MARINES AND HELICOPTERS
1962-1973

HISTORY AND MUSEUMS DIVISION
HEADQUARTERS, U.S. MARINE CORPS
WASHINGTON, D.C.

USMC Photo A192655

Cover Photo: *UH–1Es at Fire Support Base CUNNINGHAM during Operation DEWEY CANYON in northern I Corps in 1969. Without guns, the UH–1E was an excellent observation aircraft, but it often was diverted to other missions, as here supplying a remote firebase.*

MARINES AND HELICOPTERS 1962 - 1973

By

Lieutenant Colonel William R. Fails, USMC

HISTORY AND MUSEUMS DIVISION
HEADQUARTERS, U.S. MARINE CORPS
WASHINGTON, D.C.
1978

A MILITARY FORCE WITHOUT HELICOPTERS IN THE FUTURE WILL BE OBSOLETE.

Lieutenant Colonel
Keith B. McCutcheon
1951

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FOREWORD

This history traces the development of helicopters in the Marine Corps from 1962 to 1973 and is the second in a series of two volumes which between them cover the story of Marines and helicopters from 1946 to the present. In the period covered by this volume, the Marines at last acquired helicopters fully capable of carrying out an amphibious vertical assault, and they further elaborated their helicopter doctrines and tactics. In the Vietnam war, pilots and machines met and surmounted the test of actual combat. The documentary basis for this monograph was primarily the official records of the Marine Corps and Navy Department, but considerable use was made of interviews and correspondence with key individuals involved in all phases of helicopter development.

The author, Lieutenant Colonel William R. (Bob) Fails, USMC (Ret), received his Bachelor of Arts degree in English from Hiram College, Hiram, Ohio, and his Master of Business Administration in Financial Management from The George Washington University, Washington, D.C. His Marine Corps aviation experience includes tours with fixed-wing fighter and attack squadrons, as a flight instructor, and as a helicopter pilot and aircraft maintenance officer. He served in Vietnam in 1965–66 with HMM–263 and again in 1970–71 as S–4 of MAG–16 and facility manager for Marble Mountain Airfield. He came to the History and Museums Division in 1973 from the 34th MAU in the Mediterranean, in which he had been Executive Officer. Now retired, Lieutenant Colonel Fails resides and works in Tempe, Arizona.

Comment copies of the manuscript for this volume were sent to many individuals involved with both the conceptual and operational aspects of Marine helicopter development. In association with Lieutenant Colonel Fails, Dr. Graham A. Cosmas incorporated these comments and edited the manuscript for printing. Dr. Cosmas received his PhD degree in history from the University of Wisconsin and joined the staff of the History and Museums Division in December 1973 after teaching at the University of Texas and the University of Guam.

The History and Museums Division welcomes any comments on the narrative and additional information or illustrations which might enhance a future edition.

E. H. SIMMONS
Brigadier General, U.S. Marine Corps (Ret)
Director of Marine Corps History and Museums

Reviewed and approved:
1 May 1978

PREFACE

One of the most pervasive characteristics of man is hindsight. It masquerades under many guises: Monday morning quarterbacking, second guessing, and historical writing. When viewed through time, the past becomes distorted. Problems seem simpler, the choices more clear, and the conditions less complex than those of the present. The men who played a part become more heroic or more villainous than they were in life.

This volume is an attempt to portray accurately the difficulties faced and the obstacles conquered by the men who developed helicopters in the Marine Corps, so that the Marines of today and the future may meet the challenges of their own times with the same dedication as their predecessors.

The men who developed helicopters in the Marine Corps had nothing more to rely on than their knowledge of what had preceded them, intelligence liberally used, and both mental and physical courage. The present-day Marine will be well served if he applies nothing more.

This volume is no more the product of one man than is the development of helicopters in the Marine Corps. While the final responsibility must rest squarely on the shoulders of the author, many others were involved. It is impossible to acknowledge all who gave assistance, but special mention has to be made of a few. First there was Henry I. Shaw, Jr, Chief Historian of the Histories and Museums Division at Headquarters Marine Corps. His many hours of counsel, advice, and encouragement in large measure determined the form and thrust of the book. Dr. Graham A. Cosmas, who edited the book for publication and, with me, incorporated the comments of reviewers, was a welcome and expert colleague. Lee M. Pearson, Historian for the Naval Air Systems Command, and his able assistant, M. Frances Mattingly, provided a large amount of material. So did Elsie L. T. Goins of the Aviation History Office, Deputy Chief of Naval Operations (Air Warfare). Major John C. Short and his staff of the division's Historical Reference Section had unlimited patience as I researched through their files.

Many Marines aided me. Major Gary L. Telfer, a ground officer, read many of the technical sections for understandability. Always on the lookout for information were Lieutenant Colonels Alvah J. Kettering, Robert K. Goforth, William C. Ryan III, and Majors Robert M. Rose and William C. Cowperthwait. My special appreciation goes to Colonel David A. Spurlock who always found time in his hyper-busy schedule to explain technical details or provide documents from his own files. His help was invaluable.

Mrs. Keith B. McCutcheon made available to the Marine Corps many of the personal papers of General McCutcheon. They were a great help to me, and will be mandatory for any future research into the history of Marine Corps aviation.

Typing and typesetting were completed by Miss Catherine A. Stoll, layout and charts by Gunnery Sergeant Paul A. Lloyd, and production editorial work by Mr. Paul D. Johnston.

Finally I would like to express my deep and personal appreciation to a Marine who will never read the book: Major Bernard (Bernie) R. Terhorst. On 19 April 1969, while on his second tour in Vietnam, he piloted a helicopter on a night medical evacuation flight. The aircraft was hit by intense fire from the enemy. All on board perished. Major Terhorst was survived by his wife, Barbara, and six children. He and all the other helicopter pilots and crew members who gave their lives for their fellow men, and their families, were the ultimate inspiration for this book.

W. R. FAILS
Lieutenant Colonel, U.S. Marine Corps (Ret.)

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CHAPTER ONE

THE LAST CONCERT

New Year's Day 1962

New Year's Day 1962 dawned cold and bleak in Washington, D.C. The sky remained overcast and the temperature hovered just above freezing. As most of the residents slept away the revelries of the night before, in a full block of staid but substantial brick buildings located in the southeast section of the city there was a flurry of activity.

For almost 100 years, every New Year's morning the United States Marine Band had staged a well-rehearsed, impromptu concert for the Commandant. Each Commandant had responded, appearing suitably surprised even though he had spent some effort getting dressed in the required formal uniform. At the conclusion of the ritual the band always was invited into the Commandant's House to share with visitors and guests a cup of hot punch. The first of January 1962 was no exception.

At exactly 1045, Lieutenant Colonel Albert F. Schoepper, director and a veteran of 18 years service with the band, two assistant directors, the drum major and 78 members assembled on the north side of the parade ground directly in front of the Commandant's House. Fifteen minutes later as the musicians began their serenade with "Fanfare," General David M. Shoup, Commandant of the Marine Corps (CMC) stepped out the door looking "suitably surprised." [1]

The four interconnected stars of his rank covered the shoulders of his blue uniform, and at the top of the rows of ribbons denoting a total of 22 awards was the unmistakable pale blue background and white stars of the Medal of Honor. He had won it for his leadership in the battle for Betio Island of the Tarawa Atoll in November 1943. On 12 August 1959, as a major general commanding the Recruit Depot at Parris Island, S.C., he had been nominated to the top position in the Marine Corps by President Dwight D. Eisenhower. In so doing, the President had departed from previous tradition and had reached below almost a dozen other candidates who were senior to General Shoup; but the confirmation was given quickly and now he was listening to his third New Year's Day concert as the CMC.

USMC Photo A408673

General David M. Shoup, 22d Commandant of the Marine Corps. During his term of office, Marine helicopter forces were committed in the Cuban missile crisis and in aid of the South Vietnamese.

At the conclusion of the program, Lieutenant Colonel Schoepper made a short speech and the CMC responded. Then all adjourned to the punch bowl where they were joined by other members of the band who had not participated in the ceremony.[2]

Of the Marines and their guests gathered that day few could have foreseen that this would be the last New Year's Day for 11 years in which Marines were not engaged in battle. Fewer still could have known that the first major Marine unit to be committed to combat would be a helicopter squadron and that one of the last to be withdrawn also would be a helicopter squadron.

Helicopters in the Marine Corps had come a long way since the first two had been delivered 9 February 1948. At the time, those two fragile Sikorsky-built observation helicopters, designated HO3Ss, represented a total combined capacity of just six passengers—provided conditions for flight were absolutely ideal, which they seldom were.*

Marine Helicopters Around The World

Fourteen years later, the Marine Corps had 341 helicopters of all types.[3] Over half of them, a total of 196, were assigned to Aircraft, Fleet Marine Force, Pacific (AirFMFPac). Unlike the Atlantic Fleet Marine Force (FMFLant), aviation units in the Pacific were a separate command from the rest of the Marine units. Not until 1 July 1965 would the two be consolidated and Major General Avery R. Kier's AirFMFPac merged with FMFPac. General Kier, a pilot with one of the first Marine Reserve Squadrons at Minneapolis in the 1930s, became deputy commander of the consolidated forces under Lieutenant General Victor H. Krulak.[4]

Marine Aircraft Group (MAG) 16, with 64 helicopters, was based at the Marine Corps Air Facility (MCAF), Futema, Okinawa. The newest of all Marine helicopter fields, Futema had been built by Navy construction battalions (CBs) and opened in 1960. In numbers of units, MAG 16 was the smallest of all helicopter groups. Other than the normal Headquarters and Maintenance Squadron (H&MS) 16 and the Marine Air Base Squadron (MABS) 16, it had only three tactical squadrons. Marine Observation Squadron (VMO) 2 had a mixture of helicopters and small fixed-wing aircraft. There were two light transport squadrons: HMRL–261 and –362. On New Year's Day 1962, the latter was temporarily deployed on board the USS *Princeton* (LPH 5), an amphibious assault ship. HMM–362 soon would have a rendezvous with history.

The only helicopter squadron in AirFMFPac not part of a helicopter group was HMRL–161 at Kaneohe, Hawaii. It was attached to what was otherwise an exclusively fixed-wing group, MAG–13, and with 16 helicopters provided the vertical lift capability for the 1st Marine Brigade.

On the west coast of the United States, about 25 miles south of Los Angeles at Marine Corps Air Station (MCAS), Santa Ana was another unit of AirFMFPac. MAG–36 consisted of a H&MS and a MABS, four light transport squadrons)HMRLs–163, –361, –363, and –364), and one medium transport squadron, HMRM– 462, for a total of 105 helicopters; and, 40 miles further south at MCAF, Camp Pendleton, VMO–6 had 11 more plus a complement of fixed-wing observation aircraft.

Fleet Marine Force, Atlantic had concentrated all its helicopter capability at MCAF, New River, North Carolina, at the edge of the sprawling Camp Lejeune complex. There, under MAG-26, were a H&MS and MABS, VMO–1, HMRLs–162, –262, –263, and –264, and HMRM–461 for an aggregate of 108 machines.

One helicopter squadron, not a part of the Fleet Marine Force, was Marine Helicopter Squadron (HMX) 1 at MCAS Quantico, Virginia. It had a dual mission. Its historic role in the Marine Corps, ever since it was commissioned under the command of Colonel Edward C. Dyer on 1 December 1947, had been the "development of helicopter tactics, techniques and equipment for the landing force operation."

Beginning in September 1957, however, it had added another assignment: that of providing special helicopter flights to high-ranking officials in the federal government. This became known as "the Presidential mission." To accomplish both of these tasks, HMX–1 was assigned a total of 26 helicopters representing five different types.

Finally, 11 obsolete helicopters were assigned to fixed-wing air stations to act as search and rescue (SAR) aircraft in the event of an emergency.

At the time, the designation of the squadrons as to "light" or "medium" more accurately reflected earlier hopes of the planners than the actual comparative lift capability of the available helicopters. Before the end

* For a complete history of the early development of helicopters in the Marine Corps, see: LtCol Eugene W. Rawlins, *Marines and Helicopters, 1946–1962* (Washington: History and Museums Division, Headquarters, U.S. Marine Corps, 1977). Unless otherwise noted, all data for helicopters authorized or on hand is taken from the Marine Corps Aviation Status Board Photograph for the month indicated. In a few instances, aircraft technically possessed are not included in the statistics. The numbers are insignificant and the variety of circumstances is large; such as aircraft loaned to other services and aircraft on bailment (lease) to the manufacturers for special tests or modifications. The status board does include, however, aircraft assigned to a unit but undergoing overhaul and repair (O&R) or progressive aircraft rework (PAR).

of the year, the hard facts would be accepted and what had been a "light" squadron became a "medium." Likewise the "mediums" were redesignated "heavies."[5] Also the individual aircraft were to change designations when in July the Department of Defense directed a system of identifying aircraft which was the same for all military services.[6] *

The Marine Corps helicopters in 1962 represented six different types, only three of which were in use in any significant number by tactical squadrons. All types, however, flew in response to the same laws of aerodynamics.

Helicopters ARE Different

> The thing is, helicopters are different from planes. An airplane by its nature wants to fly and if not interfered with too strongly by unusual events or by a deliberately incompetent pilot, it will fly.
>
> A helicopter does not want to fly. It is maintained in the air by a variety of forces and controls, working in opposition to each other; and if there is any disturbance in the delicate balance, the helicopter stops flying immediately and disastrously. There is no such thing as a gliding helicopter.
>
> This is why being a helicopter pilot is so different from being an airplane pilot; and why, in generality, airplane pilots are open, clear-eyed, buoyant extroverts and helicopter pilots are brooders, introspective anticipators of trouble.
>
> They know if anything bad has not happened, it is about to.
>
> Harry Reasoner
> ABC Evening News
> 16 February, 1971[7]

Mr. Reasoner, a news commentator, may not have been aware fully of the technical details of why a helicopter did not want to fly, but he described the problem accurately. A lack of appreciation for just what a helicopter could—and could not—do often created misunderstandings. It was the source of numerous myths. The design and employment of helicopters were completely dominated by their aerodynamics. Thus, any understanding of the development of helicopters must start with some knowledge of the basic characteristics. Three are particularly important. The first is the inherent instability of a helicopter.

Given a suitable shape, any aerodynamic body will create lift as the air flows around it. It makes absolutely no difference if the shape is a wing, a propeller, or a rotor blade. The faster the speed of the air, the more lift generated. The forces, however, do not increase uniformly.

An airplane which accelerates from 100 to 300 miles per hour (mph) does not triple the amount of lift from the wings. The increase is nine-fold, for lift is created by the "square" of the velocity of the air. (100×100 versus 300×300). A small change in speed, obviously, creates a disproportionate difference. In a fixed-wing aircraft, with both wings firmly attached to the airplane and moving through the air at the same speed, this is no problem. There is no difficulty with a helicopter either as long as the machine is in a hover in calm air. In such a case, the rotor blades are passing through the air at the same speed at all points around the aircraft. But when a helicopter begins to move forward, the conditions change rapidly. Now as the rotor blade begins to sweep forward to the front of the aircraft, the forward speed of the helicopter is added to the velocity of the air. Conversely, as the blade retreats from the front, the velocity is subtracted. The amount of lift generated on opposite sides of the helicopter is drastically out of balance. This disparity of lift was a major stumbling block to the design of helicopters. Several solutions were proposed. The most common was to install two rotors which turned in opposite directions. In forward flight portions of each were always spinning into the wind, and equal portions turning away from the wind. There was a balance of lift, but two rotors usually turned out to be a complicated and expensive solution.

There were other methods. Igor Sikorsky's rightful claim to be the inventor of the first successful helicopter in the western hemisphere is based on his development of a method for equalizing lift on both sides of the aircraft using a single lifting rotor. As his rotor blades moved around the helicopter, they automatically changed pitch, flexed, twisted, and even adjusted speed so that no matter where they were in relation to the wind, they produced the same amount of lift. The result is termed a "fully articulated" rotor head. Modifications to Sikorsky's basic invention have provided the basis for rotors by most other manufacturers. A fully articulated rotor system, however, has one serious drawback. It results in an aircraft that is completely unstable.

The difference in stability between a helicopter and a fixed-wing aircraft is often compared to a child's swing which is hung by steel rods. If it is pushed from its normal motionless position and then left alone, the swing will sooner or later of its own accord stop exactly where it was originally. The stability of a fixed wing is similar. A helicopter, however, is like the same swing, only this time balanced upside down. If disturbed it will fall away from where it was with ever increasing speed and will never attempt to return to its original position.

To an outside observer a helicopter's instability seems impossible. The whirling rotor blades very much appear to resemble a giant gyroscope—one of the most

* See "Standard Aircraft Characteristics," p. 189.

stable devices known. What is seen as a smooth blur, though, is each individual blade moving, twisting, and changing speed to adjust constantly for the differences of lift created by the wind. To demonstrate this phenomenon, cameras have been mounted on a rotor blade and after carefully counterbalancing the others, the helicopter flown. The resulting movie indicates, not the rigid structure of a gyroscope, but what most observers describe as a "writhing wet noodle." [8]

It is somewhat as if an airline pilot were flying a jet liner that had wings made of rubber which constantly changed shape without his knowledge. Sikorsky's solution to the difference in the amount of lift generated on opposite sides of a helicopter is the ultimate source of its instability and vibration.

Designers, engineers, and manufacturers devised a number of systems to compensate for the lack of stability. Most utilized a combination of sensors, electronics, and hydraulic controls. By the late 1960s considerable progress had been made and further refinements were being incorporated into new helicopters.

Brigadier General Jay W. Hubbard, in 1972, had occasion to evaluate the latest developments. General Hubbard, a platoon commander in the 2d Raider Battalion during World War II and one of the more exuberant fighter pilots in the Marine Corps, was at this time commanding general of the 4th Marine Aircraft Wing and Marine Air Reserve Training Command. As some of his units were scheduled to receive new jet-powered helicopters, he completed a familiarization course in the CH–46F. Later he described the results:

> The stability problems that confronted helicopter designers brought out the very best technology as tough engineering problems always seem to do. It was particularly impressive to me . . . to find that the basic trim system in some of our modern helicopters actually amounted to an autopilot. I've also been impressed by both stability and control that first line helicopters demonstrate through a wide airspeed envelope—like flying from zero to 170 knots. It occurs to me that fixed wing flight control technology might welcome some engineers from the rotor community.[9]

In spite of the improvements in handling characteristics brought about by the sophisticated systems, helicopters are still basically no different than the first machines. They remain unstable. Many test pilots consider the electronic systems as "just so much cosmetic window dressing." [10] The fact is constantly brought home to Marines who fly helicopters. Periodically they must demonstrate to an inspector their proficiency in flying with all the stability systems turned off. In most machines the smallest movement will induce an ever increasing swing away from the conditions which prevailed before. If the nose of the aircraft deviates ever so slightly from the intended direction of flight, only the most delicate and precise reaction from the pilot will prevent it from moving even further askew. Even with clear skies and an unencumbered view of the ground, a helicopter without stability systems challenges the very best of pilots. At night or on instruments such flight is seemingly impossible.

Another unique characteristic of a helicopter is termed ground effect. A helicopter rapidly loses efficiency as the air becomes thinner, whether due to an increase in altitude or temperature. The reverse is true also. Under certain circumstances, the rotor can create an artificially dense cushion of air and its lifting ability is dramatically increased. This occurs as the aircraft is close to the ground. The effect is first noticeable when the rotors are at the same altitude as their diameter and continues to intensify until the helicopter lands. The down wash from the rotor literally packs the air under the helicopter and as the aircraft flies in this mass of "thick" air the blades greatly increase their efficiency. A pilot, therefore, finds that it takes less power from the engines to fly at 10 feet than at 100.

Ground effect, however, is present only under specific conditions. The helicopter must be in a hover or moving very slowly. Otherwise it will slide right off the top of the cushion and derive no benefit. The effect is present only when there is a steady wind. If it is gusty from any direction, particularly from the side, it will blow parts of the ground cushion out from under the aircraft.

The surface under the helicopter must be relatively smooth. Otherwise the rotor wash breaks up into a chaos of turbulence. Unless the landing zone is level and the wind steady, the pilot finds ground effect building up momentarily on one side of the aircraft, only to disappear and be created somewhere else for an instant. It makes a smooth landing impossible. The result is much like a sportsman trying to bring his fishing skiff to a perfect docking while bobbing in a fierce storm.

One more phenomenon associated with helicopters is translational lift. As the aircraft is picking up forward speed and passes through approximately 15–20 knots, there is a sudden decrease in the amount of power required to fly. On landing just the reverse occurs and once the helicopter slows below the critical speed, additional power must be added to maintain flight.

The aerodynamic forces which create this paradox are exceedingly complex, but basically involve the relative direction of the wind over the rotor blades. It was an attempt to exploit more fully the advantages of translational lift that resulted in the death of the first Marine ever officially designated as a helicopter

pilot,* Major Armond H. DeLalio, who received the certification on 8 August 1946 after completing training with the U.S. Navy. He followed 15 Navy aviators who had qualified earlier.[11] **

In 1952, DeLalio, then a lieutenant colonel, was conducting tests at the Naval Air Test Center (NATC), Patuxent River, Maryland, on jet-assisted takeoffs (JATO) for helicopters. Rockets had been mounted on a HRS–1 model helicopter. When fired, they rapidly accelerated the helicopter to a speed above translational lift. Many problems had been encountered, the most serious of which was "afterburning effect in which a large part of the helicopter is engulfed in a sheet of flame for a short time. The hot gases of the JATO bottle are near to and directed at the runway or ground. Good sized stones are thrown back at the main and tail rotor systems. In the field grass fires would result." [13]

With the tests over 90 percent complete, on 5 January 1952 one of the rockets broke loose, causing an explosion and fire which killed Lieutenant Colonel DeLalio.[14] Seven months after the accident, the Bureau of Aeronautics recommended that the JATO project, which had lain dormant after DeLalio's death, be cancelled. Colonel Edward C. Dyer, head of aviation plans at Headquarters Marine Corps, agreed.[15] Further efforts to provide extra power for a helicopter below the speed of translational lift were shifted to small rocket motors attached to the ends of the main lifting rotor blades.[16]

Helicopter pilots quickly learn to take advantage of both ground effect and translational lift whenever they can. If takeoff is to be made from an open field and the load is heavy, the pilot will raise the helicopter into a very low hover taking full benefit from the dense air in the rotor wash. By starting forward very slowly and keeping the cushion under the aircraft he can accelerate until translational lift is reached and then begin to climb. Likewise on landing, sufficient speed is maintained to keep translational lift until the helicopter is low enough to enter ground effect.

In either case the helicopter can lift extra heavy loads. If neither condition is present, the ability is greatly reduced. This was the cause of some serious misunderstandings. For Marines unaware of these characteristics, it was difficult to believe that a helicopter pilot could lift a large load from an open field where both translational lift and ground effect were present and yet could not hover 100 feet in the air to deliver the cargo to a small, rocky mountain top landing zone.

The "Huss"

Regardless of their aerodynamic problems, helicopters had become a vital part of the Marine air-ground team, and each machine had a portion of the overall amphibious assault mission to accomplish. By far the most common Marine helicopter in 1962 was the Sikorsky-built HUS (UH–34D) with 225 aircraft assigned[17]. It had arrived at this preeminent position almost by accident. The H–34 series had been purchased by the military initially as an anti-submarine helicopter for the Navy and was originally designated the HSS–1 (SH–34). This particular design was an outgrowth of even earlier models of Sikorsky helicopters, most particularly the HRS–3 (CH–19), which had provided the Marine Corps with much of its helicopter lift capability in the early- and mid-50s. The HSS–1 had made its maiden flight on 8 March 1954 and had been quickly put into service for anti-submarine warfare.[18] *

While the Navy was developing the SH–34, the Marine Corps was concentrating almost exclusively on much larger helicopters and showed limited interest in such a machine. It could be used, however, for minor utility missions and on 1 April 1955 General Lemuel C. Shepherd, Jr., then the Commandant of the Marine Corps, wrote to the Chief of Naval Operations (CNO) requesting that 90 such helicopters be procured to "rapidly shuttle supplies to forward elements, to execute tactical movements of small units and to evacuate battle casualties." [19] Though the Marines did not get 90, they did receive approval and funding for 45.

Production of a utility version of the SH–34 was a relatively simple process which involved removing the equipment for anti-submarine operations, strengthening the cabin floor, and installing cargo tie-down rings. This new model had its first flight in January 1957 and because the modifications from the SH–34 were so slight, formal tests at the NATC Patuxent were not necessary.[20]

The first one was delivered to tactical units on 13 February the same year and by the end of the month, HMRL–261, commanded by Lieutenant Colonel Richard J. Flynn, Jr., had four on hand at New River and

* Major General Marion E. Carl is generally credited with being the first Marine to learn how to fly helicopters in July 1945. It was not until some years later, however, that he was officially designated.[12]

** The first naval aviator designated a helicopter pilot was Commander William G. Knapp, USN, who received the certification on 15 April 1944. He retired from the Navy in 1957 and after a long illness died in the Bethesda Naval Hospital in 1965.

* Until September 1962, this aircraft was designated the HUS–1; after that date it became the UH–34. The latter designation will be used throughout this volume.

USMC Photo A149001

From 1957 to the mid-1960s, the UH–34 made up the backbone of the vertical lift capability of the Marine Corps. This aircraft is participating in training operations on board the USS Tripoli *off the California coast in January 1967.*

Lieutenant Colonel William F. Mitchell, who had taken command of HMRL–363 but a week earlier, had three more at Santa Ana. One additional UH–34D was assigned to HMX–1 at Quantico.[21]

From this almost accidental beginning, the UH–34 was to emerge as the mainstay of Marine Corps helicopters until 1968 and was to bear much of the brunt of combat in Southeast Asia for the first six years of the war.

Within a year of General Shepherd's requesting procurement of the limited number of HR–34s, and even before they were first introduced into tactical units, the requirement gained new urgency. The design and production of large assault helicopters continued to encounter technical difficulties, and it appeared that their introduction into the Marine Corps could be long delayed. The problem was recognized in May 1956 when Lieutenant General Vernon E. Megee, Assistant Commandant, gave his approval to a G-3 study which shifted priority to procuring increased numbers of H–34s as an interim helicopter until the true "heavies" could be produced in sufficient quantities.[22] Thus the Marine Corps became increasingly committed to the UH–34.

Like all Sikorsky designs, the UH–34 had a single main lifting rotor, 56 feet in diameter, with a smaller 9 foot, 6 inch anti-torque rotor on the tail pylon. All the blades were constructed entirely of metal, a development still not universally accepted in 1957. The main ones had a leading edge formed of a hollow steel "spar" providing the bulk of the structural strength and lighter "pockets" bonded to the rear of the spar to provide aerodynamic lifting surfaces. These main blades could be folded to permit operations on aircraft carriers and LPHs. The folding operation was a simple manual one in which a mechanic unscrewed a large locking bolt at the point where each main blade attached to the rotor head allowing the blade to pivot to the rear. Other crewmen attached a long crutch to the end of the blade and lowered it into racks that were temporarily installed over the fuselage of the helicopter. To unfold, the mechanics merely reversed the procedure with an additional step of inserting a safety wire through the locking bolt to prevent it from vibrating loose in flight. The rear anti-torque rotor did not fold. Instead the entire tail pylon could be unlocked and rotated 180 degrees until it was parallel to the left side of the fuselage directly in front of its extended position.

With both the main blades and the tail pylon folded, the dimensions of the aircraft were reduced from an extreme length of 65.7 feet to a modest 37 feet and the width from 56 feet to slightly more than 14 feet. It was then easy to move the airplanes on the ship's elevators or pack them tightly on the hanger and flight decks.

The engine was a Wright R–1820–84 which could produce up to 1525 horsepower.* This nine-cylinder workhorse was a slight modification of one that had been in wide use for a number of years in both commercial and military aircraft of all types. Mounted as it was in the very front of the aircraft behind large nose (clam shell) doors, it was comparatively easy for the mechanics to work on. It did require, however, careful coordination on the part of the pilot not to exceed its limitations. The UH–34 had a full set of controls for both the pilot and a co-pilot, who sat above and behind the engine and just forward of the main transmission.**

All helicopters such as the UH–34 that have but a single main lifting rotor possess a similar characteristic. They are very sensitive to the placement of their load as near as possible to the center of gravity of the aircraft. If the load is placed beyond rather narrow limitations, the amount of control the pilot has over adjusting the angle of the rotor to make turns and other maneuvers is restricted and the helicopter cannot fly. Thus the troop compartment of the UH–34 was placed directly under the main transmission and rotor, with the pilots and engine in front being counterbalanced by a long tail structure in the rear. This cabin measured over 13 feet long, almost 5 feet wide and was 6 feet high with a large sliding door on the right side. Canvas bucket seats for 12 passengers could be installed when necessary. In addition a hook underneath the aircraft, stressed to 5,000-pound capacity to allow for any jarring, could be utilized to carry loads externally, and a hoist mounted outside just above the cargo door could be used to lift loads of up to 400 pounds.[23]

One of the most difficult problems faced by Marine Corps planners was to determine accurately how much weight a helicopter could carry when conducting an assault. It was particularly critical for the UH-34s since they were to represent so much of the total lift available. This dilemma stemmed from a variety of causes. There were so many subtle differences between seemingly identical aircraft that the actual weight might vary several hundred pounds. New equipment was often added as aircraft underwent progressive aircraft rework (PAR). A squadron might have but a few of its assigned aircraft with those improvements installed. Slight variations in manufacturing also caused individual aircraft of the same model to vary in basic weight. These two conditions alone created a requirement for each helicopter to be weighed periodically on scales.

A more vexing factor was that the definitions applied by the manufacturers, the operators, and the planners were often confusing. Thus, in 1967 Sikorsky could list an empty weight for the UH–34 of 7,900 pounds [24] and at the same time, the official empty weight published by the Naval Air Systems Command (NavAirSysCom) was 8,090.[25]

Further compounding the problem, the useful load or payload of an individual aircraft had to include all the men and material required for the specific mission. If a crew chief was needed, he was part of the payload as was the fuel necessary to complete the flight. Armament and armor, if installed, further reduced the capability of the helicopter to lift combat Marines. Helicopters were extremely sensitive to the effects of altitude and temperature, both of which, as they increased, rapidly lowered the lifting capability.

While manufacturers were required to verify an "overload" condition under which the aircraft could fly under ideal circumstances, this higher weight put excessive strain on the airframe and rotor components thereby shortening their useful life. An overload also often reduced the maximum airspeed of the helicopter and the amount of shock ("G" loading) it could withstand. Unfortunately, this maximum "overload" condition sometimes gained currency as being the normal or standard load for a helicopter. Different types of takeoff and landing zones also restricted lift capacity. With a short roll on a smooth runway a helicopter could lift a great deal more than if it had to take off straight up and climb several hundred feet before starting forward flight. And finally, particularly in those aircraft with piston engines, the proficiency of the pilot was a critical item in determining absolute payload capability.

Because of these variable factors, Sikorsky could claim that the "useful" load of an H–34 was 5,100 pounds,[26] but NavAirSysCom simultaneously calculated the payload in a standard troop transport mission, as

* Engine designations utilize "R" to indicate a radial arrangement of the cylinders. Likewise "T" indicates turbine, "J" pure jet. In piston engines a number such as 1820 indicates maximum displacement or size of the cylinders expressed in cubic inches. The dash number (–84) indicates a particular modification of the basic engine.

** In helicopters the position of the pilot and co-pilot are exactly the reverse of fixed-wing aircraft in which the pilot is on the left side of the cockpit and the copilot on the right. There are many versions of how this practice began but it appears to have been the result of Igor Sikorsky's early experiments with helicopters. Because the engines were mounted backwards from a conventional airplane, the main rotor turned to the left as seen from the cockpit. This required that the anti-torque rotor had to be on the left side of the helicopter to be most efficient. To reduce the danger of an accident from being hit by the tail rotor, all cargo loading and hoist operations were on the right side of the plane. This required that the pilot be on the right side of the cockpit to observe what was being loaded. Once begun, the practice remained and other manufacturers followed Sikorsky's lead.

only 2,700 pounds.[27] Both are correct, but each was using a different set of standards.

