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A change to the status quo must occur to improve CH-53E readiness levels to meet the Joint Requirements Oversight Council's (JROC) intent. To help meet this requirement, the Marine Corps must adopt a robust Performance Based Logistics (PBL) plan covering the CH-53E's remaining time in service. The CH-53E is currently suffering from unacceptable readiness as a result of an antiquated Life Cycle Logistics Plan and poor processes. To fix this, the Marine Corps must adopt a robust PBL contract that incentivizes not only manufacturing and supply aspects, but also training and standardization of maintenance practices from the squadron to the depot.

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MASTER OF MILITARY STUDIES

TITLE:

Sustaining the Super Stallion:
The Use of Performance Based Logistics in the CH-53E Program

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

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Executive Summary

Title: Performance Based Logistics and the CH-53E: The Use of Incentives and Continuous Process Improvement to Reach Readiness Goals Until Sundown

Author: Major Matthew Dineen, United States Marine Corps

Thesis: The CH-53E has been an indispensable asset to both the MAGTF and the Combatant Commander. If the Marine Corps does not adopt a robust PBL contract to cover the CH-53E to sundown, the US will find themselves without a key asset when the Corps and the nation need it the most.

Discussion: Since the inception of heliborne operations the need for heavy lift helicopters has been evident. The Marine Corps and has been at the forefront of heavy lift helicopter operations. With the introduction of the CH-53A during the Vietnam War, the Marine Corps secured the niche as the nation's premier heavy-lift provider when conducing expeditionary operations. This niche would serve the CH-53 community well for several decades as the Delta and Echo models were fielded from the 1970s through the 1990s. The unique capability offered by the Super Stallion enhanced not only the Marine Air Task Force (MAGTF), but became a staple for the Joint force as well. Following 9/11, the CH-53 fleet would see over a decade of sustained combat operations. After performing admirably during this time, the United States Marine Corps' CH-53E helicopter fleet is suffering from extremely low readiness rates. There are several areas that are affecting CH-53E readiness such as inventory, maintenance, management, supply, and culture. The cumulative effect of these independent areas has proven to be catastrophic to the aging Super Stallion community. These airframes must bear the Marine Corps' and DoD's heavy lift requirements for at least the next twelve years until the CH-53K reaches FOC. A change to the status quo must occur to improve CH-53E readiness levels to meet the Joint Requirements Oversight Council's (JROC) intent. To help meet this requirement, the Marine Corps must adopt a robust Performance Based Logistics (PBL) plan covering the CH-53E's remaining time in service.

Conclusion: The CH-53E is currently suffering from unacceptable readiness as a result of an antiquated Life Cycle Logistics Plan and poor processes. To fix this, the Marine Corps must adopt a robust PBL contract that incentivizes not only manufacturing and supply aspects, but also training and standardization of maintenance practices from the squadron to the depot.

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THE OPINIONS AND CONCLUSIONS EXPRESSED HEREIN ARE THOSE OF THE INDIVIDUAL STUDENT AUTHOR AND DO NOT NECESSARILY REPRESENT THE VIEWS OF EITHER THE MARINE CORPS COMMAND AND STAFF COLLEGE OR ANY OTHER GOVERNMENTAL AGENCY. REFERENCES TO THIS STUDY SHOULD INCLUDE THE FOREGOING STATEMENT.

Figures

Page

Table of Contents

Page

Preface

I chose to write on this topic because I believe that if the Marine Corps does not invest the requisite time and energy to maintain the current fleet of CH-53E until the CH-53K is fully operational, we could be faced with an enormous capability gap in the next major conflict. The CH-53E is the backbone of MAGTF aviation logistics support during sea based expeditionary operations and also plays a huge role in air assault operations. The CH-53E has proven itself over and over again in multiple different operational environments from Personnel Recovery Operations, to Theater Security Cooperation, and ultimately full scale combat operations. I have seen first hand on several occasions what happens when worn down equipment fails, and I have seen good Marines suffer because of it. It is critical that we address the shortcomings present in the CH-53E community today, to ensure that we have combat ready aircrew to support the MAGTF commander during the thirteen years of transition to the CH-53K.

I would like to thank Major Tom “Banshee” Trimble in the aviation hallway at the Pentagon for putting me in contact with the right people to assist with this paper. LtCol Brian Taylor and the rest of the H-53 Team at PMA-261 were invaluable during this process and always there to assist with my research, thank you. Finally, thank you to my family: Lauren; Colin; and Alannah. Especially Lauren, who allowed me to work unbothered, as we were blessed with a new child during this process.

Introduction

The Marine Corps and Department of Defense (DoD) are currently relying on a worn and aging fleet of CH-53E as their sole source of rotary-wing heavy lift. With a gross weight of 73,500 pounds, the CH-53E is the only rotorcraft that currently meets the criteria for heavy lift in the DoD per Joint Publication (JP) 3-04, Joint Shipboard Helicopter and Tiltrotor Aircraft Operations.[1] The CH-53E has met the call to perform in "any clime and place" since its delivery in 1981. After cutting its teeth in Operations DESERT SHIELD and DESERT STORM, conducting a historic rescue in Bosnia, and sustaining the Marine Air Ground Task Force (MAGTF) throughout Operations IRAQI FREEDOM (OIF) and ENDERING FREEDOM (OEF), the fleet of CH-53Es is in need of something new.

In all of the afore mentioned theaters the Super Stallion has proven to have no equal in the rotary-wing assault support community, but it feels the burden. Having exhausted its backup aircraft inventory, today's fleet is comprised of 147 CH-53Es with plans to increase that number by two after restoring two previously stricken aircraft. This is fifty-one aircraft short of the JROC requirement. These aircraft have already flown over 53% of their allotted flight time and the first CH-53E airframe will meet its 10,000-hour air frame limit in 2018, this is one year before the CH-53K reaches Initial Operational Capability (IOC). The Super Stallion Community is one of the most stressed communities in Marine Corps aviation, and the Corps must find a way to sustain the CH-53E weapons system's readiness. By maintaining adequate equipment readiness levels, the CH-53E community will be able to train current future aircrew. Without the CH-53E to provide a stop gap until FOC of the CH-53K is reached in 2029, the Marine Corps and the DoD will be exposed to a critical vulnerability in assault support.[2]

Looking only at a snap shot in time from May 2011 to March 2012, the CH-53 team flew more than 19,000 hours, carried more than 73,000 passengers, and transported over thirteen million pounds of cargo in support of the MEU and Combined Joint Task Force HOA during OEF.[3] Though the community has stepped up to the task, this level of support comes at a cost. In order to meet these needs, the airframes have been flown at rates far above what was originally planned; upwards of three times the utilization rate. This overflight coupled with airframes approaching thirty years of age has set the stage for the rapid decline in readiness since the end of combat operations in Afghanistan. A comprehensive Performance Based Logistics (PBL) plan is need to sustain the CH-53E until the CH-53K reaches Full Operational Capacity (FOC). The CH-53E PBL plan must be holistic; thus, it must focus on supply response time, cost per flight hour, and ready basic aircraft status and their synergistic contribution to CH-53E readiness. The CH-53E's current Performance Based Agreements (PBA) cover ten components. These PBAs have led to award winning readiness levels and cost savings. By implementing a more comprehensive PBA, the Marine Corps and the Nation stand to increase the readiness of their sole heavy lift asset at current cost or better.

