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U.S. GENERAL ACCOUNTING OFFICE

STAFF STUDY

[CH-53E HELICOPTER]

DEPARTMENT OF THE NAVY

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ABBREVIATIONS

DCP	Development Concept Paper
DDR&E	Director of Defense Research and Engineering
DOD	Department of Defense
DSARC	Defense Systems Acquisition Review Council
HLH	Heavy Lift Helicopter
IDA	Institute for Defense Analyses
LHA	Landing Helicopter Assault
LPH	Landing Platform Helicopter
SAR	Selected Acquisition Report
SPOTS	Sikorsky Program Operations Tracking System
SSR	System Status Report
UTTAS	Utility Tactical Transport Aircraft System

CH-53E HELICOPTER

SYSTEM DESCRIPTION AND STATUS

The CH-53E helicopter is to be an improved version of the shipboard based CH-53 helicopter with greater lift capability. It is to be utilized by the Marine Corps and Navy for the following missions:

Marine Corps

1. Lift for amphibious assault.
2. Retrieval of downed aircraft and heavy equipment.
3. Tactical movement of weapons and equipment.

Navy

1. Vertical on-board delivery services for ships not in company with a carrier.
2. Removal of battle damaged aircraft from aircraft carriers on station.
3. Movement of mobile construction battalion's heavy equipment.
4. Loading and unloading cargo in unimproved ports.
5. Providing towing capabilities for craft, vehicles, and mine countermeasures (MCM) devices.

The Navy's July 1972, CH-53E Development Plan identifies the program objectives as designing, developing, fabricating and demonstrating a prototype CH-53E helicopter which would satisfy the Navy and Marine Corps requirements for increased lift capability, be compatible with Navy amphibious shipping, and retain maximum commonality with the existing CH-53D helicopter. The proposed CH-53E is designed to deliver a 32,500 pound external payload* with a mission radius of 50 nautical miles or a 17,900 pound internal payload** with a mission radius of 100 nautical miles. A ferry range capability of 1,240 nautical miles can be realized through addition of two 650 gallon external and seven 300 gallon internal fuel tanks.

*Take-off condition: in ground effect at sea level, 90°F.

**Take-off condition: out of ground effect at 3,000 feet, 91.5°F.

The Navy informed us that its fiscal year 1973 funding request of \$28 million had been reduced to \$10 million by the Office of the Secretary of Defense (OSD). Although the Congress approved the full \$10 million, the Navy stated that the reduction will delay the CH-53E development schedule by approximately one year. In addition, the Director of Defense Research and Engineering then withheld the \$10 million pending the results of the CH-53E Development Plan review. By December 1972, \$6.7 million of this amount had been released to the Navy which will allow the program to continue through March 1973. The remaining \$3.3 million is still being withheld.

CONTRACT DATA

When the full \$10 million is received, the Navy plans to negotiate a cost-plus-incentive-fee contract with Sikorsky for the Phase I Research and Development effort. In the meantime, approximately \$6.7 million has been added on to an existing CH-53E cost-plus-fixed-fee design contract with Sikorsky.

COST

The June 30, 1972, current cost estimate has increased by \$11.8 million to \$652.4 million over the previous year's current estimate because of (a) an increase in the number of CH-53E prototypes from two to four and (b) inclusion of 7 percent compound annual inflation for direct labor and 5 percent for materials and other direct costs. The Navy's estimate did not identify any specific dollar amounts for inflation.

The June 30, 1972, CH-53E current cost estimate for Research and Development (which includes advanced development and engineering development) is \$100.3 million. Procurement costs were estimated at \$552.1 million, however, the Navy informed us that its November 1972, DCP estimate is \$478.2 million.

The Congress has appropriated \$22 million for the CH-53E program since fiscal year 1970, however, \$9 million of this was reprogrammed to the Heavy Lift Helicopter program.

PERFORMANCE

The Navy as well as contractor officials associated with the program consider the technology to build the CH-53E to be well-in-hand. Their contentions are based on results of their prior Research and Development (R&D) efforts on technological advancements which they plan to incorporate into the CH-53E. They assess the program as being low risk. Navy officials advised us that no problems have yet been uncovered which cannot be resolved by further engineering effort.

Since the CH-53E prototype has its first flight scheduled for March 1974, no performance experience existed as of the conclusion of our review.

