U.S. GENERAL ACCOUNTING OFFICE

STAFF STUDY ON THE

CAPABILITIES OF THE HEAVY LIFT HELICOPTERS

UNDER DEVELOPMENT BY THE ARMY AND THE NAVY

MARCH 1973

Contents

ABBREVIATIONS

DOD	Department of Defense
GAO	General Accounting Office
HLH	Heavy Lift Helicopter
LHA	Landing Helicopter Assault
LPH	Landing Platform Helicopter

SUMMARY

The Army and the Navy each have under development a helicopter which would provide a much greater lift capability than is available from present helicopters.

The Army is developing a 22.5-ton heavy lift helicopter (HLH). This effort involves new technology in the development of certain critical components. The Navy is modifying its present CH-53 version to a 16-ton CH-53E. This effort largely involves the improvement of components currently in use. The HLH will be shore-based and the CH-53E will be shipboard based. The services estimate that the CH-53E will be in operation by 1977, and that the HLH will become available by 1980.

The lift capability of either helicopter will vary, being dependent on environmental conditions and load factors. Thus, each helicopter will be capable of lifting more than its designed capability at sea level and relatively lower temperatures and less than its designed capability when engaged in overland operations at higher altitudes and relatively higher temperatures.

The HLH is intended to be a multi-service helicopter and as such will be available for lifting most of the heavier items of Navy and Marine Corps equipment during operations on shore which are beyond the capability of the CH-53E. There are also some items of essential Army tactical equipment which are heavier than the designed lift capability of the HLH. The Army anticipates that with fuel and range trade-offs these, too, could be lifted by the HLH.

The primary mission of the HLH, however, will be the unloading of containerized cargo. Its 22.5-ton design point was based on the need to lift 20-foot containers having a 22.4-ton gross weight capacity. In fiscal year 1972, about 80 percent of these containers used in overseas military shipments carried cargo weighing less than 16 tons.

There are only three items shipped that can gross a 20-foot container, one being ammunition. However, restrictions on the transportation of ammunition imposed for reasons of security and safety, have up to the present time, limited the use of containers for this purpose.

The Army expects the magnitude of containerized ammunition shipments to increase, having obtained the approval from the regulatory agency this past February to ship ammunition in its Government-owned MILVAN containers for a period of one year. The Army is also working on resolving remaining difficulties in order that it will also be able to ship ammunition in commercial containers which it uses extensively. The average gross weight of cargo shipped overseas in 20-foot containers should increase once the Army begins to use them for this purpose on a regular basis.

AGENCY COMMENTS

A draft of this staff study was reviewed by Army and Navy officials associated with the management of these programs and comments were coordinated at the Headquarters level. The Army and Navy comments are incorporated as appropriate. As far as we know there are no residual differences in fact.

CHAPTER 1

INTRODUCTION

The Army and the Navy each require a helicopter for lifting heavy loads. The Army requires one to lift numerous items including loaded cargo containers, combat vehicles, and artillery pieces. The Navy and Marine Corps require a helicopter to move cargo and troops internally and to move heavy equipment and supplies externally. The Navy and Marine Corps require a helicopter which is shipboard compatible--that is, it must be of a size and weight to enable it to be based, maintained and operated aboard Navy amphibious ships.

The Army presently uses the CH-54 helicopter, which is generally capable of lifting in the neighborhood of 9.5 to 11.5 tons at sea level, depending on differing operating conditions. It also uses the CH-47C, the latest version of which can lift approximately 10 to 12 tons as governed by existing operating conditions. The Navy presently uses the CH-53D, which generally has a capability of lifting about 7 or 8 tons. Each service has sought helicopters with a much greater lift capability than those they presently have in order to improve their operational capabilities.

The lift capability of a helicopter must be understood in terms of the environmental conditions and load factors in which it operates. Altitude and temperature, for example, are two factors which influence lift capability. Generally, the lift capability is greatest at sea

level with low temperatures and diminishes at higher elevations and higher temperatures.

