant's guidance on future distributed operations, indicate that mission will require task organizing the ACE aircraft amongst all air capable ships in the ARG. While this course of action increases the operational reach of the MAGTF commander when the ARG is distributed, it simultaneously creates an aviation logistics sustainment issue. When ACE aircraft are detached aboard the LPD the ACE commander is forced to accept operational risk of distributed aviation logistics and maintenance requirements. Many facilities for executing intermediate level maintenance for embarked aircraft only exist on the LHD/LHA class ships. The ARG's Aircraft Intermediate Maintenance Department (AIMD) is an onboard repair facility capable of making intermediate level repairs, which require more specialized training and equipment sets than those provided to the operational squadron maintenance departments. With an increasing amount of operations conducted by distributed or disaggregated ARGs, the MAGTF commander often chooses to send a small contingent of Marines trained on intermediate level repairs along with aircraft detachments. Often though, this is only marginally

effective as these maintainers can bring with them only a limited amount of repair or test equipment and the LPD-17 class ship upon which the detachments are usually embarked have no test benches or repair technicians to conduct intermediate level repair.

The way ahead.

The size of the post-upgrade Aviation Combat Element will require aircraft be permanently operated from all ARG air capable ships. Additionally the aviation maintenance spaces aboard those ships must be staffed and equipped to operate in both distributed and disaggregated operational constructs. The paradigm of an ARG operating within distances to provide mutual fires, logistics, or even communications support, has shifted. According to the Marine Corps Center for Lessons Learned, “Recent MEUs have all participated in disaggregated operations at some level.”²⁸ The last two MEUs have both been extended deployments with operations disaggregated over hundreds of miles. Ships of the same ARG even operated in geographic areas owned by different fleet and combatant commanders. Based on historical analysis as well as the stated priorities of the President and Secretary of Defense, future ARG operations will continue on this trend. According to the Navy’s *30 Year Plan* and budgetary priorities, no additional ships will be added to the standard amphibious readiness group. Three L class ships consisting of an LHD or LHA, LPD, or LSD will support the ARG through 2050. The Marine Expeditionary Unit will be this nation’s forward deployed force in readiness. Contingency operations which require forces larger than a standard MEU, such as a Marine Expeditionary Brigade sized force or larger will be forced to break from the standard ARG deployment cycle because there will not be enough ships to sustain simultaneous MEU operations and MEB deployments. Consequently, the ability to operate detachments from LPD class ship will be vital

to the ATF commander who requires sustained operational efficiency from aircraft embarked on all air-capable ships.

The Navy will rely on the L class ships currently in service through the first half of the 21st Century. The ships which present challenges with weight, KG, and footprint space are LHA 5 and LHD 1-4. Due to the restricted operating conditions in which these ships are already operating, efforts to lighten the MAGTF through ground combat element equipment weight reduction can only help to delay the weight growth of the overall MEU but will not support enough weight removal to reverse the trend. Therefore, the MEU commander must ensure his individual MEU is right sized for his individual deployment. The unique strength of any MAGTF is the scalable command and control architecture it offers a joint force commander. The MEU of the 21st Century must be composited to fit the mission, and clearly, the missions most likely to occur are humanitarian assistance, amphibious operations (ship to shore or shore to ship movement), noncombatant evacuation operations, and a growing number of maritime interdiction operations.

Recent MEU deployments have conducted as many as three of these missions simultaneously and in widely dispersed areas of operation.²⁹ One option to eliminate the need for detaching aircraft away from the repair facilities on the ARG's LHA or LHD class ship might be to reduce the total number of aircraft embarked with the MEU ACE. However, reducing total aviation assets beyond current levels would diminish the MEU commander's ability to support such distributed operations in the future. While the MV-22 is operationally superior to the CH-46 in terms of capacity and speed, their total number required hinges on their use as detachments from the composite squadron. If used in a traditional fashion, with all MV-22s supporting the same mission set from the same location, then their increased efficiency and sortie generation

rate could be a logical argument to warrant their deployment in lesser quantity. However, the transition from the CH-46 to the MV-22 provided the MAGTF commander a generational leap forward in combat power projection. To further reduce the number of aircraft assigned to his unit would only serve to negate the tactical advantages afforded him by these increasingly capable aircraft. With the increase in distributed/disaggregated employment the baseline number for the medium lift tiltrotor composite squadron must remain at a minimum of (10)MV-22s. As indicated in the 2007 technical report compiled by the Naval Surface Warfare Center, the remaining LHA class ships are only able to support (10)MV-22s.³⁰ The lessons learned from the previous four MEUs deployed with MV-22s clearly illustrates that MEUs embarked on LHD class ships can accomplish their missions with 10 total aircraft vice the 12 primary authorized aircraft that each medium lift tiltrotor squadron is programmed to receive according to the FY2012 Marine Aviation Plan.³¹ This modification would also fall in line with the courses of action recommended and tested in Naval Air System Command's (NAVAIR) 2010 Operational Logistics Footprint Assessment.³²

The four courses of action presented in NAVAIR's 2010 assessment represent the best analysis to date of the space requirements and shortfalls associated with the above recommended course of action to maintain the MEU ACE aircraft assignments in their current numbers minus (2)MV-22s. By spotting all the equipment identified as "need to have" by the ACE's subordinate components, the Aviation/Ship integration departments at both NAVAIR and the Marine Corps Combat Development Command (MCCDC) have developed options for future MEU commanders to tailor their embarkation plans to meet the needs of their individual expected mission sets. In the baseline comparison, 119 items could not be spotted after all gear and

aircraft were embarked aboard an LHD. Additionally, due to flight deck congestion, two aircraft had to be parked in locked spots.