By 1962 any competent pilot, co-pilot, or crew chief could calculate exactly the lift capability of the particular aircraft assigned for the flight using a formula termed the HOGE or HIGE. They stood for "hover *out* of ground effect" and "hover *in* ground effect." To do so, however, they needed to know exactly which aircraft they were to fly and the changes incorporated into it, its latest weight on the scale, just what equipment was to be carried, the amount of fuel necessary, exact temperature, humidity, and altitude data for the expected time of takeoff and landing. Such information was seldom available in the heat of a combat assault.

Pilots and crew chiefs attacked the problem from several angles. Most of them adopted as most accurate the solution used by the men who flew helicopters during the first stages of development, and the one that remains today the final criterion for a helicopter pilot. They simply accepted any load put aboard the aircraft and attempted to take off into a hover. If they could, all was well and they proceeded with the mission. If they could not, they unloaded either some cargo or a Marine and attempted to take off again. This process was repeated until a takeoff could be made successfully. While extremely effective in determining the actual load the individual aircraft could lift under the specific set of circumstances existing at that moment, it was hardly conducive to well-organized assault landings. It also gave aviation safety officers nightmares. A second method developed by the Marine Corps Landing Force Development Center (MCLFDC) in 1960 consisted of a series of easily readable charts spelling out the effect of the major variables in lift capability such as altitude, temperature, and fuel required. These in turn were coupled with data from all over the world collected from the National Weather Center so that:

> An S-4 [logistics officer] could be 99% sure that, for example, palletized 2000 lb loads could be externally carried by HUS in area 'X'. He'd also know that there'd be a 30% chance the HUS could carry 200 lbs more. He could palletize some extra 100 or 200 lb loads.[28]

Though well conceived, and based on an accurate knowledge of the problem, the system proved cumbersome and fell into disuse.

A completely different approach to increase the payload, which was later used to great extent in tropical areas, was put forward in 1961 in a perceptive and, at the time, widely read article by Major Herbert A. Nelson, a veteran at the time of over 18 years flying with 1,500 hours in helicopters out of his total of 5,350. He recommended that prior to an assault the UH–34 be stripped of all equipment not needed on that particular mission. Thus "stripping" could include the emergency hatches, winch and hoist, heater and auxiliary power unit. Under certain circumstances even the crew chief was not needed. And there were few times when the large life raft, then required on all flights "out of gliding distance of land" was necessary. This last requirement, like that of carrying parachutes on certain flights, was an irksome holdover from fixed-wing transport operations and bore little relationship to the actual conditions which would exist if a helicopter were to have a major emergency.

Major Nelson calculated that up to 713 pounds could be stripped out of a UH–34 and that a corresponding increase in lift capability, or margin for aircraft and weather variables, would occur. When applied to a 200-sortie assault, the total benefit in combat Marines or cargo was over 142,000 pounds.[29]

Among the items that Major Nelson recommended to leave behind was the 40-pound, catch-all bag carried by the crew chief. He might have understated the potential for weight saving. Crew chiefs in helicopters were (and remain) a vital member of the pilot/co-pilot team. They flew in aircraft, however, that, when necessary in an emergency, could land in any open corn field or rice paddy. With the state of the art at the time, this was not an entirely uncommon occurance. Most crew chiefs had long since forsaken a "catchall" and normally carried a metal cruise box about the same dimensions as a large foot locker. In it would be not only tools for minor repairs, but small parts for all the systems that failed with any imaginable frequency, several cans of hydraulic fluid, an emergency supply of cigarettes, a week's supply of pilfered C-Rations, a clean set of flight clothing and, if the crew chief had had a particularly bad set of luck in his aircraft, some civilian clothes and maybe even a 20-dollar bill.

Crew chiefs on helicopters were prepared for just about any emergency, but their provisions did reduce the capability of the aircraft. Many aircraft maintenance officers combatted this by making frequent inspections and as an ultimate test, ordered the crew chief to pick up his cruise box with one hand. If he could, the weight penalty was reasonable. If he could not, something had to be left behind.

But the crux of the matter was that all these variables combined to make the prediction of the load-carrying capability of the UH–34 a very tenuous occupation. Thus a series of "rule of thumb" guidelines grew up and became widely known among the infantry as well as the helicopter crews. For the UH–34D, as an example, in combat in the humidity of Southeast Asia with both a crew chief and a gunner, armor, and enough fuel for an hour and a half mission, eight combat-equipped Marines (at 250 pounds each) was a

normal load. The inability to predict accurately the total amount of lift represented by the UH-34s and other transport helicopters continued to plague the planners. A great deal rested on their estimates, not only for combat assaults but for establishing the number of aircraft required and all the associated personnel, equipment, and ships that were necessary.

This overall lift capability had been reduced seriously a few months before General Shoup was listening to the 1962 New Year's day concert. The reduction had come in a critical area—the Western Pacific.

The Marine Corps had reached a peak of 233 UH–34s on hand in June 1961. Then, in response to an urgent requirement, it had transferred most of its Asian-based helicopter strength to "US Air Force for assignment to Air America as part of the Military Assistance program for Laos." [30]

A total of 31 UH–34s had been involved. Eight of these were diverted from the Marine Corps while they were still being assembled on the production line at Sikorsky. The rest had come from Marine Corps squadrons, mostly the Futema-based HMRL–162 and –163, which were rotated back to the United States in July leaving few helicopters for their replacement squadrons, which would arrive at Futema with only their personnel and records and would take over the aircraft and equipment already on hand. Other than five UH–34s asigned to H&MS–16, the entire vertical lift capability of the Marine Corps in the western Pacific area during July and August of 1961 was entrusted to Lieutenant Colonel Fred A. Steele and his HMRL–261, which was embarked on the helicopter assault ship, the USS *Thetis Bay* (LPH–1) in the South China Sea.[31]

In July, Lieutenant Colonel Archie Clapp, a helicopter pilot since 9 June 1951 and one of the most innovative men in that early age, and his HMM–362 were transferred to Okinawa*. Unfortunately, when he arrived from Santa Ana and assembled his unit at Futema, the helicopters that should have been awaiting him were gone. It took almost two months before sufficient aircraft could be shipped across the Pacific to make HMM–362 fully operational again.

By the end of July, with the combination of diverted aircraft from the production line, transfers to Laos, and aircraft destroyed in accidents, the Marine Corps was down to 198 UH–34s. The effect continued to be felt and the Marine Corps dropped even more the next month and reached a low of only 187 assigned to units. Then production began to catch up and by September the total was almost back to the level previously obtained: 227. The climb continued until, in February 1964, the Marine Corps would have over 350 UH–34s in service.

In a seemingly endless number of variations, the UH–34 became to helicopter flight operations about what the venerable Douglas DC–3 was to commercial and transport flight. In one modification, it even became a jet-turbine-powered helicopter, as the piston engine was replaced with two 1,000-horsepower General Electric engines. The modification did not necessarily mean an improved payload capability at sea-level conditions, due mostly to the limitations on the amount of power the airframe and rotor systems could be subjected to, but it did increase high altitude performance and provided the safety factor of two engines, in case one should malfunction. Though the Marine Corps never procured this particular model, a version of it was built and widely used by a number of foreign military and civilian operators, most notably the British who built it under the trade name of "Wessex."[32]

To Marines all over the world, the UH–34 became almost a legend in its own time. Ugly, rather crude compared to the new aircraft with which it would soon be faced, but thrifty and economical (in 1959 it had cost but $348,000 in a "fly away" condition at the Sikorsky plant), it demanded the very best technique of the pilot to exploit its potential performance.[33] Before the last one was delivered to the Marine Corps, in 1964, over 540 of these helicopters were sprayed with the paint that indelibly marked them as belonging to the Marine Corps. It was the work horse of a number of international confrontations and of a major war.

By its very reliability, simplicity, and capability, it seems to have given a new slang word to all Marines. When its more sophisticated cousins were grounded periodically for technical problems at the height of the war in Vietnam, the Marine on the ground could always give a radio call for assistance and specify a helicopter that he knew would respond. Using the old designation which never did lose its popularity among Marines and which was much easier to say over a radio, he would broadcast: "Give me a HUS." That word "huss" has been incorporated into the vocabulary of Marines to indicate something good, something beneficial, a favor, or a special set of circumstances that are pleasurable. It takes its place right along with "Gung Ho" and others.

For a helicopter that was to have been nothing more than an interim model standing in the shadow of the big assault machine, and one which had been procured almost as an afterthought by the Marine Corps, to be

* All dates for designation as a Marine helicopter pilot are taken from "Chronological List of Qualified Helicopter Pilots" provided by the Deputy Chief of Naval Operations (Air Warfare) (DCNO–AW), Code OP05D, Washington, D.C.

called a "huss" is not such a bad commendation from the men who actually depended on them: the Marine riflemen in combat.

The HOK

The most interesting helicopter available in the Marine Corps in 1962—at least from an aerodynamic standpoint—was the standard observation aircraft, the HOK (OH–43D). As other designers were wrestling with the technical problems of producing helicopters with improved performance, and different rotor configurations were still being tested, Charles (Charlie) H. Kaman developed one that was, at the time, ingenious, advanced, and very efficient. Other than the inherent instability of helicopters, the problem that had most bedeviled designers was to devise a way to equalize the amount of lift generated by the rotor blade as it traveled around in a circle. Kaman described his solution to a meeting of the American Helicopter Society in 1953:

> In fact, the single rotor helicopter such as the Sikorsky design violates the principle [of equaled lift] in that it is not symmetrical, whereas the intermeshing rotor helicopter *is* symmetrical. Unlike the single rotor helicopter where, in forward flight, different aerodynamic conditions exist on each side of the rotor disc, the intermeshing helicopter in forward flight has exactly the same condition on the right side of its overall rotor disc as it does on the left side. This is real symmetry, since exactly the same aerodynamic conditions exist for the right wing or rotor as exist for the left wing or rotor.[34]

As could be expected, the OH–43 * had two intermeshing main rotors mounted on pylons which were canted slightly to each side. As these rotors were contra-rotating they provided the desired symmetry and no anti-torque rotor was required, though to aid stability in high-speed forward flight there were fixed vertical and horizontal tail surfaces on booms extending from the rear of the aircraft. Power was supplied by a Pratt and Whitney R–1340–48 engine which could develop up to 600 horsepower.

This machine was unique in many respects. Unlike most helicopters at the time, the OH–43 did not rely on mechanical linkages at the rotor head to change pitch on the blades. Instead, Kaman had invented a system that utilized a small "servo flap" or aileron installed on the outer edges of the blades. When a pilot moved his control stick this small aileron responded and by the very aerodynamic forces generated was able to twist the blade to the desired amount of pitch, allowing the helicopter to maneuver. Initially, Kaman had used wooden blades to achieve the required amount of

USMC Photo A530120

A unique feature of the HOK–1, here sitting on the field at Quantico in June 1962, were the small servo-flaps on the rotor blades, which the pilot used to change rotor pitch.

"twist." The flexing of the wooden blades solved many of the aerodynamic problems but the quality control to insure that all the wood was suitable and could withstand the pressures soon became an insurmountable problem. In the mid-1950s Kaman changed to metal blades that could twist with more predictability. In later models, Kaman would abandon this intermeshing main rotor configuration, but would retain the servo flap system of controlling the pitch of the rotor blades.

This system of rotors in the OH–43 gave it some characteristics superior to other helicopters at the time. It was extremely stable, particularly so in a hover. It could continue to climb at 100 feet per minute at 19,000 feet altitude, performance that was far above even the next generation of helicopters.** [35] For example, the jet-turbine-powered H–46A introduced almost a decade later reached its service ceiling at only 7,300 feet [36]. This ability won the OH–43 acceptance not only as an observation helicopter but, in a turbine-powered version, as a mountain rescue aircraft. The U.S. Air Force used significant numbers of OH–43s for such missions well into the mid-60s.

But the OH–43's high altitude and hover performance were matched by off-setting drawbacks. In forward flight it took a great deal of power to exceed approximately 90 knots. The helicopter was described by one experienced test pilot as performing at that speed as "about like pushing my grandmother's Thanksgiving turkey platter broadside through the air." [37] On

* Redesignated from HOK in September 1962.

** The altitude at which an aircraft can no longer sustain a climb greater than 100 feet per minute is designated as its "service ceiling."

test flights it was discovered also that with rapid and large changes of power, particularly on recovery from a practice autorotation,* the aircraft tended to enter a stage where right rudder was required to go to the left and vice versa, and if not corrected for, the helicopter would unexpectedly enter a violent spin. This control reversal, as it was termed, was compensated for by a system linked to the manifold pressure in the engine which automatically made the correction for the pilot.[38] As long as the mechanism performed correctly, there was no problem; but like all mechanical devices it failed occasionally and when it did a pilot was in for a few thrilling moments.

A total of 81 OH–43's were procured for the Marine Corps. As was the case for many helicopter orders at the time, the delivery schedule underwent a number of revisions. The original contract called for the first delivery in October 1952 with the final deliveries being made in January 1956. After a number of changes, many of which were required to correct the problems discovered during the Fleet Introduction Program (FIP) and which had resulted in several fatal accidents, the first actual delivery was made in April 1953 and the final one in December 1957.[39]

In spite of the difficulties, the obvious advantages of the OH–43 could not be ignored. Rear Admiral Richard F. Stout, then senior member of the board evaluating the aircraft, concluded in his final report that the helicopter had many superior characteristics, one of which was that: "Due to the rotor configuration of the HOK–1 (it has) more stability than other helicopters without automatic stabilization equipment." [40]

Other than its limited top speed and the apprehension of the pilots as to whether the control reversal system would work or not, the OH–43 performed admirably for the Marine Corps. By removing the co-pilot's seat, two litters with wounded Marines could be carried and, if conditions were right, even an attendent could be added. The front of the aircraft was constructed almost entirely of clear plexiglass and the view for an aerial observer was nearly unlimited. The machine could be utilized for many missions that could not be performed economically by any other helicopter—just as long as the occupants were in no great hurry.[41]

By 1962 the OH–43 had become obsolete and the three-year search for a replacement was almost over. Director of Aviation Major General John C. Munn, who was later to become Assistant Commandant, had even suggested at one time that the ubiquitous UH–34 be substituted. He had noted in March, 1959 that:

> The HUS (UH–34) now programmed as the HRS (UH–19) replacement . . . can also perform any mission the HOK is capable of. Admittedly this is using more capability than is needed for the observation mission . . . (but) it has the capability of lifting troops and cargo during the high demand phase of the amphibious assault, prior to the time the HOK (OH–43) . . . type of observation mission becomes an appreciable requirement.[42]

While General Munn admitted that the UH–34 might not make an ideal observation helicopter, he concluded that in light of the budgetary constraints of the time it would have a better chance of being approved than a totally new design.

> Nothing in the foregoing will in any way modify our policy of developing operational requirements and development characteristics for aircraft ideally configured for the particular tasks we want performed. The objective of programming these aircraft will be aggressively pursued. However, our present approach is one of 'all or nothing'. As a result our chances of success in the several areas are remote.[43]

His plan never fully materialized. While the UH–34 was later pressed into service as an expedient for some observation missions, it had several serious drawbacks. The observer had to sit in the cabin, either looking out the open door or craning his neck to see out a window directly behind his seat. This latter procedure, if the mission was of any length, was guaranteed to give one a very stiff neck the next morning. Attempts made in 1965 in Vietnam to put an observer in the co-pilot's seat were generally unsuccessful.

The helicopter that finally did replace the OH–43 would be the first jet-powered one introduced into Marine Corps tactical units. Kaman had done much of the early pioneering of turbine helicopters and had claimed the first "turborotor" system in 1951, the first twin "gas turbine drive" in 1954, and by 1959 no longer produced any helicopters powered by piston engines.[44] It was ironical then that the replacement would not be manufactured by Kaman.

In January 1962, the Marine Corps still had 35 of these unusual aircraft: VMO–6 at MCAF Pendleton and VMO–2 at MCAF Futema each had 11, and VMO–1 at New River, nine. Four additional ones were assigned to HMX–1 at Quantico.[45] In the observation squadrons, these OH–43s were coupled with small fixed-wing aircraft to make up the eyes of the Fleet Marine Force. A total of 32 Cessna built OE–1 and –2s (Bird Dogs) supplemented the capabilities of the helicopters.**

* An exercise in controlling and landing the aircraft with the engine turned off.

** Unfortunately, the role of the fixed-wing observation aircraft assigned to helicopter units is beyond the scope of this volume. In most squadrons the pilots interchangably flew either the helicopters or the OEs. Those who fly the OEs were, and still are, the true orphans of Marine Corps aviation. Considered fixed-wing outsiders by the helicopter pilots in their parent aircraft group, they were looked upon with

Not until May 1965 would the OH–43 disappear from the rolls of aircraft assigned to the Marine Corps. Even then, for a few more months, the Futema-based VMO–2 still would be authorized six of them—most probably due to administrative oversight rather than any failure to realize that the HOK had had its day.[46] Though Kaman would build other helicopters for the Marine Corps, none of them would ever be quite as unique as the OH–43. Many commanders appreciated the superb view afforded by that plexiglass cabin, and Marine pilots told more than one sea-story about "the day the control reversal mechanism didn't work" in the HOK.

The "Deuce"

One model of helicopter had dominated Marine Corps concepts of assault landings for the 14 years from 1948 to 1962 and would continue to overshadow all procurement for another decade. It was the most significant helicopter ever developed for the Marine Corps.

This machine, on which had depended so many hopes of the early planners for a true vertical envelopment capability, was known by many identifications during its service. It had begun with a Sikorsky designation of XHR2S–A. This was a formal way of saying that the aircraft was experimental (X), was a helicopter (H), was designed to be a transport (R), was the second such model in a line of design (2), and was built by Sikorsky (S). The "A" simply identified it as the first version of the type. Later, after testing had been completed, it became the HR2S with the "X" dropped from the designation. Sikorsky, which tried—unsuccessfully—to sell the helicopter to commercial concerns, always referred to it as the S–65. The Department of Defense gave it the name of "Mohave." Under the unified system of designations, it was classified as a CH–37C. Since the most common, and widely known model of helicopter in the Marine Corps at the time was a HRS, the "2" designating a second model took on a special significance and gave rise among Marines, always fond of a good card game, to a long-lasting nickname. To anyone who flew it, tried to maintain it, rode in it, and remembers it, this helicopter is universally referred to as the "Deuce."

Marine Corps interest in a heavy helicopter dated back to 1946, when a special board had been set up at Quantico to study problems of the Corps. Three members of the secretariat of the board—Colonel Merrill B. Twining, Lieutenant Colonel Edward C. Dyer, and Lieutenant Colonel Samuel R. Shaw—began to investigate seriously the use of helicopters in amphibious assaults. This obviously would require helicopters much larger than anything built up to that time. The idea that such a machine could be built gained strength that summer when Colonel Dyer, an air defense expert who had studied the system used by the Royal Air Force in the Battle of Britain and who later would command the first Marine Corps helicopter squadron, visited the Sikorsky plant and discussed the proposal with the inventor himself. As Dyer later recalled, Sikorsky said "We can do that now. This is within our present knowledge. We can build an airplane that will carry 5,000 pounds. We can build airplanes that will carry *much* more than that. We know how to do it. Take my word for it."[47]

Lieutenant Colonel Dyer reported back to Colonel Twining and conveyed Sikorsky's optimism. Both officers then returned to Connecticut for further discussions with Sikorsky of a 5,000-pound-payload helicopter. They also visited Frank Piasecki, the only other major builder of transport helicopters. Piasecki confirmed that there would be no problem in building so large an aircraft.[48]

The idea then languished for a few months but soon was revived. In March 1947, Assistant Commandant of the Marine Corps Lemuel C. Shepherd, Jr. spelled out in detail the helicopter requirements that eventually only the Deuce would begin to meet. In a letter to Admiral Forrest Sherman, then Deputy Chief of Naval Operations (DCNO(OPS)), he stated that "the principal requirement for the helicopter for use in assault landing in amphibious warfare is a minimum payload of 3,500 pounds, or 15 fully equipped infantrymen, but that an extension of the load limit to 5,000 pounds or twenty infantrymen would greatly enhance the value of the aircraft."[49] Shepherd thus called for a helicopter that in one step could take the entire concept of vertical envelopment from an untested idea into actual capability. The attempt was particularly bold since the largest helicopters then flying could, if everything was absolutely favorable, lift the pilot and three passengers; and with that load they seldom could take off without a short run on the ground.

Two years later, Sikorsky reiterated publicly his belief that large helicopters could be built. In an article which appeared in the August 1949 issue of the *Marine Corps Gazette*, he stated:

> I believe that helicopters with a gross weight of 50,000 pounds and a lifting capability of between 30 and 50 per cent of this figure can be designed in the near future. [It will have] a range from 100 up to 1,000 miles and eventually probably up to 2,000 miles

scorn as just odd-ball helicopter pilots by their fellow Marines who flew jets. Their contribution to the Marine Corps, however, has been great and their history an interesting one. Possibly in the future they will be suitably recognized.

> . . . utilizing . . . inflight refueling or [even] by towing the helicopter.[50]

The idea of building a helicopter so large when those operating were so small and fragile might have intimidated many men, but not the Kiev-born Igor Sikorsky. In 1913, when he was only 24 years old, he had designed and built the world's first four-engine bomber, the "Russkiv Vitiaz" for Czarist Russia. Over the years he continued to produce a long line of extremely large aircraft, both in Russia and in the United States to which he emigrated in 1923. (The Marine Corps was no stranger to Sikorsky aircraft and had utilized his models as transports in the 1930 s.) [51]

Several proposals for the 5,000-pound-lift helicopter were put forward by other manufacturers, most notably Piasecki and McDonnell, but in March 1951 Sikorsky received the contract to begin building what eventually became the "Deuce." *

* See Rawlings, *op.cit.* for an interesting account of the alternatives and the selection process.

Even the most optimistic supporters of heavy helicopters realized that the technology required for such an aircraft would take time to develop and BuAir had calculated cautiously that May 1953 would be the target date for the first flight.[52] Not until seven months after that on 18 December did the helicopter finally become airborne. A month later the aircraft was officially unveiled by Sikorsky General Manager B. L. Whelan at Bridgeport, Connecticut, before a large group of senior Marine officers led by General Shepherd, who was now Commandant, accompanied by Lieutenant General Oliver P. Smith, Commanding General, FMFLant; Major General Clayton C. Jerome, Commanding General, AirFMFLant; Brigadier General Robert G. Bare, Director of Marine Corps Development Center; Colonel Richard C. Mangrum, Marine Corps Schools, Quantico; Colonel Victor H. Krulak, then Secretary of the Marine Corps General Staff; and Lieutenant Colonel Foster LaHue, aide to the CMC. Similar representatives from the Army, Navy, and Air Force also were present.[53]

USMC Photo 531855

A HR2S–1 flies in formation over Quantico with a HRS–3 and a HOK–1, July 1957. Early Marine vertical envelopment doctrine was built around this huge (for its day) helicopter.

So advanced was the HR2S and so great its lifting potential that a year later a board composed of general officers tasked to study the composition and function of Marine Corps aviation concluded that while small transport helicopters would serve a purpose, only 45 were needed. The rest of the requirements could be met by 9 squadrons of 20 HR2Ss, for a total of 180. Significantly, the senior member of the board, General Smith, and one of the other three generals assigned, General Bare, both had witnessed the first introduction of the HR2S at Bridgeport.[54]

What they and their colleagues had seen was a veritable monster of a machine. Even at this writing (1975) it remains within six inches of being the largest helicopter ever operated by the Marine Corps.[55]

In general layout, the CH–37C was a typical Sikorsky design with one five-bladed main lifting rotor 72 feet in diameter. A 15-foot diameter, four-bladed anti-torque rotor was mounted on a long tail pylon which slanted upward from the rear of the fuselage. Both rotors were powered by two Pratt and Whitney R–2800–54 engines mounted in large nacelles, or pods, attached to the ends of short wings which extended out from the top of the aircraft, an engine arrangement unusual in helicopters. Each engine had 18 cylinders arranged in two rows of nine. Larger aircraft engines had been built, but nothing approaching these ever had been used in a helicopter. Though aircraft piston engines were much more efficient than those installed in automobiles, a rough perspective of their power can be gained by comparing the volume of their cylinders. The cylinders of a typical very large American car engine displace four or five quarts—most are smaller. The two engines in the Deuce displaced almost 20 gallons. Together they could produce up to 4,200 hp.

The engine pods were roughly egg shaped. The front was constructed of a separate round section of metal with the hole for the air intake slightly to the inside and below the center. When this front section was painted white in contrast to the dark green of the rest of the aircraft—as was often the case—the resulting appearance was that of a giant eye-ball. The bolder crew chiefs, when they could get away with it, would add red lines to the white surface to simulate a pair of blood-shot eyes. Viewed from the front, an aircraft so decorated had a distinct appearance which earned it another nick-name: The Cross-Eyed Monster.

The pilot and co-pilot sat in a cockpit mounted high over the front of the airplane and reached by means of a folding ladder. Below them, large clam shell doors opened and a ramp could be lowered to allow vehicles to drive in and out. On the right side

USMC Photo A147156

Vehicles back into the maw of the mighty "Deuce." In this view, the reasons for its nickname "Cross-Eyed Monster" are readily apparent.

of the fuselage at the rear of the cargo compartment there was another, slightly smaller door. Extending out this door and running the entire length of the cabin was an overhead trolly (monorail) which was used to load and unload pallets of cargo. While the monorail could be pivoted up and fastened to the ceiling when not needed for cargo on a troop transport mission, occasionally a crew chief would neglect to do so. A generation of heliborne Marines learned always to check the position of that rail prior to jumping in the back door, for when extended it was almost a perfect match of the height of the forehead of a typical man and, if not stowed, could—and often did—inflict a painful wound resulting usually in stitches and a small scar for the victim.

The aircraft was replete with advanced and unusual features. It was the first helicopter known to have retractable landing gear, an innovation which improved its top speed. The main gear extended down from and folded rearward into the engine nacelles.[56] (The original models had but a single large wheel on each strut; later models had two smaller ones.)

Not only did it have fuel tanks for 400 gallons of gasoline located in the fuselage, but two additional 300-gallon fuel tanks could be mounted on the outside of the fuselage. These latter were always a favorite of pilots since, if there was a malfunction in the aircraft, the external tanks could be jettisoned thereby immediately lightening the aircraft to help cope with the emergency.

The Deuce had what was for the time an advanced stabilization system which, unfortunately, had one characteristic that proved troublesome to pilots used to flying the UH–34 who transitioned into the HR2S. In the UH–34. with its stabilization system engaged, to make a small correction in course the pilot had but to place one foot on the rudder in the direction he wished to turn. The same technique in a HR2S caused the stabilization system to react fully and the aircraft would snap almost broadside in the air. Usually after one such experience, a new pilot was careful to remember to put both feet on the rudders to change direction when the stabilization system was engaged.

To control both engines from the cockpit, the Sikorsky engineers had designed an imaginative device. The usual collective levers were on the left side of the pilot and co-pilot and when raised, increased the pitch (lift) of the main rotor blades. Attached to the end of this was what appeared to be a typical piston engine helicopter twist grip to control the amount of power the engines would deliver. To add power the throttle was rotated (or twisted) to the left. It looked much like the throttle twist grip on a motorcycle, though the direction of turn to add power was just the opposite, a condition that made a number of commanding officers of helicopter squadrons with piston engine machines look askance at any pilot that also rode a motorcycle. But this control in the HR2S was not a real throttle at all. Instead it was linked by a simple slip-clutch to the true throttles which were mounted overhead between the pilots. With careful coordination on their part, the one flying the helicopter could use his twist grip to make large changes in power, while the other pilot made precise adjustments in the real ones. This made for very efficient utilization of the engines.

The system, however, that set the HR2S apart from all other helicopters of the time and which insured its rightful position as the most significant machine in the history of vertical amphibious assaults, was its power folding of the main rotor blades. Prior to the introduction of the Deuce, the only way that a helicopter could be sufficiently reduced in size to enable it to be stored on the flight deck of a ship, or easily handled on the elevator and lowered down to the hangar deck, was either to actually remove the rotor blades or gather a crew such as was required for the UH–34 and manually fold them. Both processes were cumbersome but, worst of all, they could be utilized only in relatively small helicopters. If the Marine Corps was to have the size of machine it needed, the blades would be so large that either removal or manual folding by crews of Marines would be such a lengthy process as to limit effectively a flight deck to a very few helicopters.

The engineers at Sikorsky overcame that formidable obstacle and devised a system that enabled the pilot in the cockpit to fold the blades. This first such design was the basis for all other Sikorsky fold mechanisms and was very closely studied by other manufacturers who later devised their own versions of the method. It was an engineering triumph of the first order; for not only did the massive blades have to fold and unfold quickly, they had to do it in sequence to avoid hitting each other, they had to do it precisely to avoid striking the fuselage, and most important they had to fold only when the pilot activated the mechanism so that there was no possibility of them folding while the aircraft was in flight.

To accomplish this feat, the engineers first had to provide sufficient power to move the blades. For this they utilized a 3,000-pound-per-square-inch (psi) hydraulic supply that was generated by a pump on the left (No. 1) engine and served, among other things, to lower and retract the landing gear and operate the nose doors and ramp. They then relied on a complex series of electrical switches, each of which would not operate until the one before it in the sequence was in the proper position, and a number of hydrauli-

cally operated pistons that, like the switches, had to be positioned fully before the next one would work.

Even without the fold system, a rotor head in such a large helicopter was extremely complex. The addition of all wires, tubing, and mechanisms from the blade fold interlaced among the other parts created what many observers described as a "pile of lumpy spaghetti."

At times the system did not function perfectly. Frequently a blade would not fold at all or a hydraulic line which had vibrated loose under the spinning encountered in flight would erupt at its proper moment in the sequence with a high pressure geyser of red fluid. But it constituted the first really operable power folding system and assured Marines that the large helicopters they required could be operated from helicopter assault ships.

The planners had the same difficulty in determining the actual payload of the Deuce as they did with other helicopters. Officially it was listed as capable of 6,673 pounds of cargo with 2,400 pounds of fuel plus the normal crew and equipment. Though this was under a maximum overload condition, the first Marine Corps helicopter which could exceed it under the same circumstances would not be introduced until almost 10 years later.

Unfortunately, although impressive in performance, the HR2S proved to be extremely difficult to manufacture. A later age would describe the problem as too much of an advance "in the state of the art." The Sikorsky engineers labored to perfect the design and testing continued, but the Marine Corps became apprehensive about the delays in production. By 1956 it was alarmed.

The same G–3 study that had recommended an increase in the procurement of the UH–34 as an interim helicopter urged reduction of the planned HR2S force from 180 machines to only three squadrons of 15 aircraft each. Previously the Marine Corps had been reduced to only 45 UH–34s but now it was proposing a plan for nine squadrons of them to maintain a limited lift capability pending the arrival of the Deuce —an exact opposite of the ratio that had been adopted only three years previously.[57]

The HR2S however, was not quite ready to be shunted into obscurity. Just as it was about to be dismissed as of questionable value, it would accomplish some feat that set it above and apart from all others. In 1956 when the attention of the Marine Corps had switched to the UH–34, the Deuce, still the largest helicopter in the free world, set a new international speed record of 162.7 mph with Major Roy L. Anderson at the controls.* Major Anderson was one of the original helicopter pilots in the Marine Corps and seven years earlier, when he was assigned as assistant engineering officer of HMX–1, had written the first comprehensive evaluation of the role of helicopters in the Marine Corps to be published in the *Marine Corps Gazette.*[58] He was recognized as the holder of the speed title by the *Federation Aeronautique Internationale.* The aircraft continued to break records. In the same year as Major Anderson's feat, another Deuce flew to 12,000 feet with an 11,500-pound payload, a record-breaking accomplishment then and a respectable one 20 years later.[59]

Performance of individual aircraft, however, did not eliminate the delays in production that continued to plague the HR2S. Not until March 1955 was the first one delivered at New River and accepted by Lieutenant Colonel Griffith B. Doyle, commanding officer of the newly commissioned HMRM–461.[60] It would be one of only 55 "Deuces" ever delivered to the Marine Corps.** [61]

As Lieutenant Colonel Schoepper and General Shoup drank their New Year's Day punch in 1962, Lieutenant Colonel Eugene J. Pope and Major Daniel A. Somerville commanded what remained of the planned fleet of 180 HR2Ss. Now there were only 29 including one still assigned to HMX-1. Lieutenant Colonel Pope's HMRM–461 at New River had 13 machines. On the west coast at Santa Ana, Major Somerville had 15 more.[62] The third squadron, which had been planned even after the reduced requirement, had been activated, but because there were few airplanes available to assign to it, had only a brief existence and was quickly deactivated.[63] No Deuces were assigned to MAG–16 in the western Pacific area. It would

* Russia was known to be developing very large helicopters but this was during the period of the Cold War and information on them was scanty. Thus, to insure absolute technical accuracy, the caveat "in the free world" was always applied when describing the size and the capabilities of the Deuce.