The Army, in 1969, proposed to begin development of an HLH capable of lifting 23 tons under environmental conditions of 4,000 feet above sea level and 95°F temperature. The Navy recommended development of a shipboard compatible helicopter that would lift heavy equipment weighing up to 18 tons at sea level, 90°F, for Marine amphibious assault operations and for a future ship-to-ship logistic support role.

At this time, congressional interest was expressed in an HLH that would satisfy the requirements of both the Army and the Navy. A DOD task force studied the matter and concluded that a single HLH could not be designed that would meet the Army's minimal heavy lift requirements and still be shipboard compatible. The primary obstacle is that an HLH of a size and weight needed to achieve this lift capability would be too large to be based on Navy amphibious assault ships.

The DOD approved a program on September 17, 1970, which specified joint Army and Navy development of a heavy lift helicopter rated at 22.5 tons at sea level, 95°F, starting with the development of critical components. The Army was designated as lead service for the development program.

In February 1971 the Army received proposals from five contractors for the critical components phase of the development program. However, the DOD concluded that none of the proposed helicopter designs were fully compatible with the Navy's amphibious assault ship (LHA) from an operational point of view.

On May 7, 1971, the DOD approved the Army managed HLH program and authorized the Navy to submit its request for a smaller shipboard based helicopter. The Navy proposed a program to improve the CH-53 series helicopter and designated the improved version as the CH-53E. The DOD authorized the CH-53E development effort to be limited initially to two prototypes.

On June 25, 1971, the Army awarded a contract to the Boeing Vertol Company for the critical components phase of the heavy lift helicopter development program. The work under the contract is scheduled for completion in June 1974. It provides for design, construction and test of critical components for a 22.5-ton payload helicopter. The critical components comprise such items as the rotor drive system, cargo handling system, and flight control system. From this phase the Army expects to gain:

--increased technical knowledge to reduce the risk of developing a 22.5-ton helicopter, and

--a cost data base to assure that cost estimates for such a helicopter are credible.

The contract was modified by the Army on January 29, 1973, to include a single prototype.

On September 29, 1972, the Navy awarded a contract to Sikorsky Aircraft for continued design and fabrication of two CH-53E prototype aircraft. This phase is scheduled for completion in October 1974.

SCOPE OF REVIEW

Information on the heavy lift programs was obtained by reviewing plans, reports, correspondence, and other records and by interviewing

officials at contractor plants, the system program offices, intermediate and higher commands of the Department of the Army, the Department of the Navy, and the Office of the Secretary of Defense. We evaluated management policies and the procedures and controls related to the decision-making process, but we did not make detailed analyses or audits of the basic data supporting program documents. We made no attempt to: (1) assess the military threat or the technology, (2) develop technological approaches, or (3) involve ourselves in decisions while they were being made.

CHAPTER 2

THE ARMY MANAGED HLH PROGRAM

The HLH will be used by the Army in both logistical and tactical missions.

The logistical mission involves the off-loading from ship to shore of containerized cargo. The HLH is needed in situations where it alone could provide this lift capability--situations such as arise at unimproved ports where cranes are not available on shore to perform this service.

The tactical mission involves lifting heavy tactical equipment such as vehicles, artillery pieces and construction equipment for onshore operations.

Army requirements documents dating from 1969 showed a need for a helicopter designed to lift, as its primary loads, equipment weighing up to 23 tons at 4,000 feet above sea level. After the Congress directed that the new helicopter be designed so that it could be usable by both the Army and the Navy, the Army accepted DOD's proposal that it reduce its requirement to a helicopter that would lift 22.5 tons at sea level, 95°F, in an effort to make the helicopter shipboard compatible.

With the design thus reduced, the HLH will still be too large to meet the Navy's shipboard basing requirement, namely, hangar deck basing on the amphibious assault ships (LHA and LPH classes). It could be used, we understand, for Navy land based heavy lift operations. The 16-ton CH-53E, which the Navy is developing, will be small enough to be operated, maintained and based on Navy amphibious ships, specifically, the LHA and LPH.