NAVAIR COA 1 embarked only (10)MV-22s and relocated (1)AH-1Z from the hangar bay to the flight deck. This provided additional room in the hangar bay to accommodate a total of 64 “need to have” items, and left 55 items unspotted. This course of action provided maximum space in the hangar bay but resulted in an increase in aircraft parked in locked spots from two to five and significantly decreased the space between parked MV-22s. This limited the maintainers’ ability to conduct maintenance while aircraft were parked in those spots and increase the potential for aircraft damage during parking and spotting evolutions. (See Appendix A)

NAVAIR COA 2 not only embarked (10)MV22s and relocated (1)AH-1Z from the hangar bay to the flight deck, but also decreased the total number of F-35s from six to five. While this configuration also allowed the accommodation of 64 additional “need to have” items, and lessened the crowding of F-35 aircraft positioned on the ship’s fantail, it greatly decreased the operational capacity of the MEU by decreasing the size of the F-35 detachment. The current allocation of (6)F-35 aircraft is intended to support maintenance readiness rates. Six aircraft are required to ensure there are four aircraft in a full-mission capable status when called upon by the MAGTF commander and four aircraft are required for the mutually supporting combat division attack formation. The F-35 is the only aircraft that can supply escort and fire support for the MV-22 at its maximum operational range. A MEU commander’s requirement for that capability and persistent long range strike support during raid operations (given the range of the MV-22 to put Marines deep into hostile territory) make this COA an undesirable option. This option also increases the total locked spots from the baseline two to five. (See Appendix B)

NAVAIR COA 3 embarked (10)MV-22s but transferred (1)AH-1Z and (2)UH-1Ys to the LPD-17. This act of “cross-decking” detachments is not a new concept. It has been employed in the past to facilitate simultaneous fixed wing and rotary wing launches/recoveries or to allow increased deck space on the big deck during other operations such as noncombatant evacuation operations. This option left 27 aircraft on the LHD, which maximized the number of aircraft on the ship with the ARG’s I Level maintenance capability. It unlocked three aircraft parked in the area forward of the ship’s island, and afforded more room in between MV-22s. This decreased the probability of aircraft damage during parking and spotting evolutions. (See Appendix C) and provided room for 64 “need to have” items. However, it placed the (3)H-1 type aircraft away from their I level maintenance facilities. This forced a reorganization of ACE maintenance personnel and several items of daily maintenance equipment. The H-1 detachment is manned, trained, and equipped to operate independently from the reinforced squadron core but is not prepared to operate as two smaller detachments. Therefore, splitting the H-1 detachment for any prolonged period is undesirable from a maintenance, operational planning, and leadership perspective.

NAVAIR COA 4 embarked (10)MV-22s but transferred all (4)AH-1Zs and (3)UH-1Ys to the LPD-17. This maximized hangar space, again permitting the embarkation of 64 “need to have” items while also eliminating all locked spots on the flight deck. This course of action allowed the entire H-1 detachment to relocate to the LPD and function with all of the maintenance equipment and records. (See Appendix D) This increased efficiency of daily operations planning among the H-1 aircrew as it kept them collocated, but it increased the planning and execution friction associated with any operations of aircrew from the other T/M/S. A major disadvantage of this course of action is the separation of the H-1 aircraft from I Level

maintenance facilities on the big deck. As long as the LPD and LHD remained within reasonably close operating distances, the maintenance facilities on the LHD would be able to provide I Level support with minimum delay. However, if the LHD and LPD were to disaggregate or operate at increased distributed distances there is a high probability of prolonged delays in maintenance action completion for any I Level or specialized repairs. Also, large parts or specialty items would be particularly difficult to support logistically. COA 4 offers maximum flexibility on the flight deck, maximum space on the hangar deck, and maximum supportability on the LPD all the while allowing the MEU commander to retain the most ACE aviation assets within the ARG. For these reasons, COA 4 is the recommended solution for optimizing the MEU commander's ACE in the short term, but additional adjustments must be made to provide the commander full operational flexibility with his aviation assets in the future.

Additional recommendations.

An increase in AVCAL items and the addition of AIMD personnel on the LPD-17 is required to support the increase in logistics footprint as well as disaggregated or prolonged distributed operations. The current design of the LPD-17 class does not include aviation work spaces within the ship's configuration load plan (SCLP) to accommodate extensive I Level repair. In fact, an SCLP for LPD-17 has yet to be published. This is an organizational deficiency which must be corrected immediately. Identify and permanently allocate workspace for ACE AIMD personnel and AVCAL parts storage. Presently, the MEU ACE embarks three or four mobile facilities (MF) on the LHA/LAD class ship in each ARG.³³ These MFs are standard sized shipping containers which can be configured as self contained work centers complete with necessary component test benches to evaluate and certify components as 'safe for flight'. Space

must be made available for these test benches on all LPD class ships. Additionally, future ship design LPD or LSD replacements must incorporate space for these facilities as well.