This research will begin with reviewing the integral part the Marine Corps has played in the development of heavy lift helicopters. It will also discuss the rapidly changing environment that these aircraft operate in; often calling for them to perform beyond their intended design. Following this, the research will cover the current state of the CH-53E community as outlined in the Super Stallion Independent Readiness Review (SSIRR) and the recommendations that came from it. The research will then address Total Life Cycle Systems Management (TLCSM) and PBL and the impacts of implementation in the CH-53E logistics and sustainment plan. Finally, the research will cover the proposed approaches in implementing a robust PBL plan to ultimately

increase and maintain the combat effectiveness of the CH-53E weapons system. The CH-53E has been an indispensable asset to both the MAGTF and the Combatant Commander. Reduced readiness levels of the CH-53E creates a critical vulnerability in defense of the nation when conducting ship-to-shore and expeditionary logistics support. If the Marine Corps does not adopt a robust PBL contract to cover the CH-53E to sundown, the US will find themselves without a key asset when the Corps and the nation need it the most.

Literature Review

The material reviewed for this report can be separated into three main groups. The foundational documents that form the first group come from the national level and focus on reducing cost while delivering performance to the warfighter through PBL. The second group of documents reviewed cover the problems directly effecting the CH-53E community and how PBL can be part of the solution. Lastly, the third group of documents contains information that supports the use of PBL in weapons systems to help improve readiness by incentivizing productivity and innovation in industry.

The concept of PBL to support life cycle logistics came about in the late 90s and has steadily gained momentum through today. The 2001 Quadrennial Defense Review (QDR) addresses the need for improved force sustainment. In this document the DoD laid the foundation for the transformation of logistics strategies from deployment processes to reducing the cost of logistics. As a cost saving method and way to compress the supply chain, the QDR mandates the use of PBL to remove non-value-added steps in logistics processes. Following the release of the QDR, PBL was sporadically implemented across the DoD, this random implementation served as the catalyst for the next wave of guidance. In 2004 the Deputy Secretary of Defense reiterated the QDR's guidance to implement PBL to streamline process the will buy system availability and

readiness through the use of performance metrics. In the following years the services produced their own PBL procedures. Per the QDR, the one of the major stakeholders in this endeavor is the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD (AT&L).

The DoD Directive 500.01, “The Defense Acquisition System”, was signed and it clearly assigned responsibility to system Program Managers (PM) the role of developing and implementing performance-based logistics strategies. Following the release of the DoD 5000.01, the USD(AT&L), Ashton Carter, published his Better Buying Power (BBP) 1.0. BBP 1.0 provided guidance to the acquisitions workforce that emphasized getting the product to the warfighter at a reasonable cost incentivizing productivity and innovation though performance-based contracts. Following Mr. Carter, Frank Kendell, took over as USD (AT&L) and released the “Endorsement of Next-Generation Performance-Based Logistics Strategies” memo in 2012 that again emphasized the use of PBL to help manage the cost of operations and sustainment (O&S) of a system, thus, meeting the intent of BBP. Mr. Kendell has continued to emphasize the value to PBL across the DoD to improve readiness and availability through his BBP 2.0 and 3.0 initiatives. It is with this guidance in mind, that the next group of documents are reviewed.

In 2015 the Commandant of the Marine Corps voiced concern about the overall readiness of he Marine Corps aviation assets and based on this, the Deputy Commandant for Aviation ordered several Type/Model/Series (T/M/S) to undergo and independent readiness review. Germane to this research, the CH-53E Super Stallion Independent Readiness Review (SSIRR) was conducted in the summer of 2015. Completed by Booze, Allen, Hamilton over a period of five months, the SSIRR reviewed all applicable maintenance and training publications, conducted fleet wide interviews across the CH-53E aviation enterprise, and met with the T/M/S sponsors and PM. The SSIRR focused on six lines of analysis: 1) CH-53E to CH-53K transition

plan, 2) Non-Mission Capable Supply (NMCS), 3) Non-Mission Capable Maintenance (NMCM), 4) Mission Capable Non-Ready Basic Aircraft (RBA), 5) Out of Reporting Aircraft (OOR), and 6) the CH-53E Training and Readiness (T&R) Manual.

Due to the restrictions placed on this research, this paper will focus on the lines one through three and six. Based on the review this data on the CH-53E community, Booze, Allen, Hamilton recommended two main lines of effort (LOE) to attack the problem. The first step would be to surge resources and effort to restore the CH-53E community to a full mission capable (FMC) status, and the second would be to sustain the newly FMC aircraft. This paper will address how a properly executed PBL contract can meet the requirement of the second recommendation, thus, sustaining the benefits of the reset. The next set of documents reviewed for this paper were independent literature and acquisitions reports concerning PBL and its benefit to DoD systems.

In 2004, The Center for the Management of Science and Technology (CMOST) at the University of Alabama in Huntsville published a study identifying military and commercial initiatives and lessons learned for a weapons system to transition to Performance Based Logistics. This study was commissioned by the USA Aviation Missile Command (AMCOM). The theme of the recommendations of this study was that a public-private partnership must be just that, a partnership. This requires organizational change and for both parties to focus on the result, not the process, which may be contrary to past procedures. Another key factor presented by the PBL Research Team was the need for an organization to implement and effective method of tracking performance. This tracking in critical in fixed-price-performance based systems, because without the ability to accurately track readiness and availability, by both the contractor and warfighter, a PBL system cannot thrive.

There is an abundance of literature available on the topic of PBL is support of DoD weapons systems. It would far exceed the length of this paper to cover them all, but the themes of this literature remains constant. Though PBL can be difficult to implement, it is well worth the time and energy spent on the front end to establish solid working relationships with vendors, ensure the gaining organization accepts the cultural shift required, and to allow adequate trade space for the vendor to focus on continuous process improvement and innovation.

Development and Use of Heavy Lift Helicopters

The United State Marine Corps has seen the utility, versatility, and functionality of rotary wing aviation from its inception, and it would not be long before Marine Corps leadership saw the need for a heavy lift helicopter. Beginning in the early 1930s the Marine Corps began to experiment with vertical lift platforms in the form of auto-gyro aircraft that could barely function at their designed gross weight let alone with a usable payload of weapons or troops. During this initial phase of test and evaluation Lieutenant Colonel Roy S. Geiger, one of the founders of Marine Corps aviation, made it clear that Marine Corps would have no place for rotary wing assets until they could carry a mission fuel load accompanied by appropriate military cargo while maintaining the ability to conduct vertical takeoffs and landings.[4] This requirement would be made possible by ingenuity of several innovative manufactures, but mainly Igor Sikorsky.