We obtained the latest estimated performance characteristics from the Navy. These characteristics vary only slightly from those reported in our March 1972, CH-53E staff study. The differences are due to refinements of estimates as the aircraft design nears the hardware stage.

PROGRAM MILESTONES

Our review of the schedule of major milestones revealed that the Board of Inspection Survey/Initial Operating Test and Evaluation testing was scheduled to begin approximately two months prior to the Defense Systems Acquisition Review Council (DSARC) review, but was not scheduled to be completed until approximately two months after the review and production contract award. In February 1973, the Navy notified us of a change in milestones concerning this testing. The program milestone for DSARC III (production decision) now follows the completion of Board of Inspection Survey/Initial Operating Test and Evaluation.

RELATIONSHIP TO OTHER SYSTEMS

After the Congress expressed an interest in an HLH that would satisfy the requirements of both the Army and Navy, DOD approved a program on September 17, 1970, which specified joint Army and Navy development of an HLH design aimed at meeting multi-service requirements. However, DOD has now proceeded with the development of two separate helicopter systems, one for the Army (HLH) and the other for the Navy (CH-53E) after concluding that a single HLH would not meet the needs of both services.

The CH-53E is being designed to be fully operable and maintainable aboard Landing Platform Helicopter (LPH) and Landing Helicopter Assault (LHA) class ships and operable on-board other prime amphibious and non-aviation Navy ships.

SELECTED ACQUISITION REPORTING

The CH-53E program is not currently included in the SAR reporting system. We believe that since the CH-53E program meets the SAR reporting requirements and there is considerable congressional interest in this program, it should be included on the quarterly SAR.

PROGRESS MEASUREMENT

The Navy informed us that when the Phase I Research and Development contract is negotiated with Sikorsky (upon release of the remainder of the \$10 million appropriated funds), this contract will require a cost and schedule control system in conformity with DOD criteria. These criteria require that the contractor's control system provide data which properly relate cost, schedule and technical performance.

Sikorsky's proposed control system is currently undergoing DOD evaluation in connection with an Army helicopter program (the UTTAS) and the CH-53E Project Manager expects approval of Sikorsky's control system in May 1973, for use on the CH-53E.

MATTERS FOR CONSIDERATION

On October 14, 1971, a Defense Systems Acquisition Review Council (DSARC) meeting was held to discuss the draft DCP for an improved CH-53 helicopter program. There appeared to be considerable disagreement between the Navy and the DSARC concerning the need for the CH-53E.

In commenting on the draft DCP, DSARC member(s) stated:

"A review of analysis conducted to support an increased lift capability for satisfying Marine and Navy requirements reveals that current DOD inventory helicopters are capable of lifting all critical combat or combat support loads in a Marine amphibious assault. Further, these inventory helicopters in conjunction with the proposed DOD HLH performing the essentially shore-based missions could satisfy the Navy requirements."

On November 1, 1971, DOD authorized the Navy to proceed with a CH-53E development effort.

DOD is now proceeding with separate helicopter systems--the Army HLH and the Navy CH-53E--after concluding in January 1972, that a single HLH would not meet the needs of both services.

AGENCY COMMENTS

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

CHAPTER 1

INTRODUCTION

HISTORY OF THE PROGRAM

The need for a Navy HLH was initially formalized in an October 1967 Specific Operational Requirement. The Navy rationale included the requirement to increase tactical mobility and improve materiel handling for logistic support. During operations ashore, this HLH would have been required to lift heavy mission essential equipment up to an 18 ton limit and recover damaged equipment and aircraft. The Navy HLH would have been shipboard compatible with a payload lift capability rated at 18 tons at sea level, 90°F temperature.

Subsequent to the publication of the Specific Operational Requirement, the Navy and industry studied various methods to satisfy the Navy's needs for a helicopter with increased lift capability. One of these studies concluded that a lift capability of 17 to 18 tons was the minimum acceptable for the support of Navy operations. The primary recommendations from two other studies were:

1. An 18 ton HLH should be developed and procured as expeditiously as possible.
2. Strong consideration should be given to the development of a heavier lift vehicle in the 25 ton range to meet the outstanding requirement for large volume transport of fully laden containers and for movement of other military hardware in this payload class.

In August 1969, the Navy recommended to DOD that engineering development of the HLH be initiated and that immediate authorization be granted to the Navy to prepare and issue Requests for Proposals to contending contractors.