A Naval Air Systems Command audit of LHD aviation support equipment should be conducted to validate the ships' aviation support equipment allocation tables. According to interviews with a current MEU commander and a recent Maintenance Material Control Officer there is too much support equipment embarked on the LHD.³⁴ Some redundancy is required because the ship must maintain the capability to support flight operations even if the MEU disembarks and takes the MEU ACE support equipment ashore. However, with the increased footprint of the new ACE, the Navy must be prepared to deploy with only what it absolutely needs, much as the MEU Command Element and the MEU ACE do currently. Both of these entities have more equipment on their allocation tables than will fit on the ship and must place some equipment in the hands of remain behind elements (RBE) to be shipped forward if absolutely necessary. One such example of this is the current AVCAL allotment of forklifts aboard LHA/LAD class ships. As many as 15 different drivable forklifts and 15-20 electric dolly lifts are currently embarked according to AVCAL allocation tables.³⁵ These range in capability up to 20,000 pound capacity. The total number of these assets must be paired down to reduce the deck space allocated for their storage.

The largest remaining problem to be solved before the MEU ACE of the 21st Century can sail is the allocation of space for the remaining 55 "need to have" items. Considerable space can be gained by the exclusion of the F-35 DMRT from the ACE's deployment gear set. There is simply not enough space on the LHD to facilitate the mission rehearsal trainer. Trainers of this size are not embarked with the AV-8B, and until more space is available on ships

commissioned subsequent to LHA-6, they should be stricken from the equipment density list for the MEU ACE.

Some additional space can be gained by reducing redundant MEU ACE maintenance equipment. Within the contract of each upgrade T/M/S was written a requirement for ground support equipment (tow bars, auxiliary power carts, etc.) and maintenance support equipment (hydraulic servicing units, nitrogen servicing carts, etc.). Many of these items are not compatible with any other MEU T/M/S. In some cases, this is because of specific contract requirements to provide performance based logistics requirements (as in the case of the F-35). A review of these equipment items is currently underway by Aviation Support Logistics Branch, Headquarters Marine Corps in order to identify “multi-path” items and advocate redesign of early compatible equipment in order to make them multi-path through modifications. Of specific importance is the modification of the hydraulic service cart for the MV-22.

What is different about this solution set from simply the way operations are currently conducted? Some things are not much different at all. This solution isn’t meant to be a prescribed embarkation plan suitable for every MEU and every mission. It is a recommendation for maximizing square footage and operational capacity, but it will also be easily tailored. For instance, if there is a requirement for humanitarian assistance 1500 nautical miles from a simultaneous noncombatant evacuation, the MEU commander may choose to cross deck the CH-53 detachment to the LPD and retain the H-1 detachment on the LHD. This will allow flight operations on the LHD without any locked spots and will allow the squadron to maintain detachment integrity. This is but one additional option, to be sure there are many more. One of the greatest assets a MEU commander has is the flexibility of his unit. To dictate any specific embarkation plan is unnecessary. What is most important is that the MEU commander maintains

maximum capability across all air capable ships and the flexibility to tailor his forces to address contingencies as they arise.

CONCLUSION

Modifications to the ACE embarkation plans, aircraft support equipment, and aircraft maintenance capabilities aboard the LPD-17 class ship are required to increase sustainability for aviation assets during disaggregated operations. It is very likely that a commander may recognize a situation developing prior to his deployment and alter the composition of his ACE. It has been done on many occasions, such as the modified composite squadron formed around Marine Heavy Helicopter Squadron 461 to conduct humanitarian assistance missions to the 2010 earthquake in Haiti. Whether that ARG deployed as a MEU or a Special Purpose Marine Air Ground Task Force (SPMAGTF) is unimportant, what is important is that when a special need arose the MEU's command and control structure allowed it to adjust the aviation component to meet the need and afforded the joint force commander a standalone operating force tailored to accomplish the mission. MEU commanders of the 21st Century may not always need (10)MV-22s, (4)AH-1Zs, (4)CH-53Ks, (4)F-35Bs, and (3)UH-1Ys, but that mix of aircraft is proven to allow maximum flexibility across the widest range of mission sets and will ensure the MEU commander is able to respond to any threat seen to date.

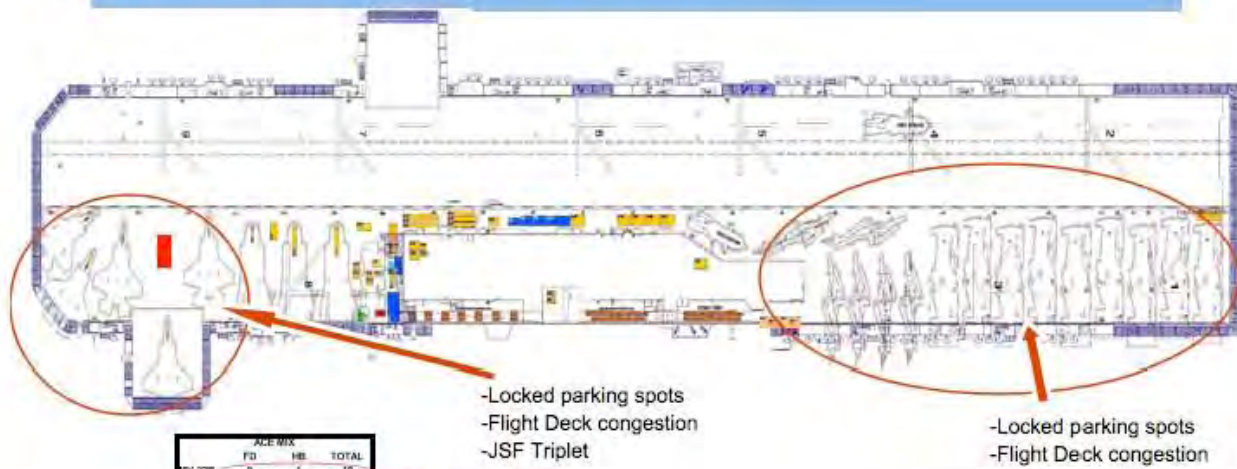
The key to the Marine Air Ground Task Force is the combined arms versatility and flexibility it affords the Combatant Commander or Joint Force Commander. The Marine Expeditionary unit is the most agile MAGTF fielded. The National Security Strategy, published guidance by the Secretary of Defense and the Commandant of the Marine Corps, and historical analysis indicate the future of this nation's forward deployed presence rests squarely on the