With Igor Sikorsky's immigration from Russia in 1919 to the United States, the Marine Corps gained its most influential ally in the development of heavy lift helicopters. Sikorsky pioneered the use of the single rotor system which allowed him to procure an Army contract in 1941 to build the first practical helicopter.[5] With the contract for the R-series helicopter, Sikorsky established himself as the key contactor in the Department of Defense acquisitions process. By the mid-1940s the R-5 had garnered the support of both the civilian and military

sector, but it would not be until 1946 that the first initial action would be taken to institute an official Marine Corps helicopter program. This program would create the frame work that would eventually produce the only heavy lift helicopter in the Department of Defense the CH-53E.

General Alexander A. Vandergrift, Commandant of the Marine Corps, established what could be called the first USMC Aviation Hallway comprised of one officer and three enlisted Marines.[6] In addition to this "aviation branch," General Vandergrift established a special board composed of three Major Generals after receiving a disturbing correspondence from General Geiger concerning the use of atomic weapons and their impact on amphibious operations. General Geiger realized that the ability to mass a large force on a beachhead such as Normandy or Okinawa was a thing of the past because of these weapons, and the Marine Corps must adapt using new techniques in the future.[7]

Major Generals Lemuel C. Shepard, Jr., Oliver P. Smith, and Field Harris led the special board directed by the Commandant and was staffed with a Secretariat of three Marines—Colonels Merrill B. Twining and Edward C. Dyer and Lieutenant Colonel Samuel R. Shaw. After meeting with both Sikorsky and Piasecki, the board was assured that both manufactures could produce a helicopter capable of lifting a payload of 5,000 pounds. This was the answer the board was looking for. They drafted a recommendation to General Vandegrift which urged the utilization of sea-based helicopters to move the landing force ashore and for the continued training of pilots and mechanics. The Commandant then sent a letter to the Chief of Naval Operations (CNO) that outlined the Marine Corps' plan to incorporate heliborne assault which would later become the Vertical Assault Concept for Amphibious Operations.[8]

The following excerpt from General Vandegrift to the CNO set the foundation for the development of carrier-based assault support helicopter for the next fifty years:

> ...[helicopters] offer all the advantages of the conventional air-borne operation but few of the disadvantages. They can be operated form aircraft carriers now in existence with cover and preparatory fires on landing areas provided by their aircraft from the same force. With a relatively unlimited choice of landing area, troops can be landed in combat formations and under full control of the flanks or rear of a hostile position. The helicopter's speed makes transport dispersion at sea a matter of no disadvantage and introduces a time-space factor that will avoid presenting at and one time a remunerative atomic target. It should be noted also that transport helicopters offer a means for rapid evacuation of casualties, for the movement of supplies directly form ship to dump and for subsequent movement of troops and supplies in continuing operations ashore.[9]

The Commandant's vision outlined above set the Marine Corps on a path of innovation in ship-to-shore tactics through a paradigm shift driven by the advent of nuclear arms, but the vision for change did not stop there. Concurrently with the HQMC actions, Colonel Robert E. Hogaboom was hard at work at Marine Corps Schools to develop helicopter tactics based on the Commandant's guidance.

The findings of Marine Corps Schools would become known as the "Hogaboom Report," but it was formally called the "Military Requirements of Helicopter for Ship-to-Shore Movement of Troops and Cargo" by Colonel Robert E. Hogaboom and it outlined the changes needed in Marine Corps tactics, techniques, and procedures (TTP) to enable successful amphibious operations using helicopters as the primary troop transport vehicle. Colonel Hogaboom not only understood the need for small troop carrying helicopters, but foresaw the utility of larger cargo helicopters to enable divisional logistics.[10] Though unfeasible at the time, the heavy lift helicopter would soon become a critical connector in amphibious logistics.

By 1958 the reorganization of the Hogaboom board had started to settle and the Office of the Secretary of Defense (OSD) wanted to procure a pressure-jet convertiplane/compound helicopter that could facilitate the needs of all services. This would not come to fruition due to disagreements in the capabilities requirements between the services. Specifically, in the Navy/Marine Corps, they found that the convertiplane/compound helicopter design to be ill-suited to their needs. Due to the relatively short time in which the new aircraft would be needed,

it was decided that an off-the-shelf version or modification of an existing platform would have to suffice. Kaman, Sikorsky, and Boeing-Vertol all were viable stakeholders in the beginning, but it was Sikorsky's modified S-64 Flying Crane that would win the day and ultimately the next half of a century.[11]

The Sikorsky S-64 Flying Crane provided a perfect base for the future development of heavy lift. The S-64 was a propriety design of the Sikorsky company being fielded for sale in West Germany. It featured a six-bladed main rotor system and four-bladed tail rotor capable of propelling the massive airframe of eighty-eight feet to a speed of 172 nautical miles per hour at a gross weight of 32,000 pounds. Her massive cabin could hold thirty combat loaded troops or 8,000 pounds of cargo. The S-64 served as the baseline for the construction of the S-65 or CH-53A Sea Stallion. The CH-53A began development in 1962 and reached operational capability in 1966. It would boast a top speed of 172 nautical miles per hour and a cabin capable of transporting thirty-eight combat troops. Igor Sikorsky had invented the military's first heavy lift helicopter and his company would continue to supply the Navy and Marine Corps with the DoD's premier heavy lift asset through the rest of the 20th century and beyond.[12]

General Krulak would again reinforce the importance of heavy rotorcraft to the Marine Corps in 1966 when he requested that the "Duece," the predecessor the CH-53A, be replaced immediately with the Sea Stallion.[13] As the Sea Stallion entered the Vietnam War it was intended to be a sky crane capable of lifting large external loads under the belly of the helicopter. This would be the niche that defined the CH-53 through Vietnam to the present day. A testament to its power, a four plane CH-53A detachment lifted a total of 103 Marine Corps and Joint aircraft in a period of five months in 1967 and by the end of the year HMH-463 had recovered 370 aircraft. Without the CH-53A these assets would have been a total loss.[14] Though designed originally for

ship-to-shore logistics support, Marine innovation shown through and helped shape future tactics. This unique capability filled a gap that would allow US forces to recover both downed helicopters and airplanes in combat and initiated the development of Tactical Recovery of Aircraft and Personnel (TRAP) tactics still used today.

With the Sea Stallion having solidified its position as the work horse of the Marine Air Ground Task Force (MAGTF) during Vietnam, the Corps eagerly awaited the delivery of the current model of the CH-53E Super Stallion. Beginning in 1981 with the delivery of the first CH-53E to HMH-464 at Marine Corps Air Station (MCAS) New River, this three-engine variant would not disappoint. The CH-53E had increased lift capability and the ability to conduct air-to-air refueling; thus, it allowed operators to conduct heavy lift operations over distances previously thought impossible. From Full Operational Capability (FOC) in 1981-2001 the Super Stallion conducted several key operations such as the evacuation of US and foreign nationals from Mogadishu, Somalia during operation EASTERN EXIT. The Super Stallion proved its worth in the TRAP mission that recovered downed pilot Captain Scott O'Grady. Though these events were important in their own right, the events of 9/11 would commit the Super Stallion to over eleven years of sustained combat operations across multiple continents and geographic combatant commands (GCC). History has shown that the need for heavy-lift helicopter support in combat operations provides a critical capability for the commander and this need is only going to increase as equipment becomes heavier.