In early 1970, a joint Army and Navy Working Committee was formed to study the development of a joint service HLH. A Navy HLH rationale paper used by the Committee stated that the Navy and Marine Corps missions supported a requirement for an HLH with a capability to lift 18 tons under the ambient conditions of sea level, 90°F temperature.

The Committee found that acceptance of a compromise multi-service HLH with a 22.5 ton payload would deny its use on service force, amphibious assault and landing platform dock ships because of its projected size and weight.

In May 1971, the DOD directed the Navy to prepare a Development Concept Paper (DCP) for a helicopter that would meet its shipboard basing requirements. This resulted in DOD approval in November 1971, of a DCP which provided for an improved version of the CH-53 helicopter.

MULTI-SERVICE HLH DEVELOPMENT PROGRAM

After the Congress expressed an interest in an HLH that would satisfy Army, Navy and Marine Corps requirements, DOD approved a program on September 17, 1970, which specified joint Army and Navy development of a compromise HLH design aimed at meeting multi-service requirements, starting with the development of critical components. The Army was designated as lead service for the phased development program.

In October 1970, the Navy requested reconsideration of the September 17th decision. The Navy stressed the requirement for shipboard compatibility, the urgent need to support amphibious assault operations, and the lack of desire to expend any Navy funds toward the approved HLH which it felt it could not use. In considering their request DOD stated that the joint Army and Navy HLH would be sized and configured to meet minimum essential needs and that other alternatives could be considered later at the program review.

Shortly thereafter, the Secretary of the Army was appointed the Source Selection Authority and requests for quotations were released to industry in November 1970.

In February 1971, proposals were received from five contractors for the program. Each contractor submitted its own HLH design concept. The Source Selection Evaluation Board determined that two of the designs proposed were in accordance with the limited dimensional and weight details contained in the request for quotation. However, the Source Selection Advisory Council concluded that none of the proposed designs were fully compatible with the LHA (amphibious assault ship) from an operational point of view. It further concluded, however, that the Boeing/Vertol design had a higher degree of LHA compatibility than the other designs and showed a much higher degree of appreciation of the operational requirement.

SEPARATE ARMY AND NAVY HLH
DEVELOPMENT PROGRAMS

On May 7, 1971, DOD approved the award of the HLH contract for critical components to Boeing/Vertol and authorized the Navy to submit its request in a DCP for a smaller helicopter to meet its shipboard basing requirement.

In May 1971, DOD notified four congressional committees (House and Senate Committee on Appropriations and House and Senate Committee on Armed Services) that the 22.5 ton HLH design will meet the shore based requirements of all services but will be too large to be routinely stationed on the LHA amphibious assault ship.

On October 14, 1971, a Defense Systems Acquisition Review Council (DSARC) meeting was held to discuss the draft DCP for an improved CH-53 helicopter program. There appeared to be considerable disagreement between the Navy and the DSARC concerning the need for the CH-53E. In commenting on the draft DCP, DSARC member(s) stated:

"A review of analysis conducted to support an increased lift capability for satisfying Marine and Navy requirements reveals that current DOD inventory helicopters are capable of lifting all critical combat or combat support loads in a Marine amphibious assault. Further, these inventory helicopters in conjunction with the proposed DOD HLH performing the essentially shore-based missions could satisfy the Navy requirements."

On November 1, 1971, DOD authorized the Navy to proceed with a CH-53E development effort - limited to two prototype CH-53E's.

SCOPE

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 decisionmaking 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

WEAPON SYSTEM STATUS

The Navy informed us that the CH-53E program has been significantly changed as a result of funding constraints in fiscal year 1973. The Navy's fiscal year 1973 funding request of \$28 million was reduced to \$10 million by the Office of the Secretary of Defense (OSD). Although the Congress approved the full \$10 million, the Navy stated that the reduction will delay the CH-53E development schedule by approximately one year. Total program cost has increased by about five percent as a result of the extension. In addition, the Director of Defense Research and Engineering (DDR&E) then withheld the \$10 million pending the results of the CH-53E Development Plan review. By December 1972, \$6.7 million of this amount had been released to the Navy which will allow the program to continue through March 31, 1973. The remaining \$3.3 million is still being withheld.