Amphibious Readiness Group and its embarked Marine Expeditionary unit. The MEU affords the President the ability to act on situations of national security while limiting the nation's footprint and maximizing operational security and force protection.

Appendix A-1



LHD COA 1 ACE



COA 1

ACE MIX		
	FD	HB
TOTAL	10	10
MV-22B	9	1
AH-1Z	4	0
AH-1Y	2	1
CH-53K	3	1
F-35B	5	1
HH-60S	2	0
JAS	1	0
	26	4

COA 1 ACE:

- Decreased ACE by 2 MV-22Bs
(1 from Flight Deck and 1 from Hangar Bay)
- Relocated 1 AH-1Z from Hangar Bay to Flight Deck

Baseline

ACE MIX		
	FD	HB
TOTAL	10	12
MV-22B	10	2
AH-1Z	3	1
AH-1Y	2	1
CH-53K	3	1
F-35B	5	1
HH-60S	2	0
JAS	1	0
	26	6

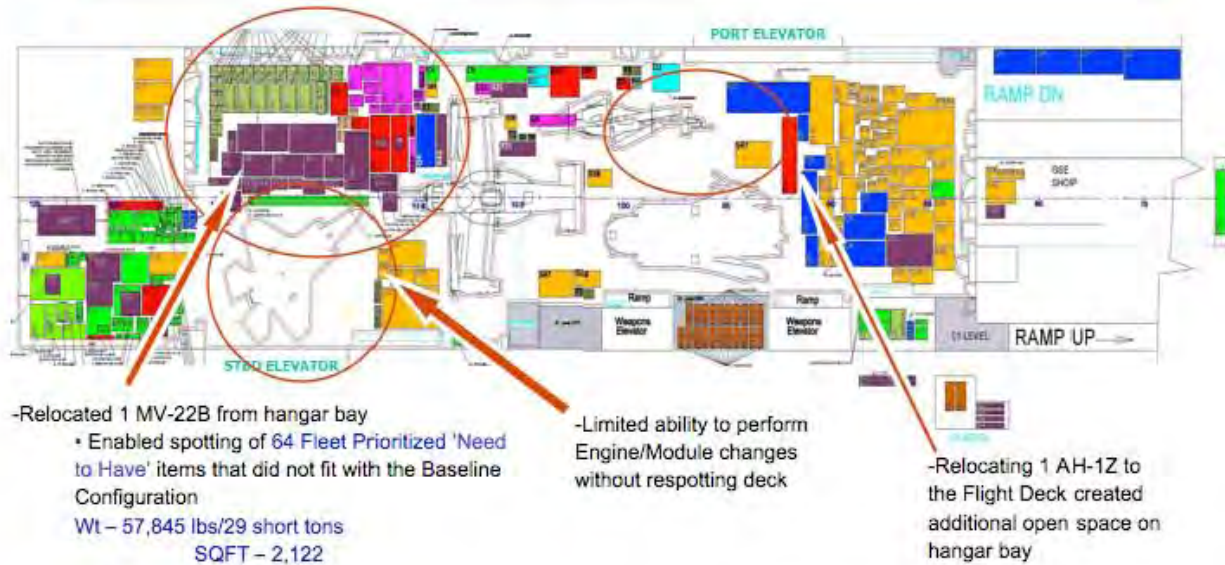
Drawing Legend

MV-22	Common SE
CH-53K	Tool Boxes
AH-1	ACE Equip
AWSE	STUAS
MHE	F-35B

Appendix A-2



LHD COA 1 ACE



- 55 "Need to Have" Items remained unspotted
- Wt – 29,007 lbs/14 short tons
SQFT – 1,337

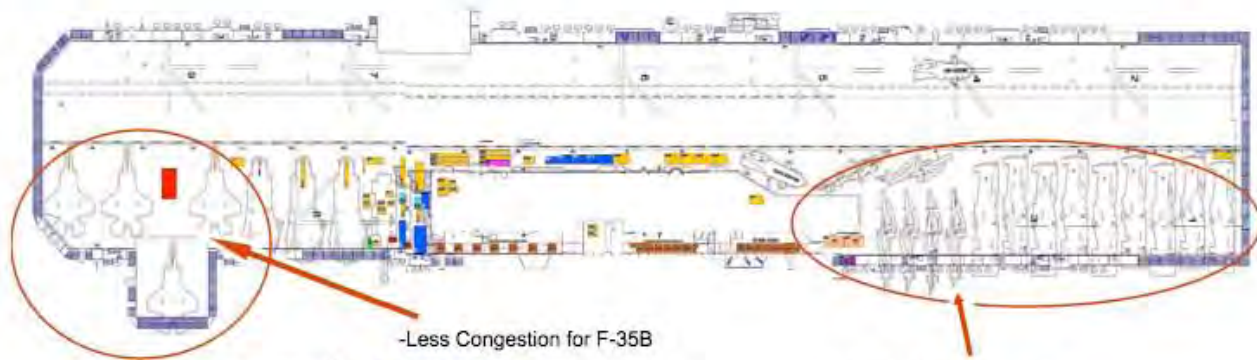
Drawing Legend			
MV-22		Common SE	
CH-53K		Tool Boxes	
H-1		ACE Equip	
AWSE		STUAS	
MHE		F-35B	