From 2001 to 2014 the fleet of Marine Corps CH-53E Super Stallions supported the Global War on Terrorism (GWOT) in multiple venues. Following the events of 9/11 the Marine Corps committed to combat actions in Afghanistan during operation ENDERING FREEDOM, and the Super Stallion fulfilled its role as a critical asset for ship-to-shore movement at the end of

2001. The demand for the Super Stallion continued as the US invaded Iraq during operation IRAQI FREEDOM (OIF) in 2003. The CH-53 community would find itself engulfed in one of the harshest environments on the planet, the deserts of Iraq. Also in 2003, the CH-53E community committed itself to support the antiterrorism fight in the Horn of Africa (HOA). The Super Stallion would continue to support the GWOT in Djibouti, Africa, continuously for ten years. Not only did the HMHs of the Marine Corps support OEF directly in the theaters mentioned above, they supported continuous Marine Expeditionary Unit (MEU) deployments during the same time period. During this period the CH-53 performed admirably in the face of a determined enemy and the difficult transition between the CH-46 and the MV-22.

Based on a planned 10,000-hours per airframe, the original plan to begin replacing the CH-53E by 2015 has, thus far, shifted by four years to 2019.[15] In 2012 the CH-53D was retired after almost a half a century leaving the CH-53E to bear the burden of assault support and heavy lift in the MAGTF and DoD. The average life of the fleet CH-53E is over fifteen years old and has flown over 3,000 hours in harsh desert environments. With this use the aircraft has become more cumbersome to maintain at a rate of 44:1 maintenance man-hours:flight hour ratio.[16] This increase in maintenance continues to drive up the cost per flight hour. At approximately $20,000 per flight hour something must be done to curb this inflation while the Corps waits for the CH-53K, as with any major acquisitions program, the timeline forecast for the CH-53K "King Stallion" may or may not hold true making it even more important to efficiently maintain the current fleet of Super Stallions.[17] Though the CH-53E has performed beyond its original expectations it cannot meet the needs of future heavy lift. As the needs of the Warfighter increase, so does the weight they bring to the battlefield, and it is due to this factor that the DoD has pursued the Heavy Lift Replacement Program.

Heavy Lift Replacement Program

The journey to find a replacement for the MAGTF heavy hauler began in November of 2003 when the Marine Corps approved the development of the CH-53X program to relieve the CH-53E.[18] Due to the airframe limitations of the CH-53E, 10,000 hours, the Marine Corps would need to begin replacing its CH-53E fleet in the 2020s. Already operating on an extension of 4,000 hours the CH-53E needed a replacement.[19] This replacement will come in the form of the CH-53K "King Stallion" and will bring the MAGTF commander significantly increased capability while maintaining the same footprint of the CH-53E, and since space is always premium on aboard amphibious shipping, this aspect of the CH-53K is key.[20] Below is an except from the Marine Aviation Plan 2016 outlining the significant capabilities the King Stallion will bring to the fight:

> The CH-53K is a critical airborne connector which will enable ship to objective maneuver and seabasing. The CH-53K will be capable of externally transporting 27,000 pounds. to a range of 110 NM under high/hot conditions. This provides nearly three times the capability of the CH-53E under similar environmental conditions. Major system improvements of this new build helicopter include: flyby-wire flight controls; a composite airframe housing more capable and fuel efficient engines and a split torque main gearbox to enable increased gross weight; advanced fourth-generation composite main rotor blades; modern interoperable glass cockpit; internal cargo handling systems compatible with USAF 463L pallets; triple hook external cargo system; and fourth-generation aircraft survivability equipment. Additionally, the CH-53K will be supported by the fleet common operating environment (FCOE) which will facilitate condition based maintenance. The CH-53K helicopter provides JTF and MAGTF commanders with a vertical heavy lift capability to project, sustain and reconstitute combat forces. The CH-53K operates at distances, airspeeds, and gross weights sufficient to support the full range of military operations, expeditionary maneuver warfare, operational maneuver from the sea and seabasing concepts. The aircraft affordably optimizes performance, survivability, maintainability and supportability in a "best value" solution to provide an effective heavy lift assault support platform.[21]

On January 3, 2006 a sole source contract was awarded to Sikorsky for the development of the new heavy lift helicopter, now designated the CH-53K.[22] Since 2006 the development of the CH-53K has seen several setbacks to its progress inciting scrutiny from the Inspector General and Congress, but even with slips in schedule and cost, the performance of the new system

continues to meet the mark. With an ever evolving compliment of equipment, the MAGTF needs this new system.[23]

The slip in the initial system development and demonstration (SDD) created ripples in the entire process. With the Preliminary Design Review (PDR) and Critical Design Review (CDR) both slipping by several months it ultimately pushed the first flight to 27 October 2015. This progress has begun to solidify the timeline. A Milestone C decision, which will give the go-ahead for low-rate initial production (LRIP), is scheduled to be given this year (FY16) with a follow on full-rate production decision in FY19. These determinations will be critical in meeting future timelines.[24]

Based on the current timeline the CH-53E can expect relief in 2019 with IOC of a four plane detachment being established at HMH-366. But, even with this relief the CH-53E community must maintain an ability to support the fleet for an additional ten years.[25] The CH-53K acquisitions plan spans a decade from IOC to FOC. The fact that the CH-53E will have to continue to perform its duties through 2029 is a key factor in investing the requisite time and money into addressing the current issues in the CH-53E community.[26] Based on comparison of the AH-1Z, UH-1Y, and MV-22 programs the average time from IOC to FOC is eleven years.[27] Given this data, and the successful transition of the aforementioned aircraft, it is reasonable to assume that the current acquisitions schedule for Marine Corps is sufficient. The issue facing the CH-53E is in fact germane to the specific system. In the case of the Super Stallion, the decade between IOC and FOC coupled with overuse and decreased inventory has negatively affected CH-53E readiness.

Readiness Overview

Per Marine Corps Order (MCO) 3000.13, readiness is defined as the ability of US military forces to fight and meet the demands of national military strategy, and is based on both unit and joint readiness metrics.[28] Unit readiness is primarily based on four areas: personnel; equipment; training; and chemical, biological, radiological, and nuclear preparedness. The CH-53E community's deficiency is training and equipment. The Headquarters Marine Corps Readiness goal is Training-2.0 (T-2.0). Training goals in USMC aviation are based on the Mission Essential Tasks (MET) that support the six functions of Marine aviation: offensive air support; assault support; anti-air warfare; electronic warfare; control of aircraft and missiles; and aerial reconnaissance. Each T/M/S then derives a mission statement based on what functions of aviation it supports.

The mission of the CH-53E is to support the MAGTF commander by providing assault support transport of heavy equipment, combat troops, and supplies, day or night under all weather conditions during expeditionary, joint or combined operations. Conduct intelligence, surveillance and reconnaissance missions and MAGTF electronic warfare missions.[29] In order for the CH-53E community to meet it T-2.0 readiness goal it must be able to generate sufficient sortie rates to conduct the requisite training. In 2012 it was identified that the training requirements imposed by the CH-53E Training and Readiness (T&R) Manual were too easy to achieve. The average T-Rating across the fleet was 1.6. After a change to the CH-53E T&R Manual in 2013, the CH-53E communities T-Rating dropped from 1.6 to 3.6 which was a dramatic over correction.[30] This over correction coupled with the continual decline of equipment readiness resulted in the large shift in T-Level. Not only was the metrics for training to high, the squadrons could not supply the requisite aircraft to meet the flight hour requirement of 16.5 hours/pilot/month.