In response to an April 1972, Navy Request for Proposal, the Sikorsky Division of United Aircraft Corp., submitted a \$35.9 million proposal for a new contract for the completion of prototype design, construction of two prototype vehicles and testing through the Navy preliminary evaluation. When the full \$10 million is received from DDR&E, the Navy plans to negotiate a cost-plus-incentive-fee contract with Sikorsky for the Phase I Research and Development effort. In the meantime approximately \$6.7 million has been added on to an existing CH-53E cost-plus-fixed-fee contract with Sikorsky.

On July 1, 1972, the Navy issued the CH-53E Development Plan. The Plan states the purpose of the program as designing, developing, fabricating and demonstrating a prototype CH-53E helicopter which will satisfy Navy and Marine Corps requirements for increased lift capability, be fully compatible with Navy amphibious shipping and retain maximum commonality with the existing CH-53D helicopter.

The Development Plan stipulates two distinct program phases. Phase I involves designing, developing, fabricating and testing two development prototypes and conducting tradeoff studies to insure that an optimum balance is achieved among improved performance, improved maintainability/reliability, cost, and component commonality with the existing CH-53 series. Phase II provides for the fabrication of two pre-production prototypes and one static test article, as well as testing and evaluation.

The Development Plan states that the CH-53E is a modification of the CH-53D, utilizing many proven components. The Plan noted that the CH-53E components which do incorporate new design concepts, (i.e., the canted tail, elastomeric rotor head and titanium spar main rotor blade), have been satisfactorily evaluated during both ground and flight testing and do not now pose significant risk problems.

In the CH-53E Development Plan the Navy provided detailed program plans for each of the conditions which the Deputy Secretary of Defense had listed as requiring special action.

The CH-53E program is not currently included in the Selected Acquisition Reporting (SAR) system, therefore, DOD furnished us with a June 30, 1972, System Status Report (SSR) on the CH-53E. The SSR

follows a format similar to the SAR but does not include as much detail. The following is our evaluation of the data provided in the June 30, 1972, SSR and the changes in cost, schedule or technical performance estimates since the previous year's SSR.

SYSTEM COST EXPERIENCE

The last two CH-53E SSRs showed the following cost estimates.

	CH-53E System Status Report	
	(In Millions)	
	<u>June 30, 1971</u>	<u>June 30, 1972</u>
Planning Estimate:		
Development Cost	\$ 71.1	\$ 71.1
Procurement Cost	569.5	569.5
	<u>\$640.6</u>	<u>\$640.6</u>
Current Estimate:		
Development Cost	\$ 71.1	\$100.3
Procurement Cost	569.5	552.1
	<u>\$640.6</u>	<u>\$652.4</u>

The Navy's June 30, 1972, current cost estimate has increased \$11.8 million over the June 30, 1971, estimate for two reasons. First, the number of CH-53E prototypes has been increased from two to four. (Note, however, that production aircraft have been reduced from 72 to 70.) Second, compound annual inflation of seven percent for direct labor and five percent for materials and other direct costs has been added. The Navy did not identify any specific dollar amounts for inflation.

The Navy informed us that its November 1972, procurement cost estimate is \$478 million, a reduction of \$74.4 million.

SYSTEM SCHEDULE EXPERIENCE

A comparison of the Navy's June 30, 1971, and June 30, 1972, schedule milestones shows that the program has been delayed for approximately one year. The milestones and accompanying dates are shown below:

SYSTEM STATUS REPORT OF
June 30

MILESTONES

	<u>1971</u>	<u>1972</u>
First flight of research and development prototype	Jul. 1973	Mar. 1974
Second flyable prototype	<u>Aug. 1973</u>	Apr. 1974
Navy Preliminary Evaluation II completed	Nov. 1973	Feb. 1975
Delivery of first preproduction aircraft	Not shown	Aug. 1975
Board of Inspection Survey completed	Mar. 1975	Feb. 1976
Initial operational capability for development prototypes	Apr. 1975	Mar. 1976

The Navy attributes the delay to the funding constraints discussed previously in this chapter. The Project Manager informed us that if additional funding is not received by March 31, 1973, additional slippage will occur.

SYSTEM PERFORMANCE EXPERIENCE

The CH-53E is planned to be a fuselage configured troop and logistics support helicopter designed to provide the Navy and Marine Corps with an increased lift capability. It is planned to be the largest class helicopter within current technology that can be operated and maintained aboard existing and planned naval amphibious shipping.