Numbers of "Need to Have" Items that could not fit

Appendix B-1



LHD COA 2 ACE FLIGHT DECK



-Less Congestion for F-35B

-Locked parking spots
-Flight Deck congestion

COA 2

ACE MIX			
	FD	HB	TOTAL
MV-22B	9	1	10
AH-1Z	4	0	4
UH-1Y	2	1	3
CH-53K	3	1	4
F-35B	4	1	5
MH-60S	2	0	2
UAS	1	0	1
	25	4	29

COA 2 ACE:

- Decreased ACE by 2 MV-22B
- Decreased ACE by 1 F-35B (from Flight Deck)
- Relocated 1 AH-1Z (from Hangar to Flight Deck)

Baseline

ACE MIX			
	FD	HB	TOTAL
MV-22B	10	2	12
AH-1Z	3	1	4
UH-1Y	2	1	3
CH-53K	3	1	4
F-35B	5	1	6
MH-60S	2	0	2
UAS	1	0	1
	26	6	32

Drawing Legend

MV-22	Common SE
CH-53K	Tool Boxes
H-1	ACE Equip
AWSE	STUAS
MHE	F-35B

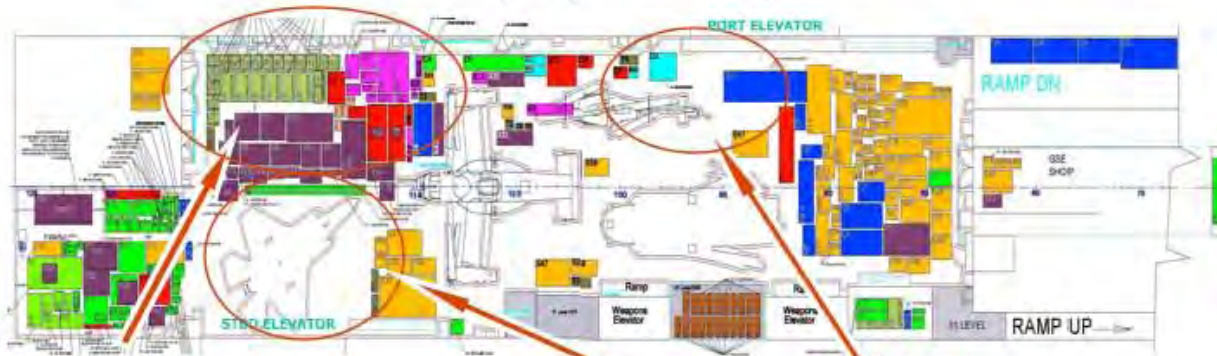
Appendix B-2



LHD COA 2 ACE



COA 2 – Hangar Bay remains unchanged from COA 1



-Relocated 1 MV-22B from hangar bay

- Enabled spotting of 64 Fleet Prioritized 'Need to Have' items that did not fit with the Baseline Configuration

Wt – 57,845 lbs/29 short tons
SQFT – 2,122

-Limited ability to perform
Engine/Module changes
without respotting deck

-Relocating 1 AH-1Z to the
flight Deck created
additional open space on
hangar bay

•55 "Need to Have" Items remained unspotted

Wt – 29,007 lbs/14 short tons
SQFT – 1,337

Drawing Legend

MV-22		Common SE	
CH-53K		Tool Boxes	
H-1		ACE Equip	
AWSE		STUAS	
MHE		F-35B	

Numbers of "Need to Have" Items that could not fit

Appendix C-1



LHD COA 3 ACE



COA 3

ACE MIX			
	FD	HB	TOTAL
MV-22B	9	1	10
AH-1Z	3	0	3
UH-1Y	2	1	3
CH-53K	3	1	4
F-35B	5	1	6
MH-60S	2	0	2
JAS	1	0	1
	25	4	29

COA 3 ACE:

- Decreased ACE by 2 MV-22B (1 ea from Hangar and Flight Deck)
- Transferred 1 AH-1Z to LPD 17
- Transferred 2 UH-1Ys to LPD 17