The new HLH still leaves the Army without the capability of lifting some of its heavy tactical equipment at higher elevations unless fuel and range are reduced. This is because the lift capability diminishes as elevation increases. At 4,000 feet above sea level, 95°F, for example (the Army's primary operating condition for tactical missions), the lift capability of the HLH is currently estimated to be 19.2 tons.

The HLH design point was fixed at 22.5 tons so that it could handle cargo transported in containers which have a gross maximum capacity of 22.4 tons. This is the capacity of the MILVAN container, 6700 of which the Army now owns. But by far the larger portion of the DOD's containerized shipments overseas are made under contract with commercial haulers. The 20-foot commercial container has the same 22.4-ton capacity as the MILVAN.

The larger commercial containers have greater capacity. The Army informed us that the larger containers account for more than 70 percent of the cargo moved. The HLH is expected to lift many of the larger-sized containers too, depending on their cargo-laden gross weight.

Up to now most shipments have been by conventional breakbulk fleet. Breakbulk ships are slated to be replaced by a fleet featuring a containerized shipment system so that the percentage of containerized cargo outbound from the United States is expected by the Army to increase by 1975 from its present 50 percent to about 75 percent of all cargo shipped.

It has been estimated by the Army that in a combat environment ammunition represents about 60 percent (by weight) of the dry bulk cargo that would be shipped to a theater.

The shipment of ammunition in the Continental United States involves certain safety and security risks and this is one reason why containers have rarely been used up to now for this purpose. The Army is trying to resolve these problems so that it will be able to use containers for ammunition shipments.

SHIPBOARD COMPATABILITY

In its requests for proposals, the Army specified that the helicopters were to be designed within certain size and weight limitations so that they would be shipboard compatible with the LHA. Of the five designs submitted in response to the requests for proposals, two were in accordance with the limited dimensional and weight details specified. However, the Source Selection Advisory Council concluded that none of the proposed designs were fully compatible with the amphibious assault ship (LHA)--that is, capable of having the required maintenance performed on board the LHA. This is planned to be the Navy's largest amphibious ship.

A Conference Report on the 1972 Appropriations Bill, dated December 14, 1971, directed the DOD to revise the Army heavy lift helicopter design so that it would be suitable for shipboard use by the Navy. The DOD, however, has not moved in the direction indicated in the Conference Report. In fact, it has eliminated from its advanced technology component program certain items which apply to shipboard compatibility requirements. It has been the DOD position that it is not practicable or desirable to constrain the operational capability of the Heavy Lift Helicopter so that it could be based on Navy ships.

The degree of shipboard compatibility that current and planned DOD helicopters have with Navy ships is contained in the following table.

DEGREE OF COMPATIBILITY WITH NAVY SHIPS

Ships	Helicopters			
Aviation Classes	[b]CH-47C	CH-53D	CH-53E	[b]Army Heavy Lift Helicopter
CVA-59	T	X	X	T
CVA-41	T	X	X	T
CVA-19	T	X	X	T
CVS- 9	T	X	X	T
LHA- 1	T	X	X	T
LPH- 2	T	X	X	[a]H
Non-Aviation Classes				
LPD- 1	T	T	T	[a]H
LKA- 113	T	T	T	H
AFS- 1	H	H	H	O
AOE- 1	T	T	T	H
AOR- 1	T	T	T	H
LSD- 28	T	T	T	H
LSD- 36	T	T	T	H
LST-1179	T	T	T	O
AE - 26	H	H	H	O

X - Deployable, with no physical restrictions (Hangar deck based).
T - Temporary basing/operation (Flight deck based).
H - Hover/lift operations only.
O - Incompatible with obstruction clearance or flight deck strength.

Note: [a]The quadricycle landing gear was eliminated from the advanced technology component program. By doing this, the Army eliminated the temporary basing/operation capability of the helicopter with the LPH and LPD class ships.

[b]The Navy advised us that neither the CH-47C nor the HLH have folding rotor blades and therefore are not deployable without physical restrictions.