** There were other production models, however. The US Army procured almost 100 in a simpler version that did not incorporate the blade folding mechanism necessary for shipboard operations and had a much less sophisticated stabilization system which was all that was necessary if flight on instruments in clouds was not contemplated. These Army HR2Ss were subsequently returned to the factory for, among other modifications, the installation of a stabilization system suitable for instrument flight. The U.S. Navy procured an HR2S-1W, which substituted a large radar dome in place of the clam shell doors in the nose of the airplane, to evaluate as an early warning radar aircraft. It was not adopted. Sikorsky also built a "crane" version in which the entire cabin was eliminated and only the cockpit and enough fuselage to support the engines and rotor systems was retained. This become the prototype of a long series of flying cranes from Sikorsky.

take a war to demonstrate their value and create a need sufficient to justify shipping such large helicopters across an ocean.

In the meantime, Lieutenant Colonel Pope and Major Somerville, and those that succeeded them in command, had to content themselves with the knowledge that, though the vertical assault elements of a regimental landing team (RLT) had been sufficiently streamlined so that the interim UH–34 could carry almost all of the Marines and their equipment, there were at least two vital items that had defied attempts to reduce them to the weight the UH–34 could lift. Both were radio jeeps. The first was the Mark 87, utilized by the air liaison officer which provided the critical link between the infantry commander requesting close air support and the jet attack aircraft that could deliver it. The second was the Mark 83, used by the naval gunfire observer to provide a similar link to the ships off shore and to artillery units firing in support of the assault elements. Both radio jeeps had to go ashore early in an assault, and each was an easy load for a Deuce and an impossible one for any other Marine Corps helicopter. Therefore, in the initial waves of an assault, the Deuces usually would bring in the radio jeeps. When not carrying these two items of equipment, the giants supplemented the lift capability of the UH–34s.

Efforts had begun long before 1962 to procure a replacement for the ailing monster helicopter. The search would be side-tracked several times, but when a new heavy lift helicopter finally was selected and designed, it would be based on the bold engineering efforts made by Sikorsky in designing the HR2S. In the meantime, the Deuce—the dream, the frustration, and the disappointment of Marine Corps planners—continued to furnish what heavy lift capability the Marines had. In 1962, it was not yet ready to be discarded and soon would have its proudest moments.

The Last of a Breed

The only other helicopter assigned to Marine tactical units in 1962 was the aged HRS–3 (CH–19E). First entering service in 1953, it was the latest model in a long series of HRS designs that had begun in 1946.[64] Earlier versions had provided the Marine Corps with its troop transport capability in the Korean War and the peacetime operations that followed.* The HRS–3's lifting ability was limited. Even with just one pilot as crew, and under ideal circumstances, it accommodated only 1,800 pounds of payload. Were it not for the shortage of UH–34s, the older machines would have been phased out of the squadrons before 1962. The CH–19, however, had been procured by the Marine Corps to fill the initial gap between awarding of the contract for the HR2S and the predicted production date of that large assault helicopter. Thus it had a certain kinship with the UH–34 which had been procured under similar but later circumstances. Both were interim models to maintain a limited lift capability until the HR2S could become fully operational.

The CH–19 had another distinction. It was one of the last helicopters to lack a "stick positioning" system. The absence of such a system was the bane of all pilots who flew such an aircraft. To maneuver any helicopter, the pilot had to be able to make adjustment in the "pitch" (angle) of the rotor blades. Though the actual mechanism for this differed between designers and even to some extent between different aircraft from the same designer, they all had one thing in common: almost without exception, and particularly for the lifting blades, the force required to make the adjustment was so great that no combination of levers and cams even in the smaller helicopters could ever provide enough mechanical advantage for the pilot to control the airplane with any precision, if at all. To overcome this, manufacturers had provided hydraulic pistons, much like power steering in an automobile, to translate the movement of the pilot's stick and collective lever (and in some helicopters, the rudders) into changes in the pitch of the rotor blades. When the pilot moved his controls, he actually was moving valves in the hydraulically-powered control system. This created a situation in which there was no "feedback" from the rotors to keep the control stick and collective in any given position.

In a CH–19, if the pilot took his hands off, the stick simply fell over to the side, the rotors attempted to respond and the aircraft crashed. Early attempts to provide a means to counteract this disturbing characteristic met with little success, though in the HRS–3 Sikorsky engineers had designed a simple locking mechanism which the pilot could engage to keep the collective lever from moving. Even this simple lock was subject to malfunctions and most pilots preferred to keep a firm grip on the collective.[65] Colonel Dyer remembers the problems well:

> Your right hand is on the cyclic pitch (control stick) which determines your direction of flight. Your feet are on the rudders which also determines your direction of flight by controlling the tail rotor and assisting you in turns. The throttle is also on the collective stick. So while your left hand had the throttle and collective, your right hand had the cyclic stick and your feet are on the

* For an excellent account of the use of helicopters in Korea, see: Lynn Montross, *Cavalry of the Sky: The Story of U. S. Marine Combat Helicopters* (New York: Harper, 1954).

USMC Photo A324918

Long after it had been retired from assaults, the HRS–3 continued to serve the Marines in a variety of missions. This aircraft of HMX–1 is participating in a test at Quantico in 1955 and is equipped with ROR (Rocket on Rotor), the dome-like device in the center of the rotor blades, which functioned as an auxiliary power unit.

rudders. And this thing was inherently unstable. That's a big difference between fixed wing and a helicopter. If you turn loose the controls of a fixed wing, and if a fixed wing aircraft is properly trimmed . . . it will tend to restore itself. The helicopter, however, is basically unstable . . . (and) it does *not* tend to restore itself. [Before stick positioning systems were installed] with a helicopter of those days that was basically unstable and with both feet and both hands busy it was quite an operation to turn loose of any of your controls to, let's say, adjust a radio, or something like that. So most of the buttons [for] things like radios were on the sticks. If you had to shift the fuel tank, you would lock your collective stick, make the tank shift and get back to your collective as quickly as you could . . . you couldn't let go of the thing once you had a-hold of it. It was [very] tiring to fly.[66]

High performance Marine aircraft, particularly jets, also used similar hydraulic systems. In most cases, however, this was to improve the response of the aircraft to the pilot's control movement. In helicopters the system was adopted just to get the machine to fly at all. Of all the helicopters the Marine Corps had in 1962, only the HOK did not need stick positioning. It was so stable and aerodynamically unique that the controls would remain in position even if the pilot took his hands and feet off momentarily.[67]

In the others it was not possible. A co-pilot could take over, but he further reduced an already restricted payload. Thus pilots developed a rather elaborate set of contortions to allow them to take their hands and

feet off the controls for a few seconds. Modern helicopters have sophisticated mechanisms to compensate for the problem, but the techniques originated by the pioneers still persist. A thigh wedged firmly against the collective lever provided some assurance it would not move; likewise with practice and determination many pilots found that they could still keep both feet on the rudders, yet lock their knees around the control stick to keep it from falling over for at least long enough to switch fuel tanks.

The difference in what it took to fly a jet and what it took to fly a helicopter did not go unnoticed by the young pilot in the Marine Corps. While his fellow aviators soared overhead at supersonic speeds, tracing contrails in the sky in a sleek, stable aircraft that required only a minimum of attention once properly trimmed, the Marine helicopter pilot was struggling along, thousands of feet below with both hands, a thigh, both knees and feet busily engaged in just keeping airborne at 80 knots and desperately wishing for a way to scratch his itchy nose. Attempting to fly classic tight formations under such circumstances produced less than satisfactory results and would have to wait until better stabilization systems were introduced.

On the first day of 1962 the Marine Corps still had four of these HRS–3 aircraft assigned to tactical units: two remaining at HMRL–263 at New River and two at HMRL–161 in Kaneohe, all of which were simply awaiting the arrival of the UH–34. Two more were with Marine Wing Service Group 17 (MWSG–17) at Iwakuni, Japan and were utilized for general utility missions. All of the rest were SAR aircraft.[68]

The HRS–3 had remained in the inventory of Marine helicopters longer than originally anticipated. It was, after all, just a temporary stop-gap until the HR2S began flowing off the production lines. It was to remain a familiar helicopter to Marines for a number of years more, although in a slightly different role. At the height of the war in Vietnam it almost had a brief and spectacular comeback. But in 1962 the HRS–3 was soon to be phased out and with its departure all Marine helicopter pilots would be flying machines with stick positioning in which they finally would be able to scratch their noses—albeit with their knees still locked firmly around the control stick.

The White Tops

The remaining two types of helicopters assigned to the Marine Corps were unique in that they were both assigned to HMX–1 and it was highly unlikely that either would ever be a part of the assault forces. Both were reserved for the "Presidential mission."

This task was initiated in September 1957 when a UH-34D, piloted by then commanding officer of HMX–1, Major Virgil D. Olson, had lifted President Eisenhower from his vacation home at Newport, Rhode Island to Quonset Point Naval Air Station.[69] Two months later, the Commandant directed HMX–1 to establish a permanent executive flight section with especially prepared helicopters.[70] Because of the distinctive paint scheme of dark glossy green on the lower portion of the fuselage and white on top, these executive mission helicopters were normally called "white-tops" and distinguished by a "Z" designation prior to 1962 and a "V" prefix after adoption of the uniform numbering system.

HMX–1 still had four HUS–1Z (VH–34) aircraft available in January 1962. These had been modified considerably with executive interiors, extra soundproofing, and numerous additional features, and required rigorous maintenance procedures designed to guarantee the safety of the President while flying in them. Regardless of these measures the VH–34 re-

USMC Photo A329349

A "White-Top" VH–34 of HMX–1 flies over Sugar Loaf Mountain, Rio de Janeiro, Brazil in February 1960. These aircraft were specially outfitted for Presidential missions.

mained a single-engine aircraft and in case of malfunction the lives of passengers could be jeopardized. Rear Admiral Paul D. Stroop, Chief of the Bureau of Naval Weapons, had requested approval for the purchase of twin-engine helicopters in June 1961. Though he did not specify which of the two suitable aircraft then available should be selected, it was the Sikorsky-built HSS–2 (VH–3) that was chosen. Three of these helicopters were available at HMX–1.[71] They were to become a familiar sight to millions of television viewers as they shuttled back and forth from the front lawn of the White House. A cargo and troop assault version of the HSS–2 was one of the strong competitors for a medium helicopter to replace the UH–34 and the features of this particular model will be discussed more fully later in conjunction with the selection process.

An Extended Range

> Studies and past experience indicate that the most desirable type of assault shipping for such a [helicopter-borne] force will be ships which can accommodate the necessary embarked troops, the helicopters to land them and the crews to operate and maintain the helicopters. It is becoming increasingly urgent to commence a ship conversion or building program that will parallel the availability of the . . . 36 man helicopter.[72]
>
> General Clifton B. Cates, USMC
> Commandant of the Marine Corps
> 17 July 1951

With the advent of atomic weapons, it was obvious immediately that the capability of the Marine Corps to conduct amphibious assaults was in jeopardy. It would be impossible to have the masses of ships carrying assault Marines all converge at a single point on a shoreline. Such a concentration of power would present an atomic-equipped enemy with an irresistible target. A method had to be found to disperse the Marines and bring them together only at the moment they assaulted the beaches. Submarines were considered, but technical problems were too great to overcome. Giant seaplanes were a strong contender, but a series of disastrous crashes and a stringent budget caused the Navy to drop the program.

Helicopters seemed to offer the only solution. As unpromising as these machines were, and however many years it might take to develop suitable craft, helicopters had several potential advantages. The most important of these was the fact that they could land Marines far inland from the sea as well as on the beaches. Unlike the seaplanes and submarines, however, helicopters were limited in the distances they could fly.

All the other alternative vehicles had the common advantage that they could transport Marines to the objective area and then carry them in the actual assault. There was no need for any other conveyance between the rifleman embarking from his staging port and his actual attack on the shore. Helicopters lacked the range to combine these functions. Even the HR2S with nothing more for payload than a crew and its maximum fuel load could fly no further than 350 miles. Most helicopters were even more restricted. Efforts to increase the range of helicopters kept running up against the limited payload available in the helicopters of the time. Each pound of fuel carried was a pound less of payload of any kind.

In his famous article in the 1949 *Gazette*, Igor Sikorsky confidently had predicted that: "[a helicopter will have] a range from 100 to 1,000 miles and eventually probably up to 2,000 miles . . . utilizing inflight refueling or [even] by towing the helicopter." [73]

By 1956 HMX–1 had successfully demonstrated inflight refueling from one HRS to another. To avoid the whirling rotor blades they had utilized a probe and drogue system. The former was a long pipe that stuck out in front of the helicopter to receive the fuel, the latter, an aerodynamically stable basket trailing horizontally on the end of the refueling hose from the tanker aircraft. This was the basic technique utilized by fixed wing aircraft and was to form the basis for helicopters when the system was finally adopted for them.[74]

Sikorsky's other prediction was not ignored either. In 1959 the All American Engineering Company of Wilmington, Delaware provided the Marine Corps with the details of a project then being conducted by the U.S. Air Force. This particular method of increasing the range of a helicopter required the pilot to maneuver his machine close to the tail of a C–47 (military version of the DC–3) at which time he could hook on to what amounted to a long tow rope trailing behind the transport. Once attached, the engine of the helicopter could be stopped and the aircraft towed along much like a glider. Under these circumstances, the rotor blades would generate sufficient lift in the wind stream to keep the helicopter airborne. As the objective area was reached, the helicopter pilot would start his engine, engage the rotor, cast loose from the tow rope, and make the assault.[75] The Marine Corps apparently never responded to this proposal, as its lack of feasibility was evident. As one senior Marine aviator later wrote, "The drag of a hel[icopter] of any size was enough to slow the DC–3 down to stall [non-flying] speed." [76]

Interesting as they were, none of these attempts to extend the range of the helicopter promised an early solution to the problem of mobility. The Marine Corps, accordingly, turned to the Navy's proven method of moving aircraft by sea. It began adapting aircraft carriers for helicopter operations.

The Conversion

In 1962, four ships were available from which a helicopter-borne assault could be launched. All had been converted from other types. The USS *Thetis Bay*, the first of these conversions, had had a checkered career. A product of the Kaiser shipyards in Vancouver, Washington, which had gained fame in World War II as a mass producer of ships, she was not one of those more rapidly rushed to completion. Kaiser received the contract for her on 18 June 1942 but did not lay the keel until three days before Christmas the next year. The ship was launched 16 April 1944 and commissioned five days later. After short service in World War II she went into mothballs along with much of the rest of the fleet. Initially designated simply Maritime Commission Hull No. 1127 (while under construction), she sailed in World War II as CVE 90, an escort carrier; and after conversion to a helicopter assault ship became for a short time CVAH 1 (carrier, assault, helicopter) and finally LPH 6.

The conversion started in the San Francisco Naval Shipyard 1 June 1955 and was finished 1 September 1956. In an unusual event, the vessel was recommissioned prior to the completion of the work. Captain Thomas W. South II* ran up his flag on 20 July 1956 as the commanding officer of the first—and at this time—only ship specifically adapted to conduct helicopter assault operations.

To the Marine Corps, the *Thetis Bay* constituted visible proof that amphibious vertical assaults could be conducted, but compared to other warships of the time, she was not impressive. At maximum load she displaced only 10,866 tons. Modern attack aircraft carriers were being launched at the same time that displaced 56,000, and it would not be long before ship engineers started designing carriers that would displace over 85,000 tons. *Thetis Bay's* overall length of 501 feet was slightly less than half that of the new attack aircraft carriers, and the conversion's flight deck did not extend the entire length of the ship. Yet this small LPH would have to operate with the HR2S which was 88 feet long as it lifted off with the assault troops. The ship could accommodate 103 Marine officers (including the helicopter pilots) and 901 enlisted men in addition to the 40 officers and 598 men required to operate her. Her two boilers and double propellors could drive this small ship through the water at 19 knots.

USMC Photo A191124

The USS Thetis Bay *(LPH 6), the first carrier converted for use as a helicopter assault ship, participates in PHIBEX 1–62 off Puerto Rico in April 1962. UH–34s are operating from her deck.*

Less than a month after the conversion was complete, on 24 September 1956, Colonel Frederick R. Payne had the distinction of being the first Marine helicopter pilot ever to land on an actual LPH when he brought his HRS–3 helicopter down on the flight deck and was eagerly greeted by Captain South.[77]

This ship was always known to pilots and Marines who operated from her as the "Teddy Bear," from her identifying call sign on the radio. The nickname became almost a term of affection among the early pilots operating from her decks rather than any comment on her size. She would serve long after 1962, serve well, and serve courageously. In retrospect, the *Thetis Bay* seems pathetically small. At that time, however, she was the forerunner of all that would come after her.

A second CVE conversion had been approved in the Fiscal Year 1957 program, the USS *Block Island*. Work had begun on 2 January 1958, but budgets were tight. The Navy had other priorities for what funds Congress had approved. The *Forrestal* class of attack aircraft carriers was vital; the atomic submarine and the Polaris missile required huge sums. There was little left over for Marines who still were convinced that a vertical assault in amphibious landings was a

* Captain South had close association with both aviation and the Marine Corps. The son of Marine Colonel Hamilton D. South, Captain South had flown in the Pacific during World War II and had commanded an experimental unit equipped with remote-controlled assault drones. Captain South, who eventually attained the rank of rear admiral, had a brother, Colonel Hamilton D. South, who was a Marine flier and later Director of Information at HQMC.

valid part of the nation's military strategy. Conversion of the *Block Island* was cancelled.

The newly appointed Commandant, General Randolph McC. Pate, reacted sharply. In one of the more remarkable letters ever sent by a CMC to a CNO, he pointed out the disparity in priorities:

> I view the recent action by the Secretary of the Navy which eliminated the LPH conversion from the Fiscal Year 1957 shipbuilding and conversion program with extreme concern. The Marine Corps has reorganized and introduced new items of equipment to a degree where it is unquestionably ready to exploit the potential of the helicopter. Only one major component of this weapons system is missing—the modern amphibious assault ship.[78]

He continued, to insure that the CNO understood exactly how he felt:

> But without this component of the system our capability in the already developed components is negated. This situation is analogous to one which would exist if the Polaris [missile] were in being, but the submarines to carry it were still years in the future.[79]

The comparison of the Marine Corps vertical assault capability and that of the Polaris submarine was not lost. In essence he had said that the Marine Corps had made great strides to insure that they still maintained the capability of conducting amphibious assaults in an atomic age and flatly challenged the Navy to match these efforts. It was a daring stroke.

The results soon were evident as the lagging conversion program picked up impetus. Six months later, on 30 January 1959, the USS *Boxer* was recommissioned as LPH 4. It was followed in April the same year by the USS *Princeton* (LPH 5) and after some delay, the USS *Valley Forge* (LPH 8.)

USN Photo 1111758

The USS Princeton *(LPH 5), second of the* Boxer-*class conversions, steams toward Chu Lai, Vietnam, with UH–34s of MAG–36 on her flight deck in August 1965.*

These ships were a far cry from the "Teddy Bear." All were of the "*Essex*" class, the first-line attack aircraft carriers of the Pacific campaign in World War II. Weighing in the 38,000-ton class they were nearly four times as large as the *Thetis Bay* and their 888-foot length, with a flight deck almost as long, gave the necessary space for a number of helicopters to load and take off simultaneously. Eight boilers generated 150,000 horsepower, as compared to the 11,200 the two on the *Thetis Bay* could produce, and with this power, gave the carriers a speed well above the rest of the ships in the amphibious fleet.

Each new LPH had accommodations for 171 Marine officers and 1,701 men, including those necessary for the helicopters. Each also officially required over 1,500 sailors to man her, as compared to the 598 on the "Teddy Bear."[80] And in time of tight budgets, where every serviceman was carefully scrutinized to insure that his cost was necessary, this became a point of controversy which had far-reaching implications.

Soldier Mechanics of the Sea

By definition, Marines are "soldiers of the sea." Marines have been a part of the crew on capital ships, not only since the founding of the U.S. Marine Corps, but far back into the dim reaches of naval history. Since the 1930s, Marine Corps fighter, bomber, and scout squadrons routinely have operated with, and as part of, U.S. Navy carrier air groups (CAGs).

Few Marines have not sailed on a Navy ship, though in most cases they are merely passengers and not members of the regular crew. The large numbers of sailors required to man the *Essex* class LPHs created an entirely different, and to date unique breed of seagoing Marines: the soldier mechanics of the sea. If the Marines were going to have large LPHs, they were going to have to provide part of the crews.

On the 183rd anniversary of the founding of the Marine Corps, 10 November 1958, the first mechanics reported to the yet to be activated USS *Boxer*.[81] They were not Marine detachments, they were not part of the Marine squadrons attached to the CAGs, and they were not passengers: they were full-fledged members of the crew of the ship.

Only in the engineering, navigation, and medical departments were the Marines not used. They filled billets in supply, as cooks and bakers, and disbursing clerks. The Air Department, with the exception of the men who refueled the helicopters and a few Navy officers, was made up completely of Marines. Marines manned

the shops which did the major repairs on the helicopters and, in a more traditional role, even made up the crews for several of the guns.[82]

The initial augmentation on the *Boxer* had been one officer and 92 enlisted men out of a total of 57 officers and 1,077 men. This was to grow until there were 10 officers and 317 Marines serving in the crew.[83] When the USS *Princeton* was converted and reclassified as an LPH on 2 April 1959 the scene was the same.*

These aviation officers and men, unfortunately, were not in addition to those required to operate the squadrons. Instead, under the rules then in force within the Department of Defense, they were included in the overall strength of Marine Corps aviation. On 29 July 1960 with the imminent conversion of the third *Essex* class LPH (the *Valley Forge*), Major General Arthur Binney, who at the time was the Director of Aviation, became concerned. He wrote that this practice could not be extended and that the use of Marine aviation officers and men to man Navy ships without any compensating increase in overall strength was extremely difficult due to "an almost impossibly austere manning level" in aviation.[84]

The problem had been recognized. Once again, far-sighted officers in the Navy realized that the Marine Corps vertical assault was a vital part of the overall strength of the United States. It had to be preserved, even if some sacrifices had to be made. Negotiations had been going on as to just where these cut-backs could be made. A month previous to General Binney's letter, the Director of the Policy Analysis Division at Headquarters Marine Corps could circulate the results.

The Navy, like the Marine Corps, he pointed out. was under a Department of Defense imposed absolute ceiling of the number of personnel authorized. It was the people to man these large LPHs that was the major stumbling block. The letter declared that the Navy considered the minimum crew for the *Valley Forge* (or the other candidate for the forthcoming fourth—but later abandoned—conversion, the USS *Lake Champlain*) to be at least 1,000 men, though they considered 1,250 more near the actual requirements.[85]

Even though the Commandant had been assigning over 300 Marines to the *Boxer* and the *Princeton*, provision of sufficient sailors to man the next conversion would require the Navy to mothball other ships. In the Navy's first proposed trade-off it calculated that an attack transport ship (APA) required a crew of about 400 men. If three of them were withdrawn from active service, from the Pacific fleet, sufficient men would be released to man the *Valley Forge*. After additional negotiations, the Navy agreed it would be more suitable to decommission just one APA and five landing ships tank (LSTs). It was also concluded that the first of a new type of true LPHs then being built would require a crew "about the same (400) as an APA."[86]

While the *Valley Forge* never would have the same contingent of soldier mechanics of the sea as her two predecessors and the estimates of the number of Navy men required on the true LPHs were to prove conservative, a serious problem once again had been resolved. In the meantime the *Boxer* and the *Princeton* continued to have much of their crews made up of Marines. It was not until 1964 that they would depart. On 15 January the Marines left the *Boxer* and on 31 January, the *Princeton*.[87] Staying behind would be only three permanent crew members: the assistant air operations officer, the combat cargo officer, and his NCO assistant, who are still assigned to all LPHs as the only remaining vestiges of the soldier mechanics of the sea. Those Marines who served on the two ships have a unique and exclusive claim to fame.

Marines supplementing Navy crews, however, really was not the answer to the problem. The disadvantages of converting World War II aircraft carriers to LPHs were becoming increasingly apparent.

Keel-Up LPH

On the outside, all four of the ships converted into LPHs appeared to meet General Cate's requirements. They all had flight decks and, except for the *Thetis Bay*, were sufficiently large to accommodate all the ground and helicopter elements of the assault team. Inside their gray hulls, however, all the conversions had serious deficiencies.

The original ships had had to provide for just two combat elements: the aircraft and their crews and the sailors to operate the vessels. On a true LPH, a third element had to be accommodated: the assault Marines and their equipment. An LPH had to have large living compartments for the combat troops and storage holds for their gear, and it also had to have elevators for bringing men and material easily and quickly to the flight deck for loading on the helicopters. Efforts to rearrange the interiors of the conversions to accommodate these changes had to contend with the fact that in modern warships most of the bulkheads (walls) are more than partitions; they comprise a vital part of the vessel's structural strength and ability to withstand battle damage. Thus every removal and repositioning of interior bulkheads had to be weighed carefully

* Commanding officer of the detachment on the *Princeton* was Lieutenant Colonel Homer S. Hill, who also served as air officer. Hill, as a major general, would be Deputy Chief of Staff (Air) at HQMC from 1963–1972.

against the internal integrity of the ship as a whole, and often desirable changes could not be made. As a result, in the USS *Princeton* for example, the assault Marines had to be split up among 27 berthing compartments ranging in size from four to 157 men, totally destroying shipboard unit cohesiveness. The situation was similar on the other three conversions.[88]

The Marine Corps needed a ship designed and built from the keel up to provide for this third element, a ship in which the designers could provide for large troop spaces and cargo elevators right from the initial concept. Such a ship, in essence, would be built around the ship's crew, the helicopters, and the assault Marines. The first such vessel to be built was the USS *Iwo Jima* (LPH 2).* The construction of this unique ship was authorized 27 January 1958 and her keel laid at the Puget Sound Naval Shipyard at Bremerton, Washington on 2 April 1959, just a year after General Pate had compared the lack of such ships to building Polaris missiles without providing submarines to launch them.[89]

What was launched 17 September 1960 still looked from the outside somewhat like a conventional aircraft carrier. Only half as large as the *Essex* class conversions (with a full load displacement of 18,000 tons), *Iwo Jima* was only 592 feet in length, just barely longer than the *Thetis Bay* although with almost twice the "Teddy Bear's" displacement. This combination gave the *Iwo Jima* and the six almost identical ships that were to follow her none of the sleek lines of a fast warship. Instead, she was almost "plump" in her appearance, square sterned, with a short sharp bow that quickly flared out into her 84-foot beam and with a flight deck 52 feet above the water line that covered all but a very small portion of the entire outline of the ship.

Inside her hull was what none of the conversions had, full provisions for all three elements of the amphibious assault team—the helicopters, the combat Marines, and the crew of the ship.

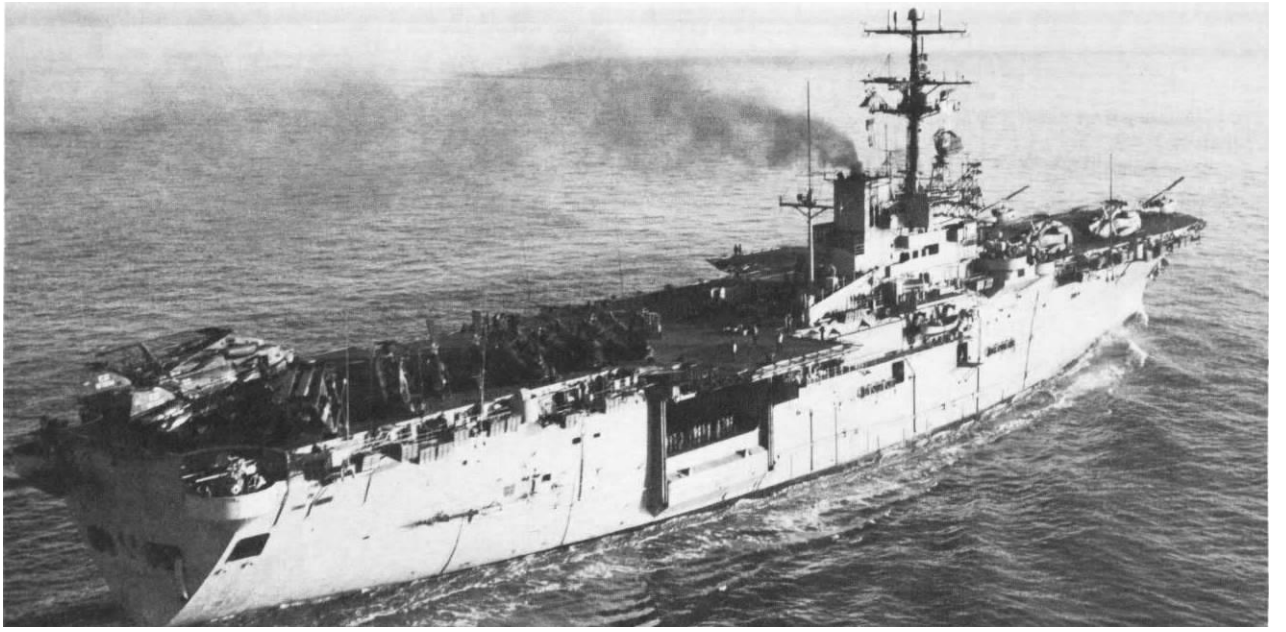
In the simplest terms, an LPH of the *Iwo Jima* class was not a single type ship. She was three completely different vessels stacked on top of each other. At the lowest level was what amounted to an attack cargo ship (AKA) with large holds to store the supplies and equipment of the assault Marines and two large cargo elevators that could bring the material up to either the hangar or flight decks for staging. Both areas were normally used. This storage area was supplemented by an area aft of the hangar deck in which combat vehicles could be carried. To expedite loading at a dock, the designers had included a ramp which could be attached to the aircraft elevators on the outside of the hull, allowing the jeeps and other vehicles to drive directly on to the ship and into the vehicle stowage area.

The second layer of the *Iwo Jima* class extended from the holds up to the hangar deck and was equivalent to an amphibious assault transport (APA). In this section, and a few others scattered throughout the hull, were the large berthing and messing spaces required by 1,900 assault Marines and helicopter mechanics. Though hardly luxurious, these spaces did provide each Marine with a small metal locker to store personal items, separate storage rooms for his pack and rifle, and in the description of one observer who obviously had had experiences with older troop transports: "a comfortable bunk, complete with mattress." [90]

These two layers made the *Iwo Jima* class unique. The provisions for them was what had so seriously handicapped the conversions.

The final layer was more conventional and was what gave the ships their distinctive aircraft carrier-like appearance: the facilities for launching and recovering helicopters from the flight deck, storing them on the hangar deck, and the machine shops and work spaces for the mechanics to maintain the aircraft. To expedite the moving of helicopters from the flight deck to the hangar deck, two elevators, each with a capacity of over 17 tons (a fully loaded HR2S weighed slightly more than 15), were installed, not in the center of the flight deck as had been the case in World War II carriers, but on the outer edge of the flight deck where they operated up and down the outside of the hull. One was on the port side directly abeam the island superstructure; the other one was on the starboard directly aft of the island. To insure that the ships could traverse the Panama and other canals (for when both elevators were extended the ship had an extreme width of 105 feet), the elevators could be folded up along the side of the hull. In actual usage, these aircraft elevators performed an additional function. Cargo could be brought up from the hold to the hangar deck, staged there and moved aboard the lowered elevator. Then to rapidly bring large quantities up to the congested flight deck, the elevator was simply raised. This proved extremely effective, particularly if the cargo was to be carried externally by the helicopter. The same method was used to assemble large units of Marines on the flight deck, ready for boarding their aircraft. The individual teams would form up on the elevator from the hangar deck and with a blare of the klaxon horn, a slight jerk, they would be lifted up to the flight deck beside their waiting helicopters.