The CH-53E is planned to incorporate a redesigned 79 foot diameter main rotor (the 72 foot diameter blades common to the CH-53D with extenders mounted on the root ends of the blades), a 20° canted (tilted) 20 foot diameter tail rotor, 11,570 shaft horsepower transmission system, and three engines.

In congressional testimony during January 1972, the CH-53E was identified as a multi-mission heavy assault transport helicopter with a 16 ton capability over a 50 nautical mile radius. The CH-53E Project Manager's Office October 1972, estimate of payload capability was 16.25 tons.

The current Navy estimates for the proposed CH-53E performance and configuration characteristics are as follows:

	<u>Transport Mission¹</u>	<u>Cargo Mission²</u>
Hover gross weight (pounds)	56,300	69,750
Weight empty (pounds)	31,915	31,915
Payload (pounds)	17,900	32,500
Radius (nautical miles)	100	50
Cruise speed with payload (knots)	150	100

¹Conditions - 3,000 feet altitude at 91.5°F, hovering out-of-ground effect, internal payload.

²Conditions - sea level at 90°F, hovering in-ground effect, external payload.

We obtained the latest estimated characteristics from the CH-53E Development Plan and Naval Air Systems Command officials.

The estimated characteristics shown above vary only slightly from those reported in our March 1972, CH-53E staff study. The Navy attributes these differences to refinements of estimates as the aircraft design nears the hardware stage.

SELECTED ACQUISITION REPORTING

Weapon system acquisitions which are expected to have development funding of \$50 million or more, or procurement funding of \$200 million or more, meet DOD SAR reporting requirements. Since the CH-53E development and procurement cost estimates exceed the SAR requirements, and since there is considerable Congressional interest in the program, we recommend that the CH-53E program be included on the quarterly SARs.

PROGRESS MEASUREMENT

Program visibility on major weapon systems is essential because of their complexity, size, urgency and high dollar value. Obtaining this visibility requires a technique for providing current, accurate information which shows where an acquisition stands in relation to where it was expected to stand at a given point in time in terms of cost, schedule and technical performance.

Without such information, an accurate determination cannot be made on whether an acquisition is being accomplished at a cost higher or lower than was planned, is proceeding in accordance with established schedules, or is meeting its technical performance requirements. Conversely, when integrated cost, schedule, and technical performance data are reported regularly on a summarized basis and compared to firm, time-phased goals for these elements, early warning signs of impending cost overruns, schedule slippages, and performance degradations should be detected in sufficient time to initiate corrective action.

The CH-53E Development Plan states that the contractor will design and furnish a Project Profile Manual based on his planning, control and reporting system to the Project Manager. This manual is to provide the Project Manager and his staff with a uniform set of documents depicting project plans and progress in achieving these plans, and is to serve as a communication link between the contractor and Government management

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functions. The manual is to be used by the Project Manager in conjunction with the project master plan and is to contain progress reports and status data summarized for management use. It is to be continually updated by incorporation of contractually required reports.

The Navy informed us that when the Phase I Research and Development contract is negotiated with Sikorsky (upon release of the remainder of the \$10 million appropriated funds), this contract will require a cost and schedule control system in conformity with DOD criteria. This criteria requires that the contractor's control system provide data which properly relate cost, schedule and technical performance.

Sikorsky's proposed control system is called SPOTS, (Sikorsky Program Operations Tracking System). SPOTS is currently undergoing DOD evaluation in connection with an Army helicopter program (the UTTAS). The CH-53E Project Manager informed us that re-evaluation of SPOTS for its applicability to the CH-53E program will take place after approval is received for the UTTAS program. He expects approval of Sikorsky's control system for use on the CH-53E in May 1973.

The Navy plans surveillance of the contractor's system through the Defense Contract Administration Services Office and the Defense Contract Audit Agency to assure continued compliance with DOD criteria. Indications that a contractor's system is failing to comply with any of the DOD criteria can be cause for review or revocation of prior DOD approval.

Since Sikorsky's system is presently being evaluated by DOD, we did not attempt to evaluate the system.