OPERATIONAL AND PAYLOAD REQUIREMENT

In 1969, the Army requirements for a heavy lift helicopter specified one that could lift a 23-ton payload at 4,000 feet altitude, 95°F temperature, hover out-of-ground effect, 500 feet per minute rate of climb, and the ability to transport the load 100 nautical miles. These requirements

were developed from a study which shows that to have a 95 percent probability of mission success a helicopter must be capable of lifting its designed payload under these environmental conditions, and in a hover out-of-ground effect. The payload requirement was based upon the Army's need to lift the following items of essential equipment: maximum loaded MILVAN container (22.4 tons), mechanized infantry combat vehicle (22 tons), self-propelled medium artillery (22.5 tons), bridging (20 tons), dozer (23 tons), air defense artillery (19-20 tons), and mobile supply vehicle (20-21 tons).

The Army subsequently received DOD and Congressional approval for an alternate helicopter design with a 22.5-ton payload at sea level, 95°F temperature, hover out-of-ground effect. At 4,000 feet altitude, 95°F temperature, hover out-of-ground effect, the Army currently estimates the lift capability of the HLH to be approximately 19.2 tons. If this capability is realized the Army believes the HLH will be capable of lifting the essential tactical equipment enumerated above by reducing the amount of fuel carried and the mission range.

As noted earlier, the helicopter's lift capability would be influenced by atmospheric and other factors. Thus, just as it estimates a 19.2-ton lift capability for the shore based missions, so does the Army estimate that given the operating conditions of sea level, 90°F, hover in-ground effect, the HLH would be able to lift containerized and other cargo weighing up to 33.6 tons.

LOGISTICAL MISSION REQUIREMENTS

The Army, in testimony before congressional committees, has stated that the heavy lift helicopter's greatest impact on the operations of all types of maneuver forces would be its ability to lift the fully loaded MILVAN container in ship-to-shore and aerial port clearance movements. Army officials have told us that their testimony was intended to cover not only the MILVANs but also the more frequently used standard commercial containers.

Containerized Shipments of Military Cargo From the Continental United States

The majority of cargo shipped overseas is loaded into 35- and 40-foot containers. Statistics furnished by the Army show that the following shipments were made in these containers in fiscal year 1972:

Container Size	Up to 16 tons	16 to 20 tons	21 to 25 tons	Over 25 tons
35-foot	23,464	12,226	15,390	19
40-foot	23,471	7,384	5,686	110
TOTAL	46,935	19,610	21,076	129

The Army states that at sea level the HLH would be capable of lifting all of the larger containers loaded up to 22.5 tons and, under certain conditions, some whose gross weight is higher.

Although the larger containers carry most of the military cargo shipped overseas, the HLH design point of 22,5 tons was based on the proposed use of the 20-foot container loaded to its gross 22.4-ton weight.

The Army statistics show that the HLH would have been capable of lifting virtually all shipments in 20-foot containers made from the

Continental United States during the fiscal year 1972. The breakdown of these shipments, by weight, follows:

Gross Container Weight	Number of 20-Foot Containers
Up to 15 tons	48,514
16 - 20 tons	11,950
Over 20 tons	296

Containerized Shipments of Ammunition

Army officials also stated in testimony that there are three categories of items that would fill a MILVAN container to its maximum gross weight--ammunition, spare parts and items such as engineering barrier materiel. Due to constraints on the transporting of ammunition, MILVAN containers have rarely been used to ship this item.

The Army expects the use of MILVANs for ammunition shipments to increase as a result of progress recently made towards resolving several of the attendant problems. It is trying to resolve problems connected with the use of commercial containers for ammunition shipments so that these, too, could be used for this purpose.

Three factors which have limited the use of MILVANs and commercial containers for ammunition shipments are (1) the difficulty of achieving economic cube utilization with ammunition-laden MILVANs, (2) problems with safety and security, and (3) the limited number of available ammunition ports which could handle these shipments.

The Army, in an Ammunition Container Criteria study, found that current ammunition pallet configurations were such that the utilization of the full MILVAN payload capacity of 22.4 tons was impracticable, except for the most dense items such as bombs and large caliber projectiles.