* The cancelled conversion of the USS *Block Island* was to have been LPH-1. In the redesignation of amphibious ships, the *Thetis Bay* became LPH-6, the *Boxer* LPH-4, *Princeton* LPH-5, and *Valley Forge* LPH-8. The intervening numbers were given to *Iwo Jima* class ships.



USMC Photo A141545

The USS Guadalcanal *(LPH 7) steams out of Morehead City, N.C. on the way to an exercise in January 1972. This and other* Iwo Jima*-class LPHs were the first ships built from the keel up for helicopter operations.*

Smaller portions of other ships were included also. Above the vehicle stowage area was a hospital that could, in an emergency, accommodate more than 300 casualties (by utilizing the troop berthing space directly aft of it). This particular feature would take on increased importance as the LPHs responded to natural disasters and evacuation of civilians from troubled areas. The deck edge elevators could be utilized in just the reverse of their role in launching assault troops. The sick and wounded were unloaded directly from the helicopters onto one of them, dropped down to the hangar deck and moved to a waiting elevator which lifted them up one deck to a large door leading to the hospital. This fifth elevator, incidentally, was often loudly—and accurately—proclaimed as the only one in the entire ship specifically designed to move people.

In addition, each of the LPHs of this series had a complex communications center for the control of all the helicopters in the assault. Termed the HDC (for Helicopter Direction Center), it and a similar one for the control of supporting fires (FSCC), which were interconnected along with the ships own Combat Information Center (CIC), could act as the coordinating agency for a much larger assault with other ships and aircraft. Though the LPHs to follow were almost identical, the *Iwo Jima* and several of her sister ships had provisions for another function: the offices and communications for both the amphibious force commander and the landing force commander. Ships so modified were tagged "flag configured."

Both as a matter of comfort for the crews and embarked Marines and to assist in maintaining structural strength in a ship that was such a hybrid, the entire vessel was air-conditioned. Popular legend had it that there were no port holes in the LPHs. There were, but what few of them existed were all high in the island structure, an area not normally visited by the assault Marines.

As if the combination of an APA, an AKA, and a helicopter aircraft carrier were not enough, the ship had a space for the crew of 50 officers and 500 Navy men to operate her. The design of such a ship was a remarkable achievement for all the engineers who visions for almost every conceivable situation from played a part. Into her stubby hull were crammed pro-amphibious landing in an atomic age to peacetime disaster rescue missions and most assignments between those two extremes. She was designed to be very versatile. To accomplish all of this, however, the designers had to make a few compromises.

The ships had two separate boilers and associated engines but a single propeller. Such a design saved space for other functions (and was less expensive), though the 22,000 horsepower generated was enough to drive her through the water at a speed slightly in excess of 21 knots. This combination, coupled to the

size and shape of the hull, led to some unexpected results.

One characteristic was first noticed shortly after the *Iwo Jima* left the dock on 5 September 1961 for her initial tests at sea. On board were Captain Thomas D. Harris, USN, the first naval officer ever to command a true LPH, his crew learning the intricacies of an entirely new breed of ship, and the officials and engineers from the Puget Sound Naval Shipyard, who had built her.

The next day she returned to dock. Obviously such an innovative design was going to have a number of small discrepancies on her first shakedown. The *Iwo Jima* did. One of the most serious was described in the official reports as: "severe hull vibrations at high power." On 14 September once again she cast off, heading for sea. Most of the original difficulties had been corrected. The vibration persisted. A week later a third trip was made, this time as her official Builder's Sea Trials, a period of testing and exercising the ship to verify if she would perform as predicted.* The hopes of the engineers were vindicated. She performed well. The only disappointment was that "the chief remaining discrepancy was (still) vibration at high power."

This characteristic vibration was never to be cured in any of the class. At about 15 knots the entire ship began to shake every time one of the blades of the screw took a bite of the water. At that speed it was slight throughout all the ship, but more pronounced in the stern and bow Marine berthing areas. As the speed increased, the vibration increased correspondingly in frequency and severity.

Embarked Marines soon learned to recognize it and within a short period of time actually could tell how fast the ship was going by the rattle of the decks. It was as if the builders had given each man aboard the vessel his own private speedometer. As the *Iwo Jima* and her sister ships reached 21 knots the pounding became more pronounced and was inescapable anywhere on board. To the builders this was "severe vibration at high power". To all Marines who experienced it, it was "the twenty-one knot thump."

While on a peacetime deployment, if wakened by the thump in the middle of the night, the Marines knew that another crisis had occurred, that their ship was proceeding at maximum speed, and that the next morning could bring them into action. When the thump began, the ship would come strangely to life, unbidden. Marine officers would begin appearing at the HDC. Assault riflemen would be restless in their bunks and helicopter mechanics would begin worrying about some minor detail on their aircraft that they had postponed repairing. The designers had not intended it this way but they had given each Marine an unavoidable and unmistakable alarm system.

On New Year's Day, 1962, the *Iwo Jima* was in port at San Diego with much of her crew on leave and the rest busy maintaining the ship. She was not quite ready to conduct an assault—but she would be soon.

The Last Concert

And so a bleak and cold New Year's Day in 1962 was to mark the last time for over a decade that a Commandant could be "surprised" and not have some of his Marines actively engaged in a war. Marine helicopters were stationed around the world. There were several models specifically designed for Marine Corps requirements, and the amphibious ships to give the helicopters and the assault troops the mobility to react in any geographical area bordering on the sea were becoming available rapidly.

The 343 helicopters then in service were far fewer than the Marine Corps thought necessary to carry out the mission it had been assigned, but regardless of their small numbers, the helicopters, combined with the mobility of the new assault ships, gave Marine assault forces a flexibility never before available. Over the next decade, these forces would be called upon a number of times to enforce the decisions of the U.S. Government. These landings, however, were not without cost. By the end of the decade few of the original helicopters would remain. Many of the crews would be gone also.

* Designers of ships, much like airplanes, have complex formulas, even computers, to predict how an individual craft will perform. The variables are so great that it is impossible to predict with any absolute certainty. There is only one way to do it: take the ship to sea, or the aircraft into the air, to see if it will perform as expected. Considering the divergent demands that the engineers had to resolve, the *Iwo Jima* class LPH was a resounding success.

CHAPTER TWO

MANEUVERS AND DEPLOYMENTS

Possible Deployment

At the conclusion of the New Year's Day ceremony around the punch bowl, most members of the band and the guests went home to watch the football games. One, at least, did not.

Lieutenant General Wallace M. Greene, Jr., Chief of Staff of the Marine Corps, had serious work to do. He noted in his diary that he had departed promptly at 1230 and returned across the parade ground to his quarters for lunch. At 1330 he started to "review current problems, schedules and pending items of business." He continued until "past midnight." [1]

General Greene was the son of a village shopkeeper in Waterbury, Vermont, a small town of 1,500 near Lake Champlain. A descendent of *Mayflower* immigrants, he included among his forebears the Revolutionary War hero, General Nathanael Greene.[2]

General Greene described his youth as:

> For one thing, everyone knew you, so you had to live up to the community's standards. Another advantage lay in the schooling we received. New Englanders have always been strong supporters of education and in Waterbury we had a good school system. I took Latin for six years and music for 12, and this was a country school.[3]

After graduating from high school in 1925, he entered the University of Vermont with every intention of becoming a doctor. He worked nights to supplement his income and attended classes in the daytime. While still a freshman, he saw an announcement in a newspaper that competitive examinations for the Naval Academy were to be held. As he later explained: "At the time I didn't know much about the Navy, but the tests were free, so I decided to try for the appointment."[4]

He was accepted and the next year began classes at the academy. He still was unsure about the course he had chosen. Only in his senior year did he give any serious thought to the Marine Corps. Then, on a cruise as a midshipman, "I began talking to the captain of the ship's Marine detachment. I decided that if half his stories were true, then I wanted to be a Marine." [5] On graduation in June 1931, he was commissioned a second lieutenant in the Marine Corps.

This flinty Vermonter would preside over the most turbulent and explosive era in the development of helicopters in the Marine Corps. On New Year's Day 1962,

USMC Photo A409014

Lieutenant General Wallace M. Greene, Jr., Marine Corps Chief of Staff in 1962, became 23d Commandant on 1 January 1964. He participated in many crucial helicopter development decisions.

he could not foresee what was to come, but one of the problems he pondered was "the possible deployment of the first Marine unit to the Delta area of South Vietnam,"[6] and he also reviewed intelligence reports on the worsening situation in Cuba.[7] In those places and elsewhere, Marine helicopters and the men who flew them soon would be tested.

Between the end of the Korean War and the beginning of 1962 a number of exercises had been held to test the concept of vertical amphibious assaults. All of them had suffered from being relatively small scale, as the necessary LPHs were not available until late in the period. In addition, no matter how realistic the landing, it still remained a peacetime maneuver and there was no sure method to determine if the same procedures would be equally effective in war.

The next three years provided the Marines with four major opportunities to evaluate fully the concept. The first of these, although the smallest operation, was, in retrospect, the most significant.

SHUFLY

The military situation in South Vietnam had deteriorated seriously in the last half of 1961.* General Maxwell D. Taylor, special military advisor to President Kennedy, had recommended in November an expanded program of U.S. support for the beleaguered government. Many of his suggestions had been approved by the President. They had, however, only a limited immediate effect on the Marine Corps. Its role was still confined to furnishing advisors, members of joint staffs, and specialized communications personnel. The U.S. Army was to supply most of the increased effort—including helicopters.

By December the first two of three helicopter companies planned had been committed. Equipped with the Piasecki-designed tandem-rotor H–21s they represented a small but much-needed increase in mobility for government forces. Each of the aircraft was capable of carrying approximately 10 assault troops in addition to the two gunners who manned machine guns in each door.[8] The H–21, though, suffered a loss of lift capability at high temperature or altitude even more serious than other helicopters of the time and was only marginally suited for night and instrument flight.[9] The JCS became concerned that additional helicopters might be needed. On 17 January 1962, they directed the Commander in Chief, Pacific (CinCPac), Admiral Harry D. Felt, to review the total requirements for Vietnam. The admiral responded on 28 February. Though the third Army helicopter company had arrived, there was a need for one more. He recommended another Army unit be dispatched to the Mekong Delta region of southern Vietnam.[10]

By coincidence, the same day the Commanding General, FMFPac, Lieutenant General Alan Shapley, who had been a member of the Marine Detachment on board the USS *Arizona* when the ship was sunk on 7 December 1941, sent a message to CMC outlining an entirely different plan. The proposal had been developed by Major General Carson A. Roberts, Commanding General, AirFMFPac, who was scheduled to replace General Shapley on 1 July 1962.

The two generals repeated a request from Major General Charles J. Timmes, USA, Chief, U.S. Military Assistance Advisory Group, Vietnam (ChMAAGV) to augment Army squadrons with Marine Corps pilots. Nine officers, he suggested, could be selected at a time and sent to Vietnam for 60 to 90 days of familiarization and indoctrination. Such a program would have been complementary to one General Shapley's command had initiated in May 1961 in which monthly increments of 20 Marines, officers and senior enlisted men, were sent to Vietnam to observe ground operations.

On receiving General Timmes's request, General Roberts pointed out that the Marines would have difficulty working with Army squadrons. Since the Marine pilots would be flying aircraft in which they had no experience, some of the time they spent in the battle zone would have to be used for nothing more than training them to fly the Army H–21. As an alternative he suggested that an entire Marine Corps squadron be sent to the area to replace one of the Army companies. This would increase the total lift available since the 24 UH–34s assigned could carry more and were less susceptible to altitude and heat than the H–21s. In addition, familiarization still could be obtained by rotating pilots from other Marine squadrons. If the helicopters were located in the more mountainous northern portion of RVN they would be operating in an area that was a Marine Corps responsibility under contingency plans then in existence.[11]

While this proposal was being studied, on 6 March the JCS approved the deployment of the fourth Army helicopter unit. The 33d Transportation Light Helicopter Company at Ford Ord, California was alerted to depart 18 April. Apparently unaware of this decision two days earlier in Washington, the Commander, U.S. Military Assistance Command, Vietnam (ComUSMACV), General Paul D. Harkins, informed CinCPac that he agreed with Generals Shapley and Roberts and

* For a complete history of this period see: Captain Robert H. Whitlow, *U.S. Marines in Vietnam, 1954–1964: The Advisory and Combat Assistance Era* (Washington: History and Museums Division, Headquarters, U.S. Marine Corps, 1977.)

desired a Marine Corps squadron instead of the fourth Army unit. He requested that it be sent to the Mekong Delta. The Army's 93d Helicopter Company had only recently become fully operational at Da Nang, and to move it south now would result in a decreased level of support just as the monsoon was ending and the weather was becoming more favorable for helicopter operations. "When the tempo of operations permit," he added, "the Marine helicopter squadron will be relocated to the I Corps (northern/Da Nang) area and the 93d helo company to the III Corps [southern] site." [12]

The next day, 9 March, the Commander in Chief, U.S. Army, Pacific, General James F. Collins, added his opinion. He stated that in view of the decision to deploy the company at Fort Ord, no Marine Corps helicopters were necessary in Vietnam. The Army was still anxious, however, to have Marine Corps pilots to augment the units already there.[13]

The issue was not resolved until 19 March. The JCS then approved a Marine Corps squadron instead of the 33d Helicopter Company at Fort Ord. Target date for the squadron to be in place was approximately 15 April.[14] Unlike the Army, which would have to arrange shipping from Hawaii or the West Coast of the United States—a fairly complicated revision of already demanding schedules—the Marine Corps had two squadrons immediately available nearby. Both HMM–261 and HMM–362, the two transport squadrons of MAG–16 in Okinawa, were temporarily in the Philippine Islands. They were scheduled to be the vertical assault portion of a large-scale Southeast Asia Treaty Organization (SEATO) exercise, code named TULUNGAN. The operation was to start 25 March.

The recently promoted commanding general of the 1st Wing, Major General John P. Condon, had already left Iwakuni, Japan and had established his headquarters on Mindoro Island when he received notice on 22 March to deploy a squadron to Vietnam. General Condon, though not designated as a helicopter pilot, was no stranger to them. In later years he described his experience:

> My whirly-bird initiation went back as far as '47 and '48 when the thing was just evolving. General Harris, who was then Director of Aviation, had me evaluate about every helicopter in the country . . . so I covered a lot of helicopter territory kind of early in the game. In fact, some of my bones are still shaking from some of those machines.[15]

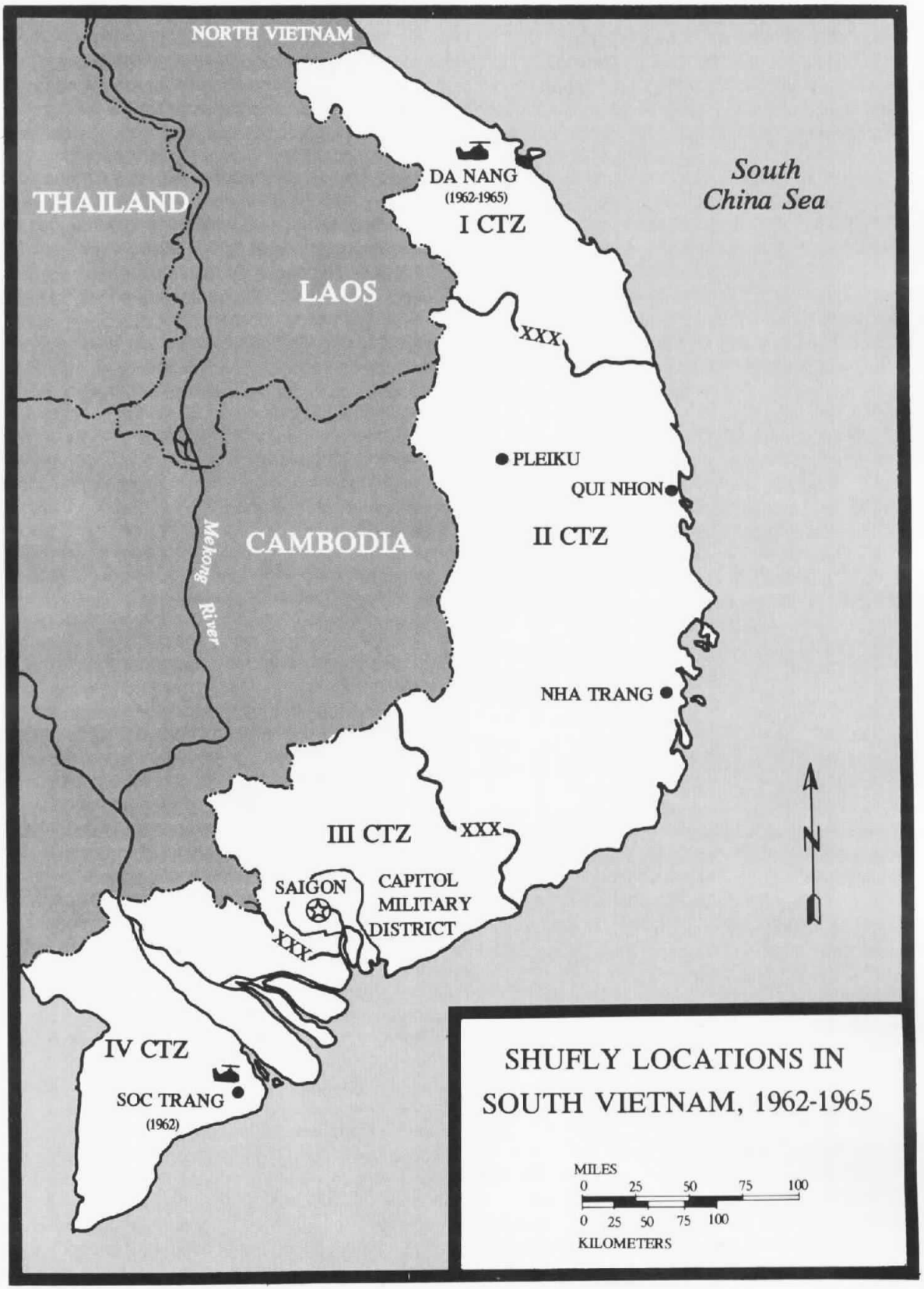
Planning began immediately. General Condon selected HMM–362 as the squadron to go. Since the previous October it had been assigned as the helicopter portion of the Special Landing Force (SLF) and had spent most of the intervening months on board the USS *Princeton* (LPH 5) patrolling the South China Sea. (Lieutenant Colonel Fred A. Steele and the members of HMM–261 were not to be the first in Vietnam but they would have an emergency deployment. Less than two months later, on 17 May, they flew off the ship in the Gulf of Siam and supported contingency operations in northern Thailand. HMM–261 remained at Udorn there until relieved by Lieutenant Colonel Reinhardt Lee and his HMM–162 at the end of June).[16]

By 30 March General Condon had submitted the broad outline of his plan.[17] He proposed a small headquarters group of eight officers and six enlisted men commanded by the chief of staff of the 1st Wing, Colonel John F. Carey, one of the most experienced helicopter pilots in the Marine Corps. On 6 August 1948 he had become the 18th Marine designated and had been the second commanding officer in the history of HMX–1.

To provide the necessary base services, a subunit of MABS–16 with 193 enlisted men and 18 officers also would be sent. This unit was to be led by the current commanding officer of MABS–16, Lieutenant Colonel William W. Eldridge, a helicopter pilot since 5 January 1952. The final element would be Lieutenant Colonel Archie J. Clapp and his HMM–362.

Lieutenant Colonel Clapp had enlisted in the Marine Corps in December of 1940. Two years later he entered flight training and was commissioned in July 1943. He saw combat as a fighter pilot in the campaigns for Iwo Jima and Okinawa. Then, in March 1951 he was assigned to HMX–1 and designated a helicopter pilot on 9 June. In the squadron he expanded his career as a prolific and articulate writer and soon was editing a news sheet distributed throughout the Marine Corps detailing the latest developments in helicopters. After the Korean War he continued to write articles for professional journals. One of them received an honorable mention from the Marine Corps Association contest in 1958. This particular article demonstrated the imaginative approach to a problem that was to make him well suited for his duties in Vietnam. He proposed that helicopters be used as a method to launch and recover fixed-wing aircraft. The helicopter would lift the other airplane to a suitable height and speed and release it. Landing was just the reverse. Such a system would eliminate the need for long runways in a combat area.[18]

As TULUNGAN was concluded and the men of HMM–362 along with the rest of the Marines began reembarking on their ships, planning progressed for what would become known as Operation SHUFLY. Colonel Carey hastily assembled his small staff at Iwakuni. One of their first tasks was to select a site. Of those available in the delta most were surfaced with laterite.[19] Many Marines would learn later that this is


NORTH VIETNAM
THAILAND
LAOS
CAMBODIA
Mekong River
DA NANG
(1962-1965)
I CTZ
South China Sea
XXX
PLEIKU
QUI NHON
II CTZ
NHA TRANG
III CTZ
XXX
SAIGON
CAPITOL MILITARY DISTRICT
XXX
IV CTZ
SOC TRANG
(1962)
N
SHUFLY LOCATIONS IN SOUTH VIETNAM, 1962-1965
MILES
0 25 50 75 100
0 25 50 75 100
KILOMETERS

a red clay often used to pave roads and runways in Vietnam. When dry it has the consistency of talcum powder; when wet, bottomless glue. Colonel Carey was concerned that the laterite would damage, not only the helicopters, but the transport aircraft which would be necessary to support his task unit. There was, however, an abandoned airfield that had a suitable concrete runway: Soc Trang. Built by the Japanese during World War II, it was approximately 85 miles south-southwest of Saigon.[20]

To insure flexibility for HMM–362, its normal complement of 24 UH–34s was supplemented by three OE–1 (01–B) fixed-wing Cessna observation aircraft from Lieutenant Colonel Donald H. Foss's VMO–2 and a C–117 (military version of the improved DC–3 transport) for liaison and supply flights. Approximately 50 additional mechanics were assigned to the squadron for aircraft maintenance.

On the morning of 8 April, Colonel Carey and members of his staff departed Iwakuni in the C-117. After a short stop in Okinawa to pick up others, they proceeded to NAS Cubi Point in the Philippines for final briefings. The next morning they discovered that the aircraft had developed mechanical difficulties and could not proceed to Vietnam. Colonel Carey was remembered as surveying the aircraft and exploding, "We have a war going on and now our horse just died"! [21]

There was, fortunately, another C–117 at Cubi on a routine logistics flight for the 1st MAW. Colonel Carey is again remembered as walking over to the pilot, a captain, and saying:

"Too bad your airplane is sick."

The captain responded that his aircraft was in fine shape.

"Oh, no it isn't." Colonel Carey answered. "Yours is over there and it's sick. This one is mine." [22]

A quick switch was made and the party continued on to Soc Trang.

Colonel Carey's determination to arrive on the 9th was prompted by a plan that called for all but fuel and water to be delivered by air. The first KC–130s bringing the MABS subunit to set up the base were due to land that afternoon.*

When the staff finally arrived, they found a runway approximately 3,000 feet long, a dilapidated hangar, and a few long-abandoned buildings. As others began preparations for the arrival of the KC–130s, a pilot of the C–117, Captain James P. Kizer, busied himself by converting the airplane into an improvised control tower. He removed the escape hatch on top of the cockpit, turned on the radios, "put my sun glasses on, stuck my head out and said 'Hello there, this is Soc Trang Tower' "; [23] he then was able to give landing information to the KC–130s, the first of which was piloted by General Condon. Lieutenant Colonel Ethridge and his men, on their arrival, immediately set about establishing the necessary facilities to provide for the Marines yet to arrive.

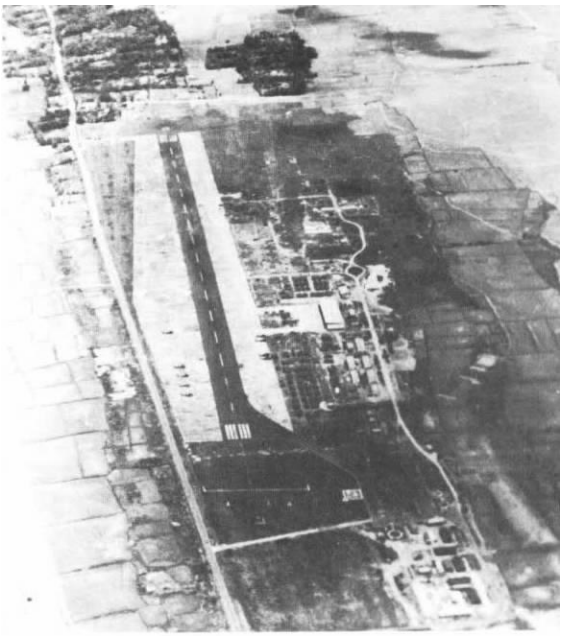


Photo courtesy of Lieutenant Colonel James P. Kizer, USMC

Soc Trang Airfield, SHUFLY's first operating base in the Mekong Delta. Flying from Soc Trang, the Marines quickly learned many vital lessons in helicopter operations and tactics.

Meanwhile, HMM–362 was busily preparing for the deployment. At the conclusion of TULUNGAN, on 1 April, it reembarked on the USS *Princeton* and proceeded north to Cubi Point in Luzon. There it exchanged some of its aircraft with HMM–261 so that those with the longest time before regularly scheduled overhaul would be assigned to HMM–362. In a "round the clock" operation under the direction of the aircraft maintenance officer, Captain James R. Plummer, and the maintenance chief, First Sergeant Robert A. Schriefer—both of whom were to receive citations later for their skills during SHUFLY—the switch was made.[24] Now with the two squadrons on board, the *Princeton* proceeded back to Okinawa to load the men and equipment that had not been deployed to the Philippines.

On 10 April, still with HMM–261 on board to assist in the unloading, the ship departed. Its destina-

* The C–130 is a four-engine turbo-prop aerial refueler which can be converted for cargo and troop transport operations.

tion was 20 miles off the mouth of the Mekong River. Operations were scheduled to start at dawn, 15 April.

In response to a request made on 29 March by the State Department, the landings were to be made as inconspicuously as possible. The Commander, Seventh Fleet, Vice Admiral William A. Schoech, planned to keep the *Princeton* out of sight of land.[25] He also ordered that the escorting jets from the USS *Hancock* (CVA 19) remain well out to sea to be called in only if necessary. This deviation from helicopter assault doctrine which called for the escort "aircraft [to] cover the helicopter waves and provide protection from enemy ground fire" seemed insignificant at the time.[26] It was, however, an ominous indication of further changes to come.

The flights to Soc Trang began on schedule. The only incident recalled by Lieutenant Colonel Clapp occurred shortly after the takeoff of one of the OE–1s. The engine began to malfunction. The pilot, First Lieutenant Francis M. Walters, Jr., quickly turned back to the *Princeton* and even without a tail hook or arresting wires on the ship made a successful emergency landing. The airplane was repaired and flown to Soc Trang later in the day. By mid-afternoon the transfer was complete. HMM–261 returned to the ship to assume duties as the new SLF squadron.

Within three days in Vietnam, HMM–362 discovered that additional development of tactics and machines was going to be required—a process which was to characterize its entire operation. The first incident was a small, but typical one. Two aircraft had been committed to haul badly needed supplies to an isolated town deep in the delta. Lieutenant Colonel Clapp described it:

> [The pilots] landed and shut down on what appeared to be hard dry ground. In a couple of minutes, though, they noticed that the landing gear was slowly but

USMC Photo

The commanders responsible for SHUFLY confer after arriving at Soc Trang in April 1962. Major General John Condon, Commanding General, 1st Marine Aircraft Wing (fourth from left) confers with Colonel John Carey (extreme right), the task group commander. Lieutenant Colonel Archie Clapp, HMM–362 squadron commander, is third from left, holding coat and briefcase.

> steadily sinking. Timbers were quickly shoved under the axles, yet [they] were solid on the timbers before the helicopter could be started and rotors engaged for takeoff. After that experience the helicopters always carried a short length of marston matting to be placed under the wheels by the crew chief before the helicopters were shut down in the field.[27]

Lieutenant Colonel Clapp could have added that the problem triggered off a renewed search for an "instant" helicopter landing pad. Several models were later produced in limited quantities.

Another problem the men of HMM–362 could solve immediately, and their experience influenced the design of all helicopters in the future. It had not occurred to the squadron that the small size of the Vietnamese troops "made it difficult for them to embark in the helicopters when they were on solid ground and impossible in mud. The squadron metal-smiths built large jury-rig steps [to the cabin door] from wood and angle iron to solve the problem." [28] Later prefabricated metal steps were added to the UH–34s operating in Vietnam. But the most lasting effect was that the ease of exit and entrance became a factor in the design of future helicopters.

Nine days after their arrival in Soc Trang the Marines had a helicopter shot down. A single bullet pierced an oil line in the engine. The pilot was able to fly the airplane out of the battle to a safe area, but the incident pointed up the vulnerability of the oil system in the UH–34. The vital cooler was located on the bottom of the engine and provided a tempting target for the enemy until later when armor plating was added.*

Lieutenant Colonel Clapp also began refining "short-order" missions, in which the rapid response and mobility provided by the helicopter provided a means to exploit any sighting of the enemy. These operations were subsequently developed into the "Chickenhawk" (or Eagle) fast reaction concept and employed with great success.

To overcome the difficulty of navigating across the featureless swamps and rice paddies of the delta region and yet to provide the surprise resulting from flight at extremely low levels he once again demonstrated his imagination. The leader of a flight would position himself to the rear of the formation high above at 1,500 feet altitude. From there he could identify landmarks and broadcast course corrections to the other helicopters without alerting the enemy to the impending assault.

By the time HMM–362 left Vietnam on 1 August 1962, Lieutenant Colonel Clapp and "Archie's Angels," as the members of his squadron called themselves, had identified almost every area which would eventually require further development in helicopters.

Built-in armor plate was needed. Some integral fire power was necessary though unlike the Army H–21s no machine guns had been mounted in the aircraft. Instead, the crew chief and co-pilot were equipped with "grease gun" submachine guns. "The co-pilot covered the left side of the helicopter while the crew chief covered the right when [they] were close to, or on the ground."[29]

The many studies conducted in the previous 10 years of the possible effect of combat damage had been tested. The helicopter "does not seem to be as fragile as some people think," [30] it was reported.

Landings in the face of heavy fire or "in the vicinity of a machine gun concentration" seemed "foolhardy." Though "some losses will likely occur when operating in an environment" of light enemy fire, "it is not necessary to 'sanitize' an area completely before helicopters con operate in it, if moderate losses are an acceptable factor."[31]

New flight clothing and body armor for helicopter crews were a high priority item.

While the squadron occasionally had fixed-wing aircraft support from the Vietnamese Air Force, the results were uneven. Lieutenant Colonel Clapp accurately predicted what would have to be developed for protection of helicopters in a counterinsurgency war:

> Helicopters need escort aircraft to call on for suppressive fire. The escorting aircraft must have flight characteristics that permit them to stay close to the helicopters and constantly in a position to initiate an attack. A target is not going to be seen until it is firing at the helicopters, and when this happens, even a short delay is too long. The armament of the escort aircraft should be antipersonnel in nature. Their sole mission is to make someone stop shooting at the helicopters. And to make them stop immediately. The results the helicopter leader needs in order for him to get his work done [are to] keep the opposition off his back while he places troops where they are supposed to be.[32]

Unknown to the Marines at Soc Trang, their deployment had created an additional problem. General Shoup had approved the move but he harbored reservations. The Marine Corps was undergoing a major expansion of the helicopter program and planned to add one medium transport squadron to the existing 11 in each of the next four years. The inventory of UH–34s would increase to 294 by fiscal year 1964.[33]

To fill the new units, additional mechanics, technicians, and pilots would have to be recruited and trained, and much of the training would be done by Marines already assigned to helicopters. Any further commitments of active units, therefore would put a severe strain on the planned progress. The Comman-

* Armoring of helicopters will be discussed in Chapter 5.

dant feared that the Marine Corps might be asked to provide another squadron to MAG–16 in addition to HMM–362 and HMM–261, resulting in a disruption of the expansion. He indicated that he would oppose the use of the Marine helicopters in Vietnam if this were to be the situation.[34] He made this position clear to Generals Shapley and Roberts on 7 May. The third transport squadron to be sent to the western Pacific was not scheduled to be ready for deployment until March 1964. The plan would be adhered to.[35]

The fears of General Shoup had foundation. Less than a month after his warnings, ComUSMACV stated an urgent need for additional helicopters in Vietnam and requested CinCPac provide another Marine squadron.[36] General Shoup, however, was at least partially successful in his efforts to build up the helicopter program before committing more squadrons to an expanding war in SEA. Not until late fall 1963, would the additional squadron arrive. The three transport units of MAG–16 initially rotated between Vietnam, the ship-borne Special Landing Force, and home station at Futema.