Establishing Cost, Schedule, and Technical Baselines

If progress is to be measured with any degree of accuracy, it is important that realistic cost, schedule, and technical performance goals or baseline estimates for the program be developed and agreed to by the Government and contractor activities involved, and that controls be designed to prevent undisciplined changes to these goals. Therefore, we have reviewed the process used in developing CH-53E program estimates to determine its reasonableness for establishing baselines against which to measure progress.

In a previous review, we developed criteria considered basic to an effective estimating process. These included availability of valid data, broad participation in preparing estimates, use of a standard structure for estimating, provision for program risks, recognition of inflation, full disclosure of excluded costs, independent review of estimates, and revision of estimates when significant program changes occur. The importance of adequately documenting estimates was also stressed.

Cost Estimating Process

We reviewed the process used in preparing the June 30, 1971, development cost estimate and the subsequent revisions to that estimate in order to determine the reasonableness of the estimating process.

The purpose of the development cost estimates was to define as accurately as possible the cost of designing, developing, fabricating and demonstrating a prototype CH-53E helicopter.

Parametric cost estimating and engineering cost estimating techniques were utilized in the cost estimates. For example, by using historical data, a parametric cost to weight relationship was defined and projected in estimating the CH-53E airframe cost. When it was possible to define materials and/or labor required, the engineering approach was used.

Our review showed that:

- Documentation of the estimates was adequate.
- The latest estimates were based on data which appear to be valid.
- Adequate input was received from various sources that should participate in the estimating process.
- A Work Breakdown Structure was used in making the estimates.
- Inflation was included in the latest cost estimates.
- According to the Deputy Project Manager the project office updates its cost estimates every 4 to 6 weeks but it does not revise the baseline estimates unless significant program change occurs.
- The Navy believes that technical risk was considered in the cost estimates.

The Development Concept Paper (DCP) and Development Plan cost estimates stated that the program risk is relatively low and that the long lag time between R&D and production reduces the risk of having to retrofit aircraft already produced. Plans for trade-off studies include cost, schedule and technical risk analyses and comparisons to be made available to decision-makers.

We believe there is evidence that the Navy has not included a reasonable provision for technical uncertainties in the estimate. This is discussed below.

--The DCP cost estimate received an independent review in September 1971, by the Institute for Defense Analyses. The focus of the review was on costs related to technical risks and the validity of manufacturing-hour estimates and total airframe costs for production.

The Institute concluded that the \$570 million production estimate was acceptable. IDA also concluded that the \$66 million research and development estimate (i.e. the Navy's \$71.1 million less the \$5.1 million of prior years funds) was low and would most likely be approximately \$100 million. The \$34 million addition represents a provision for technical uncertainties in the program. The IDA draft report states:

"The baseline program of \$66 million for airframe development does not appear to have sufficient allowances for possible problems which may be encountered if difficulties develop with any of the known areas of technical risk. In other words, it is an 'all-success' program..."

"To summarize the evaluation of technical risk as affects cost, three points may be noted from the 'Development Program Assessment:'"

- 1) The CH-53E development program may be characterized as one which calls for substantial, but not unrealistic, improvements in performance of the CH-53D components--plus the development of certain essentially new components.
- 2) 'Almost all of the major components in the CH-53E require significant redesign, reconfiguration or strengthening in at least some of their elements even when such components are generally similar to the CH-53D.'
- 3) The integration of the components into a final configuration provides potential problems such as aerodynamic interference, unsteady loads, stability and control, handling characteristics and aeroelastic stability. 'In this respect the proposed CH-53E rotary wing is no different than other new developments as far as the possibility of encountering unknown and unexpected problems--.'

"It is extremely difficult to quantify the degree of technical risk and the associated cost, but a rough guess would suggest that ... the costs ... might increase as follows:

	<u>Millions</u>
Engineering and Manufacturing - One year at, say, \$33 million per year	\$ 33
Flight Test Hours (say 100 at \$10,000 per hour)	<u>1</u> <u>\$ 34</u>

On this basis, it is recommended that the baseline program be considered to be approximately \$100 million (66 million plus 34 million) when allowance is made for technical risks. (In committee discussion, some members felt that the program might go as high as \$120 million.)"

"In addition to the above costs, the committee recommends that a third test flight vehicle be added to the program. This is estimated by the Navy to cost \$5 million. A fourth flight test vehicle would cost approximately \$4 million."