Cube utilization is particularly important in moving any cargo overseas in containers since both port handling and transoceanic line-haul costs are based on volume rather than weight. Significant economic penalties are incurred when container cube is poorly utilized. The Army advised us that it is currently revising its ammunition pallet configuration to permit better utilization of the full 20-foot container capacity of 22.4 tons.

The use of containers for the shipment of ammunition has also been limited by safety and security factors which require placing restrictions on transporting ammunition over highways and rail lines. Storage loading and movement of ammunition is closely regulated by various agencies including DOD, the Department of Transportation, the Coast Guard, and the Bureau of Explosives.

Further, the Army informed us that most ports currently have only a limited capability for handling the shipment of containerized ammunition.

The Army informed us that the safety questions have been resolved to the extent that MILVAN containers were certified by the Department of Transportation in February 1973 for the shipment of ammunition for a period of one year. The Army is trying to resolve problems connected with the shipment of ammunition in commercial containers so that these, too, could be utilized for this purpose.

The Army also told us that port facilities are being upgraded so that more will be able to handle containerized shipments.

The Army also furnished us with statistics on seven recent test shipments of containerized ammunition. These averaged out to a gross weight of 18.6 tons per container. As test data is developed and remaining loading and safety questions resolved, the Army anticipates that the median gross weight will be approximately 20 tons per container.

CHAPTER 3

NAVY CH-53E PROGRAM

The CH-53E is to be a shipboard compatible helicopter for the performance of certain Navy and Marine Corps missions. Shipboard compatible helicopters are primarily used for the Marine Corps' amphibious assault mission.

The CH-53E program is designed to provide a big increase in lift capability over the helicopters currently available without having to significantly advance technology. Since most of the critical components of the CH-53E will represent strengthened and tested versions of helicopter components in use, it is considered a low risk program. The current development plans call for the first CH-53E to be delivered in 1977, about 3 years before the Army managed heavy lift helicopter.

The CH-53E is being designed to lift 16 tons at the operating conditions of sea level, 90°F temperature, and 100 nautical miles. Its lift capability will be affected when environmental conditions change, for example, when operating at higher elevations and in higher temperatures. A comparison of its lift capabilities with those of other helicopters used by the services, under various operating conditions, is shown in the following table.

PAYLOAD CAPABILITIES

Operating Condition	Helicopters CH-53D	[b]CH-47C	[a]CH-53E
Sea level, 90°F, hover in-ground effect, 100 nautical miles	7.2 tons	10.5 tons	16.1 tons
Sea level, 95°F, hover out-of-ground effect, 100 nautical miles	6.9 tons	10.1 tons	13.4 tons
3,000 feet altitude, 91.5°F, hover out-of-ground effect, 100 nautical miles	4.5 tons	9.3 tons	10.0 tons
4,000 feet altitude, 95°F, hover out-of-ground effect, 100 nautical miles	3.7 tons	8.5 tons	8.9 tons

[a]Payloads for this helicopter are based upon its designed operating capabilities.

[b]Army version without automatic blade fold, non-corrosive material, armor, or Navy avionics, which the Navy advised would reduce payload by one ton under each of the operating conditions cited above.

CH-53E LIFT CAPABILITY CONSTRAINED BY SHIP COMPATIBILITY REQUIREMENT

The CH-53E, as designed, provides the Navy and Marine Corps with a significant increase in lift capability and meets the ship compatibility requirement. At the same time, this requirement constrains the CH-53E from lifting some of the heavier mission equipment. The Army managed heavy lift helicopter is being designed to fill all services' needs for heavy lift in shore based operations.

The degree to which the current inventory of helicopters, the CH-53E, and the Army managed heavy lift helicopter, could accomplish Navy and Marine Corps missions is shown in Appendixes I and II. Examples of Navy and Marine Corps missions and the extent to which the CH-53E is being designed to perform them are described below.

Marine Corps Missions

Each of the Marine Corps missions involves or results from an amphibious landing where in some cases the CH-53E may be required to operate at 3,000 feet altitude, 91.5°F temperature. Although the performance of the CH-53E should surpass that of current inventory helicopters, there are still several types of divisional equipment which the CH-53E will not be able to lift at that altitude.