For three years after "Archie's Angels" first touched down at Soc Trang, SHUFLY continued to provide the Marine Corps with information that greatly affected further development of the helicopter. But SHUFLY had become almost a totally land-based operation. The amphibious capability, which gave the Marine Corps such a unique strength, was seldom utilized. The Marine Corps soon was to have an opportunity to evaluate the concept and the machines in an operation which was almost completely sea-based.

The 1962 Missile Crisis

The first week in October 1962 found Marine Corps helicopters engaged in a wide variety of commitments. HMM–163, led by Lieutenant Colonel Robert L. Rathburn, had replaced HMM–362 in SHUFLY on 1 August. Lieutenant Colonel Rathburn, a fighter pilot in World War II, had made the transition into helicopters and had been designated 23 November 1951.

After turning over all of its equipment and aircraft to HMM–163, "Archie's Angels" had proceeded to new assignments in the United States. HMM–362 was reformed at Santa Ana, but in October found itself once again, as in Futema a year before, awaiting the assignment of aircraft. It was, also, about to have a new mission.

In Thailand, Lieutenant Colonel Steele with HMM–261 had been replaced by the newly arrived HMM–162. The commander, Lieutenant Colonel Reinhardt Leu, was one of the earlier helicopter pilots, having been designated 27 November 1950. Only a small cadre of HMM–261 had been transferred from Thailand to MAG–26 at New River in July, but by mid-September the squadron nearly had regained full strength and was engaged in intensive training.

Lieutenant Colonel Robert L. Cochran had assumed command of MAG–26 on 1 February 1962. Two months later he was promoted. An expert on aviation electronics, he had participated in the battle of Okinawa and had completed flight training after World War II. He had made the transition to helicopters in 1958.

On 1 October he and 74 of his helicopters (out of a total of 122) were deployed to NAS Memphis, Tennessee for what was officially described as "support of Federal operations to control civil disturbances".[37] Rioting had broken out in nearby Oxford, Mississippi when James H. Meredith, a black, had attempted to enroll in the university, and Colonel Cochran and most of his forces had been dispatched on short notice to assist the authorities. They began returning to New River on 8 October.[38]

Eight more of the group's aircraft were embarked in the USS *Shadwell* (LSD 15) in the Mediterranean Sea as the vertical lift component of Battalion Landing Team (BLT) 1/2. These UH–34s were a detachment from HMM–262 commanded by Major Wilbur O. Nelson. Not only did Major Nelson have to start preparing a new subunit for the replacement scheduled for November of the *Shadwell* detachment but on 3 October CMC had announced that his squadron was to undergo a reorganization. The expansion of the helicopter program was progressing on schedule but there remained a serious shortage of pilots to fly the additional aircraft. To alleviate this, one squadron on each coast was to be reformed into a training unit. Experienced fixed-wing pilots were to be ordered to transition training with the first ones due 1 November.[39]

When Colonel Cochran arrived back in New River, he was immediately faced with another challenge. Two of his squadrons, HMM–264 and –261, were scheduled to embark on 16 October for a large-scale exercise (PHIBRIGLEX–62) in the Caribbean. HMM–264, under the command of Lieutenant Colonel Rocco D. Bianchi, would sail in the newest *Iwo Jima*-class LPH, the USS *Okinawa* (LPH–3) which had been commissioned 14 April. In addition to 12 UH–34s, he would be assigned four HR2Ss from Lieutenant Colonel Eugene J. Pope's HMH–461 and two OH–43s from Lieutenant Colonel Earl W. Cassidy, Sr.'s VMO–1. Lieutenant Colonel Frank A. Shook, Jr., was to embark in the USS

Thetis Bay with 12 UH–34s. Due to the small size of the "Teddy Bear," no additional aircraft were assigned to HMM–261.[40]

D-day for the landing was scheduled for 23 October with the fleet to arrive back on the east coast a week later. Loading of the 6,000 Marines and their equipment went smoothly, and on 17 October the combined task force sailed with the landing force, under the command of Brigadier General Rathvon McC. Tompkins, Assistant Division Commander, 2d Marine Division, and a winner of the Navy Cross in World War II.

Coincidentally, on the same day in California, the *Iwo Jima* departed for her first deployment in the western Pacific. She would replace the USS *Valley Forge* (LPH 8), an *Essex*-class conversion which had relieved the *Princeton* as the LPH for the Special Landing Force. Plans for all of these units were to change abruptly.

For several years, the situation in Cuba had been growing steadily worse. The day after HMM–264 and –261 and the *Iwo Jima* had left on routine operations, President Kennedy received information indicating that the Russians had introduced missiles into Cuba which were capable of striking the United States. On the 19th, he received further confirmation of the presence of rockets. As the Administration prepared to meet this direct threat to national security, the *Iwo Jima* was ordered to return to the West Coast immediately.[41] PHIBRIGLEX-62 was hastily cancelled and the entire fleet, now numbering over 40 ships, was diverted for new assignments.[42]

On 22 October, President Kennedy went before a nationwide radio and television audience to announce that he was instituting a blockade and quarantine of Cuba to force the removal of the missiles. That same evening, additional Marine helicopter units were alerted for action. The only remaining LPH in the Atlantic, the USS *Boxer*, was ordered to a position off New River, where she was to embark troops and helicopters. The *Boxer* arrived at New River on the 27th and sailed the same day for the Caribbean. On board was HMM–263 under Lieutenant Colonel Clyde H. Slaton, Jr., with 20 UH–34s augmented by four HR2Ss, five OH–43s, and nine O–1s. Also crowded on *Boxer's* decks were 16 more UH–34s to be delivered to the *Okinawa* and *Thetis Bay* to bring HMM–261 and –264 up to their full complement of 20 aircraft each.[43]

Meanwhile, on the west coast, the *Iwo Jima* had returned to port the same day as the President's announcement and immediately began embarking elements of the 5th Marine Expeditionary Brigade (MEB), commanded by Brigadier General William T. Fairbourn, Assistant Division Commander, 1st Marine Division. The commanding officer of California-based MAG–36, Colonel Earl E. Anderson (later to become Assistant Commandant of the Marine Corps), selected HMM–361 to deploy with the 5th MEB. The squadron had a routine change of command scheduled, and the date was changed to allow Lieutenant Colonel Thomas J. Ross to assume command on 22 October.[44] A detachment of observation aircraft from Lieutenant Colonel Henry K. Bruce's VMO–6 was added to HMM–361. The *Iwo Jima* sailed again on 27 October and this time set course for the Panama Canal.[45] Two weeks later, she was in position in the Caribbean.

The second week in November saw a reduction in tension as the Russians began removing their missiles from Cuba. The amphibious fleets with their LPHs began to plan training maneuvers—within range to permit rapid return to Cuba if necessary.[46]

On 20 November, President Kennedy announced the lifting of the blockade, and the *Okinawa*, *Thetis Bay*, and *Boxer* shortly proceeded back to the New River area to conduct exercises and unload the Marines. All units were home by 2 December.[47] The *Iwo Jima* remained in the Caribbean until 1 December to take part in practice operations at Vieques Island east of Puerto Rico. On 1 December, the ship sailed for the west coast via the Panama Canal.[48] Two weeks later, HMM–361 arrived back at Santa Ana.[49]

Though the Marines had not been engaged in combat during their deployment and had spent almost all of the time at sea, they again had demonstrated the flexibility and mobility available to assault troops in the LPH/helicopter combination. It also had confirmed the necessity of maintaining the LPH construction program and the expansion of Marine helicopter forces as a high priority. As a side effect, the Cuban Crisis had proved invaluable in furthering the indoctrination of many Marines in amphibious vertical assault warfare. Lieutenant General Robert B. Luckey, commander of the landing forces, reviewed the problems at the annual General Officers' Symposium in July 1963. He concluded that "all in all, it was an instructive embarkation drill. As a result, the II Marine Expeditionary Force is better prepared." [50]

More important, the Cuban crisis had demonstrated the need to conduct large-scale exercises incorporating long-range strategic mobility. It would be another two years before sufficient LPHs, helicopters, and crews were available, but when the first such operation was held it would test fully the entire concept of vertical amphibious assault.

STEEL PIKE I

Lieutenant General James P. Berkeley assumed command of FMFLant on 1 August 1963. Born into a Marine Corps family, he was the son of Major General Randolph Carter Berkeley who had won the Medal of Honor at Veracruz, Mexico in 1914. General Berkeley had followed in his father's footsteps and had enlisted in the Marine Corps in 1927. After almost three years as an enlisted man, including duty in Nicaragua, he was commissioned a second lieutenant on 31 January 1930. He became an expert on communications and served in a variety of billets in that field during World War II. After the war, he was an amphibious warfare advisor to the Argentine Naval War College and to the Argentine Marine Corps.

Three months after assuming command of FMFLant, General Berkeley departed on a trip to those areas in Europe in which his Marines had interest. One of his first stops was on the southwestern coast of Spain. As the general later recounted:

> We'd been interested in the Rota beaches for a long time in the Marine Corps. General Luckey had been over there a number of years before . . . and had surveyed these beaches. We'd been interested in this as an exercise area.[51]

After inspecting the site, General Berkeley "talked to the Commandant of the Spanish Marines . . . about the possibility of having a joint maneuver. The Spaniards were enthused about the idea." [52]

Returning to his headquarters in Norfolk, Virginia, he discussed the area with Vice Admiral John S. McCain, Jr., Commander, Amphibious Force, Atlantic (ComPhibLant). PhibLant was the navy counterpart to FMFLant in landing operations. Coincidentally, Admiral McCain was also the son of a famous military man. His father, Vice Admiral John S. McCain, was the World War II commander of a fast carrier striking force that compiled an enviable battle history in the Pacific as Task Force 38.

Admiral McCain agreed with General Berkeley that a large-scale strategic mobility landing was feasible and desirable. Spain, however, was not the only possibility:

> We [FMFLant staff] physically reconnoitered Jamaica, Panama, Puerto Rico, and Vieques. In addition, Trinidad, Nicaragua, Dominican Republic, Haiti, and areas in South America were investigated. All . . . were inadequate, either from a political, hydrographic or topographic point of view. Therefore we turned our attention to Spain.[53]
>
> Through Commander-in-Chief, Atlantic Fleet (CinCLantFlt), the matter was brought before the JCS exercise scheduling conference in late January. After [the] presentation . . . a 'Carib Mobex' was recommended by the conference for FY 65 (July 64–June 65), with the understanding that it might be conducted in Spain.[54]

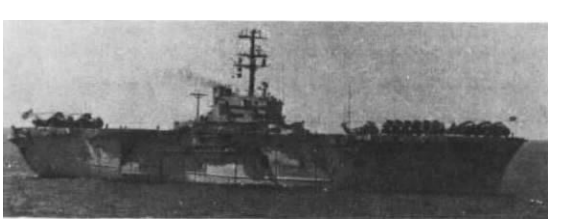
On 31 March, the JCS approved the recommendations of the scheduling conference and shortly thereafter the code name STEEL PIKE was substituted for "Carib Mobex." D-day was set originally for 29 October, but at the request of the Spanish Government, moved up to 26 October.[55]

Three weeks before the landing, ships of the largest amphibious operation in the Atlantic Ocean since World War II began embarking supplies, equipment, and Marines. By the time the fleet arrived off the coast of Spain it consisted of almost 115 U.S. Navy ships, 21,642 men of the II Marine Expeditionary Force, the Mediterranean Ready Amphibious Squadron, and 17 Military Sea Transport Service and commercial charter vessels.[56]

In the objective area the American forces were joined by Spanish units, including 25 additional ships, a Marine battalion landing team, aircraft, and Army forces.[57] The 60 ships of the fleet assigned to carrying the Marines included three LPHs: the *Boxer*, the *Okinawa*, and the newest one, USS *Guadalcanal* (LPH 7).

On board these ships were most of the helicopters in MAG–26. The commanding officer, Colonel Stanley V. Titterud, had been the 24th Marine designated a helicopter pilot. An aviator since he was commissioned in August 1942, he had qualified in helicopters on 11 June 1949.

Six of the seven tactical squadrons in the group with a total of 105 aircraft were committed to STEEL PIKE. There were 80 UH–34s. HMM–261, commanded by Lieutenant Colonel Mervin B. Porter, was in the *Guadalcanal;* HMM–262 with Lieutenant Colonel Edward K. Kirby in the *Okinawa;* and both Lieutenant Colonel Warren L. MacQuarrie's HMM–263 and Lieutenant Colonel Frederick M. Kleppsattel's HMM–264



USMC Photo A450013

The U.S.S. Guadalcanal *(LPH 7), with HR2S1s and UH–34s on her deck, participates in Operation STEEL PIKE I in October 1964. In all, seven Marine helicopter squadrons and three LPHs were involved in this major test of the vertical assault concept.*

in the *Boxer*. Each had 20 UH–34s. Major Donald R. Navorska, who had taken command of VMO–1 two months earlier, had 10 of his UH–1Es distributed among all three ships. In addition, Lieutenant Colonel Truman Clark was on board the *Boxer* with eight of the HR2Ss from HMH–461. Finally, the seven UH–34s from HMM–262 which had been on board the USS *Donner* (LSD 20) as part of the Mediterranean ready force rendezvoused with the rest of the group for the operation. The only squadron left at New River, Lieutenant Colonel Eldon C. Stanton's HMM–265, was in the process of converting to a new type of aircraft.

The scheme of maneuver in STEEL PIKE called for one regimental landing team (RLT) to land by boats and another by helicopter in the vicinity of Huelva, on the Atlantic coast of Spain. A second landing to the north would also be made by boat. Both surface thrusts, though, would encounter populated areas in their advance and the final assaults on the inland objectives were planned to be helicopter borne.[58]

The D–day weather was ideal. Clear skies and calm seas prevailed. On hand to observe was a large group of dignitaries, including the CMC, General Greene. The assault was almost classic in its perfection. General Berkeley reported that "all surface and assault elements of landing force executed [operation] on time. Combat efficiency remains excellent."

The only incident to mar the exercise was the collision of two helicopters from HMM–262. The crash resulted in the death of one of the crew chiefs and eight members of BLT 3/8. One pilot, First Lieutenant Donald W. Soper, was critically injured. The rest of the crews and passengers escaped with minor injuries.[59]

As the attack progressed, tests of helicopter operations continued, including the simultaneous lifting of members of the same unit from different ships to a single landing zone. The careful control of so many aircraft within the target area received special attention. To expedite the movement of supplies from the landing zones, lightweight, rough-terrain fork lifts were brought ashore inside the HR2Ss. U.S. fighters practiced escort of the helicopters circling over the transport aircraft, and keeping at bay the Spanish air force which was acting as the "enemy." (Many of the Spanish airplanes were German-designed Messerschmitt ME 109s—the most common fighter of the Nazi Luftwaffe in World War II. Helicopter pilots were often startled when attacked in mock battle by an airplane they had seen only in old newsreels.) General Berkeley utilized the rapid response and versatility of his helicopters and reported that "further helo assaults [are] planned to expedite seizure of force objectives." [60]

By 30 October the assault forces had gained all of the objectives and reembarkation began the next day. The usefulness of the helicopter had one more demonstration. A Douglas A–4 jet attack aircraft was unable to complete in-flight refueling on the way back to the United States. The pilot spotted an Italian ship, ejected from his airplane beside it, and was picked up promptly. As the freighter passed through the straits of Gibraltar, there was a Marine helicopter hovering above which lifted the pilot on board and returned him to the *Boxer*.

With reembarkation complete, the ships steamed to various European ports to give their crews and the Marines a few days of liberty before returning to the United States. Colonel Titterud and his men arrived back at New River on 28 November.[61]

Major General Louis B. Robertshaw, Deputy Chief of Staff (Air), summed up the operation, saying: "STEEL PIKE has again demonstrated the soundness of Navy-Marine Corps amphibious concepts. The exercise test objectives of the Wing were accomplished proving the validity of the need for such exercises." [62]

The need to conduct another large-scale exercise was satisfied in March 1965 on the west coast. Operation SILVER LANCE was similar to though smaller than STEEL PIKE. Almost 15,000 Marines loaded into 28 ships—only one of which was an LPH—and made an amphibious assault on the beaches of southern California. The initial helicopter landings were limited to 15 UH–34s.[63] Once ashore the Marines conducted extensive counterinsurgency training operations which had been impossible in Spain. Additional large exercises were planned but events intervened. To this date, STEEL PIKE remains the largest amphibious assault ever made utilizing helicopters.

Dominican Republic

Lieutenant Colonel Kirby's HMM–262 remained at New River for only a short time after returning from STEEL PIKE. Less than two months later, he and his squadron embarked in the *Guadalcanal* as the helicopter squadron of the Caribbean Ready Force. This unit, which consisted of a battalion landing team, specialized support units, and a small headquarters, in addition to the helicopters, was positioned in the Caribbean Sea to deal with any emergency that might develop in that troubled area. If necessary, jet aircraft would be provided to assist them. The units of the ready force normally returned to their home bases after five or six months of deployment. Due to the short time at New River since the STEEL PIKE deployment, HMM–262 was scheduled for an abbreviated tour of three months.

USMC Photo A368913

UH–34s loaded with troops leave the deck of the U.S.S. Valley Forge *(LPH 8) to conduct an assault during Operation SILVER LANCE, 9 March 1965. This exercise similar to STEEL PIKE but smaller in size, involved both a heliborne amphibious assault and counterinsurgency operations.*

The squadron's relief, Lieutenant Colonel Kleppsattel's HMM–264, departed Onslow Beach on the USS *Boxer* on 3 April 1965.[64] The *Boxer* met the *Guadalcanal* at Vieques Island east of Puerto Rico for an exercise in conjunction with QUICK KICK VII, after which the pilots and crews of HMM–262 returned to New River and Lieutenant Colonel Kleppsattel's unit assumed the ready force mission. After a short visit for training to Guantanamo Bay, the ships returned to Vieques for another exercise. This one, called PLACE KICK, concluded with a week of extensive training for the Marines on the island. They reembarked on their vessels on 24 April.

That night, CinCLantFlt began to receive reports of riots, demonstrations, and an attempted coup in Santo Domingo from the American embassy there. The next morning the ready force was ordered to move toward the Dominican Republic, but to remain out of sight of land. The fleet, and the Marines, were underway less than an hour later. As the ready force was sailing from Vieques, the situation in Santo Domingo was reported to be disintegrating rapidly, with leftist-led rebels controlling the streets and the local authorities powerless to stop them.

The ships and the Marines arrived off the coast in the predawn hours of 26 April and established contact with the embassy. Late that evening, the ready force was requested to begin the evacuation of Americans starting at first light the next day. Lieutenant Colonel Kleppsattel's helicopters were scheduled to conduct much of the lift.

Kleppsattel had been commissioned a second lieutenant in the Marine Corps in July 1945 and was designated a helicopter pilot on 12 October 1951. He had seen his first combat flying helicopters with VMO–6 in Korea. Subsequently he had served three years as a helicopter flight instructor at Pensacola and before assuming command of HMM–264 had been the operations officer for MAG–26. In the latter position he had instituted an expanded program of night and instrument flying, an effort that was to pay large dividends in Santo Domingo. By 1965 he had amassed almost 4,000 hours of flight time in helicopters and was one of the most experienced pilots in rotary-winged aircraft. To conduct the evacuation, he had 20 UH–34s and two UH-1Es. While there were two HR2Ss attached to the squadron, both were grounded by mechanical troubles.

On 27 April, the squadron lifted a total of 558 civilians from Haina, a small port several miles west of the city. Slightly more were loaded on two American ships in the harbor. The next morning the passengers on the *Boxer* were again moved, this time to the USS *Raleigh* (LPD 1). The ships with the refugees departed for San Juan, Puerto Rico, leaving the *Boxer* to stand by off Santo Domingo. She was needed. During the afternoon of the 28th, Ambassador William Tapley Bennett, Jr., who had been on leave when the rioting began and had just arrived back, relayed requests from the Dominican government to land Marine forces to help restore order. At 1820 they were ordered to go ashore. The *Raleigh* was recalled to the scene and arrived before midnight. The landing zone chosen for the assault was a large polo field on the western outskirts of the city. In the nearby Hotel Embajador—the largest resort hotel in the nation—there were additional refugees and more were arriving hourly.

USMC Photo A19949

UH–34s of HMM–264 land U.S. civilians evacuated from the Dominican Republic on the U.S.S. Boxer *(LPH 4) in April 1965. In one day, this squadron lifted 558 persons out of the revolt-torn nation.*

As night fell clouds formed "right on the deck" and rain began to fall. The training in night and instrument flight became the critical factor. Leaving coordination at the ship to his executive officer "and right arm," Major Thomas L. Spurr, Lieutenant Colonel Kleppsettel led a two-way shuttle of helicopters. On each trip from the ship to the polo field, the UH–34s lifted combat Marines. On the return they carried evacuees. Utilizing a tight diamond formation of four aircraft which Kleppsattel "had always flown in 264" the helicopters took off under radar control.* Unable to see the water or the land, they relied on instructions from the radar operators to bring them to the polo field. There they were guided to a landing by a "black box." This was a series of focused beams of light of different colors which were pre-set on a given angle in the air. A pilot could land by flying the angle indicated by the appropriate color. The return trip to the ship was just the opposite, with radar assistance for the landing.

Shortly before midnight all the Marines were ashore and an additional 684 refugees had been brought to the fleet. Starting before dawn the next day, HMM–264 continued to ferry supplies and equipment to the polo field and evacuate civilians.

At the same time, other units on the east coast had been alerted for movement to the Caribbean. One was HMM–263 at New River. The squadron recently had had a change of command. Lieutenant Colonel Truman Clark had taken over after being relieved in HMH–461 by Major Royce W. Watson. On 29 April, the *Okinawa* was ordered to proceed to a position off Onslow Beach and load BLT 1/2 and the helicopters. In addition to its normal complement of 20 UH–34s, Lieutenant Colonel Clark's unit was augmented with two UH–1Es from VMO–1 and two HR2Ss from his former command HMH–461. The *Okinawa* arrived at dawn 1 May and by late afternoon the embarkation was complete. The ship immediately departed at 21 knots for Santo Domingo and arrived in position the night of 4–5 May. HMM–263 took over helicopter operations, allowing the "Black Knights" of 264 to rest and to repair their aircraft.

The polo field had begun to take on the appearance of a miniature airport. There was a small concrete grandstand on the east side and the Marines had converted the space under it into a combined passenger and cargo terminal. Radios were mounted in the stands and assisted in controlling the constant arrival and departure of helicopters. Both squadrons kept a few

* Unlike fixed-wing aircraft formations in which each succeeding aircraft is slightly lower than the one ahead, helicopters fly slightly higher, to escape the down blast from the rotors and to increase the cockpit visibility of the wingmen.

USMC Photo A19485

UH–34s of HMM–264 lift in vehicles for Marine forces establishing positions in Santo Dominigo City, April 1965. The Marine aircraft operated from a polo field hastily converted into a landing field.

mechanics nearby to make emergency repairs of aircraft. To complete the scene, the Marines had erected a large, handpainted sign announcing the polo field as the home of "The Teenie Weenie Airlines. You call—we haul." [65]

Within the city there were constant clashes between Marine patrols and rebels. Sniper fire was always a hazard.[66] The Marine helicopters were a favorite target but the rebels' aim was poor and none had been hit. Then the snipers got lucky. Captain Thomas ("Tee Squared") P. McBrien was a pilot on one of the UH–1Es attached to HMM–263. The morning of 6 May he was ordered to fly over the city in an attempt to locate four civilian newspapermen who had been

caught in an ambush. With him were an aerial observer, First Lieutenant Richard C. Mittelstadt, and the crew chief, Sergeant Thomas Doyle. Sergeant Doyle reported hearing shots go by the aircraft. Almost immediately one penetrated the lower side of the UH–1E striking the pilot. Though painfully wounded, Captain McBrien was able to bring the helicopter to a safe landing at the polo field and was evacuated to the *Okinawa*.[67]

It was the only such incident experienced by the Marine helicopters. McBrien retains the dubious distinction of being one of the very few Marine aviators ever to become a combat casualty in the western hemisphere.*

Intense political negotiations had been going on since the first rioting. By the end of May a compromise solution had been agreed to and the situation became relatively stable. Soon military units from other nations of the Organization of American States were arriving to relieve the U.S. forces. Some Marine units now could be withdrawn.

First priority went to HMM–263 which was scheduled to be transferred to Okinawa in October and needed to return to New River as soon as possible to prepare for the move to the Pacific. Accordingly, on the afternoon of 26 May, the JCS directed the withdrawal of the *Okinawa* with HMM–263 and most of BLT 1/2 on board. The ship headed home as soon as the orders were received and arrived off Onslow Beach the morning of the 29th, after another 21-knot ride. Two weeks later HMM–264 and the *Boxer* left Santo Domingo to take up their normal ready force alert.

The operation in the Dominican Republic was the last test of Marine helicopters before they were fully engaged in combat. It had combined the hostile environment of SHUFLY, the sea-based mobility of Cuba, and the assaults from both land and sea of STEEL PIKE and SILVER LANCE. In retrospect it was much like a final examination before graduation. Most of the grades were good but at least one was marginal. The Dominican Republic confirmed the urgent need for a new generation of helicopters to replace the UH–34 and, particularly, the obsolete HR2S. The requirement, fortunately, had been recognized almost five years previously and by 1965 considerable progress had been made toward meeting it.

* Total casualties for Marine units were nine killed and 30 wounded.

CHAPTER THREE

INTRODUCTION OF THE TURBINES

More Lift Per Aircraft

The Marine Corps was faced with one inescapable fact. The total number of aircraft it could possess was strictly limited. The ceiling had been imposed by the Department of Defense and Congress. Since each aircraft required manpower, ships, bases, and operating money, control of the total number of aircraft was in effect control of expenditures in other areas. The limitation had been used as a vital tool of management of the military forces. Any attempt to increase the number resulted in a lengthy and often unsuccessful effort. Conversely, a decrease had been imposed often to reduce funds.

Within the ceiling, however, the Marine Corps had some latitude in deciding what types of aircraft would make up the total. Though it was not easy to do, the mix could be varied. The result was that as additional helicopters were necessary a corresponding number of fixed-wing aircraft often had to be deleted from the inventory—a move that was not universally popular with jet pilots. The same limit was a stumbling block to the introduction of large numbers of very small helicopters into the Marine Corps.

From 1952 to 1963 the total aircraft in the Marine Corps had remained slightly more than 1,050,[1] but in that period the makeup of the force had undergone a significant shift. Even more changes were planned. From a ratio of one helicopter to every five fixed-wing aircraft in 1952, the planned expansion of the helicopter program would result in an almost one-to-one ratio in 1967.

Even this increase in helicopters could not meet the almost insatiable demand for more vertical lift capability. Fortunately, there was another way to meet the requirements: improve the load-carrying capability of each helicopter.

The Turbine Engines

As installed in helicopters, much of the power of a conventional piston engine was expended just lifting itself. The figure varied somewhat between different models, but most reciprocating engines weighed approximately three pounds for each horsepower they could produce. Typically, the engine in the UH–34 weighed over 3,500 pounds but could develop continuously only 1,275 horsepower. Higher amounts, up to the maximum of 1,525, were restricted to short periods of time. As the size of a piston engine was increased, the weight to horsepower ratio remained about constant, but complexity and reliability became such problems that there was an effective limit to the amount of power. If the Marine Corps was to increase the payload capability of new helicopters, a different source of power would have to be found.

Small turbine engines, fortunately, were becoming available which had much different weight to horsepower ratios. The General Electric-built T–64–G–6 jet turbine could produce 2,270 horsepower continuously, was able to exceed 2,800 for short periods, yet weighed only 728 pounds.[2] Every improvement of the weight-to-power ratio was synonymous with additional lifting capability; hence, conversion from piston to jet engines for helicopters was extremely attractive to the Marines. Like so many other aspects of the development of helicopters, however, the introduction of turbine engines was not as simple a problem as it at first seemed to be.

The basic jet engine contains three main parts. Behind the intake is a large fan used to squeeze the air into a dense mass suitable for efficient operation. The compressed air is fed into burning chambers where it is mixed with fuel and ignited. The result is a massive expansion of hot air which is then directed out the tail pipe. Before leaving the engine the air passes through a turbine which captures some of its force and transmits it back to turn the compressor. The power of the engine is largely determined by the amount of air the compressor can deliver to the burning chambers and the amount of fuel available for combustion. The turbine simply drives the compressor.

In a conventional jet aircraft this is all that is necessary for operation. The hot expanding gasses ejected from the tail pipe provide almost all of the thrust.

The pure jet engine was not suitable for all aircraft. To take advantage of the light weight and large amounts of power which could be generated, in some designs a fourth element was added. An increase in the size and efficiency of the turbine allowed almost all of the power from the compressor and burning chambers to be captured and used to drive not only the compressor but also a gear box mounted on the extreme front of the engine. By converting the high rpm of the jet engine to a slower more powerful force, the gear box now could be used to turn a propeller. The result was a "turbo-prop" engine.

A few designs were given further modification. Instead of a propeller the gear box turned the rotor on a helicopter. When the American Helicopter Society held its 17th annual national forum in Washington, D.C. in May 1961, the members heard the latest developments in helicopter propulsion described:

> At first glance, the . . . turbine appears to be the answer to all helicopter pilots' nightmares, namely, the ability to maintain automatic main rotor rpm; and certainly in most regimes of flight [in small lightly-loaded helicopters] this may be true.[3]

But for most other helicopters all jet engines then available contained a serious flaw. The problem stemmed from two sources. Jet engines operate efficiently only when turning near their maximum allowable speed. The slightest decrease results in a large loss of power. In addition, most of the engines had the turbine and compressor solidly attached to the shaft which connected them. A gear box, if installed, was also fixed to the same shaft. In pure jets, turbo-prop aircraft, and even in small lightly-loaded helicopters this was not a particular disadvantage; but in a large heavily-laden transport helicopter, it could be disastrous.

As previously discussed, the rotor blades of a helicopter achieve lift by the square of the velocity of the air passing around them. To insure that sufficient lift was always available, most helicopters flew with their rotors turning as fast as aerodynamically practicable. Any change in direction of the aircraft was effected by changing the pitch—not the speed—of the blades. Occasionally a pilot inadvertently would allow the rotors to slow up (lose turns) and the aircraft would falter. If not immediately corrected, any further loss of rotor speed would cause the aircraft to enter an uncontrolled descent. The quick response of a piston engine over a wide range of power settings had salvaged many such situations.

In a turbine-driven helicopter with the rotor directly connected to the engine through the gear box, any such loss of turns also slowed the engine. Now the pilot faced a condition in which he needed maximum power to accelerate the rotor, but the engine could produce only a fraction of its full capacity. The more the pilot needed, the less was available. It could become a vicious circle.

The answer was to design a jet engine in which the turbine was not connected to the shaft. This would allow the compressor and burning chambers to operate at maximum efficiency independent of the rotor system. If more power was required rapidly, it would be available. The result was the "free turbine" or "gas-powered turbine" engine.

Two such engines were becoming available at the beginning of the 1960s. The Lycoming-built T–53 developed approximately 900 horsepower while the larger General Electric T–58 was rated up to 1,250 for short periods of time.