Baseline

ACE MIX			
	FD	HB	TOTAL
MV-22B	10	2	12
AH-1Z	3	1	4
UH-1Y	2	1	3
CH-53K	3	1	4
F-35B	5	1	6
MH-60S	2	0	2
JAS	1	0	1
	26	6	32

Drawing Legend

MV-22	Common SE
CH-53K	Tool Boxes
H-1	ACE Equip
AWSE	STUAS
MHE	F-35B

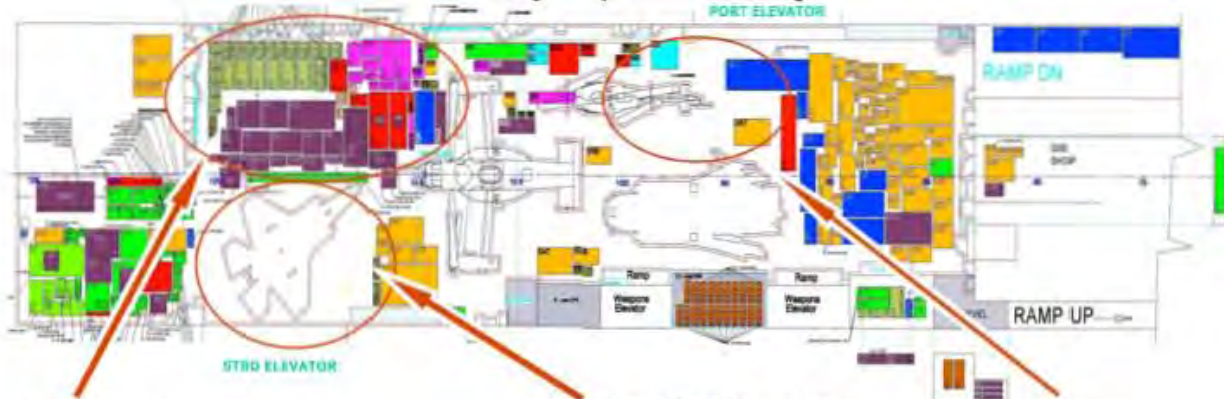
Appendix C-2



LHD COA 3 ACE



COA 3 – Hangar Bay remains unchanged from COA 1



- Relocated 1 MV-22B from hangar bay
 - Enabled spotting of 64 Fleet Prioritized 'Need to Have' items that did not fit with the Baseline Configuration
 - Wt – 57,845 lbs/29 short tons
 - SQFT – 2,122

- 55 "Need to Have" Items remained unspotted
- Wt – 29,007 lbs/14 short tons
- SQFT – 1,337

- Limited ability to perform Engine/Module changes without respotting deck

- Relocating 1 AH-1Z to the Flight Deck created additional open space on hangar bay

Drawing Legend

MV-22	Common SE
CH-53K	Tool Boxes
H-1	ACE Equip
AWSE	STUAS
MHE	F-35B

Numbers of "Need to Have" Items that could not fit

Appendix D-1



LHD COA 4 ACE FLIGHT DECK



COA 4

ACE MIX			
	FD	HB	TOTAL
MV-22B	9	1	10
AH-1Z	0	0	0
UH-1Y	0	0	0
CH-53K	3	1	4
F-35B	5	1	6
MH-60S	2	0	2
UAS	1	0	1
	20	3	23

COA 4 ACE:

- Removed 2 MV-22B from the ACE Mix (1 ea from Hangar and Flight Deck)
- Removed all 4 AH-1Zs (to LPD 17)
- Removed all 3 UH-1Ys (to LPD 17)

Baseline

ACE MIX			
	FD	HB	TOTAL
MV-22B	10	2	12
AH-1Z	3	1	4
UH-1Y	2	1	3
CH-53K	3	1	4
F-35B	5	1	6
MH-60S	2	0	2
UAS	1	0	1
	26	6	32

- Less Congestion
- Less Locked Spots

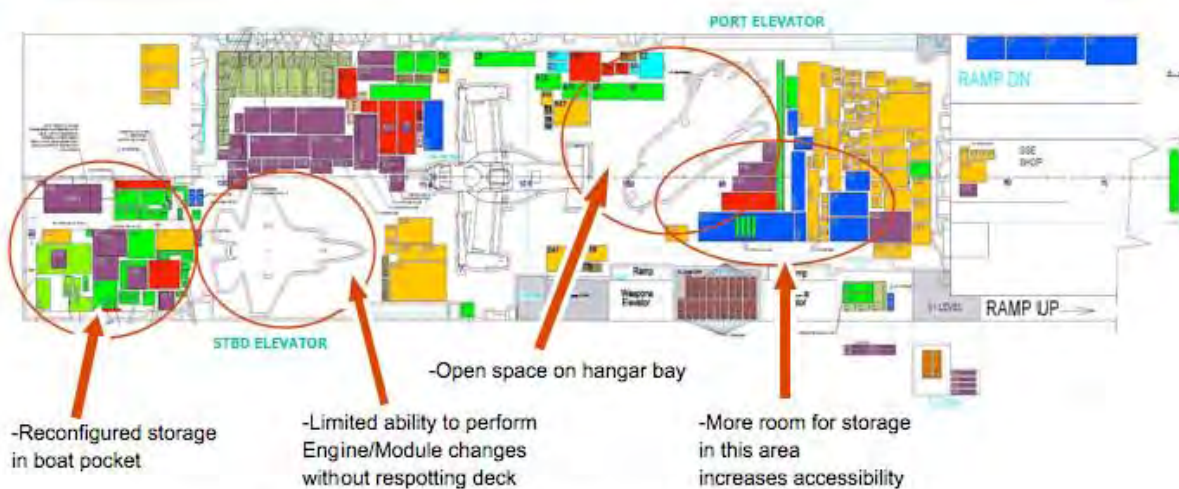
Drawing Legend

MV-22	Gunman SE
CH-53K	Tool Boxes
H-1	ACE Equip
AWSE	STUAS
MHE	F-35B

Appendix D-2



LHD COA 4 ACE HANGAR DECK



Removal of H-1s and their Logistics Footprint (Wt 24,692 lbs / Sq Ft 1,089):