The Navy's latest development cost estimate of approximately \$100 million appears at first glance to take the IDA judgement into account. However, the Navy estimate includes \$5.1 million of prior years funds and two additional flight test vehicles. If the IDA estimate is adjusted to reflect these facts approximately \$114 million becomes the IDA adjusted estimate comparable to the Navy's \$100 million estimate.

The Navy's latest development estimate does not include the provision for technical uncertainties recommended by IDA. The CH-53E Project Manager stated that in his judgement there are no technical uncertainties in the program which require a provision of this kind.

The Navy stated that the IDA conducted this study on a two day visit to the contractor's facility and that many of the risk areas have been resolved and remain well within the funding established by the Navy. The Navy considers IDA's parametric cost estimate of \$33 million to be excessive. The Navy added that although the program is austere through fiscal year 1974 based on recent fiscal reductions, the currently programmed funds for fiscal years 1975 and 1976 appear adequate to complete the entire R&D program.

Basically, there is a difference in judgment between IDA and the Navy with regard to the provision for technical uncertainties. Aside from this one questionable area in the Navy estimate, based on our review of the cost estimating process, including the latest revisions to the Navy's development cost estimates, we conclude that the process is reasonable.

Scheduling Process

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The CH-53E project office generates the development schedules. In establishing program schedules:

- Various organizations have participated, including the prime contractor, major subcontractors, all Naval Air Systems Command functional groups and DDR&E.
- Consideration has been given to the effect of program risks. Project office officials believe there are no major technical risks because many high risk items have been previously tested or flown.
- CH-53E project office officials consider DSARC and DDR&E to be the independent reviewers of the CH-53E program schedules. At the request of DDR&E, the Institute for Defense Analyses also performed a review of the proposed development program to upgrade the CH-53E. The Institute's draft report stated:

The overall program schedule is relatively slow for development with little concurrency between development and production. There should be ample time to discover and solve development problems before heavy commitments to production hardware are made. The time available allows many options for extension of flight and ground testing on critical problems.

Technical Risk

The CH-53E Development Plan identified the following actions and program approaches for eliminating or reducing potential risks.

- Commonality of parts with the CH-53D is being emphasized, although some parts require modification.
- Fabricating the prototype dynamic system test bed and some initial testing have revealed some typical development problems which have been solved using the test bed.
- The first prototype flight schedule has been extended 8 months, allowing additional time to incorporate design improvements.
- The prototype approach will validate a design which satisfies mission requirements.
- The prototype will provide close-to-production hardware for thorough testing.
- The prototype approach will reduce cost and performance uncertainties prior to production decisions.

The Development Plan also identifies the areas which require improvements over existing helicopter systems. These areas include the main rotor hub and blade, drive train, tail rotor configuration, stability and control, structural integrity, and hover and forward flight performance.

Sikorsky Aircraft's preliminary detail specifications for the CH-53E prototype helicopter stipulate a 300 pound weight contingency in the estimated empty weight of 31,915 lbs. A Naval Air Systems Command senior engineer indicated that this relatively small allowance for weight growth suggests the degree of confidence Sikorsky has in its design.

This engineer stated that the technology to build the CH-53E is well-in-hand and that it is a low risk program, requiring no real R&D effort or advanced development; many proven components from aircraft in existence prior to the CH-53E will be utilized. ~~The CH-53E Project~~ Manager stated that no significant problems have been uncovered that cannot be resolved by further engineering effort.

An independent review of the CH-53E program was performed by the Institute for Defense Analyses (IDA), at the request of DDR&E. The IDA review team consisted of civilian consultants from the National Aeronautical and Space Administration, the Air Force, Ohio State University and IDA staff members. The review was performed during an August 1971, visit by the team to Sikorsky Aircraft.

The IDA team was asked to assess technical risk, the adequacy of airframe and dynamic systems qualifications, and the realism of cost and schedule estimates.

In their CH-53E study IDA was not able to specifically identify any technical problems that were beyond the expertise of Sikorsky Aircraft.

The Sikorsky CH-53E project manager was of the opinion that the IDA team identified all the known-unknowns and that steps had been taken to reduce their risk. Only the unknown-unknowns remain. The Navy Project Manager indicated that no significant new problems were uncovered through the IDA analysis.

The CH-53E is considered to be a relatively low risk development program. However, it must be noted that this does not preclude the possibility of significant unanticipated problems occurring during the system's development.