Even with free turbines, the problems of installing jets in helicopters were not completely solved. One of the most serious was foreign object damage (FOD) to the engine. As the compressor sucked in large amounts of air for the burning chambers, it did not discriminate about what else it picked up. Fixed-wing jet pilots long had become accustomed to the sight of motorized sweeper trucks scouring the runways and parking aprons to insure that no debris was lying about to be swallowed by engines which could be seriously damaged by a small stone or piece of metal. For helicopters landing in rocky fields, mountain tops, and small clearings in a forest, FOD was going to be a problem. David Richardson, Chief Systems Engineer of the Vertol Division, Boeing Airplane Company, presented his views at the same Helicopter Society forum in 1961:

> Foreign object damage with the helicopter turbine engine is becoming an increasingly significant item. The cost in terms of replacement parts . . . is large. As this paper was being written an engine . . . was removed from a Vertol test helicopter for foreign object damage after less than 60 hours of operation. This was the result of a large foreign object.[4]

He went on to describe a different type of FOD:

> There is another type . . . of foreign particle damage. [These] may be ice, salt water, sand, etc. They do not result in as rapid engine deterioration as caused by large objects, but they may be more costly in that more [of the engine] may be damaged.[5]

He also noted that recently Bureau of Weapons (BuWeps) had begun including specifications for air filters in new helicopter jet engine designs. Richardson concluded that Vertol was working on a filter but

needed more information about the effect of sand and grit from the manufacturers of the engines.

Other difficulties challenged the designers. While in a fixed-wing aircraft, the engine was always in a position to receive ample quantities of air, the effect of a helicopter flying sideways or backwards had to be considered.* No matter where the engines were placed on the aircraft, the down wash from the rotor would affect the air surging into the inlet. The results required careful testing. The vibration resulting from the articulated rotor heads was a new factor to any jet. "An engine which has thousands of hours of test time may not withstand the helicopter vibration unless it was designed and tested . . . to the stresses it will be subject to", one report said.[6]

The introduction of turbine engines in helicopters was not just a matter of putting a jet on an existing aircraft. It required a major engineering and design effort and lengthy testing. Enough progress had been made, however, that by 1962 the Marine Corps was about to have jet-powered helicopters.

The "Huey"

> The proposed replacement for both the HOK and the OE in the VMO squadrons . . . has really been a yo-yo project, alternately being in and out of approved plans, programs and budgets. Again, however, I am happy to state that it is "in."
>
> Colonel Keith B. McCutcheon
> Director of Aviation
> 18 January 1962[7]

A replacement for the OH–43s had become enmeshed in a difference of opinion as to just what was the mission of the aircraft. One view held that there should be a new aircraft fully configured for observation purposes to replace the O-1s in the VMO squadrons, and a distinctly different type of aircraft for assault support. This position was centered at the Marine Corps Schools at Quantico commanded by Lieutenant General Edward W. Snedeker. A veteran of almost every major campaign in the Pacific from Guadalcanal to Okinawa in World War II and of the Chosin Reservoir in Korea, General Snedeker had been awarded both the Navy Cross and the Silver Star for heroism.

General Shoup, however, insisted that a single type of aircraft, an assault-support helicopter (ASH), could replace both the OH–43s and the O-1s. Attempts to procure either—or both—of the new aircraft were consistently frustrated by performance deficiencies of models proposed by manufacturers or by funding difficulties. By 1960 the continued deterioration of the OH–43s added urgency to finding a suitable new helicopter. General Shoup restated his policy in August that year in a letter to General Snedeker:

> The number one procurement priority in the light observation area is assigned to ASH . . . No new evaluations . . will be commenced until the ASH is programmed and funded.[8]

General Snedeker still held out for two. The ASH could replace the OH–43, but a short takeoff and landing (STOL) attack reconnaissance aircraft to replace and expand the present mission of the O–1s was also needed. General Shoup was not to be swayed and in February 1961 wrote that until "the Assault Support Helicopter is on track, no other light observation type aircraft will be considered".[9]

Difficulties in procuring the replacement aircraft were not confined to the Marine Corps. In September the Deputy Chief of Naval Operations (Air), Vice Admiral Robert B. Pirie, summed up the frustrations of the previous months in a letter to Rear Admiral Paul D. Stroop, Chief of the Bureau of Naval Weapons. Admiral Pirie pointed out that in March he had suggested that "a limited competition be conducted [by BuWeps] to select an aircraft to fulfill the Marine Corps ASH mission."[10] In the same letter he had assured Admiral Stroop that:

> . . . once a satisfactory selection and model evaluation has been made, that every effort would be expended to effect necessary reprogramming of funds within the FY 62 budget to permit the accelerated purchase of the operational vehicles.[11]

BuWeps had indeed conducted an evaluation. "Representatives of the Bureau of Naval Weapons presented the results of the preliminary study of those helicopters under consideration for selection of the assault support helicopter." Admiral Pirie complained that:

> . . . no recommendations were made as to the aircraft best suited to the mission or the most appropriate course of action to be followed in conjunction with an orderly procurement program. Each model reviewed failed to qualify under the recognized guidelines because of one or more deficiencies such as size, cost, capability or lack of qualifications.[12]

"It became apparent," he wrote, "that compromises must be made in regard to funding considerations and aircraft selection." [13]

The crux of the matter was that in August Admiral Stroop had requested CNO to provide 5.1 million dol-

* Long a problem almost exclusively in helicopters, the effect of air not entering directly from the front of the engine was the cause of the cancellation of the first trans-Atlantic flight of the giant Boeing jumbo jet—the 747. While waiting for takeoff on 21 January 1970, the wind was blowing from the side. The designers had not taken this into consideration for so large an engine. It overheated and the plane had to return to the terminal—precisely the problem facing helicopters 10 years earlier.

lars for procurement before BuWeps even would request manufacturers to propose the modifications to their helicopters which would make them compatible with the stated requirements of the Marine Corps. Admiral Pirie pointed out that the "CNO cannot receive Congressional Committee approval of funding support for the ASH requirement without selection (first) of a specific model." [14]

To solve the "chicken before the egg" dilemma, he suggested that:

> In the selection of a suitable helicopter, the element of time is of paramount importance. It may well be in the best interests of the service to accept the burden of increased size and cost of an operationally qualified model rather than gamble on a reduced capability or a possible lengthy and costly development program. In such cases, additional potential of such a vehicle in the role of a trainer or light utility vehicle might well be considered.[15]

Admiral Pirie reassured Admiral Stroop that funding could be arranged only if BuWeps would go ahead and select a type of helicopter. The OH–43s rapidly were approaching the end of their usefulness and the "imperativeness of positive action leading to a solution of this increasingly critical subject cannot be overemphasized." [16]

The admiral had made his point. On 16 October, BuWeps solicited bids from 10 different manufacturers for an assault support helicopter for the Marine Corps. Seven responded.[17] *

The original development characteristic (specifications) published on 29 July 1960, had called for an ASH with a total weight of 3,500 pounds, a payload of 800 pounds or three troops, and a cruising airspeed of 85 knots. There was also a long standing requirement "for the provisioning of all helicopters with the necessary attachments for carrying, either internally or externally, of the maximum numbers of canvas litters practicable, such installations not to jeopardize the primary mission of the helicopter." [18]

The aircraft envisioned was similar to a requirement established by the U.S. Army. If both services could procure a single type, costs could be lowered. Even after BuWeps had published the desired specifications, conversations continued with the Army on their need for a light observation helicopter (LOH). Hiller, Bell, and Hughes all had submitted designs but there were too many differences between what the Marine Corps wanted (including carrying litters) and what the Army desired. The Marine Corps indicated "no immediate interest in the proposals to the Army for a LOH." [19]

Evaluation of the seven proposed designs for the ASH continued into the spring of 1962. On 1 March the selection was approved by the Secretary of the Navy and the next day a public announcement was released that the winner was a slight modification of the Bell Helicopter Company's UH–1B. The U.S. Army had procured several hundred of these helicopters and they were already in action in Vietnam. The designation of the Marine Corps version would be UH–1E—soon shortened to "Huey."

Bell had experimented with tandem-rotor helicopters providing additional speed up to the maximum of 120 knots. Due to its small size and rotor design, stabilization of the UH–1E did not require elaborate electronic systems, though several were tested.[20] Sufficient stability could be achieved by mechanical devices. One characteristic of the airplane not universally appreciated at the time was its extremely low silhouette. It was only 12 feet high and the cabin was even lower.

The adoption of the UH–1E did not still all the doubts previously expressed by some Marines. Of particular concern was that the visibility from the aircraft appeared much less than from the OH–43. Colonel Marion E. Carl, who had become the Director of Aviation in February 1962, decided to prove how well a commander could observe from the UH–1E. Colonel Carl, one-time holder of the world's speed record, commander of the first tactical jet squadron in the Marine Corps, World War II ace, and recipient of two Navy Crosses, arrived at the NATC at Patuxent River on a Saturday morning.

One of the aircraft utilized by BuWeps to evaluate the UH–1s had been retained by the center for further

USMC Photo A412088

The UH–1E was the first turbine-powered helicopter assigned to Marine tactical squadrons.

* The seven were Bell, Hiller, Kaman, Lockheed, Piasecki, Republic, and Sikorsky. The three not responding were Cessna, Gyrodyne, and Doman.

testing. This helicopter, a UH–1B, was on loan from the U.S. Army. A few days prior to the arrival of Colonel Carl, a truck had backed into the short wing attached to the tail pylon. The stabilizer was damaged beyond repair and there was insufficient time to order a replacement. Across the Potomac River at Fort Belvoir, the Army had a number of UH–1As. A stabilizer was produced and hastily bolted onto the helicopter at Patuxent River.

There was one small problem. The improvements made between the UH–1A and UH–1B included a change in the stabilizers, and the one from Fort Belvoir was only half the size of the one left on the aircraft. Colonel Carl did not seem to be dismayed when he arrived and discovered that the aircraft was decidedly lopsided. He got in the helicopter, along with a test pilot attached to NATC, Marine Captain David A. Spurlock, and took off heading for Washington. The weather was poor with low clouds and intermittent rain. By following highways they soon arrived at the helicopter pad in front of the Pentagon.[21]

There they were met by a delegation of Marine officers, including the Deputy Chief of Staff for Research and Development, Brigadier General Bruno A. Hochmuth. Colonel Carl got out and invited General Hochmuth to get in. He then turned to Captain Spurlock and said, "Show the general how good the visibility is at 3,000 feet." [22] By now the weather had become worse. After a short flight at tree top level to avoid the clouds, a small opening was found and the General and his pilot found themselves evaluating the visibility. The opening, unfortunately, had disappeared. While they were at 3,000 feet, they could see nothing but solid clouds. Later and under better circumstances, the visibility from the UH–1E was found to be excellent and the program was continued.

A total of 72 operational aircraft were required to bring the VMO squadrons up to full strength, replacing both the O–1s and the OH–43s on a one-to-one basis with UH–1Es. The first step was the procurement of four additional aircraft to test fully the modifications from a UH–1B. By October $1.5 million had been provided for the program.[23]

The differences between the Army and Marine Corps versions appeared slight but each was vital if the UH–1E was going to fulfill its role in amphibious warfare. The most important was the installation of rotor brakes. This device was unnecessary when operating from wide open fields and few military or civilian helicopters had them. The major exceptions were the Maine Corps and the Navy. With plenty of room and time, a pilot could shut off the engine of his aircraft after landing and let the rotor slowly wind down to a stop. On the crowded flight decks of amphibious ships this was impossible. The helicopter had to be landed and the rotor rapidly stopped so that the machine could be moved to a parking area to make way for the next one about to come aboard.* Even when flight operations were not being conducted a rotor brake was essential for shipboard operations. As the ship steamed through the water, the wind over the deck often would be sufficient to cause the rotor blades to spin unless locked securely. The Bell solution was a simple brake disk on the main transmission which could be hydraulically activated.

The UH–1E also had to be equipped with radios and communications compatible with both the air and the ground forces. This in turn required that the electrical system of the aircraft be converted from the standard Army direct current to the Navy and Marine Corps alternating current.

The only other significant difference was that much of the UH–1E was constructed of aluminum. Most helicopter designers previously had relied on magnesium to fabricate parts of a helicopter, since the lightness of the metal improved the payload capability of the aircraft and more than compensated for magnesium's inflammability (illumination flares usually are made of magnesium due to the ease of ignition, rapid burning with bright light, and the ability of the metal to burn even under water) and tendency to corrode when exposed to salt air or water. If this corrosion was not halted, the metal soon disintegrated into a pile of white dust. On board ship mechanics constantly had to paint and clean every portion of a helicopter made of magnesium.

By constructing the helicopter of aluminum, much of the problem with corrosion was eliminated. The difference in construction, indistinguishable from previous UH–1s, represented a major improvement in helicopter design. The use of heavier aluminum was possible only as a result of the increased weight/horsepower ratio of the turbine aircraft.

Events moved rapidly once the program was approved and funded. In October even before the four test aircraft had been delivered, funds for the first 30 production models were approved.[24] By the end of January 1963, the aircraft was ready for its first inspection. The configuration engineering inspection (CEI) was a final check to insure that the helicopter was designed as specified. On hand was Colonel George

* During the May 1965 Dominican Republic crisis, a company of U.S. Army UH–1s was rushed to the scene on board the USS *Guadalcanal*. The lack of rotor brakes required crews to physically catch the blades to bring them to a halt. There were numerous minor injuries from unsuccessful attempts and the loading was considerably delayed.

L. Hollowell, the UH–1E program manager for BuWeps.[25] The aircraft passed the test without difficulty.

The aircraft was then turned back to the manufacturer for avionics and structural testing. Bell completed all the required work on 30 July. The next month the helicopters were delivered to NATC Patuxent River for final trials by the Board of Inspection and Survey (BIS).[26] The evaluation concluded on 10 and 11 December as the UH–1E completed carrier qualifications on board the USS *Guadalcanal* (LPH 2).[27]

Ceremonies at the Bell plant in Fort Worth on 21 February 1964 marked the delivery of the first UH–1E to a Marine tactical squadron. Accepting the helicopter was Colonel Kenneth L. Reusser, commanding officer of MAG–26 and winner of Navy Crosses both in World War II and Korea. Also on hand was the commanding officer of VMO–1, Lieutenant Colonel Joseph A. "Jumpin' Joe" Nelson.[28] The first UH–1E arrived at New River four days later. The schedule called for two additional aircraft to be delivered in March and three each month thereafter.[29] By now the order had grown to over 100 helicopters and almost 15 million dollars.[30] General McCutcheon's yo-yo had finally stopped and a replacement for the aging OH–43s and O–1s was on the way.

Replacement for the HUS

The search for a replacement for the OH–43 was not the only program to be plagued with delays and disagreements. The process of selecting a successor to the UH–34 encountered similar difficulties.

Though the UH–34 was procured only as an interim helicopter in the late 1950s it remained the backbone of Marine vertical lift capability. In 1957 Sikorsky engineers were working on a new model for the Navy. This helicopter would replace the SH–34s utilized for anti-submarine warfare. Designated the HSS–2 (Helicopter, anti-submarine, Sikorsky) (HS–3 under the unified designation system) it was to be powered by two General Electric T–58 free turbine engines, each of which could develop up to 1,050 horsepower. To provide for emergency landings in the water the lower portion of the fuselage was watertight similar to a boat hull. It had a large door on the starboard side of the cabin, a factor that was to have special significance for the Marine Corps.

General Randolph McCaul Pate, Commandant of the Marine Corps, wrote the CNO on 9 January 1958 requesting procurement of modified HSS–2s to replace the UH–34s. In his letter he pointed out the problems of developing helicopters:

USMC Photo A402599

General Randolph McC. Pate, 21st Commandant of the Marine Corps, began the process of securing a replacement for the UH–34.

> The Marine Corps concept for amphibious operations is characterized by the utilization of helicopters to give the amphibious attack increased depth, speed, mobility and flexibility.
>
> Implementation of this concept has progressed somewhat slower than anticipated, particularly in the achievement of a helicopter modernity program.[31]

He went on to point out that the HUS (UH–34) procurement:

> . . . through 1961 falls considerably short of the Marine Corps requirement. In order to satisfactorily alleviate this condition it is requested that a transport version of the HSS–2 which is considered the logical replacement for the present light assault helicopter, be programmed and budgeted for the Marine Corps in

sufficient quantity to operationally support a total of 210 helicopters during the 1962–1966 time frame.[32]

General Pate recommended that the transport version of the HSS–2 be designated the HR3S (Helicopter, Transport—3—Sikorsky). The plan envisioned conversion of all six transport and three composite squadrons then in existence from the HUS–1 to the HR3S. No other aircraft was seriously considered for "at this time there appeared to be no other helicopter available which was competitive with it from either cost or technical viewpoint." [33]

Funds for aircraft procurement were short in 1958 and progress on the design of the HR3S was slow. Then, on 29 March 1959, the HSS–2 made its first public flight.[34] Interest in the assault transport version was rekindled. In July 1959 General Pate requested CNO to provide for a full-sized model of the HR3S as soon as possible.[35] This "mock-up" could be utilized to inspect the proposed changes from the anti-submarine version. It was not until November that the Bureau of Aeronautics responded that until a contract had been awarded for the production of the HR3S no funds could be made available for a mock-up.[36]

In the meantime, a careful review of what modifications were desirable was being conducted within the Marine Corps. Of particular importance was the door on the side which had to be used for troops and cargo. Such a configuration would make it difficult to load small vehicles. If a ramp, similar to that installed in the HR2S, could be included in the HR3S, access to the cabin would be improved. Due to the basic design of the HSS–2, a ramp—if adopted—would have to be in the rear of the cabin and would require a significant redesign of the helicopter.

Not all Marines were convinced that such a method of loading was necessary. In August the Marine Corps Landing Force Development Center reported that:

> [The rear ramp] . . . appears to warrant little consideration since our tactics and techniques are emphasizing the use of external loading with the automatic release cargo hook. This leads to the conclusion that the ramp for internal loading is of small and occasional value. This is particularly true when it is recognized that design investigation for including a ramp, and its design and test will considerably extend the time when new machines could be made available to the FMF.[37]

Not only might it not be necessary to modify the side door but even the watertight boat hull of the standard HSS–2 could prove to be an advantage. MCLFDC proposed loading the helicopters in the well decks of amphibious ships. On reaching the objective area, the deck could be flooded, the aircraft floated out, and the blades unfolded. Sea-based helicopters could be used to augment the capacity of the few LPHs then available. MCLFDC did admit that "launching techniques in an open sea condition would have to be evaluated by extensive testing under operational conditions." [38]

As refinements in the design of the HR3S progressed, General Pate continued to press for a mock-up. In November he again requested CNO to provide the necessary funds. This time he was successful and BuWeps was directed "to proceed with the mock-up as expeditiously as possible." [39] On 1 February 1960, $50,000 was provided to "proceed immediately with all actions necessary to complete the mock-up by 15 June." [40]

Guiding the efforts to procure a replacement for the HUS was the Director of Aviation, Major General John C. Munn, a pilot since 1930 and a veteran of the Guadalcanal campaign in World War II. On 1 December 1959 just two weeks before he was promoted and appointed Assistant Commandant of the Marine Corps, he summed up the progress attained in improving the vertical lift program:

> Tentative programmed procurement (is) 70 HUS per year through 1965. Funding support for the HR3S is scheduled during the FY 62 budget cycle with a buy of ten aircraft. Subsequently, the HR3S is included at a rate of 60 per year. This will likely result in an enforced compensatory reduction in the HUS procurement. A mockup of the assault version of the HSS–2 will be conducted in the near future and detailed specifications are in the final draft form.[41]

The officer who replaced General Munn as director of Aviation was Major General Arthur F. Binney. Among his many decorations gained in almost 30 years in the Marine Corps, General Binney was one of the few Marine aviators still on active duty who had been awarded the Nicaraguan Cross of Valor. He had won it in 1932 for frequent flights over dangerous terrain to rescue a detachment of Marines who had become lost in the jungle.

One of his first acts was to publish further information on the HR3S. The design now called for rear ramp loading and a modified hull to permit safe operations in rough water. General Binney calculated that the new helicopter would be capable of lifting up to 23 fully-equipped combat troops, have a speed over 125 knots, and be fully compatible with the LPHs. By utilizing the basic design of the HSS–2, the new assault helicopter would:

> . . . insure a stable long range production run, minimizing the training problem, simplification of logistic support and a unit cost savings to the government which would not be possible had a new development been undertaken to fulfill this requirement.[42]

He concluded that the HR3S "is a prime program" and asked for "support whenever possible and feasible." [43]

Detailed specifications for the new helicopter were published by CNO on 7 March 1960 as Development Characteristic No. A0 1750–2. The document was a further refinement of one published the previous March. Four items were of special significance. A rear loading ramp was to be included, the fuselage was to be capable of landing in water, the helicopter "must be ready for operational evaluation by 1963," and "It is anticipated that the requirements stated in this Development Characteristic will be met by modification of a helicopter that has already been developed." [44] The development characteristic accurately described only the HR3S among aircraft available at the time.

While the design of the assault transport version was in final review, the HSS–2 was being tested by NATC at Patuxent River. Problems were encountered. The helicopter lacked the desired stability. More disturbing, the main transmission was limited to 2,000 horsepower, even though at peak power the engines could produce more. In the event that more powerful engines could be procured in the future, for them to be installed in the HSS–2 would require extensive—and expensive—alterations to the transmission and drive shafts.[45] Finally, Sikorsky engineers were having difficulty modifying the HSS–2 to provide a rear ramp for vehicles. On 29 June they reported that to give the aircraft the necessary balance, the forward fuselage would have to be extended 30 inches. This would take additional time.[46]

Sikorsky's difficulties did not go unnoticed by other manufacturers. In July 1959, before the selection of the HR3S, Vertol Aircraft Corporation had given presentations at Quantico and at HQMC on one of their new models, the 107A.* [47] This helicopter was designed primarily for civilian use. While it had two free turbine engines it had neither a rear ramp nor a blade-folding mechanism. Thus it could not meet all the desired specifications. The 107 was based on an earlier model, the YHC–1A, three of which were procured by the U.S. Army for evaluation.[48]

The Army model more closely met the specifications and had a rear ramp, though its blades would not fold. However, it was still experimental. The basic design would have to be a proven one before the Marine Corps would indicate much enthusiasm. The scars and disappointments of designing and producing a helicopter from the ground up, such as the "Deuce," were still vivid memories.

In late March 1960, with Sikorsky engineers still wrestling with problems in the HSS–2 and designing a ramp for the HR3S, Vertol dispatched a YHC–1A to the Landing Force Development Center at Quantico. Six experienced helicopter pilots conducted short orientation flights and recorded their observations.

Lieutenant Colonel Victor A. Armstrong, later Major General, flew the aircraft from the plant at Philadelphia to Quantico. He described it as "handling very nicely, with control forces being light and appear adequate for all flight attitudes. The stability augmentation system (SAS) is a fine addition to the control system." [49] Lieutenant Colonel Armstrong added that if the Marine Corps were to consider procurement of the YHC–1A, modifications would have to be made to the ramp area. A jeep could fit inside the fuselage but would not clear the doors over the ramp.

Another pilot who expressed enthusiasm was the Quantico Air Station comptroller, Major Fred M. Kleppsattel (who would command HMM–264 during the Dominican Republic crisis in 1965). He already had amassed 2,360 hours of helicopter flight time. He reported that the center of gravity limitation in a tandem configuration such as this aircraft was 60 inches—far superior to a conventional single main rotor helicopter.[50] (The first helicopter procured by the Marine Corps, the Sikorsky H035, had a center of gravity limit of exactly 3.78 inches.) The four other pilots were equally impressed and all reported that the aircraft had excellent potential as a replacement for the HUS.*

A week after the demonstration, on 8 April 1960, Brigadier General William R. Collins, Director of the Landing Force Development Center, forwarded the comments of the pilots and his own analysis to the Commandant. General Collins had just been promoted and had moved from President of the Tactics and Techniques Board to take command of the center. A survivor of the USS *New Orleans* at Pearl Harbor on 7 December 1941, he later would have command of the Marine ground forces at Guantanamo Bay, Cuba during the first critical eight weeks of the 1962 missile crisis. He said,

> It is understood that present plans are to replace the HUS with the HR3S, beginning sometime during the 1962–1963 period. Before the procurement plans for the HR3S reach fruition, I believe we should run an evaluation of its most serious competitor, the Vertol YHC-1A, a forerunner of the Vertol 107M. The 107M has been

* The original Piasecki Aircraft had been reorganized in 1956 into Vertol Aircraft Corporation, The name was derived from *VER*tical *T*ake *O*ff and *L*anding.

* The four were: Majors James W. Ferris, Lloyd J. Engelhardt, and Joseph L. Freitas, Jr., and Captain Guy R. Campo.

proposed by the manufacturers as an HUS replacement.[51]

After repeating information he had received about the difficulties being encountered by the HSS–2 and emphasizing the findings of the six pilots who had flown the YHC-1A, General Collins concluded that "It is therefore recommended that CNO be requested to conduct a complete test, evaluation, and comparison of the YHC-1A with the HSS–2 before a final decision is made for a follow on helicopter to replace the HUS." [52] General Snedeker in his endorsement agreed that an evaluation would be "of valuable assistance in expediting further development and procurement in the event the HSS–2/HR3S fails to measure up to specifications." [53]

BuWeps did not share the enthusiasm of General Collins. On 4 May it outlined its position to General Binney and proposed to proceed with the development of the HR3S.[54] This information was followed on 7 June 1960 by a presentation by BuWeps to General Shoup. The Navy concluded that "in all these proceedings, the HR3S–1 was shown to be significantly cheaper in total program cost and to have obvious logistic and training advantages. The Vertol 107M, [however], was presented as being fully as adequate technically as the HR3S–1 to accomplish the assault mission." [55]

General Collins was not to be dissuaded. On 1 July he again submitted his side of the issue and disputed the presentation by BuWeps. He continued to press for obtaining one or more 107s for a comparative evaluation.[56]

On 3 June, Vertol requested BuWeps to allow it to submit proposals for a replacement for the HUS. During conferences that month, Vertol was assured that it would receive full consideration for its 107M. The company then requested an opportunity to present a number of demonstrations and analyses for evaluation purposes within a three-month period.[57] Much of the rest of the summer was spent by both manufacturers strengthening their arguments as to why their particular model was best for the Marine Corps. On 8 September, BuWeps notified General Shoup that it no longer opposed the position first put forward by General Collins and that it "would secure competitive proposals from Sikorsky and Vertol." [58] Until the evaluation of the two aircraft had been completed, further work on the mockup of the HR3S was halted.[59]

In view of now having two different models competing for the contract, in October the Commandant directed General Collins to review a revised Development Characteristic. It was subsequently published as AO 17501–3 and called for the new aircraft to be ready for operational evaluation by 1 July 1964, one year later than had been originally scheduled.[60]

Between 9 and 17 February 1961, Admiral Stroop reviewed the different proposals. His task was not easy, for "It was through strong and persistent persuasion by Marine aviation that Vertol was selected over Sikorsky which had been the 'front runner' for a considerable period of time." The admiral recalled:

> . . . Sikorsky, of course, had a head start and . . . was favored by the Bureau Evaluators; however, the Marines persisted in their recommendation for Vertol, the CH–46, and since they were to be the operators and users of the aircraft, their recommendations had to have considerable weight and it . . . resulted in obtaining the CH–46 helicopter to be manufactured by Vertol.[61]

On 17 February, Admiral Stroop informed the Assistant Secretary of the Navy for Materiel, Kenneth E. Belieu, that the Marines had prevailed and that the recommendation was to purchase the CH–46. Belieu agreed with the choice.[62]

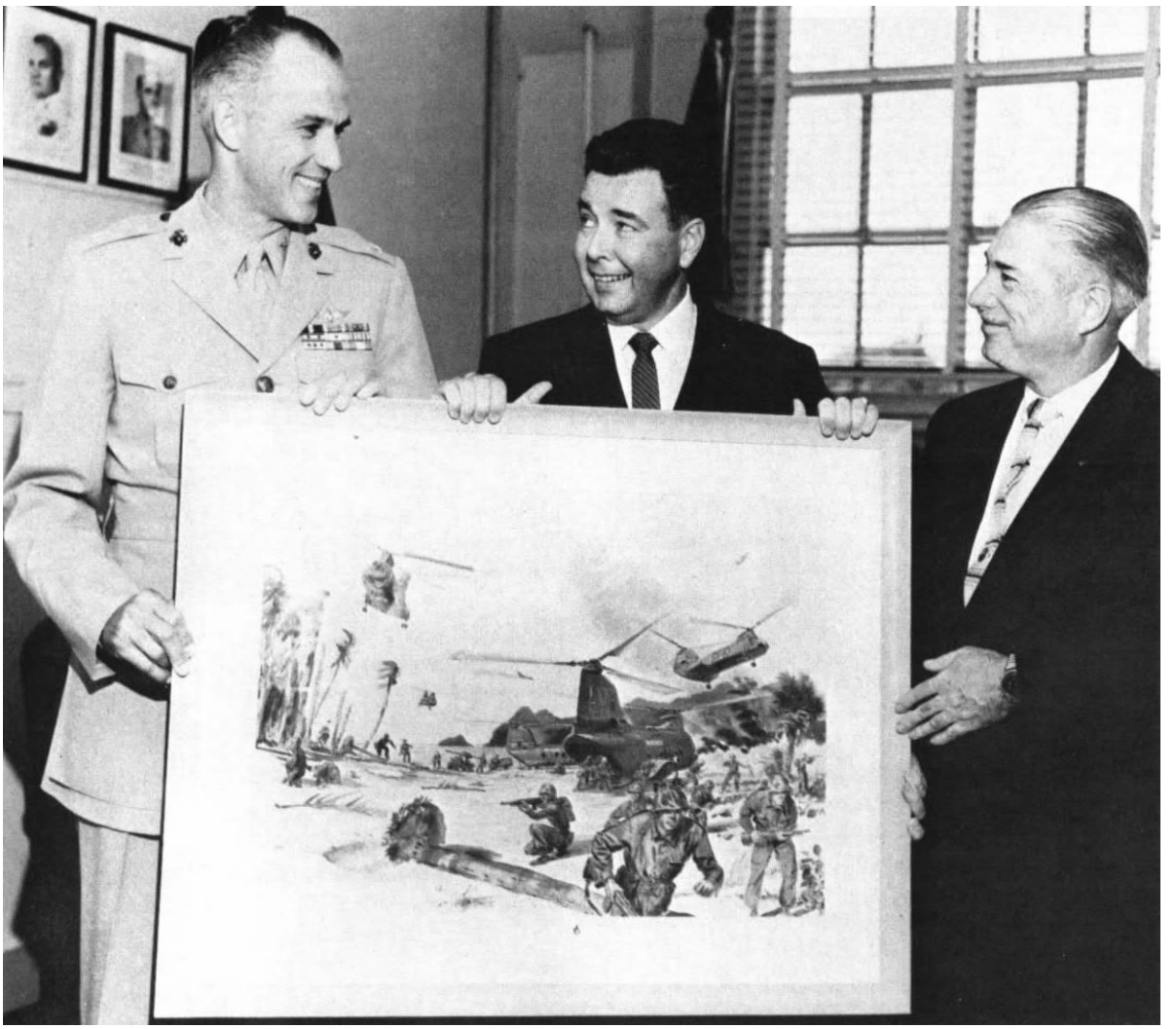
Late in the afternoon of 20 February, Admiral Stroop made two long distance telephone calls. The first one was to Lee Johnson, General Manager of Sikorsky Aircraft. Stroop advised Johnson that "Vertol and not Sikorsky had won the HRX competition and that a press release would be issued in a few minutes," at 1730 Washington time. The second call was made to Don Berlin, Vice President and General Manager of Vertol Division, Boeing Airplane Company.* After informing him that Vertol had won the competition, Admiral Stroop extended his congratulations.[63]

Stroop now had to obtain official acceptance of the contract offer from Secretary of the Navy Fred Korth. Belieu wrote a letter giving the rationale for the decision:

> The choice as to the prime contractor is sound on the basis of operational requirements, technical characteristics (Vertol far excels Sikorsky in this field) and cost wise. As far as cost is concerned our long-range program contemplates 194 aircraft at a total cost of $271 million. By year, the approximate breakdown is as follows:
>
> 14 helicopters in the '62 buy.
> 60 for each year thereafter.
> On the basis of the estimated cost per lot, Vertol is about $2.5 million lower.[64]

Admiral Stroop personally carried the Assistant Secretary's recommendation to the office of the Secretary of the Navy, "with the thought that I would obtain immediate approval." Stroop felt that quick ap-

* The original Vertol Aircraft Company had been purchased by Boeing. In May 1961, Boeing Airplane Company changed its own name to The Boeing Company.