I. Amphibious Assault

To perform this mission, the Marine Corps requires that the helicopter be shipboard based on amphibious ships and be capable of lifting troops and equipment ashore in a mid-range amphibious assault.

Presently, the primary assault vehicle for this mission is the CH-53D, which has operational capability of lifting a payload of 7.2 tons at sea level, 90°F temperature, hover in-ground effect, on a 100 nautical mile mission. On assault missions, where range is a factor, the CH-53D can lift 4 tons within a 227 nautical mile range. This capability indicates that the CH-53D can adequately perform the mission of lifting troops in an assault.

At sea level, 90°F, hover in-ground effect, the Navy states that the CH-53E will lift 94 percent of the projected (mid-range) Marine Corps equipment that may require tactical lift during amphibious assault. This compares to 36 percent which can be lifted by the CH-53D and 65 percent for the CH-47C. A shore based HLH with a 22.5-ton payload, at sea level, would be able to lift 100 percent of this equipment.

For missions which may require operations at 3,000 feet, 91.5°F, the CH-53E would be able to lift 81 percent of the combat equipment requiring tactical lift, according to the Navy.

II. Retrieval of Downed Aircraft and Heavy Equipment

This mission involves operations ashore subsequent to an amphibious landing and may involve operating conditions of 3,000 feet, 91.5°F. In an aircraft retrieval from a combat zone, the Navy does not expect that the retrieval of high performance fixed wing aircraft will be a factor since these aircraft are normally totally destroyed upon ground contact. Downed helicopters, on the other hand, seldom sustain serious damage and, if expeditiously recovered, can be quickly repaired and returned to an operational status.

The Navy states that the CH-53E will be capable of returning all other models of Marine Corps assault helicopters at altitudes in excess of 3,000 feet and at temperatures greater than 91.5°F. The Navy also states that the CH-53E will be capable of recovering a downed CH-53E at altitudes near sea level. This could also be accomplished under the 3,000 foot/91.5°F condition but a certain amount of disassembly of the downed helicopter for the purpose of weight reduction would be required.

In the recovery of projected Marine Divisional equipment weighing in excess of 8 tons, the Navy anticipates the CH-53E will lift 81 percent of such equipment at 3,000 feet, 91.5°F and 94 percent at sea level, 90°F. This capability, while below that of the shore based HLH, is a quantum improvement over currently operational helicopters.

III. Tactical Movement of Weapons and Equipment

The Navy expects the CH-53E to be able to lift 94 percent of Marine Corps weapons and tactical equipment during operations ashore at sea level, 90°F. For missions which may require operations at 3,000 feet, 91.5°F, the CH-53E is expected to lift 81 percent of that equipment.

A Marine Corps Tactical Mobility Study, completed in 1972, indicates that at sea level, the CH-53E will lift all essential items required to establish and support Marine aviation ashore.

Navy Missions

I. Vertical On-Board Delivery Services for Ships not in Company with a Carrier

This mission is based upon the need to deliver high priority fleet freight, mail and passengers directly to all ships, permitting them to remain on station for greater periods of time. This service is not presently available to ships which are not in the company of a carrier but it is being patterned after the carrier on-board delivery services available to ships in the company of a carrier.

A specific payload and range have not been specified by the Navy for this mission. The increased range/payload capability of the CH-53E over the CH-53D is the reason the Navy is specifying vertical on-board delivery as its prime mission for a CH-53E. The Navy has estimated that the CH-53E will be capable of delivering a 3.5-ton payload a distance of 1,080 nautical miles. For the CH-53D to obtain a range which would be useful for this mission, it would necessitate the addition of external fuel tanks at the expense of payload lift capability. The

Navy estimates that the CH-53D helicopter with external tanks could deliver a 3.5-ton payload a distance of 520 nautical miles. We were advised by the CH-53D project officer that the Navy has installed fuel tanks on at least two of its CH-53Ds.