- Option 1 - Use space to increase Operational Flexibility
 - Modeled by Experienced Fleet Operators during conference
- Option 2 - Add more "Need to Have" items
 - Wt 4315 lbs, 248 Sq Ft of remaining items still would not fit

Drawing Legend	
MV-22	Common SE
CH-53K	Tool Boxes
H-1	ACE Equip
AWSE	STUAS
MHE	F-35B

Appendix D-3



LPD 17 Baseline



	ACE Mix		TOTAL
	FD	HB	
AH-1Z	3	1	4
UH-1Y	2	1	3
	5	2	7

Drawing Legend			
H-1		Common SE	
MHE		Tool Boxes	
STUAS		ACE Equip	
AWSE			

Notes

¹ The work conducted by HQMC Aviation in the fall of 2011 was an attempt to further develop the discussion through historical review and course of action analysis. Post deployment lessons learned reports indicated issues with increased storage space requirements and aircraft movement windows for upgrade aircraft far exceeded the requirements of the legacy platforms. Total weight and KG limitations would also be a factor for LHD 1 class ships beginning in 2015. Recognizing the long-term implications of these factors and looming budgetary constraints, aviation planners began to explore courses of action that would optimize MEU capabilities. Major Douglas C. Sanders USMC, et al., Future MEU ACE In-Progress Review (Washington DC: HQMC Aviation, October 2011).

² Whitney, Bradley, & Brown Inc., Future Marine Expeditionary Lift Requirements vs. Amphibious Ready Group Capacity Study (Reston, VA: Whitney, Bradley, & Brown, 2010), E-1.

³ Captain Douglas Pack USMC Amphibious Assault Ship Operational Logistics Footprint Assessment for the 2015 Marine Expeditionary Unit (MEU) Air Combat Element (NAS Patuxent River, MD: Naval Air Systems Command, August 2010), 8 and 12.

⁴ Applied Physics Laboratory, Future Navy/Marine Corps Amphibious Requirements Study (Baltimore, MD: John Hopkins University, 2011), 59.

⁵ Colonel Eric Steidl USMC, Commanding Officer, 22d MEU, email to author, January 2012.

⁶ Congressional Budget Office, An Analysis of the Navy's Amphibious Warfare Ships for Deploying Marines Overseas (Washington, DC: Congressional Budget Office, November 2011), 2.

⁷ Chief of Naval Operations, *Report to Congress on Annual Long Range Plan for Construction of Naval Vessels for FY 2011* (Washington, DC: Director, Warfare Integration, February 2010), 5.

⁸ Congressional Budget Office, 8.

⁹ General James T Conway USMC, Marine Corps Vision and Strategy 2025 (Headquarters United States Marine Corps, 2008), 16.

¹⁰ Congressional Budget Office, 5.

¹¹ OPT In progress Review.

¹² Whitney, Bradley, & Brown Inc., 8.

¹³ Leon Panetta, Sustaining U.S. Global Leadership: Priorities for 21st Century Defense (Washington DC: Department of Defense, January 2012), i.

¹⁴ David A. Blank, Arthur E. Brock, David Richardson, Introduction to Naval Engineering, Second ed. (Annapolis, MD: United States Naval Institute, 1985), 85.

¹⁵ James A. Griffin, III, USMC Aviation Combat Element (ACE) Changes and Their Impact on Large Deck Amphibious Ships (West Bethesda, MD: Naval Surface Warfare Center, June 2007), 5. Cited hereafter as Griffin, "ACE Changes".

¹⁶ Griffin, "ACE Changes", 6. Due to weight and KG increases, the ships moved from Status 1: "no displacement/stability problems" to Status 2: "deficient in both displacement and KG margins." Robert M. Borka, "Navy/Marine Corp Team's Analysis of Integrating USMC's State-of-the-Art Heavier and Larger Vehicles and Aircraft Onboard USN Ships," American Society of Naval Engineers, 2010 #1, https://www.navalengineers.org/SiteCollectionDocuments/hamilton_award_papers/122_1/paper3.pdf.

¹⁷ Griffin, “ACE Changes”, 10.

¹⁸ Griffin, “ACE Changes”, 10-13.

¹⁹ Griffin, “ACE Changes” 16.

²⁰ Griffin, “ACE Changes”, 31.

²¹ James A. Griffin, III, USMC Ground Combat Element Changes and Their Impact on LHD Class Ship Stability (West Bethesda, MD: Naval Surface Warfare Center, June 2009), 21. Cited hereafter as Griffin, “GCE Changes”.

²² Griffin, “ACE Changes”, 30.

²³ Pack, 2.

²⁴ Pack, 8.

²⁵ Pack, 8.

²⁶ Pack, 14.

²⁷ In an email to the author in January of 2012, Colonel Eric Steidl USMC, Commanding Officer, 22d MEU, stated: “Anything less than 10 (MV-22s) would cut into capability.” The intent of the author’s recommended course of actions are to leverage increased capability of upgrade aircraft over legacy platforms to facilitate the ever increasing amount of disaggregated operations. Using the increased capabilities achieved through T/M/S upgrades as justification for reducing aircraft configuration numbers in order to “gain space” which would result in a net zero gain for the MAGTF commander.

²⁸ “Lessons and Observations from the 26th MEU Deployment August 2010 - May 2011,” November 2011, Marine Corps Center for Lessons Learned, Quantico, VA, 16.

²⁹ Lessons Learned, 26th MEU, 16-19.