USMC Photo A410548

Colonel Marion E. Carl, Deputy Chief of Staff (Air), receives a painting from representatives of Vertol Division, The Boeing Company, in June 1962, on the occasion of Marine Corps acceptance of the Vertol aircraft as the new medium transport. Colonel Carl was one of the first Marine helicopter pilots, having learned to fly them in July 1945.

proval was important for two reasons: 'First, we had already experienced considerable delay while Vertol was catching up with Sikorsky; and, in addition, we had a very good price offer from Vertol which would expire in just a few days." The admiral pointed out that the lower price of the Vertol offer was about to expire and advised Secretary Korth that "if he would simply initial the recommendation for Vertol I would carry it back to my office and the procurement would be under way." [65]

For once the Navy was not going to have difficulty in obtaining timely release of the funds required for the initial purchase of helicopters for the Marine Corps, for even as Admiral Stroop and Assistant Secretary Belieu were recommending Vertol as the winner of the competition, they were discussing methods to provide the company with procurement funds ahead of schedule. The first 14 aircraft normally would have been purchased with $21.8 million of FY 62 funds which would not have been available until 1 July. BuWeps, however, had $14.5 million left from FY 61 programs and proposed that it be released to Vertol as soon as possible to take advantage of the low-cost contract.[66]

Apparently unknown to the Marines or Admiral Stroop, two weeks before the recommendation was delivered to Secretary Korth, on 2 February, President Kennedy had ordered all the military services to explore ways to expedite contracts to manufacturers located in areas of high unemployment.[67] The Vertol manufacturing plant was located in Morton, Pennsylvania, a suburb of Philadelphia, and could qualify for the President's program. It was surprising to Admiral Stroop, then, that when he asked Secretary Korth to initial the contract immediately, "the Secretary decided that his staff should study the problem further and to my considerable disappointment, did not give his final approval until after Vertol's offer had expired." The helicopters built at Morton would carry the higher price tag.[68]

The CH–46

Both the YHC–1A and the Model 107 were based on earlier designs by Frank Piasecki. He had considerable success utilizing two main rotors mounted in a tandem (one on each end of the aircraft) configuration. Since the rotors turned in opposite directions, lift was partially equalized on each side of the aircraft and there was no need for an anti-torque rotor.

The redesign of the 107 into what was originally called the HRB–1 (Helicopter, Transport, Boeing) for the Marine Corps required major modifications. The most pressing one was to install a rotor blade folding mechanism. Without it the helicopter could not operate from amphibious assault ships.

This modification was not an easy task, for the basic 107 design had fully-articulated rotor heads. Thus any addition of weight for a blade fold system would require major revisions of the entire rotor. These modifications in turn would make it necessary to strengthen the transmissions and those parts of the fuselage to which they were attached. Vertol, however, was successful in designing an electrically operated system in which the blades from both the forward and aft rotor heads folded inward and were stored above the center of the aircraft.

The second problem revolved around what Lieutenant Colonel Armstrong noted on the initial orientation flights of the YHC—1A at Quantico. The rear ramp and doors had to be increased in size to permit entry of a jeep. Such change required careful engineering, for the fuselage of an aircraft is much like the shell of an egg. As long as the shell is fully intact, it retains a remarkable amount of strength for its weight. But if a hole is cut into the shell, the strength is quickly lost. Any widening of the rear door would have to be compensated for by greatly increasing the strength of the surrounding fuselage.

The final problem was that new models of the T–58 free turbine were to be installed which could produce more power than the ones in the 107. The greater power was certainly desirable, but it required even more redesign. Most critical were the drive shafts from the two jet engines to the main transmission. These "high speed" shafts had to be balanced precisely. At the speed they were turning, the slightest vibration would create massive strain on the aircraft. All helicopters were subjected to vibration, particularly from a fully articulated rotor head, but the large and relatively slow bumps and thumps from such a source while uncomfortable, did not seriously affect the aircraft. High frequency vibration was another matter for the stress produced was determined by the square of the vibration.*

The engineers at Vertol had their work cut out for them. What finally emerged on 30 April 1962, when the Navy accepted the first aircraft for testing, superficially resembled the YHC–1A and the 107 but was basically an entirely new helicopter.

The CH–46, as the HRB–1 was known under the unified designation system, had two 50-foot, contra-rotating rotors mounted on pylons, directly over the cockpit and the extreme rear of the aircraft.[69] The rotors overlapped each other at the center of the aircraft for a distance of 16 feet. To prevent the blades from striking each other in this overlap area, the two rotors were interconnected by a carefully geared drive shaft.

With the blades folded for movement on the deck of an LPH, the aircraft measured slightly less than 45 feet long and 15 feet wide. With them extended, the aircraft was 83 feet long. The cargo compartment had no obstructions throughout its 24-foot length to hinder the entry of vehicles and troops. It was almost perfectly six feet square. This clean cabin was made possible by the use of small stub wings or sponsons attached to the outside of the fuselage. They doubled as fuel tanks and mounting points for the main landing gear. The sponsons also added stability if the aircraft were landed in the water, for which provisions had been incorporated.

When viewed from the side the CH–46 had two very distinct features. The nose landing gear was much longer than the main ones and gave the aircraft the appearance of squatting down to the rear with the rear tail pylon towering over the rest of the aircraft.

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* For those engineering minded, the formula is: G (Forces produced) = K (a constant) × F (frequency)^2 × A (amplitude).

USMC Photo A411784

The CH–46A became the replacement for the UH–34. This aircraft is lifting a 1,780-pound "Mighty-Mite" vehicle on its 10,000-pound-capacity external cargo hook.

In the aft pylon were both General Electric T–58–8B free-turbine engines and the main transmission. Each engine was connected to the transmission through other gear boxes by individual high-speed drive shafts. Another shaft was placed outside, along the top of the fuselage, and connected the front transmission to the one in the rear. Also in the pylon were the auxiliary power unit (a small jet engine which provided electrical and hydraulic power when the rotors were not turning) and other accessories required by the aircraft. To solve the problem of the bulk of the basic machinery of the aircraft being located directly above the enlarged hole in the egg shell created by expanding the opening for the ramp, the Vertol engineers designed what was essentially a shelf extending rearward from the back of the cabin over the ramp doors. The engines, main transmission, and other equipment were mounted on this platform.

Empty, the CH–46 weighed 11,641 pounds and with 2,400 pounds of fuel and a crew of three was designed to carry either 4,000 pounds of cargo or 17 combat-equipped Marines. Under emergency overload condition, the cargo capacity could be increased to almost 7,000 pounds.[70] Its top speed was 137 knots.

A helicopter which had undergone such an extensive redesign of almost all critical parts as had the 107 to create the CH–46 would require exhaustive testing. Any new aircraft normally encountered areas which would need further refinement and the CH–46 was to be no exception.

The initial flight, which had been scheduled in June 1962, was delayed four months and was not completed

until 16 October.[71] The first eight aircraft all were scheduled for the test program. The next six were to be delivered to operating units for initial training of crews.[72]

The first phase of the Navy Preliminary Evaluation (NPE) for the new helicopter was conducted by Patuxent River personnel at the Vertol plant in Morton during the period 14 through 30 January 1963. The changes from the 107 had created new factors in the CH–46. Lieutenant Colonel Perry P. McRoberts reported the results. "The 107 prototype helicopter was very smooth. It was known prior to testing that the additional mass distribution to the rotor heads for the . . . automatic blade folding system would cause vibrations." They were, he noted, "excessively high in all flight regimes." [73] The vibrations from the blade fold system, however, were of low frequency. They made for an uncomfortable ride but imposed little stress on the aircraft. More serious were other vibrations.

There had been "difficulty in assuring proper alignment in the high speed engine shafts. During the testing the aircraft involved was realigned each night to insure proper balance. This problem is related to the [other] vibration problem. Improved methods for realigning are also under study." [74] Any misalignment of the shafts could create extremely high frequency vibrations which could impose serious stress on the aircraft.

The problems were neither unusual nor unexpected. Lieutenant Colonel McRoberts ended his report on a note of optimism: "In spite of the apparent seriousness of some of the items listed above, the inspection team summarized that the evaluation was successful and the momentum generated toward correction of the . . . deficiencies was outstanding." [75]

As the design and testing of the CH–46 continued, the Marine Corps made final plans for the introduction of the new helicopter. In March 1962, Colonel Marion Carl, the Director of Aviation, outlined the program for the next five years. Starting in FY 1963, each year a new CH–46 squadron was to be commissioned until four were formed. (This was the same expansion which had caused General Shoup to be wary of the introduction of Marine helicopters into Vietnam.) In addition during the same period of time, each year one UH–34 squadron would be equipped with the CH–46. According to Colonel Carl's plan the conversion would be complete by FY 1970. At that time, all the UH–34s would have been taken out of service and each of the 15 medium transport squadrons would be operating 24 CH–46s.[76]

The goal for the end of FY 68 was 10 CH–46 squadrons with five other units operating at reduced strength of UH–34s. Procurement of the first 14 CH–46s was now scheduled to be completed in November 1963. Starting the next month, aircraft were to be produced at an initial rate of one per month and increase to five per month in December 1964. By 1967 it was estimated that the manufacturer could produce 96 helicopters per year until conversion was complete.[77]

Number of Medium Transport Helicopter Squadrons and Type of Aircraft

	HRB (CH–46)	*HUS (UH–34)*	*Total*
FY 1962	0	11	11
FY 1963	0	12	12
FY 1964	2	11	13
FY 1965	4	10	14
FY 1966	6	9	15
FY 1967	8	7	15
FY 1968	10	5	15

While the build up of the CH–46s was underway, the venerable UH–34 would continue to be purchased until sufficient numbers of the new helicopter could be produced. Not until January 1964 was the Marine Corps to stop receiving the "Huss."

The original schedule required that four CH–46s be delivered in September 1963 for the Fleet Introduction Program (FIP).[78] Additional helicopters were to be available in January 1964. Almost as soon as testing of the aircraft had begun, there was a revision in the time table. In January 1963 BuWeps concluded that the target date a year hence might have to be changed to May, although production was expected to catch up a few months later.[79]

The new design of the CH–46 continued to plague the engineers. The fifth test aircraft was four months late in being delivered and the sixth was provisionally accepted on 24 July, six months behind the original schedule.[80]

The delays centered around the vibration caused by the blade-fold mechanism and the high-speed shafts. At the end of December, NATC reported that the helicopter had successfully passed all portions of phase three of the preliminary evaluation, but it considered "improved vibration levels mandatory for Bureau of Inspection and Survey" trials.[81] Vertol had, however, "on a high priority basis made progress." [82] It was a vexing problem. Several different modifications were attempted. Finally, the last week in August 1964, a solution was found and it was concluded that "NATC flights indicate satisfactory vibration levels for unrestricted Fleet Release." [83]

CH–46 Helicopters in Operational Squadrons and Total Inventory Assigned. [79]

	CH–46		UH–34	
Per End of FY	*Oper* *	*Inv*	*Oper*	*Inv*
1962	1	1	278	347
1963	10	10	342	402
1964	24	31	300	415
1965	62	75	283	374
1966	109	133	251	311
1967	166	203	211	261
1968	230	280	155	184
1969	249	304	112	118
1970	227	277	46	47
1971	198	242	9	9
1972			0	0

* The difference between operational helicopters and total inventory compensate for aircraft undergoing PAR.

As General McCutcheon was to explain to the Commandant, the engineers had reduced the cockpit vibration to "acceptable limits by the installation of three absorbers. The absorbers constitute a weight reduction in payload of approximately 355 pounds." [84] The loss in lift capability was unfortunate but it represented another example of the difficulties in designing a helicopter.

Even before the absorbers had been agreed on as the solution, on 30 June, the first three CH–46s were delivered to Lieutenant Colonel Eldon C. Stanton's HMM–265 at New River. Stanton, a fighter pilot during the Okinawa campaign in World War II, thus became the first Marine officer to command a squadron of CH–46s.[85] During Operation STEELPIKE in the fall of 1964, his squadron remained at New River converting to the new medium helicopter.

The day after Stanton's unit received its first CH–46s, on 1 July, a second squadron of the aircraft was activated at Santa Ana. This unit, HMM–164, was commissioned under Lieutenant Colonel Herbert J. Blaha. The continued difficulties with vibration and delays in production at Vertol, however, held up delivery of CH–46s to Blaha's squadron until 21 December. In the meantime, his crews operated UH–34s. By mid-1965, HMM–164 had received 23 CH–46s and was engaged in intensive training.

Over six years after General Pate first had recommended a replacement for the interim HUS, the Marine Corps had a medium helicopter that increased the total lift capability without reducing seriously the numbers of other aircraft. The wait was worth it.

The VH-3A

Ironically the helicopter that had first triggered off the long selection process and which was rejected in favor of the CH–46 still would end up in the Marine Corps. The HSS–2 had first flown on 11 March 1959. As an anti-submarine warfare aircraft, for which it was originally built, it was a very successful design. In the fall of 1961, the HSS–2 set the first of a series of records that culminated on 5 February 1962 when the helicopter became the first officially to exceed 200 miles per hour by logging 210.6 miles per hour over a 19-kilometer course at Windsor Locks, Connecticut. One of the pilots was Marine Captain L. Kenneth Keck, a test pilot at NATC who was later presented the American Helicopter Society's annual Frederick L. Feinberg award for outstanding achievement in helicopters.

In July 1961, Admiral Stroop of BuWeps had received a memorandum from the Secretary of the Navy requesting more modern aircraft than the UH–34s then in use to carry the President and other dignitaries. The Secnav suggested that either the HRB (CH–46) or the HSS–2 would be suitable as both had the additional safety factor of two engines.[86]

Admiral Stroop recommended a version of the HSS–2. In 1962 Sikorsky built eight of these "executive mission" models, with half going to the Army, the others to the Marine Corps. In April 1962 HMX–1 received the first one. Like the predecessor UH–34 White Tops, it contained special electronics and safety features and was fitted with an executive interior. Under the unified designation system, the aircraft became a V (executive) H (helicopter) 3. Over the years it has become a familiar sight to television viewers as the Marines take off and land on the White House lawn.

The ill-fated HR3S, while not suitable for the Marine Corps, was to find new life from an unexpected source. In December 1962, the U. S. Air Force purchased 22 of them for long-range search and rescue missions.[87]

USMC Photo A149481

The VH–3A was the executive mission version of the CH–3. Marines of HMX–1 flew the President in these aircraft, including "Marine One," here taxiing for takeoff at El Toro MCAS in July 1970.

These helicopters, which had been designed originally for the Marine Corps, were well known to most Marine helicopter pilots in Vietnam, albeit with the U. S. Air Force insignia painted on the side.

The VTOLS

> There is much potential worth in an aircraft which can hover as efficiently as a helicopter. If we further supplement this hovering ability with the capacity for achieving great speed and carrying heavy loads, we can see that such a hypothetical aircraft would most certainly be a tool of prodigious capability for the military planner.
>
> Lieutenant Commander James R. Williford, USN
> Head, Vertical, and Short Takeoff and
> Landing Branch, Flight Test Division
> Naval Air Test Center
> Patuxent River, Md.[68]

There was never any question that another helicopter would be selected to replace the HOK and the UH–34. In the case of the HR2S the choice was not so obvious.

All helicopters are classified as Vertical Take Off and Landing machines (VTOL, often pronounced "vee-tall"), but not all VTOL aircraft are helicopters. Paralleling the development of early helicopters had been a similar effort in other types of aircraft, which had the same takeoff and landing characteristics. By the late 1950s sufficient progress had been made to indicate that a major breakthrough in non-helicopter VTOL aircraft was within grasp.

Superficially most of these aircraft appeared similar to a normal fixed-wing machine, but in a variety of designs, they were capable of making vertical climbs and descents. Some utilized wings which would swivel 90 degrees from horizontal. The engines then pointed straight up and acted much like the rotor on a helicopter. After the aircraft was safely airborne it could make the transition into normal forward flight by moving the wings and engines back to a conventional position. Other designs had just the engines tilt, leaving the wings stationary. Some designs had the engines inside shrouds to improve the lift capability; some had propellors; some had jet engines from which the blast could be directed downward for take off and landing * Regardless of the particular design, each of the aircraft had one distinctive advantage over helicopters: Once engaged in normal forward flight, they could carry heavier loads at faster speeds because the wings, not a rotor, carried the weight.

In a rotor system, the tip of the blade—which is passing through the air faster than any other portion of the aircraft — encountered serious aerodynamic problems as it approached the speed of sound. Due to this effect, the helicopter was normally limited to speeds of less than 200 knots. A winged VTOL aircraft was not. The biggest problem in such a hybrid design was producing enough lift to permit vertical climbs and descents. No system had been created which equalled

* The latter system is utilized in the Marine Corps' AV–8 "Harrier."

the efficiency of a rotor blade of a helicopter for vertical flight.

A compromise solution was the "compound" helicopter. In this design, short wings were attached to what was otherwise a conventional helicopter. At high speeds the wings produced lift and relieved the rotor of some of the load. Under those circumstances, the rotor could turn more slowly than would be necessary in a craft not equipped with wings. This in turn permitted higher speeds for the aircraft. The increase, however, was not as great as that in a winged VTOL, because, as the speed increased even more, the rotor blades once again would have to spin at maximum speed just to keep from producing drag. The compound helicopter, while an improvement, was not enough to warrant the extra complexity.

In 1956 the Marine Corps "could foresee the requirement for a follow on aircraft for the HR2S." [89] In spite of the foresight, 1956 was a time of extremely limited funds and with the much-ballyhooed HR2S finally becoming operational, it was an inauspicious year to discuss a replacement. Two years later the situation suddenly changed. In response to a request in early 1958 by the Joint Coordination Committee on Piloted Aircraft (which was disbanded shortly thereafter) of the Office of the Secretary of Defense, BuWeps conducted a study of the feasibility for a VTOL aircraft which could satisfy requirements of the Air Force, the Army, the Navy, and the Marine Corps for a medium-sized transport aircraft. Major General John C. Munn, Director of Aviation, reported that the study showed "conclusively that it was technically feasible and practical to develop a pressure jet convertiplane [winged VTOL] which would meet all requirements." [90]

The Air Force and Army soon dropped out of the program. The Air Force required a "750 mile radius . . . for rescue aircraft" [91] and was unwilling to pursue a development program for an aircraft that did not possess at least this range. The Army withdrew for a different reason. Instead of a winged VTOL transport it decided to develop another helicopter with a three-ton payload capability.* "The Department of Defense reluctantly authorized the Army to proceed with such a program but agreed that the Navy-Marine Corps position of developing a convertiplane was sound." [92] Although the Air Force and the Army were not going to participate, General Munn said, "We should push this program as fast as we can . . . welcoming the Army aboard at any point along the route." [93]

* This program resulted in the CH–47 "Chinook" built by Vertol.

The development characteristic, entitled VTOL Assault Transport, AO 17501–1 was approved and published by the CNO on 16 March, 1959. It was based on a compound helicopter. In FY 60, $350,000 was provided for initial studies. This money was followed the next year by a request for $2.6 million to complete the initial competition and start procurement of the aircraft to be utilized for testing.

> BuWeps then made a recommendation to CNO that the program would be too expensive for a single service development. Further, that the interim step of obtaining a compound helicopter was unnecessary and efforts should be directed toward a sophisticated VTOL transport. As a result, the funds were reprogrammed and efforts were directed toward a tri-service [Army, Air Force, Navy and Marine Corps] VTOL program.[94]

The specifications developed for this new joint project called for an aircraft which could cruise up to 250 knots. This effectively ruled out a compound helicopter. Like it or not, the Marine Corps would have to look to the tri-service program for a replacement of the aging HR2S.

Three VTOL aircraft eventually were designed and tested. The Vought-Hiller-Ryan XC–142A was initially ordered to make a full evaluation of a four-ton payload transport. The aircraft relied on four General Electric T–64 turbo-prop engines mounted on a tilting wing. They produced sufficient power to allow vertical take offs and landings. Once airborne, the wing moved to a conventional position for forward flight. The first successful transition from VTOL to forward flight was not made until January 1965.[95]

Another system was utilized by the Curtiss X–19A. In this aircraft only the engines tilted while the wing remained in a fixed position. The X–19 was not designed as a transport but was built "to support technology development of other promising concepts." [96]

The final aircraft was the Bell X–22A. It was to be utilized to test missions other than transport. This design had four large propellors installed inside shrouds or ducts. Each fan was mounted on the ends of small wings extending out from the front and rear of the aircraft. Four General Electric T–58 turbine engines were interconnected to the propellers. By tilting the fans, sufficient lift could be produced for VTOL and forward flight.[97]

Even as the competition began, General Greene realized that it would end with nothing more than a prototype for further development and in October 1960 concluded that "the tri-service could not possibly provide a timely follow-on for the HR2S." [98] Simultaneously a new Development Characteristic (AO–17501–3) was prepared calling for a conventional helicopter to replace the "Deuces." Later the winner of the VTOL evaluation was to be the tilt-winged

XC–142A, but it was found "unsuitable for Navy use" and the Navy withdrew from the program in August 1961.[99]

General Greene continued his search for a conventional helicopter. The prescribed characteristics of the new helicopter were very similar to those first proposed for the fixed-wing VTOL. An 8000-pound payload was to be carried over a radius of 100 nautical miles. A helicopter, however, would be unable to meet the original speed requirement so that requirement was revised to a cruise speed of 150 knots. The Development Characteristic was submitted to CNO in October 1960 and approved and published 27 March the next year.

The tri-service VTOL program had delayed the replacement of the HR2S by several years. It was becoming imperative that new aircraft be provided, for by the end of 1961 there were only 29 "Deuces" left in operation. The search for a new helicopter, however, was finally underway.

The CH–53

Colonel McCutcheon, Director of Aviation, was hopeful.

> The . . . big void in our inventory is the large helicopter. The follow-on to the HR2S is referred to as the HH(X) [Helicopter, heavy, experimental] It is anticipated that BuWeps will go out to industry some time soon in order to complete the evaluation . . . before [July 1962.] [100]

On 7 March, BuWeps invited interested manufacturers to submit bids for the replacement for the HR2S. Since time was running short, all proposals had to be based on a helicopter then in existence. Three responded. Kaman Aircraft had initially intended to propose a version of the British-built Fairey Rotodyne. Unable to reach a successful arrangement with Rotodyne, it dropped out of the competition. The two bids received 7 May were from the arch rivals, Vertol and Sikorsky.

Vertol made two separate proposals, both based on the CH–47 "Chinook" it was producing for the U.S. Army. The CH–47 retained the typical tandem rotor configuration of the original Piasecki design. From a distance it resembled the CH–46, though it was half again as large and, in fact, a completely different aircraft. The primary bid from Vertol was to redesign the CH–47 to meet the requirements of the Marine Corps, in a program similar to that which had converted the 107 to the CH–46. New engines, rotors, transmissions, and other components would have to be designed and installed.

Their second proposal was to make the minimum modifications to a CH–47. Blade folding and a rotor brake would be added. Since the aircraft was too tall to fit on the hangar deck of an LPH, the landing gear was to be redesigned so that the helicopter could "kneel down" to insure sufficient clearance. The necessary modifications would weigh enough to reduce the payload capability to 6,000 pounds, a loss which was unacceptable. The minimum proposal was not considered further.[101]

The aircraft proposed by Sikorsky was a direct descendent of the HR2S. The difficulties in designing and manufacturing that giant helicopter had provided the engineers with a wealth of knowledge and at the conclusion of the final refinements of the HR2S, Sikorsky had taken the new-found techniques and applied them to a series of "flying cranes." The crane helicopter was not a new idea. Hughes Aircraft, Piasecki, as well as other manufacturers had all proposed versions. Such a machine had no cabin for passengers or cargo. Instead, only the mechanical components of the helicopter were included along with a small cockpit for the crew. The weight saved by not building a large fuselage could be converted into additional payload which was to be carried externally underneath the aircraft.

The Marine Corps from the start of its development of helicopters had showed interest in such a crane. In 1951 it stated requirements for a "medium and a heavy" cargo lifter with payloads of 25,000 and 50,000 pounds.[102] They were obviously beyond the capability of any designer at the time. Sikorsky, however, continued to pursue the idea. In 1959, at the request of the Navy, it had modified the basic structure of the "Deuce" just enough to manufacture one true "crane" version. Called the S–60, it first flew on 25 March.[103]

In June the Marine Corps expressed interest in the S–60.[104] The S–60, unfortunately, was equipped with the same piston engines as the HR2S. The weight-to-power ratio continued to frustrate designers in their attempts to make a break-through in lift capability. The next version still retained the basic design of the "Deuce" but now was powered by jet engines. Sikorsky designated it the S–64. It was a commercial success. In 1962 Sikorsky proposed as an HHX for the Marine Corps essentially the S–64 with cargo and passenger cabin built back on. The evolution of the "Deuce" had come full circle.

On 26 July Admiral Stroop received approval of BuWeps selection of a new heavy helicopter. This time Sikorsky was the winner. The decision had been based on both technical and production capability factors and—even more important—costs. For research and development for the series, and construction of four aircraft for testing, the winning bid was $15 million.

USMC Photo 527964

The Sikorsky S–60 "Flying Crane," a development from the HR2S, sitting on the field at Quantico in September 1959, became, with later modifications, the ancestor of the CH–53.

Then in one of the typically frustrating moments in the development of helicopters in the Marine Corps, part of the expected funding was withdrawn.[105] Colonel Hollowell, who was managing the HHX program as well as the UH–1E, reported BuWeps "was now in the position of having sent out requests for proposals, having evaluated and determined that one of the bidders had won, and yet not having enough money" to award the contract.[106]

Because of the funding situation, Colonel Hollowell "was forced to inform Sikorsky that although they had won the competition, we could not do business with them unless they lowered their proposal on the initial research and development program from $15 million to $10 million because we only had $10 million to spend." [107]

The chief of Staff, General Greene, was hardly pleased with the impasse. On 14 August 1962 he wrote the CNO that:

> it is understood that the evaluation of the HHX proposals has been completed by the Bureau of Naval Weapons. The announcement of the results of the evaluation, initially expected in June 1962, continues to slip. It is requested that the announcement of the results of the competition be made as soon as possible in order that steps may be taken . . . to get the program moving again.[108]

Sikorsky had been stung when it had lost the HR3S contract to Vertol. With the HSS–2 and HUS contracts coming to an end, its production lines would be almost vacant if it did not have the HHX contract. Its engineers went to work "with a very sharp pencil" and rebid the research and development contract for $9,995,635.00." [109] Instead of four aircraft for initial tests, only two would be built. On 24 September 1962 the Department of Defense officially announced that Sikorsky had won the competition to design the HHX.[110] The helicopter would be known as the CH–53A.

General Greene and Colonel Hollowell were not alone in their frustration at not getting the CH–53 program off to a speedy start. The new Deputy Chief of Staff (Air), Brigadier General Norman J. Anderson, was about to join them.*

Before being appointed an aviation cadet in 1936, General Anderson had received his degree and had completed graduate work in history. He was designated a naval aviator in 1937 and served at Quantico until April 1940 when his active duty period expired. He continued flying as a pilot for American Airlines. When World War II started, he rejoined the Marine Corps and flew combat operations in the Pacific and Korea, and later in Vietnam.

Five days before the official announcement on the CH–53 contract, he had received a letter which indicated that all FY 64 funds for procurement of production models of the heavy helicopter were to be deleted by the Navy comptroller. The basis was a Navy policy of buying initial test and evaluation aircraft with research and development funds only.[111] The initial aircraft for test and evaluation, Anderson responded, had been properly purchased. The FY 64 funds were for helicopters to be assigned to Marine units. "If follow-on procurement funds are not avail-

* In reorganization of HQMC in 1962, the Director of Aviation was retitled Deputy Chief of Staff (Air). The duties remained the same.

able in FY 64 there will be a one-year gap in the production line. The price to the Navy cannot be retained with such a major delay in the program." [112]

General Anderson went on to point out that the program had been approved by Secretary of Defense, Chief of Naval Operations, Secretary of the Navy and all other authorities. In addition, the CH–53 was not a totally new design based on the "crane" version. "The aircraft being procured is a modified, off-the-shelf design. A full R&D effort, as for a new helicopter, was neither planned nor funded." The introduction of the CH–53 into tactical units already had slipped one year because of funding difficulties. Any such action as proposed by the Navy comptroller would further delay it. General Anderson had made his point. Even though funds were difficult to obtain, the planned procurement remained for the moment at 2 aircraft in FY 63, 16 in FY 64, and 18 in FY 65.[113]

There was no mistaking the ancestor of the CH–53. It was obviously the "Deuce." The dimensions were almost identical.[114] The new helicopter was equipped with the familiar 72-foot-diameter main rotor and an anti-torque rotor on the tail similar to that of its predecessor. Close inspection of the transmission and drive trains revealed that they were improved and refined versions of the same systems over which Sikorsky had labored so long 10 years earlier. Two General Electric T–64–GE–6 engines were mounted on either side of the main transmission, although unlike those of the HR2S they were not on stub wings but attached directly to the fuselage.

It was the fuselage which created a distinct appearance. The requirement for a rear loading ramp instead of nose doors had resulted in a cockpit that was in a more normal position. The ramp also required that the tail pylon extend out directly from the top of the cabin area so that vehicles and troops leaving the aircraft could avoid the tail rotor.

Each of the jet engines could produce up to a maximum of 2,850 horsepower for 10 minutes and was rated at 2,270 for continuous operation. In a normal assault mission over a radius of 100 nautical miles, the helicopter could carry 8,000 pounds either in the 30-foot cabin, or externally.

An unusual feature of the design of the CH–53 was capacity for non-stop flights of over 1,500 nautical miles. By filling the cargo compartment with special fuel tanks over 25,275 pounds could be carried. The helicopter could not hover at the resulting gross weight of 25 tons, and needed a runway to take off, but such a range opened new horizons in the employment of the CH–53. The cargo compartment also could carry 38 assault troops, or alternately, 24 litter patients.

Like the HR2S, the new helicopter had landing gear which would retract, a power-operated ramp, and an automatic power blade folding system. The latter was a highly improved version of that which had been first designed for the Deuce. It proved much more reliable, and the geysers of red hydraulic fluid which had so entertained observers of the HR2S became forgotten history. Originally rated as having a top speed of 168 knots, later improvements boosted the CH–53 into the select group of helicopters to exceed 200.

But before the design of the new heavy helicopter had even progressed beyond initial drawings, it appeared for a moment that the entire program was once again in jeopardy. On 12 July 1963, the Secretary of Defense questioned why the Army had ordered the CH–47 Chinook and the Marine Corps the CH–53. Would not a single type be less costly? General Anderson was quick to respond. He and the Army repeated the earlier arguments as to why the need for shipborne

USMC Photo A412901

The CH–53A was the largest, most powerful helicopter in the Marine Corps when it was introduced in the fall of 1966.

operations made the CH–47 unsuited unless extensive and expensive modifications were incorporated.[115] Some members of the Office of the Secretary of Defense (OSD) staff were slow to see the difference. In August they deferred all funds for the FY 64 procurement. These were to be the 16 helicopters built after the first two used in testing. If production dates were to be met, the funds would have to be made available prior to 15 September. On 10 September, OSD was still pondering the difference between the Chinook and the CH–53.[116]

Two days before the deadline, OSD agreed that the requirements of the Army and the Marine Corps were different and could not be met by a single type of helicopter. Colonel Robert L. Cochran (commanding officer of MAG–26 during the Cuban crisis), who had replaced Colonel Hollowell, was able to order the 16 aircraft.[117]

The seeming lack of understanding of OSD points out that the road from Marine combat units first establishing a requirement for a new helicopter, to the time when the finished machine is performing in the field, is a long and difficult one. Not only does every factor of funding, selection, development of tactics, and training of personnel have to be carefully coordinated, but even the machine itself has to have each part completely compatible with every other one.

A brief look at some of the problems encountered by Sikorsky in building the CH–53 gives some indication of the difficulties encountered in developing a new aircraft.[118]

The cutbacks in production suffered by Sikorsky in 1960 and 1961 had resulted in many skilled workers and engineers being laid off. With the announcement of the CH–53 contract, Sikorsky tried to reassemble its development team, but many of the former members had found permanent employment elsewhere. It takes years to train such workers and engineers and Sikorsky was hard pressed to find new ones. Two months after the award the company already was reporting severe manpower shortages. Sikorsky had been caught in the boom and bust cycles of defense-related industries. The shortage of engineers, particularly in the airframe design department, was to plague the CH–53. Blueprints were constantly late and Sikorsky was forced to go to other manufacturers to assist it in the design effort.

