Revitalizing a Legacy: The Remaining Future of the CH-46E

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INTRODUCTION

For over 40 years, the Marine Corps has relied on the CH-46E Sea Knight, or "Phrog," as their primary rotary-winged assault support aircraft. Through the years, the Sea Knight has proven itself in every topography, climate, and mission it has supported. While the service life has been extended another 12 years, the future versatility of the venerable helicopter is in jeopardy. Already, the results of doubling its twenty year projected service life[1] are "escalating maintenance costs, reduced reliability, availability, maintainability, and significant performance degradation." [2] These well-documented problems will continue to shift focus away from the CH-46 as the primary choice for tactical assault support missions. Therefore, the future CH-46E community will be restricted from performing tactical missions unless necessary airframe upgrades are performed,

SEA KNIGHT LEGACY

The CH-46 made its first flight in 1958 as a potential replacement aircraft for substantially less capable, piston-driven, medium-lift assault support helicopters. The Sea Knight's tandem rotor design and dual gas-turbine engines made it capable of executing missions unlike other helicopters. The

[1] General James L. Jones, 1 May 2001, Speech before the House Armed Services Committee, "Concerning The MV-22," <http://armed-services.senate.gov/statemnt/2001/010501 jones_.pdf.> (14 December 2004).
[2] Jones.

Marine Corps made the first Sea Knights operational in October 1964, and used them to perform an extended variety of tactical and administrative tasks. Success of the airframe continued for twenty-six years when production of the Phrog ended in 1990.[3] However, without a suitable replacement aircraft identified, the Marine Corps renegotiated the Sea Knight's Service Life Extension Program (SLEP) through 2017.

With the current Service Life Extension Program, CH-46 squadrons will see about forty-two more Marine Expeditionary Unit (MEU) deployments, excluding training obligations and other operational commitments. Most Sea Knight airframes have over 10,000 hours "well on their way to the Naval Air Systems Command's established service life limit of 15,000 hours."[4] The aging CH-46 has been listed as a 'legacy' aircraft for the obvious fact that it needs to be replaced. However, with twelve years of service life left, revitalizing performance through upgrades would be beneficial.

INCORPORATED CHANGES & THEIR EFFECTS

When production of the Phrog ended in 1990, difficulty in sustaining performance, acquiring parts, and performing maintenance began. Although the CH-46E has had over 500 minor

[3] Anonymous, "CH-46 reaches a milestone," *Marine Corps Gazette,* Vol. 85, Iss. 4 (2001): 6.
[4] "Boeing Model 107/H-46 Chronology," *Boeing*, 9 September 2003, <http://www.boeing.com/rotorcraft/military/ch46e/ch46chron.html> (14 December 2004).

airframe changes,[5] it has only seen only a few major changes in the last four decades: 1968, 1975, and 1985.[6] In addition, the 'Bullfrog' fuel capacity system was introduced in 1990"extending combat range from 80 to 160 miles."[7] In 1992, the Dynamic Components Upgrades DCU "replaced drive train and rotating parts with new and in some cases upgraded parts."[8] Through the 1990's the safety, reliability and maintainability program (SR&M) was added to the airframe. Other notable capabilities upgrades included the following: aircraft survivability equipment (ASE) meant to defeat or detect hostile threat weapon systems; helicopter emergency floatation system (HEFS) designed to inflate in the event of an emergency water landing; helicopter emergency egress lighting system (HEELS) which provides exit lighting for passengers following irregular helicopter behavior; flight control armor, engine armor, and armored cockpit seats; Doppler capability; and night vision goggle heads-up display. The commonality between these, and most other upgrades to the airframe, is that they add or increase capabilities. Few Sea Knight upgrades have increased performance.

Unfortunately, the effect of added capabilities is reduced performance. In helicopter aerodynamics, every pound of mechanical weight that is added to the basic weight of the

[5] Anonymous, 6.
[6] "Boeing Model 107/H-46 Chronology."
[7] "Boeing Model 107/H-46 Chronology."
[8] "Boeing Model 107/H-46 Chronology."

helicopter (the weight without fuel or people), reduces the total payload available. Less lift means that the Sea Knight is unable to operate in conditions or carry payloads previously possible. Payload is the combination of fuel and passengers that can be embarked for a mission. Figure 1-1 shows the difference in payloads of a Phrog in 1975 and in 2005.

	1975	2005
Maximum Operating Weight (lbs)	24,300	24,300
Average Basic Weight (lbs)	- 12,405[9]	- 18,000
Payload (lbs)	=11,895	= 6,300

Figure 1-1
CH-46 Payload capabilities in 1975 and 2005

A few upgrades have actually increased performance: The replacement of the GE-T58-10, 1400 shaft-horsepower engine[10] with the GE-T58-16, 1870 shaft-horsepower engine; Fiberglass rotor blades in 1978[11]; and the Engine Condition Control System (ECCS). Each of these upgrades either directly affected engine performance, and/or decreased aircraft basic weight.