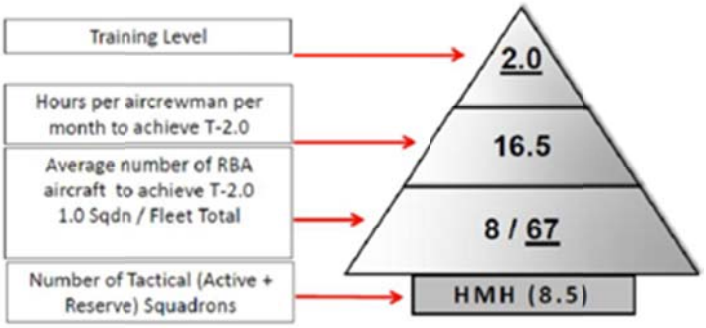

FIGURE 1

The figure to the left graphically depicts the HQMC Ready Basic Aircraft (RBA) Model. This model outlines the foundational approach to achieving the commander's end state of a 2.0 level of training readiness. It is based on the USMC layout of eight active duty Marine Heavy Helicopter (HMH) squadrons and one reserve squadron. The next level depicts the number of RBA aircraft to achieve T-2.0 per squadron and the requisite number of aircraft required to be RBA in the fleet. When with model was developed, each CH-53E squadron rated sixteen aircraft; therefor, half of the squadron aircraft needed to be RBA at any given time to facilitate the next level. In order the achieve the peak of T-2.0 each pilot in the squadron is required to fly 16.5 hours per month. This is not the case in the CH-53E community and has invited attention all the way up the chain of command to the Commandant of the Marine Corps (CMC).

During an interview with the House Armed Services Committee, the Deputy Commandant for Aviation (DCA), Lieutenant General Jon M. Davis, was questioned regarding the overall state of Marine aviation readiness; he painted a bleak picture. Because of the last decade plus of sustained operations a majority of USMC squadrons lack the number of aircraft needed to conduct training. The USMC is down by 150 aircraft, or 20% of their wartime inventory.[31] With these losses, the overall USMC aviation T-Rating dropped from 2.0 in 2003 to 2.7 today.[32] Though the DCA addressed USMC aviation as a whole, he stressed the need for heavy lift in the Marine Corps, and described the dire situation it is in:

> We have seen a sustained and unprecedented operational demand for our legacy heavy lift assault CH-53E fleet, which has prematurely aged an airframe that is on average 26.8 years old, making it ever more challenging to maintain. There are currently 149 CH-53Es

> in the USMC inventory, 47 aircraft short of the requirement to sustain the fleet until 2030, directly decreasing our readiness. The atrophy of the CH-53E's heavy lift capability and readiness, the limited CH-53E inventory and the rising cost of CH-53E flight hours clearly underscores the importance of its replacement, the CH-53K King Stallion.[33]

Shortly after this testimony, a CMC directed study was completed by Booz, Allen, Hamilton that did a deep dive into the CH-53E readiness issue. In June of 2015 the Super Stallion Independent Readiness Review (SSIRR) investigated all CH-53E metrics that contribute to readiness such as inventory, maintenance, management, supply, and culture. In addition to a critical review of the CH-53E community, the report covers best practices from other military agencies, specifically the Army and the Air Force. It was determined that in its current state the CH-53E community is unable to meet its training readiness goal of T-2.0 due to a lack of available aircraft to use for training.

Super Stallion Independent Readiness Review

The Joint Requirements Oversight Council (JROC) revalidated the heavy lift helicopter requirement for the Marine Corps in 2007 at 200 helicopters comprised of 168 primary mission aircraft and 32 airframes in the backup aircraft inventory to cover pipeline and attrition aircraft.[34] Due to the current status of the CH-53E fleet, the Marine Corps cannot meet this requirement. The SSIR outlined the deplorable status of the CH-53E fleet:

> If called to "fight tonight", the Marine Corps could only meet the number of airframes for its operational requirement by deploying *every single aircraft regardless if it is "up" or "down" to include pulling aircraft out of depot level maintenance and 75% of the aircraft away from the training squadron.* As of May 22, 2015 only 35 of the Marine Corps' 149 CH-E's were available for operational or training mission—only 23% of the existing fleet and fully 91aircraft short of the JROC-implied readiness requirement. The combination of a serenely depleted inventory of aircraft and the low readiness of those aircraft that are on hand means that operational commanders cannot currently meet Marine Corps heavy lift helicopter requirements.[35]

At the time of this report there were 149 Super Stallion airframes in service with plans

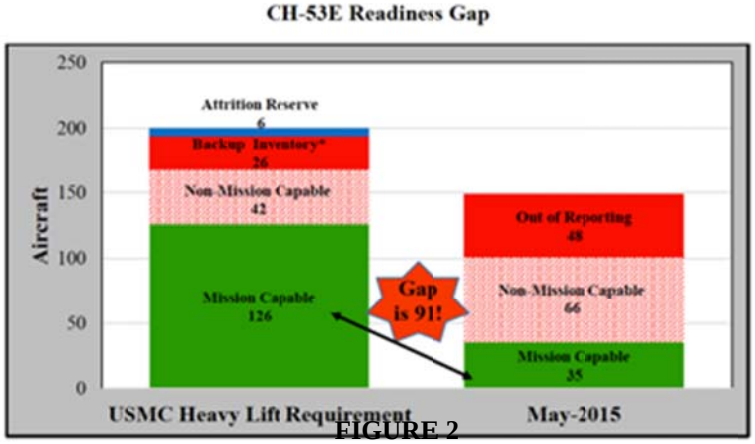

FIGURE 2

on restoring two aircraft from storage, but even with the addition of two aircraft back into the inventory the fleet has a zero gain due to losing two aircraft in FY 16 to Class A Mishaps.[36] According to OPNAV N98, the planned attrition rate for the CH-53E is 0.2% per annum and based on the past ten years that number is closer to 0.9%.[37] With airframe availability being reduced at a higher than planned rate, it is imperative that the Marine Corps take whatever steps necessary to preserve the health and readiness of the existing CH-53E fleet through 2029. Also contributing to decreased readiness is inefficient maintenance at the squadron level. This deficiency can be attributed to a culture of "always making the next launch." With this in mind, Marines have been conditioned to do what ever is necessary to make takeoff times. By often bypassing trouble-shooting and resorting immediately to cannibalization of parts; Marines often degrade the long term readiness of the unit by creating excess supply demand.[38] This culture has developed over the last fourteen years as the CH-53E has born the burden of the Marine Corps assault support responsibility.