By March 1963, the company realized that changes in the original concept of the aircraft might increase the weight. In November it was estimated that the helicopter would be 725 pounds heavier than the desired target. The next month a decision was made to replace the steel main rotor head with one just as strong but 500 pounds lighter made of titanium. This and other changes reduced the weight back to acceptable limits but required further design efforts by the already hard-pressed engineers.

Like most major manufacturers, Sikorsky subcontracted the building of many parts of its aircraft to other companies. A late delivery or production difficulties in any one of the subcontractors could cause serious delays throughout the program. As design was progressing, individual components were put through rigorous testing. Occasionally one would be found not compatible with the others and another redesign would have to begin.

The first flight of the CH–53 was originally scheduled for 1 June 1964. Shortages of parts from subcontractors and of government-furnished equipment aggravated the difficulties and the date was repeatedly postponed. The first aircraft to roll off the assembly line was accepted by Sikorsky Flight Test Division on 28 May 1964. It would undergo further testing prior to flight. By October, flight test personnel were working six days a week for a total of 53 hours attempting to improve the schedule. Finally on 14 October a CH–53 took to the air. It was actually the second of the two test aircraft built (Bureau Number 151614) as the other was still undergoing ground tests.*

Sikorsky would continue to struggle to meet deadlines for the next three years. The task was to be complicated by increasing orders from the Marine Corps and U.S. and foreign services for the CH–53 and other helicopters. The company experience was no different, and possibly a little bit better, than other manufacturers of aircraft. The design and production of the CH–53, however, amply illustrates the complexity of developing any new helicopter for the Marine Corps.

In August 1965 the next step in that development was ready. By this time the aircraft was also known as the "Sea Stallion," a name selected personally by the twenty-third commandant, General Greene.[119] The Naval Preliminary Evaluation (NPE) uncovered only a few problems. The most aggravating was a strong shimmy in the nose wheel. The solution was elusive but one was finally devised.

The evaluation included tests on board amphibious ships. No LPHs were available so the USS *Lake Champlain* (CVS–39) was pressed into service in March of 1966. A CH–53 was flown from the plant at Bridgeport, Connecticut, to the ship at nearby Naval Air Station, Quonset Point, Rhode Island. Among the helicopter crew for the tests were Lieutenant Colonel Joseph L. Sadowski, who was later to be commanding officer of the first CH–53 squadron in

* BuNo 151614 was subsequently destroyed 2 February 1966 in a freakish accident. Its loss created another delay.

combat, and Master Sergeants C. A. Lamarr and J. A. Reid.[120] No problems were encountered.

The same month NPE was completed. The next step was the Board of Inspection and Survey trials held at Patuxent River. They began 2 June and ended 8 October 1966. Other than a continued shortage of parts and skilled workers at the Sikorsky plant, the BIS trials indicated that the CH–53 was back on track. Rear Admiral Robert L. Townsend, Commander of the Naval Air Systems Command (NavAirSysCom), was briefed by his staff that "reports from the BIS board have shown that the CH–53A completion of BIS was superior to that of any fixed wing or rotary wing aircraft that has been tested at Patuxent River during the past three years."* [121]

The original plan was for a total of 106 CH–53s. Of these 32 would be allowed for aircraft undergoing PAR and normal attrition from accidents. The remaining 74 would be distributed to all five air stations having helicopter units. Ultimately HMM–462 at Santa Ana would have 30 aircraft, HMM–463 at Futema 12, and HMM–461 at New River another 24. A small detachment of six was to be positioned at Kaneohe and two more at Quantico.[122]

The first helicopters delivered to the Marines were intended for the Fleet Introduction Program (FIP). MAG–26 at New River had been the first unit to have the UH–1E and the CH–46. Now it was MAG–36's turn at Santa Ana. On 9 September Major General McCutcheon, who had returned to the position of Deputy Chief of Staff (Air), arrived at the Sikorsky plant to observe the first four FIP aircraft in their final preparations before being turned over to the Marines.[123]

As he accepted the first CH–53 on behalf of the Marine Corps, he told the Sikorsky officials that "this is another milestone for Sikorsky, the Naval Air Systems Command and the Marine Corps". The general praised the UH–34 for doing a fine job in Vietnam. He then added: "We have plenty of room out there for the CH–53A."

USMC Photo A149242

Two CH–53Ds of HMH–363 fly in formation over MCAS Santa Ana in June 1968. The CH–53D had still more speed and lifting power than the "A" model.

Major William R. Beeler, commanding officer of HMH–463, received the four aircraft at the plant. On 20 September, after a two-day flight across country, they arrived in Santa Ana.

At long last the "Deuce" had a successor in sight. Now all three main helicopters in the Marine Corps had jet-powered replacements in production and being delivered, the UH–1E, the CH–46, and the CH–53. It was not a moment too soon.

* BuWeps had been abolished by a reorganization 1 May 1966 which assigned elements to three new commands. Naval Air Systems Command was the aviation portion.

CHAPTER FOUR

THE MEN WHO FLEW HELICOPTERS

Who Wants To Fly Helicopters?

5 September 1960. Lieutenant Colonel Thomas H. Miller, USMC, sets new world's speed record for 500-kilometer course averaging 1216.78 mph in a McDonnell F–4 Phantom II jet fighter. By January 1962, the F–4 has been clocked at 1,606 mph and has flown from Los Angeles to New York in 170 minutes. The Marine Corps is scheduled to receive the Phantom.*

20 February 1962. Lieutenant Colonel John H. Glenn, USMC, becomes first American to orbit the earth reaching speeds up to 17,545 mph in his 81,000-mile trip. Other Marines are being considered for the space program.

5 February 1962. Captain L. Kenneth Keck, USMC, flies in an HSS–2 which sets new world's speed record for helicopters—210.6 mph.**

The difference in speeds of the three records did not go unnoticed. The development of the LPH for mobility and the turbine-powered machines for lift capability had been a long and arduous process for the Marine Corps. The problem which was to prove most thorny, persistent, and demanding was finding the personnel to man and maintain the helicopters. The heart of the issue is contained in the accomplishments of Colonel Miller, Colonel Glenn, and Captain Keck.

Aviation, almost by definition, is a profession of speed and altitude. The aura of dashing pilots executing their daring deeds with cheerful abandon long had permeated the admiring public's view of the flyers and also the flyers' view of themselves. The decades of the 1950s and 1960s had seen an almost continuous succession of new records set, astounding developments, and major breakthroughs. It was a time of jets, supersonics, afterburners, rockets, and space. There was little to attract a pilot to a machine that normally flew at speeds that had been exceeded in 1913 ***; which continually tried to destroy itself; seldom got much above a few thousand feet, even if it was capable of doing so, and many were not; and totally lacked sleekness and aerodynamic beauty.

No pilot in a helicopter was ever going to be declared an "Ace" for shooting down five airplanes, nor could any of them ever hope to take credit for sinking an enemy ship.

A helicopter was slow, low, ugly, uncomfortable, and noisy. It was no consolation to many Marine pilots that it was vital for the prosecution of amphibious warfare. They wanted no part of such a machine. The attitude was spelled out accurately in 1955 by an irate letter to the *Marine Corps Gazette.*

> In the first place, Naval Aviators do not want to fly helicopters. For them being shifted from appealing jets to the whirlybirds is comparable to a hard-charging infantry officer being assigned as Secret and Classified (S&C) files officer when there is a good fire fight going on.**** Naval Aviators want to fly fixed wing aircraft! Secondly, the use of Naval Aviators as helicopter pilots is a waste of trained manpower. [To fly fixed wing aircraft] requires higher physical and mental standards than that of a 'copter pilot.'[1]

Right or wrong the author of the letter correctly identified the problem. Helicopter pilots were considered definitely second-class citizens by their fellow aviators. To order pilots to helicopters was difficult. To get them to volunteer was almost impossible.

Colonel Edward C. Dyer discovered the attitude as he attempted to assemble the pilots for the first Marine Corps helicopter squadron. At the conclusion of his duties in 1947 on the Special Board which had initially recommended helicopters for the Marine Corps,

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* Colonel Miller was also one of the first Marines to evaluate the British aircraft that resulted in the AV-8 "Harrier." In 1977, he was a lieutenant general on active duty.

** The pilot of the aircraft was Lieutenant Robert W. Crafton, USN.

*** Normal cruise speed for the UH–34-and HR2S was approximately 110 knots, roughly equivalent to 128 mph which had been reached on 6 April 1913 by Marcel Prevost in a French Deperdussin aircraft.

****S&C Files Officer is a very necessary but particularly onerous duty involving a great deal of detailed responsibility and very little authority.

Colonel Dyer had been ordered to form what was to be known as HMX–1. In later years he described the first attempt to recruit pilots:

> I went to the Marine Corps Schools and got permission to interview all the members of the junior course * who were interested in joining the helicopter squadron. The commanding officer of the course [Colonel Peter P.] "Pete" Schrider put out a notice saying that I would be in my office at a certain time. I would give a short briefing on the helicopter and its future and our plans for it in the Marine Corps for anybody who might be interested in later joining the squadron. At the appointed time about 60 guys showed up . . . in the main school building. I brought out some drawings of helicopters of the future that I had gotten from Sikorsky Aircraft—these were big twin engine things, and pretty visionary, although the HR2S turned out to be very much like them.
>
> We had other information on the possible speeds and payload that helicopters would achieve. I described what our squadron hoped to accomplish and how we hoped to go about it. Then I said, 'Now there is a large body of opinion in the Marine Corps that figures helicopters aren't going any place, so if you are interested, stay here and I'll get your names.' [2]

About two-thirds of the group left. Of the less than 20 remaining a few more opted for speedier aircraft and dropped out. "But I ended up with a nucleus of people that later formed HMX–1. I must say that they were all good men . . . and I think they all did a splendid job as we could see later." [3]

The meager results of Colonel Dyer's efforts to recruit volunteers to the first helicopters would recur many times in the future. It made no difference if the claims were unjustified, the second-class syndrome was a fact of life.

Five years later, the situation still was discouraging. The Commandant, General Shepherd, pointed out that as of 22 March 1952, a total of only 344 pilots had been trained in helicopters. Over 40 had left the program and of those remaining, many were reserves and presumably would leave the Marine Corps at the end of the war in Korea. By December there would be a requirement for 487 helicopter pilots.[4]

The problem was compounded by the fact that total manpower in the Marine Corps was held under a tight ceiling. It was a condition identical to that existing with the aircraft. Every pilot assigned to the growing helicopter force had to be offset by the reduction of one in fixed wing, unless another source within the Marine Corps could be found.

Director of Aviation Lieutenant General William O. Brice reported progress at the 1955 General Officers' Conference. General Brice was a veteran of World War I service in the Army. He had been commissioned in the Marine Corps in 1921 and was designated a naval aviator in 1924. He was promoted to brigadier general in 1947. Brice told his fellow generals, ". . . emphasis will be placed on increasing the number of pilots qualified in helicopters." He said, "This action is necessary in order to provide pilots for the increased helicopter lift programmed for the forthcoming years." [5] Recognizing the opinion of helicopter pilots held by many Marines, he added, "There can be no sacrifices made in the aeronautical adaptability and educational background in the selection of applicants for helicopter pilot training." [6]

Sources of Marine Aviators

The root cause of the chronic shortage of helicopter pilots was the more general shortage in the Marine Corps of recruits for any kind of pilot training. Traditionally, Marine pilots were officers who had been commissioned and who had completed at least Basic School prior to reporting to Pensacola to begin their careers in aviation. The time necessary for this sequence made it attractive only to Marines who already had decided to make a life career of the Marine Corps. For those who were still undecided, there was a reluctance to become obligated for so many years of service. It appeared that a way was needed to recruit directly into aviation.

In early 1955, Lieutenant General Brice called into his office the procurement aids officer at HQMC, Captain Herbert M. Hart. The general asked him what he had to publicize the aviation officer programs. Captain Hart, a ground officer, had to admit that the only material "was an obsolete booklet that was almost out of stock." [7] The general wanted to know why this was so, and the hapless captain could only respond "because we do not have any program to procure aviators directly through Marine Corps channels." Fortunately, there was already in existence a program which seemed ideal to meet the requirement.

The Platoon Leader's Class (PLC) had been a major source of officers entering The Basic School. College students were recruited and spent two summers training with the Marines. On graduation they were commissioned and sent to Basic School. If this source could be tapped, and the officer ordered directly to Pensacola instead of Basic School, the time required could be shortened and a direct method of obtaining pilots would be established. The idea was approved. Some years later, the now Colonel Hart remembered the beginning of the program. "We labored long trying to come up with a cute, gimmicky name for [the program] and finally decided that it would be better to consider it just as part of the routine PLC" recruiting.

* Equivalent to the present Amphibious Warfare School.

Thus, the PLC (Aviation) source came into being. The first difficulty was preparing literature and posters to advertise the new way to become a Marine pilot. Photographs were particularly nettlesome to Captain Hart and his crew, since none of them were aviators. This small difficulty did not deter them. He remembered:

> In all our photography, we tried to have at least a "token" pilot. This was not always possible so I bought a set of wings at the post exchange and used these to arbitrarily designate a pilot before a picture was taken. Usually the officer who had most recently flown in a commercial airliner became our pilot for the photograph.
>
> There are still a few ground officers around today as colonels who occasionally are asked about whether they were aviators by officers who remembered seeing them wearing wings in the 1957-era posters.[8]

The ingenuity of Captain Hart in creating "instant" aviators for the photographs assisted the direct recruiting and the PLC (Aviation) program became a success. The basic concept was expanded and by 1963, there was also an Aviation Officer Candidate Course (AOCC) in addition to the PLC (Aviation) and Basic School graduate programs.

There was one other major source: Naval Aviation Cadets (NavCads). The program was initiated in 1935 to augment the supply of officers. All NavCads who completed flight training were eventually commissioned in the Navy or the Marine Corps. Prior to World War II, only college graduates were accepted. But under the demands of the war, the educational requirement was cut to three years of college, then two years, and finally high school graduates were accepted. In the final phases of the war, two years of college were again required.[9]

As far as the Marine Corps was concerned, the cadet program was satisfactory. The Navy held a different view. In December 1957, Rear Admiral Frederick N. Kivette, ACNO(Air), pointed out to General Pate that the Navy had to do all the recruiting for both services and "must procure fairly large numbers . . . to meet Marine Corps requirements."[10] More disturbing to him was that "The Marine Corps has the capability of selecting only those cadets who it considers most desirable, thus in essence leaving the lesser quality to the Navy."[11] There was no question that the capability was being utilized. Since the NavCad did not have to submit his request to become a Marine until near the end of his training, there was time to identify the superior students. Marine officers undergoing training as well as Marine flight instructors conducted an unofficial, informal, but high intensity recruiting campaign to persuade the best cadets to choose the Corps. Their efforts met considerable success.

Admiral Kivette listed other disadvantages of having the Navy recruit all cadets and the Marine Corps select the most promising. He concluded, "It, therefore is requested that the Marine Corps implement a program for procurement of Marine Aviation Cadets and assume the full responsibility for meeting its own input requirements to Flight Training." Finally, he requested that, "this recruiting program be implemented as expeditiously as possible and be fully effective by 1 July 1958."[12]

General Pate agreed that the Navy had a legitimate complaint and directed that studies be made on the possibility of a Marine Corps-managed cadet program. A number of alternatives were proposed. Each study agreed that it would be impossible to meet the target date of 1 July 1958. By the end of the year, however, the issues had been resolved, and on 1 December Major General Carson A. Roberts, at the time Acting Chief of Staff, announced the new Marine Corps Aviation Cadet (MarCad) program. It was very similar to NavCad. Applicants were required to have two years of college (with some permissible exceptions), agree to remain unmarried during their training, and serve three years after they received their wings. Both civilians and enlisted Marines on active duty were eligible.

The first MarCads were to be ordered to Pensacola starting 1 July 1959. In the meantime NavCads who were under training prior to that date would still be offered the opportunity to become Marines. It was not until 21 April 1961 that Second Lieutenant James R. Foster became the last NavCad to be commissioned in the Marine Corps. Lieutenant Foster, a former enlisted man in the Navy, was assigned to jets at Cherry Point, North Carolina.[13]

Two months earlier, the MarCad program began producing pilots, Second Lieutenant Clyde "O" Childress, the first former enlisted man to graduate and be commissioned, arrived at New River in February. He was greeted by the MAG–26 commanding officer, Colonel Paul T. Johnston, and immediately assigned to HMR(L)–262 as a helicopter pilot.[14]

Originally, the Marine Corps planned to obtain 200 pilots a year through the MarCad program. Acknowledging that not all applicants would complete successfully the year and a half of training, it established a quota of 252 to be recruited.[15] A year later Major General Norman J. Anderson did not have encouraging news of the results. From January through December 1960, 242 MarCads had been obtained. Before training started, 12 had been disqualified or dropped out. Of the remaining 230 who began flight instruction, 52 percent did not complete it. Instead of the 200 pilots hoped for, only 110 graduated.[16] The picture was not much brighter for the pilots from officer

sources. Only 369 had been recruited to meet a goal of 455. The completion rate was somewhat better with 65 percent graduating, but the net result was still only 210. The Marine Corps had achieved 320 new pilots in 1962. It needed 500.[17] Progress to overcome the chronic shortage was not going to be easy.

To add to the difficulties facing General Anderson, "curtailment of officer training classes in the Marine Corps School system in the coming year will (further) reduce the number of candidates available for training." [18] "As a result," he added, "more candidates will be required from MarCad sources." [19]

Recruiting efforts on college campuses had to be bolstered. He detailed a plan to provide radio and television advertisements and recruiting films. In addition he had obtained CNO approval to "provide indoctrination flights for bona fide MarCad candidates to include combining the flight with transportation to the nearest Naval facility which would provide" for physicals and testing.[20] Not only were civilian sources of MarCads to be combed but General Anderson suggested "that equally intensive recruitment be accomplished in all Marine Corps commands." [21] There could be no repetition of the disastrous attrition rate in 1960. "It is recommended that screening boards of experienced aviators review all applications and interview all candidates carefully to insure that only those qualified candidates who are highly motivated and enthusiastic are recommended." [22]

In the next 10 years, a total of 1,296 MarCads won their wings and a commission in the Marine Corps. In 1968 procurement from officer sources had finally begun to meet total requirements, and the MarCad program was quietly brought to a close. On 22 March that year, Second Lieutenant Larry D. Mullins became the last MarCad to be commissioned. On hand to witness the end of the program was Brigadier General William G. Johnson, Assistant DC/S (Air) and a former NavCad himself.[23]

The MarCad and NavCad programs had served a purpose. They had provided an alternative source of pilots. The lack of a degree, however, proved to be a handicap in later years for the pilots in competition for promotion and assignments. Many of them overcame the difficulty and became successful senior officers in the Marine Corps. Regardless, the fact remained that the Marine Corps felt better served if all its pilots were graduates of college and, when that became possible, discontinued the cadet programs altogether.

STUDENT AND NAVAL AVIATOR DATA

1. *Student Naval Aviator Inputs*

	Authorized		*Actual*	
End FY	*MAR CAD*	*OFFICER*	*MAR CAD*	*OFFICER*
60	252	455	242	369
61	323	430	329	393
62	407	407	461	324
63	465	472	—	—
64	280	516	—	—

2. *Naval Aviator*

	*NATC Output**				
FY	*Planned*	*Actual*	*Strengths*	*T/O Reqm'ts*	*Shortages*
60	500	418	3932	4689	557
61	475	402	3976	4720	794
62	475	320	4067	4782	725

Example:	*CY–60 Input*	*Training Losses*	*% Attrition*	*FY62 Output*
Mar/Cad	230	120	52.1	110
Officer	326	116	35.5	210
Total	556	236	42.44	320

*Calendar Year input (18 months prior) minus flight training attrition results in Fiscal Year output.

Selection of Helicopter Pilots in Training

Once pilots were recruited, some of them had to be persuaded to specialize in helicopters. Factors at work within the training process made the helicopter option doubly unattractive for the new student aviator. Periodically, a forecast would be made of the needs for each type of pilot in the forthcoming months. This formed the basis for the numbers assigned to the different categories of advanced training, such as jets, propeller aircraft, and helicopters.

As the student neared the end of basic flight training, depending on his academic and flight grades, he received a choice of advanced training until the quota was filled. Those with the highest marks had first opportunity. The next highest group then could select any opening remaining. Though such a system put a premium on speed of learning and ignored depth of learning, it seemed like a convenient way to manage the program. Almost without exception, the highest-graded students chose the glamorous jets. The next group had to be satisfied competing for assignment to propeller aircraft advanced training. What was left got helicopters. The equation was perfect. Helicopter pilots were second-class citizens so second-class pilots got helicopters. The syndrome was self-perpetuating.

The typical attitude prevailing among jet pilots was clearly established in an article in the *Marine Corps Gazette* in 1962.[24] The author invoked the spectre of pilot-caused aircraft crashes to explain why only the most select of pilots could qualify to fly jets. The screening process was rigorous and "this quality input [of students] and careful aptitude analysis" paid off with a new safety record.[25] He went on to say: "It is assumed that all naval aviators are born to fly and that they come equipped with flight aptitude of the highest order. This is nonsense. No two are similar." [26] He then got to the very crux of the syndrome:

> What is flight aptitude? . . . its prime ingredients are headwork, judgement, basic air work and reaction time. Reaction time is of special note because as aircraft performance goes up, reaction time goes down. . . . Aptitude graduates upward in order of increased performance or reaction time.[27]

Even among jet pilots there were those more equal than others. The same article reported "one solution (and a darn good one) mentioned not too long ago was to form an elite cadre of 500 jet pilots, replace them as needed to keep the number constant." [28]

With the benefit of over a decade of hindsight, it is tempting to be harsh with the judgment of the jet pilot. At the time, however, the opinions expressed in the article were widely held and hardly considered radical. It was a simple fact accepted by all fixed-wing pilots—speed of the aircraft equalled superior aptitude. Perpetuation of this myth was helped considerably by the fact that few jet pilots had any contact with, or knowledge of, helicopters. As long as the selection process was based on the reverse assumption that helicopters did not need as proficient pilots as fixed wing, the second-class syndrome would continue to exist, and as long as it did, few pilots would volunteer for helicopters if they had a choice.

Recruiting Expedients

To secure qualified men to fly helicopters in the face of these obstacles, the Marine Corps considered a number of alternatives. In 1956, Major General Henry R. Paige suggested one of the more original ones. Though not an aviator, General Paige had been deeply involved in the early development of helicopters. In January 1956 he had visited Fort Benning and had received an orientation from the Army on its helicopter program. On his return to Quantico he wrote General Pate suggesting that the Marine Corps "train enlisted pilots on six years enlistments for duty, initially as co-pilots" in helicopters.[29] "Two officer pilots in each helicopter seems uneconomical," he observed.[30] Such a program as he proposed recognized the difficulties in recruiting helicopter pilots and "would also give a group of personnel who make a career in helicopters their principal interest. Now the Marine aviator's interest is divided into many fields of which the helicopter is more or less 'poor relation' and something which few Marine aviators want to make a career of." [31]

He could have added that enlisted co-pilots would avoid transferring fixed-wing aviators into helicopters —a spectre that haunted many jet pilots. In spite of the advantages of the plan, it was directly contrary to the goals spelled out by General Brice and was not adopted at the time.

The idea of only one of the pilots being an officer, however, did not die out entirely. In December 1961 the Director of Aviation, Colonel McCutcheon, held an aviation training conference at El Toro. On his return he reported that: "One point that we tried to sell, but which the field did not buy, concerned the assignment of one vs. two helicopter pilots to passenger carrying aircraft." [32] The attendees at the conference, however, were acutely aware of the "can't let go to scratch your nose" problem, "and were unanimous in expressing a desire to retain two pilots." Colonel McCutcheon went on to say:

> My personal opinion is that there are some occasions when one pilot is sufficient to carry out the particular

> mission and that the operational commander involved is the logical person to decide when this situation prevails.[33]

Colonel McCutcheon was reassigned shortly afterwards, but his opinion prevailed. On 18 September 1962 the Navy directive which had established pilot criteria was revised. The new regulation allowed single engine helicopters to be flown under certain conditions by only one pilot. The DC/S (Air) at the time, Brigadier General Norman J. Anderson, commented: "We feel that this is a more realistic approach to the plane commander-co-pilot problem that exists in the helicopter program." [34] The restrictions which remained were such that most combat Marines seldom saw a helicopter with anything but two pilots in it. The basic problem remained unsolved.

Another suggestion of General Paige in the 1956 letter came closer to being adopted.[35] The Marine Corps long had utilized warrant officers. Most were former enlisted men of a number of years of military experience. Many served in highly technical and specialized fields. Some were further designated as limited duty officers (LDOs) and always were assigned the same type of duty. General Paige had wondered if "maybe something in the LDO (helicopter pilot only) line could be worked out." [36]

The Division of Aviation conducted a study in 1960 to investigate the desirability of replacing a portion of the commissioned officer pilots with warrant officers or enlisted pilots. The study concluded "that a commissioned officer structure composed of college graduates was most desirable and recommended . . . restricting warrant officers to technical specialties." [37]

What was desirable was not always possible. During 1960 and 1961 the Marine Corps could not recruit enough college graduates to fill its need for pilots. Warrant officers still might offer a solution. In the summer of 1961 the Warrant Officer, Helicopter Only (WOHELIO) program was initiated. Colonel McCutcheon hoped to reach a goal of 60 the first year and eventually build up to 100.[38] "Our original sources," he noted, "were both active duty and inactive duty reservists [officers] with priority on those who were currently designated" helicopter pilots.[39] At the end of the first six months, 47 reserve lieutenants and captains had been selected and exchanged their insignia for those of a regular warrant officer. Of the total, 11 already were on active duty. The other 36 returned to the Marine Corps from civilian life.[40]

After the initial surge, new applicants were scattered, and Colonel McCutcheon began exploring other methods. "We are now pursuing two other courses of action" he noted in January 1962, "screening Naval aviation pilots* who still meet the criteria for warrant officer programs" and "selecting probably a small number of regular lieutenants and captains that have been twice passed over for promotion." [41] Even the resourceful Colonel McCutcheon had to admit that procuring pilots for helicopters was not an easy task. He concluded, "Where we go from here . . . to get any increase over the 60 is as yet an unsolved problem." [42]

Two years after the WOHELIO program was initiated, only 78 pilots had been produced. "The program began to die on the vine." [43] In September 1963 an attempt was made to revive it in conjunction with the selection of warrant officers for other technical specialities. Once again the goal was set at 100 pilots.

Marine Corps Order 1040.14A announced the new program. "Requirements for the flight training program are the same as those for the Corps' basic Warrant program . . . with the exception" of a higher score in aptitude testing.[44] Unlike the effort in 1960 no previous flight experience was necessary. "Upon successful completion of the screening and basic courses," it was explained, "qualified applicants will be ordered to Naval Air Station, Pensacola for training." [45]

The response to this new program was unimpressive. Only nine enlisted Marines applied and seven of them were found unqualified. An analysis of the failure some years later concluded: "the poor response was due to the fact that the requisites for the warrant officer flight training program were identical to those for the Marine Cadet program except for marital status." Warrant Officers could be married, cadets had to be single but became commissioned officers.[46] "Presumably the nine applicants were married." [47]

A program such as WOHELIO had several inherent defects. First, the idea of anyone other than a commissioned officer flying an aircraft was not universally accepted. In fact, the issue could be explosive. Many years after the event, Brigadier General Samuel R. Shaw could regale his listeners with an anecdote in which the difference of opinion was expressed exactly.

Colonel Shaw had been another of the three members of the secretariat of the special board which in 1947 first had proposed helicopters in the Marine Corps. Though not an aviator, Colonel Shaw had a deep appreciation of the potential—and difficulties—of vertical envelopment. He was also one of those Marines who appear periodically in the Corps in the middle of a controversy over major changes in policy. In 1956, as a colonel serving as Director of Policy

* The Marine Corps had previously used a few enlisted men as pilots. Designated naval aviation pilots (NAPs) to distinguish them from the officer naval aviators, a few were still on active duty in 1962.

Analysis at HQMC, he had prepared a paper recommending that enlisted men and warrant officers be used to fly helicopters. He found himself in front of the Commandant, General Pate, accompanied by two senior aviator generals discussing the merits of his proposal. He remembers the conversation as:

> Well, somewhere along the way the generals were both going on at considerable length at a simple fact. To fly an airplane you had to be an officer. That was the central characteristic of people who flew airplanes: they had to be officers. I burst into the conversation. 'Well, how can that be? If they got to be officers, what are all those damned civilians doing flying airplanes?' [48]

General Shaw still chuckles over the results of his remark. "Godalmighty! They tore into me and that was the end of the conversation in front of the Commandant." [49]

A more serious disadvantage of the WOHELIO and other warrant officer programs was that warrant officers were limited in the types of duties they could perform. General Greene pointed out this drawback in a memorandum to the Secretary of the Navy in 1966:

> The Warrant Officer helicopter pilot is restricted in assignment, primarily to operational (flying) billets. Within these billets, he is restricted in assigned responsibility. As his aviation knowledge and pilot proficiency progresses, his responsibilities remain at somewhat the same level.[50]

General Greene continued: "The relatively small size of the Marine Corps demands maximum flexibility in the assignment of the total aviator inventory. The concept of a large Warrant Officer pilot population is in conflict with this requirement." [51]

Periodically there have been attempts to revive the warrant officer program. In each case it seemed to offer a timely solution to an immediate problem. In each case, however, the long-term effects were a handicap which could not be overcome. The Marine Corps simply could not afford to have pilots who could not be assigned to a broad spectrum of duties. To date, no other warrant officer program has been adopted.

Transitions

By the summer of 1962 the situation was critical. Forty percent of all Marine Corps pilots were needed in helicopters. Only 29 percent were assigned to them.[52] The future looked bleak. Helicopter squadrons were flying in Vietnam, more squadrons were planned, and the growing success of vertical amphibious landings from the new LPHs required a quickened pace of training. The few pilots in helicopters were being stretched thinner and thinner. Some sought a different profession. There was a "marked attrition rate among helicopter pilots, mainly junior officers who feel they aren't going anywhere but up and down." [53] The shortage was so acute that there were restrictions on assigning a helicopter pilot to any duty but in a squadron. The constant deployments and commitments resulted in few of them ever remaining at their home station for any length of time. Helicopter crews could "point to jet and transport pilots, who admittedly have fewer crash projects to meet" in contrast.[54] A number "disliked living out of a sea-bag" to the point where they left the Marine Corps, further compounding the shortage.[55]

General Anderson, DC/S (Air), could see no improvement unless drastic steps were taken. He predicted that by June 1963 the helicopter units would be operating short one-third of the pilots required.[56] The result could only be that even more pilots would leave the Marine Corps when their obligated service was completed. It was a vicious circle. He had, however, another manpower source. At the same time that helicopters were expected to have only 66 percent of their authorized pilots, jet units would have 95 percent, and transports a whopping 114 percent. General Anderson presented a plan to General Shoup, who agreed. It was then forwarded to the CNO who approved it on 30 August 1962. Approximately 500 fixed-wing aviators were to be forced to make a transition into helicopters.* The purpose, General Anderson pointed out, "is to rectify imbalances in the distribution of Marine Aviators . . . caused by abnormally low retention rates of helicopter pilots, increased commitments and requirements for their services." [57]

Those to be selected all had flown at least one tour in fixed-wing aircraft. Most were experienced first lieutenants and captains, though there was a sprinkling of majors and even a few lieutenant colonels. If at all possible, each had been eligible for a routine change of station anyway. Instead of proceeding to the duties they expected, they were to report to helicopters. Help was on the way.

While the overburdened helicopter crews greeted the news with joy, the reaction by most of the 500 fixed-wing pilots chosen was just the opposite. Cries of anguish, incredulous looks of "Why me?", and threats to get out (a few did) resounded throughout the Marine Corps. For those who made a quick trip to HQMC to review their records, hoping to find the reason they had been discarded into helicopters, the experience was even more perplexing. All the information indicated that they were considered among the better officers and pilots in their previous squadrons.

* Similar programs on a smaller scale had been utilized in the mid-1950s.