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U. S. GENERAL ACCOUNTING OFFICE

STAFF STUDY

[SURFACE EFFECT SHIPS]

DEPARTMENT OF THE NAVY



FEBRUARY 1973

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C O N T E N T S

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SYSTEM DESCRIPTION AND STATUS

In June 1966, following several years of independent development studies of Surface Effect Ships (SEs), the U.S. Navy and Maritime Administration, Department of Commerce, signed an agreement to establish a Joint Surface Effect Ships program. The SES is a vessel whose weight is borne by a volume of high air pressure trapped beneath its surface by sidewalls and seals while movement is provided by propellers or jets. The Navy expects SEs to attain speeds of approximately 80 knots. Appendix I shows pictures of SEs, (courtesy of Aerojet General Corporation and Bell Aerospace Company).

The objectives of the program were to determine the technological and economic feasibility of constructing and operating high-speed, ocean-going SEs for naval and maritime purposes. These objectives were to be achieved through a program of basic research, experimentation, and operational evaluation of three sizes of test craft--100 tons, 500 tons, and 4,000 tons.

Navy officials informed us that subsequent to the original plan, the 500-ton vessel was replaced by a 2,000-ton vessel. The reason for the change was that knowledge gained by developmental efforts showed that this size ship could be built with the same technology and propulsors and little increase in risk over building the smaller vessel. They stated that scaling of the major hardware subsystems such as the waterjet pumps, propellers, lift fans, and transmissions does not appear to require new breakthroughs in technology.

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They further informed us that it was decided to develop a 10,000-ton ship, rather than the 4,000-ton vessel which was the minimum economically viable commercial size. This change reflected the next significant improvement in the state-of-the-art and is an initial estimate of the size of an aircraft carrier configuration with missions similar to those of current carriers. Studies are now underway to determine the smallest effective platform for an SES aircraft carrier. This phase of the SES program is in the preliminary planning stages and its implementation is dependent on a successful 2,000-ton program.

100-ton Surface Effect Ships

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In April 1967, the Navy released the Request for Proposals for preliminary design for the 100-ton SES. In June 1967, design study proposals were received from the (1) Aerojet-General Corporation, El Monte, California; (2) Bell Aerosystems Company (currently Bell Aerospace Company), New Orleans, Louisiana; (3) Electric Boat Division of General Dynamics Corporation, Groton, Connecticut; (4) Hydronautics, Inc., Laurel, Maryland; and (5) North American Aviation (currently North American Rockwell Corporation), Los Angeles, California.

In July 1967, following evaluation of the proposals, three fixed-price contracts for design studies--each for \$125,000--were awarded to Aerojet-General Corporation, Bell Aerospace Company, and the Electric Boat Division of General Dynamics Corporation. The design contractors completed their work during December 1967. Following this effort, each was awarded a scope change for \$200,000 to permit the development of systems specifications for defining the contract hardware and supporting activities, and to investigate specific problems uncovered during the design studies.

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It was originally planned that following completion of the design studies, the contracts for detailed design and construction would be awarded in July 1968, allowing 18 months for detailed design and construction and 6 months for contractor test and evaluation. This schedule was to provide a decision point of July 1970, at which time it would be decided whether to proceed with the next larger-sized vessel. This decision point was extended a year to July 1971, due to congressional restrictions on fiscal year 1969 program funds.

During 1968, the three contractors completed their design studies and their results were formally evaluated by the Navy. In January 1969, cost-plus-incentive-fee contracts for the construction of a 100-ton vessel were awarded to the Aerojet-General Corporation and Bell Aerospace Company. Two contracts were awarded in order to test different SES technologies--one craft would be moved by waterjet propulsion while the other would be moved by propellers.

The July 1971 decision point date has subsequently been revised to October 1973 because of problems with both craft. The ship built by Aerojet developed fabrication problems with the waterjet inlets and directional stabilizers and installation problems with the electrical, lubrication, and hydraulic subsystems. The ship built by Bell developed transmission problems. In addition, both test craft suffered numerous equipment failures during builders' trials.

According to Navy officials, changes have been made and the propeller-driven test craft designated SES 100 B started contractor test and evaluation in June 1972 with a planned completion date of February 1973.

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The waterjet test craft designated SES 100 A started test and evaluation in August 1972 and the first phase of testing should be completed about May 1973. At the completion of this test and evaluation phase, both craft will be refurbished and turned over to the Navy for additional testing.

The SES program became a Navy project on July 1, 1971, when the Department of Commerce withdrew from the program in order to concentrate its resources on the immediate revitalization of the U.S. Merchant Marine. As of June 30, 1972, \$53.9 million had been committed to the 100-ton SES program. An additional \$16.1 million had been committed through fiscal year 1972 which is classified as technology funds and attributable to the overall SES program.