Maintenance

According to the data derived from the SSIRR, Non Mission Capable Maintenance (NMCM) is a greater driver of poor readiness then Non Mission Capable Supply (NMCS). NMCM is the term used to identify when an aircraft is not RBA do to a lack of maintenance that could be performed at the squadron level. While NMCS is the term used to identify when an aircraft is not RBA due parts unavailability. This data is reported in two separate and distinct reports. The Aviation Maintenance Supply Readiness Reporting (AMSRR) and the Aircraft Inventory Readiness Reporting System (AIRRS). The AMSRR is a "snapshot" of a certain point in the day and has the ability to be shaped by the reporting unit; therefore, commands have the ability to report data that is advantageous to the unit by avoiding times when aircraft are NMCM vice NMCS. Conversely the AIRRS data is refreshed at a near instantaneous rate throughout the day; thus, it offers a much more realistic picture of a unit's equipment readiness. As seen in the figure below based on AIRRS data, NMCS rates have remained fairly steady over the last thirteen years around 12%, while NMCM have risen from 20-35% seeing an almost two fold increase.[39] It is obvious based on this data the maintenance practices in the squadrons need to change.

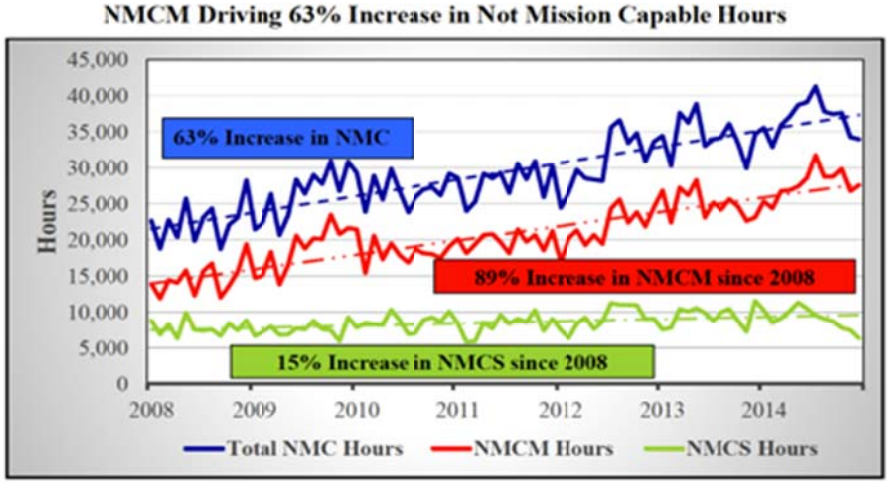

FIGURE 3

Though CH-53E material condition has been declining since before 9/11, it has declined at a much higher rate in the last eleven years. The average Full Mission Capable (FMC) rate prior to 2001 was 50% while the FMC rate in 2014 was approximately 20%.[40] FMC rates can be

contributed to two factors—Non Mission Capable Maintenance (NMCM) and Non Mission Capable Supply (NMCS). The data shows the NMCM rates to be the predominant contributor to Non Mission Capable rates; why is this? The explanation of the rise in NMCM rates from 20%-35% from 2001 to 2014 is rooted in poor maintenance practices and decreased school house training.[41,42]

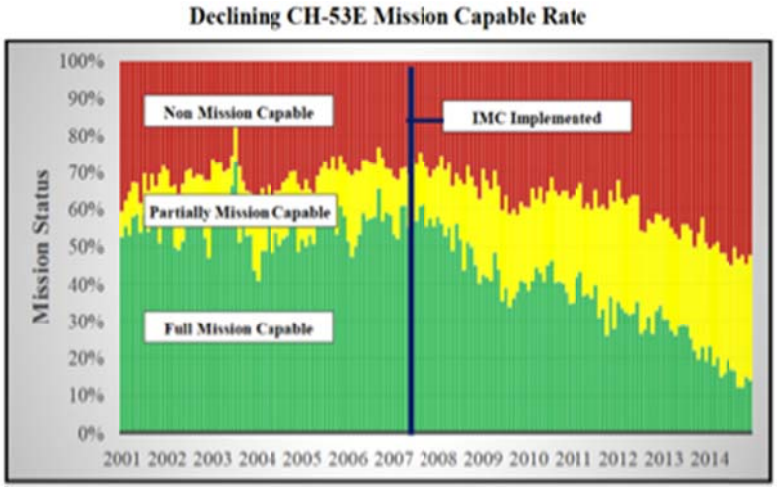

FIGURE 4

From 2011 to 2014 the CH-53E community had the worst cannibalization rates in rotary wing USMC Aviation. Squadrons often utilize cannibalization to replace high time components with known availability issues. While other reasons may be to swap an easily replaceable part while aircraft are spinning on the line to facilitate making a takeoff time. This is good and bad in both of these examples. The good side of this problem is it produces one FMC aircraft by taking the part from an aircraft being inducted into either modification or depot level maintenance vice being down two aircraft. The bad is the increase in consumption and addition of more NMCM time. Often times Marines will "break" several parts in the attempt to do a

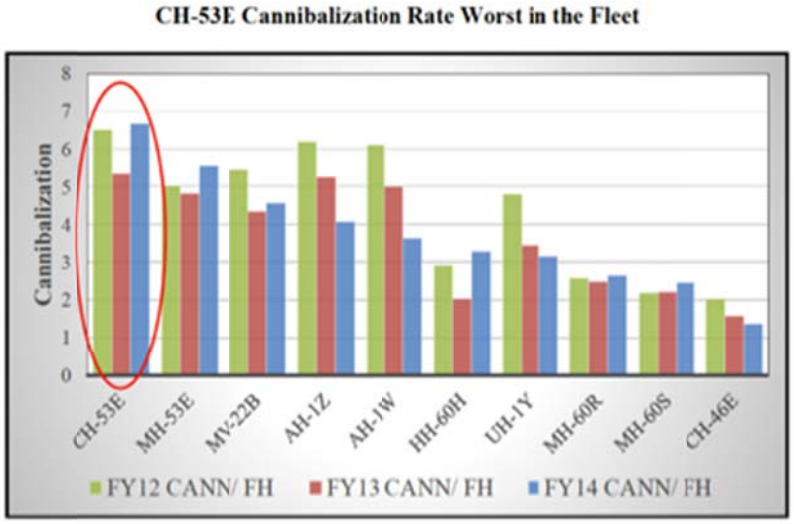

FIGURE 5

"quick fix" because they have not properly trouble shot the problem.[43] This causes the supply system to work overtime and can cause people to look at it as a supply issue when in fact, the root cause is poor maintenance action. Though a majority of the blame can be placed on individual or squadron actions, supply is sometimes at fault as well.

A specific example of this was found in MAG-16 in a single engine temperature sensor that had been installed on eight different engines in fourteen months.[44] Another prime example of wasted man-hours caused by supply is the T64-GE-419 engine upgrade. The upgrade is intended to improve performance and power of the current T64-GE-416A engine, and it does. The drawback to the upgrade is the frequency squadrons are cannibalizing from the reclaimed (Reclamation in Lieu of Procurement - RILOP) engines to install working fuel controls when facing a lack of appropriate parts.[45] This short sighted approach is great for immediate results, but it causes a skew in the reporting by doubling the reported maintenance man-hours and pushing the problem downstream to the FRC. These problems stem not just from the availability of parts, but from a decline in maintenance proficiency and fleet support at the squadron level.