³⁰ Griffin, “ACE Changes”, 26.

³¹ Lieutenant General Terry G. Robling USMC, FY2012 Marine Aviation Plan, (Headquarters Marine Corps Aviation, December 2011), 2-6. According to phone interview with APW-52 on February 22, 2012, all MEU’s to deploy with MV-22s to date have only deployed with 10 aircraft due to aircraft induction rates but all VMM squadrons will eventually be outfitted with 12 aircraft.

³² Pack, 9.

³³ Captain Douglas Pack USMC, USMC Aviation/Ship Integration Officer Naval Air Systems Command, email to author, April, 9, 2012.

³⁴ Colonel Eric Steidl USMC, Commanding Officer, 22d MEU, email to author, January 2012 and phone interview Captain D.B. Pack USMC, USMC Aviation/Ship Integration Officer Naval Air Systems Command, 27 January 2012.

³⁵ Lieutenant Michael Mullerheim, USN, Aviation Stores Officer USS Bataan, phone interview April 4, 2012.

TABLE 1 – Inventory of Amphibious Warfare Ships

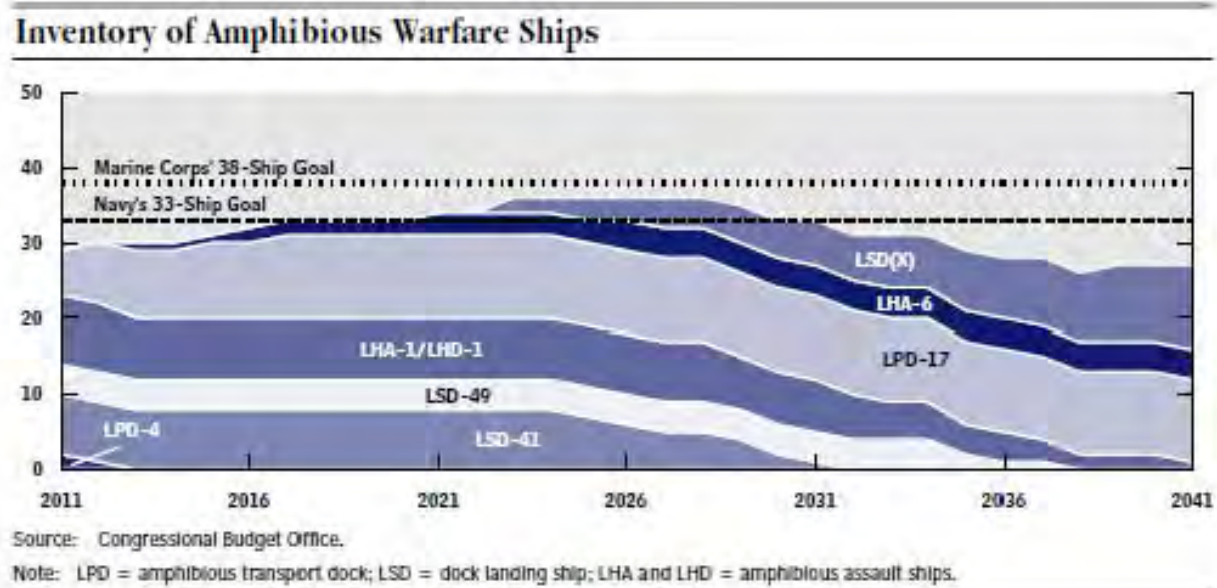


TABLE 2 – Execution of MEU METs 1980-2010

MEU Mission Essential Tasks	# of Ops	Percentage
Conduct Humanitarian Assistance Operations	72	28
Conduct Amphibious Operations (ship-to-shore movement)	44	17
Conduct Stability Operations	36	14
Conduct Noncombatant evacuation operations	25	10
OEF/OIF	17	7
Conduct/Support Theatre Security Cooperation Operations	16	6
Conduct Maritime Interception Operations	14	5
Conduct Advanced Force Operations	13	5
Conduct Joint/Combined Operations	9	3
Conduct an Amphibious Raid	5	2
Conduct Tactical Recovery of Aircraft and Personnel	4	2
Conduct Airfield/Port Seizure	3	1
Conduct Aviation ops from shore based sites	0	0
Totals	258	100

Table 3 –Logistics Footprint Assessment: Courses of Action



LHD ACE COURSES OF ACTION



COA#	VARIATION FROM BASELINE CONFIGURATION	Total LHD A/C
COA 1	Decreased ACE by 2 MV-22B (1 ea. from hangar bay and flight deck) Relocated 1 AH-1Z from Hangar Bay to Flight Deck	30 aircraft
COA 2	Decreased ACE by 2 MV-22B (1 ea from hangar bay and flight deck) Relocated 1 AH-1Z from Hangar Bay to Flight Deck Decreased ACE by 1 F-35B (from flight deck)	29 aircraft
COA 3	Decreased ACE by 2 MV-22B (1 ea from hangar bay and flight deck) Transferred 1 AH-1Z and 2 UH-1Ys to LPD 17	27 aircraft
COA 4	Decreased ACE by 2 MV-22B (1 ea. from hangar bay and flight deck) Transferred 4 AH-1Zs, 3 UH-1Ys and their Log Footprint to LPD 17*	23 aircraft

*COA 4 may drive requirement to procure additional SE for LPD 17

- ❖ Spotting Analysis Repeated For Each COA
- ❖ Scenarios Provided by HQMC (APP) During Conference

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