Recently, the Engine Reliability Improvement Program (ERIP) was implemented in 2003 to replace all the old GE-T58-16 engines with GE-T58-16A engines.[12] This improvement did not upgrade the

[9] Greg Goebel, "The Boeing Sea Knight & Chinook," *Internet FAQ Archives*, 01 Jul 02 <http://www.faqs.org/docs/air/avch47.html> 3 Jan 05.
[10] John Pike, "H-3 Sea King" *Global Security.org,* 10 December 2004, <http://www.globalsecurity.org/military/systems/ aircraft/h-3-specs.htm> (14 December 2004).
[11] "Boeing Model 107/H-46 Chronology."
[12] Stanley W. Kandebo, "T58 Core Upgrades Target Engine Durability, Life" *Aviation Week & Space Technology,* Vol. 157 Iss. 9 (2002): 4.

performance as first thought, but did “improve the reliability, and extend the service life by lengthening the engine replacement cycle from 350 to 900 hours”[13]

NECESSARY PERFORMANCE UPGADES

In order to truly improve performance of the Phrog, upgrades must come in the form of weight reduction. Already squadrons are enhancing performance by reducing weight without significant capabilities degradation. Sea Knight squadrons have begun removing the Emergency Floatation Systems in Operation Iraqi Freedom, increasing payload by 230 pounds. However, more drastic measures must be taken to ensure performance remains plausible through 2017. Items such as inoperable HF radios, orphaned components for a Doppler radar system, and seldom used NVG heads-up display could be removed entirely.

Already identified is the lightweight armor replacement system (LWARS). LWARS would replace cumbersome engine and flight control armor with a lighter weight version without decreasing survivability. However, the concept has not yet been incorporated into the aircraft. Installation of the LWARS “would provide a 35 percent weight savings [over the current armor], (160 pounds).”[14] Furthermore “implementing a basic strip list that leaves all of the airframe's aircraft survivability equipment (ASE) intact would reduce aircraft basic weight by

[13] Kandebo, 4
[14] William D. Catto, “A Phrog for combat,” *Marine Corps Gazette*, Vol. 82, Iss. 11 (1998): 63-64.

almost 400 pounds." These upgrades alone would decrease the basic weight of the airframe by almost 800 pounds.[15]

The most sought after improvement for the CH-46 is a newly designed rotor blade. Current fiberglass rotor blades were a tremendous reliability improvement over old steel blades. First installed in 1978,[16] the blades offered little performance enhancement; fiberglass blades were designed to have the same stiffness and weight as the original blades. Sea Knight performance would benefit from blades with new geometry. These new blades could increase Phrog payloads though use of weight reducing composite materials. Furthermore, maneuverability and reliability would be increased due to advancements in swept-tip rotor blades. Deputy Commandant for Aviation, Lieutenant General Hough in a brief to aircrew at Miramar MCAS in 2002 stated, "new rotor blades for the CH-46E would never be seen due to budget restraints and production time. Each blade would cost around 250,000 dollars."[17]

The inevitable question arises; can necessary performance upgrades be conducted for a feasible amount of money? The cost to outfit new rotor blades would be about 1.5 million dollars per aircraft for a total cost of 354 million dollars to outfit all 236 Marine Corps Sea Knights.

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[15] Catto, 64.
[16] Sam Helland, "The CH-46E Sea Knight - A story of longevity," *Marine Corps Gazette*, Vol. 74 Iss. 5 (1990): 70.
[17] LtGen. Michael A. Hough, (diss., Marine Corps Air Station Miramar, 2002).

The LWARS will cost of approximately $5,500 per aircraft or $1.3 million for the entire fleet of CH-46s.[18] These are the costs associated with only two identified components. In order to revitalize a "legacy" aircraft, money must be taken from other programs. Funding will certainly not be pulled away from the MV-22 program. However, in today's rotor-centric Marine Corps, money taken from less operationally committed communities might be a suitable answer to keep the Sea Knight tactically viable.

ALTERNATIVES

A replacement aircraft may seem to be the only alternative for the CH-46. The revolutionary MV-22 Osprey tilt-rotor will be that replacement aircraft, but not until 2017. Increasing production to deliver the MV-22 to the operating forces quicker is unlikely due to fiscal year budget constraints, production facilities and demands from other armed services. This leads to either an interim airframe, or upgrades to the existing fleet of CH-46Es.

One interim airframe is the H-60 Blackhawk. The H-60 is an extremely cost efficient alternative. It has been a proven airframe for the United States Army and Navy. Contract workers provide proactive and reactive maintenance above the levels possible by squadron personnel. Parts would be readily available due to service commonality. However, due to the small

[18] Catto, 64.

cabin and troop carrying limitations compared the Sea Knight, the Marine Corps has already opted against procuring these airframes.

Another interim option is the CH-53E Super Stallion. The CH-53E is undoubtedly capable of performing CH-46E missions. However, it suffers from the same performance degradation as its Sea Knight counterpart. The large footprint means less aircraft embarked aboard Naval shipping at any given time. The larger landing zones it requires, makes special operations difficult to perform. Furthermore, the CH-53 moves slower into and out of landing zones, making it a susceptible target and unreasonable risk during troop inserts. Its man-hour to maintenance ratio is high, as is its cost to operate. Its benefit is its heavy payload; the ability to move heavy objects medium-lift helicopters cannot. Its capability to carry more passengers can be both a positive and negative attribute: The negative being a significant amount of lives and combat power is lost with a downed helicopter. Simply, the Super Stallion is good at what it can do, but is no replacement for a medium-lift helicopter.

Procurement for interim airframes is a time consuming and costly investment. Time to acquire contracts, train aircrew, and deploy ready squadrons will take much longer than the twelve years of service the CH-46E has left. An interim aircraft is not a viable alternative for upgrading the CH-46E.

CONCLUSION

The USMC needs a revitalized assault support platform capable of performing missions well into the future. The MV-22 will not have enough airframes to sustain the Marine Corps deployment cycle for almost another decade. Since there is no other interim airframe to replace the Ch-46 until the MV-22 phases it out, upgrades must be made to the 46 to increase power, operational reliability, mission readiness and mission supportability. With the upgrades the Phrog can continue to support the Marine Corps mission until it is phased out by the MV-22

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