Once a figure that was readily accessible on the flight line, the Field Service Representative (FSR) has become someone used as a last resort vice someone who is seen during the day to day conduct of maintenance. Originally intended to be a "feet" standardization tool, moving from unit to unit helping with training and maintaining best practices. The "Tech Reps" have been constrained through bureaucratic red tape to only helping put out the hottest fire on the flight line after a lengthy approval process.[46] This must change. It is time the FSR returned to their position of teacher and facilitator on the line and this change would aid in the on the job training which no occurs in lieu of hands on school house training.

As sequestration rattled the DoD in 2011, the Navy sought to reduce its cost by cutting the time for training in its aviation maintenance schools. Naval Education and Training Command (CNET) schools have moved to a heavily computer based training (CBT) approach.[47] This CBT approach is proving inadequate to meet the needs of the operating forces. Marines show up to the squadron incapable of fulfilling even the most basic role as a worker on the flight line. This creates an immense burden for the already taxed squadron. It causes the Collateral Duty Inspectors (CDI) to perform and teach remedial tasks that should have been grasped at the training command, and by doing so, detracts from the CDIs primary task of supervising and inspecting the work being conducted on the flight line. If CNET continues to avoid hands on training something must be incorporated at the squadron level to supplement this deficiency while maintaining standardization across the fleet. The lack of standardized training is not only present in junior Marines.

Once a Marine leaves C school, he or she is not required to attend any formalized maintenance training. All training occurs at the squadron level and is, therefore, subject to normalized deviations. According to Diane Vaughan, author of *The Challenger Launch Decision*, normalization of deviance in an organization is defined as, and occurs in the following way:

> Social normalization of deviance means that people within the organization become so much accustomed to a deviant behavior that they don't consider it as deviant, despite the fact that they far exceed their own rules for the elementary safety. But it is a complex process with some kind of organizational acceptance. The people outside see the situation as deviant whereas the people inside get accustomed to it and do not. The more they do it, the more they get accustomed.[48]

By placing so much stock in OJT, the Marine Corps is leaving the CH-53E community extremely vulnerable to normalization of deviance at the operational and intermediate levels. The DCA of aviation is currently completing a program that was intended to be completed in

conjunction with MAWTS-1. Project 21 will establish a Maintenance Training Instructor (MTI) Course that will complement the Weapons and Tactics Instructor (WTI) Course.[49] Though this program will not be able to focus on the actually T/M/S requirements for each of the maintenance shops, it will be able to standardize administrative procedures and training programs. This standardization will intern facilitate proper adherence to published manuals and troubleshooting procedures increasing productivity, and ultimately, readiness at the squadron level. MTI in concert with the FSR will be able to establish standardized training program to decrease NMCM time, but this is only one part of the equation. Marines must have the parts they need in a timely fashion to perform the maintenance.

Supply

Supply rates are directly related to aircraft readiness and FMC status. The CH-53E NMCS supply rate, though stable from 2001-2014, have never been in single digits.[50] The CH-53E NMCS rate is 10.2% and when compared to services as a whole, it underperforms by 3.6% when compared to the Navy as a whole, and 6.3% worse than the Army.[51] These statics take on a more meaningful metric when CH-53E readiness rates are directly compared to the Army CH-47D. The CH-47D is a comparable airframe in both life-cycle stage and mission type. Looking at a period from 2012 to 2015 the CH-47D boasted a 71% FMC rate while the CH-53E reported 27% FMC.[52] Though supply is not the sole contributing factor in the comparison, it cannot be put aside as a contributor. Supply responsibility in Marine

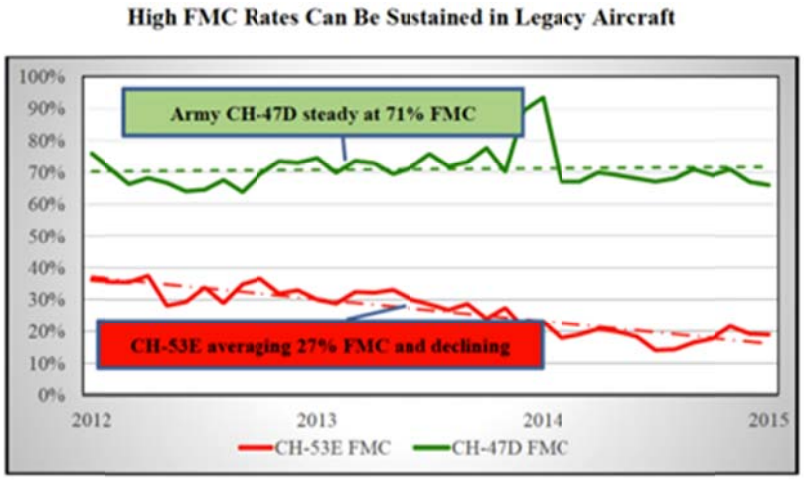

FIGURE 6

Corps Aviation falls on two different agencies—the Defense Logistics Agency (DLA) and Naval Supply Systems Command (NAVSUP).

The DLA is America's combat logistics support agency responsible for providing the DoD with full spectrum logistics support, acquisition and technical services. In this role the DLA provides almost 90% of the military's spare parts.[53] Given this role, it is not surprising that DLA holds the majority of culpability regarding the CH-53E supply issues. The DLA provides parts at both the squadron and depot levels which are both experiencing long wait times for the DLA managed and supplied parts. Approximately 70% of NMCS orders back logged at the squadron level belong to the DLA and 93% of those parts in a long-term wait status at the level are provided by DLA.[54] Though DLA clearly is responsible for a piece of the CH-53E readiness issue the DLA is merely a third party facilitator who purchases and stocks parts based on reported needs. The Part needs are outlined in the Bill of Materials (BOM), and the CH-53E BOM has not been updated in years.[55] It is important to note that the DLA is designed to procure vast quantities of parts per order. For example, if a High Mobility Multipurpose Wheeled Vehicle (HMMWV) is showing a shortage of oil filters or brakes it is easy for the DLA to fulfill this order in bulk to supply the tens of thousands of HMMWVs in the DoD, but this is not the case for niche aviation parts.[56] Even when parts requirements are correctly identified it is difficult to match the need to a qualified vendor.