II. Removal of Battle Damaged Aircraft from Aircraft Carrier on Station

There are 26 types of Navy aircraft, weighing from 2.5 to 33.5 tons, which may require helicopter lift from an aircraft carrier. This data was obtained from the Navy's heavy lift helicopter requirements study.

The Navy stated during fiscal year 1973 hearings before the Senate Committee on Armed Services that the CH-53E can lift and transport 92 percent of the projected 1975 Navy aviation inventory up to 100 nautical miles. If environmental conditions increase above the CH-53E's design point capability, this percentage would decrease.

III. Movement of Mobile Construction Battalion Heavy Equipment

The Navy states the CH-53E will lift 88 percent of the heavy equipment in this mission and that it would require a 36-ton lift capability to significantly increase this percentage. We verified that the CH-53E should be capable of lifting 88 percent of the types of heavy equipment at sea level, 90°F, but that the Army heavy lift helicopter, with a 22.5-ton lift capability at sea level, should be able to lift 97 percent of this heavy equipment.

Since this is an ashore mission, it is necessary to evaluate the CH-53E on its ability to lift this equipment when operating at a condition more demanding than sea level, 90°F temperature (such as 3,000

feet altitude, 91.5°F temperature). At this more stringent condition, the CH-53E is designed to lift 75 percent of the types of equipment in this mission.

IV. Loading and Off-loading Ships in Unimproved Ports

This mission requires the rapid and responsive logistical support following an amphibious assault, and the support of advanced naval units and facilities ashore. The Navy states that the MILVAN containerization concept will apparently be the major supply handling method of the future and that the CH-53E capability can significantly assist naval forces in this regard. The Navy will have to limit its denser cargoes to a gross weight of 16 tons per MILVAN, instead of the 22.4-ton MILVAN maximum.

[a]CAPABILITY OF ACCOMPLISHING MARINE CORPS MISSIONS

Helicopter	Payload	Environmental condition	I - Amphibious assault	II - Retrieval of downed aircraft and heavy equipment		III - Tactical movement of weapons and equipment
				Aircraft	Heavy Equipment	
CH-53D	13.0 tons	3,000 Ft., 91.5°F hover out-of-ground effect	81	82	75	Approx. 81
CH-53E	16.1 tons	Sea level, 90°F hover in-ground effect	94	100	94	Approx. 94
CH-53D	7.2 tons	Sea level, 90°F hover in-ground effect	36	60	36	36
[b]CH-47C	10.5 tons	Sea level, 90°F hover in-ground effect	[b]65	60	65	65
[b]Army HLH	22.5 tons	Sea level, 95°F hover out-of-ground effect	[b]100	100	100	100

[a]Performance capability expressed in percent.

[b]The CH-47C and HLH are not fully shipboard compatible with the LHA and LPH class ships.

[a]CAPABILITY OF ACCOMPLISHING NAVY MISSIONS

Helicopter	Payload	Environmental condition	I - Vertical on-board delivery services for ships not in company with a carrier	II - Removal of battle damaged aircraft from aircraft carriers on station	III - Movement of Mobile Construction Battalion heavy equipment	IV - Loading and off-loading ships in unimproved ports
CH-53E	13.0 tons	3,000 ft., 91.5°F hover out-of-ground effect	[b]	NA	80	[c]
CH-53E	16.1 tons	Sea level, 90°F hover in-ground effect		89	88	
CH-53D	7.2 tons	Sea level, 90°F hover in-ground effect		51	49	
CH-47C	10.5 tons	Sea level, 90°F hover in-ground effect		62	70	
[d]Army HLH	22.5 tons	Sea level, 95°F hover in-ground effect		100	93	

[a]Performance capability expressed in percent.

[b]Specific payloads are not identified for this mission. An increased range capability is desired by the Navy to perform it.

[c]This mission is the ship-to-shore movement of breakbulk and containerized cargo. The Navy states payloads for this mission will be restricted to 16 tons by repacking containers prior to shipment.

[d]The Army CH-47C and HLH are not fully shipboard compatible with the LHA and LPH class ships.