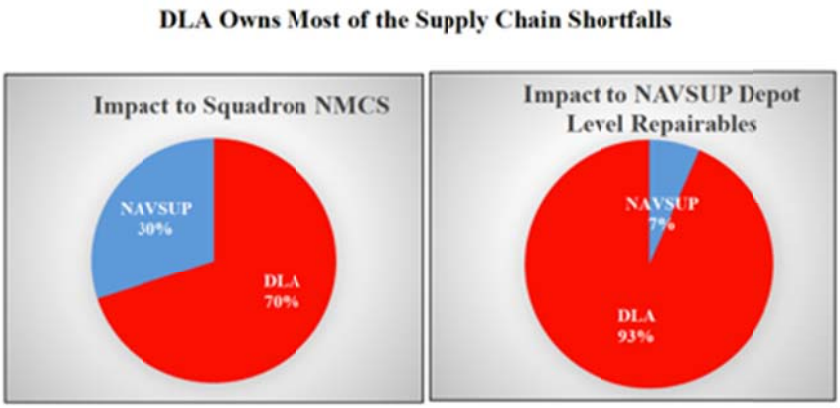

FIGURE 7

Due to the lengthy acquisitions approval process for new vendors, the supply chain

cannot function smoothly even when the need for a part is identified. There is a lack of pre-approved vendors in the CH-53E acquisitions world and this is due to a lack of adequate forecasting regarding parts needs. Much of this can be attributed to the aged BOM that sources parts acquisition. There is little incentive for vendors to provide the manufacturing capability for parts in the CH-53E due to the lack of long term contracts and commitment by the government.[57] The most reasonable and reliable fix to this issue is the establishment of a Performance Based Logistics (PBL) contract.

Performance Based Logistics

According to the DoD publication, *Performance Based Logistics: A Program Manager's Product Support Guide*:

> PBL is the purchase of support as an integrated, affordable, performance package designed to optimize system readiness and meet performance goals for a weapons system through long-term support arrangements with clear lines of authority and responsibility. Simply put, performance based strategies buy outcomes, not products or services.[58]

The outcome for the CH-53E is readiness; and this increase in readiness is attained by enhancing the supply chain through long-term contracts with vendors. This gives vendors the confidence in the duration of the contract incentivizing them to procure the necessary resources to manufacture and deliver parts in a timely fashion throughout the life cycle of the system. PBL is implemented through a PBA that creates a public-private-partnership (PPP). The PPP brings together the DoD and corporate entities to maximize productivity and readiness. PBL consolidates the supply system under a single vendor which eliminates the current cumbersome third party managed process, thus, reducing total cost through process improvement and training.[59] Based on the information provided, it is reasonable to proceed down a path to establish a robust PBL contract for the CH-53E. This new contract should include metrics to measure the contractor's direct or indirect contribution to readiness. These metrics should not solely focus on supply response time

(SRT).[60] Though critical, SRT is only one small piece or the framework that enable good readiness.

As outlined above, RBA is a collaborative effort between the maintenance force and the supply system. These efforts are mutually supporting, and failure in either area will result in training degradation. In performance-based life cycle support product support outcomes—RBA in the CH-53E's case—are acquired through performance-based arrangements which provide the warfighter with mission essential equipment and services.[61] This is PBL, and PBL has been mandated for the use in major weapons systems since 2001 as directed by the Quadrennial Defense Review (QDR).[62] Although first mandated in 2001, PBL has been in use since the late 1990s.

As early as 1995, the DoD began to see the value in PBL contracts. When the F-117 Night Hawk was faced with the closer of its logistics center Lockheed Martin Aeronautics-Palmdale (LM Aero-P) proposed a new way of doing business. The Total System Support Partnership (TSSP) contract was awarded in FY99. [63] LM Aero-P was able to consolidate from 180 prime contractors down to one allowing for a streamlined approach to systems sustainment. Although this was a sole source contract to LM, it encouraged completion among the subcontractors which LM managed.[64] This initial contract spanned eight years and resulted in both high operational readiness and cost savings. Prior to the TSSP response time was ninety hours for mission capable deliveries and 190 hours for engineering dispositions. Under the TSSP these metrics fell to 23.4 hours and 2.1 hours respectively.[65] Through this revolutionary PBL contract the Air Force Saved over $217.5 million and allowed the warfighter to achieve mission success.[66] Another key aspect of the PBL is the ability to address obsolescence issue before they arise. As mentioned above DLA has difficulty in supplying small scale quantities of niche

aviation parts. With the PBL construct the contractor, LM in this case, is able to identify these issue before they become a problem and impact the weapons system.[67] Though the Air Force was the pioneer in the PBL concept it did not take long for the Navy Marine Corps Team to follow suite.

The CH-53E currently enjoys three award winning PBL programs. Hamilton Sundstrand Power Systems (HSPS) has been supplying Auxiliary Power Units (APU) to both the H-46 and H-53 since 2003. [68] Michelin is under a PBL contract to provide sixteen different airframes tires including the CH-53E. [69] Sikorsky is currently responsible for providing ten key components to the Ch-53E under its current PBL contract.[70] Everyone of these contracts has met or exceeded expectations and improved readiness at reduced cost. Based on this data it makes sense to proceed down a path toward a more robust PBL plan for the CH-53E. Program Manager Air (PMA) 261 is currently working toward a PBL contract through Sikorsky to cover 147 weapons replaceable assemblies (WRA).[71]

Recommendations

Based on the critical capability the CH-53E provides the MAGTF and the DoD coupled with the data provided in the SSIRR regarding the communities' poor materiel condition, it is imperative that an aggressive and innovative approach be taken to right the readiness problem. The use of a robust PBL will help to solve this problem and maintain the fleet after being reset. In order for the synergistic PBL to be most effective, the fleet must be reset to FMC condition. CH-53E reset is currently being accomplished following the Army's CH-47 mode and will be accomplished by at the organizational, or squadron, level. The contract must contain provisions to maintain or increase current supply response time, place the onus on the contractor to improve processes, and focus on the contract's direct contribution to RBA. It is imperative that all parties

involved remember the reason for the change: readiness.

The public-private partnership that is formed in this contract must facilitate streamlined continuous process improvement and standardization across the fleet common operating environment of the CH-53E. The FSRs need to be given sufficient trade space allowing them make improvements. The squadron commander's must be receptive of this new program and embrace standardization across the fleet and get out of the mindset of always making the next launch. Instead the community needs to focus on the overall health of the fleet which in turn, will improve readiness and allow them to achieve the goal of T-2.0.

All of these processes are required to maintain the CH-53E for the next ten years. Though it would be ideal to have a new helicopter today, this is not feasible. With the protracted timeline required to develop a major weapons system, the warfighter must adapt to make the most out of what they have before the new system reaches maturity. A new PBL strategy helps this happen in the CH-53E community. With the implementation of BBP initiatives and the mandated use of PBL these issues should become a thing of the past as our future aircraft sundown. If the DoD does not get it right in the future the US warfighter will find themselves in an even tighter spot. For example, the CH-53E was extended from 6,520 hours of life to 10,000 hours with minimal input, but the CH-53K will not have that luxury.[72] With the currently knowledge of metallurgy and material strength, what the DoD buys is what the get, making it ever more critical that the correct processes are established now to carry over into the future.

Conclusion

Marine Corps aviation as a whole is recovering from over a decade of combat operations in harsh and unforgiving environments. The CH-53E community is not the only T/MS that is suffering from reduced aircraft inventory and poor readiness, but it is the worst off. The SSIR

uncovered numerous areas for improvement from culture to technical procedures. Several of these areas can be addressed by developing a dynamic PBA with Sikorsky to manage, not only the supply of parts, but the improvement of processes in the fleet. A PBA that provides consistent supply response time, reduced cost per flight hour, and improved processes across the CH-53E aviation enterprise will help prevent the Marine Corps and the Nation from developing a capability gap as the CH-53K is brought on line.

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