The Navy estimates an additional \$49.7 million will be needed to continue testing and modifying the 100-ton test craft through fiscal year 1978.

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2,000-ton Surface Effect Ships

The Navy has proposed continued development of the SES principle with the design, construction, and testing of two 2,000-ton ships which is the smallest size likely to have military value in the open ocean. The 2,000-ton ships are intended to provide the transition from the 100-ton technology to operationally capable ships. The initial objective is to prove the scaling up of the SES technology to the 2,000-ton size, followed by demonstration of operational capability.

Navy officials believe the high speed of the 2,000-ton SES (approximately 80 knots) will provide military capabilities of decreased reaction time, reduced vulnerability, increased search rate, and restore to surface ships the speed advantage over submarines.

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The Request for Proposals for preliminary design of the 2,000-ton operational prototypes was issued August 3, 1972, and resulted in proposals being received from the following firms:

1. Acrojet-General Corporation
El Monte, California
2. Bell Aerospace Company
New Orleans, Louisiana
3. Litton Systems, Inc.
Culver City, California
4. Lockheed Missiles and Space Company, Inc.
Sunnyvale, California

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These proposals were reviewed by the Defense Systems Acquisition Review Council in October 1972, and approved in November 1972. As a result of this approval, design study contracts totaling \$10.5 million were awarded to the four contractors in November 1972.

Navy plans indicate that following completion of the 2,000-ton preliminary design contracts and evaluation of the 100-ton SES test results, another Defense Systems Acquisition Review Council meeting will be held to determine if the 2,000-ton SES will be permitted to proceed into the detailed design phase. At that time, the decision will be made on the number of 2,000-ton prototypes to be constructed. If Defense Systems Acquisition Review Council approval is given to proceed with detailed design, another Council review will be required prior to proceeding into the construction phase. Current project plans call for awarding detailed design contracts during the second quarter of fiscal year 1974.

Assuming eventual approval to proceed into the detailed design phase, the Navy would like to design and build two 2,000-ton prototype ships. Navy project office officials stated that two prototypes will provide continuing opportunities to (1) explore different design features, (2) broaden the technical and industrial base, (3) reduce test and evaluation time, (4) prevent contractor monopoly, (5) permit different mission options,

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(6) provide two ships with eventual military utility, and (7) increase the probability of project success by providing a backup ship if one should be destroyed.

Larger Size Surface Effect Ships

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This phase of the SES program is in the preliminary planning stages and its implementation is dependent on a successful 2,000-ton program.

The next larger-sized prototype SES planned, assuming a successful 2,000-ton program, is on the order of 10,000-tons. Navy officials stated that this ship could be designed as a high speed aircraft carrier.

Sizing and costing studies are currently underway to determine the smallest effective platform for the SES/aircraft carrier roles.

COMING EVENTS

The 2,000-ton SES preliminary design is scheduled to be completed during the first quarter of fiscal year 1974. Additionally, the results of the 100-ton contractor test and evaluation program should be available during this time frame. A Defense Systems Acquisition Review Council meeting is scheduled in October 1973, at which time a decision is to be made on whether to proceed with the detailed design of the 2,000-ton SES and the number to be built.

SYSTEM COST DATA

The Navy projects a need for an estimated \$346.2 million for fiscal years 1973 to 1978 to design, construct, and test two 2,000-ton prototypes. This amount includes \$30 million for installation and adaptation of weapons and sensors, but does not include costs for the weapon suites themselves which, at this time, have not been selected. This amount does not include an estimated \$11 million in military construction funds to build a test facility to test and modify the 2,000-ton vessels following their delivery to the Navy.

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Economic Escalation

The project office computes economic escalation for the SES program based on indices provided by the Assistant Secretary of Defense, Comptroller. The amount of escalation computed for the 2,000-ton phase is \$46.1 million through fiscal year 1978. This amount is included in the estimate of \$346.2 million.

Funding for total SES program

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As of June 30, 1972, the Congress had appropriated \$61.1 million for the SES program. Reprogramming actions of \$3.9 million increased this amount to \$70.0 million of which an estimated \$67.8 million had been obligated and expended.

As of December 1972, the Navy estimated the cost of the SES program through fiscal year 1979 to be \$817.3 million as illustrated below.

<u>Appropriation</u>	<u>Funds Programmed through June 30, 1972</u> ----- (Millions)	<u>Fiscal Year 1973 through fiscal year 1979</u> -----	<u>Total</u> -----
RDT&E Planned	\$68.2 ^a	\$457.8 ^b	\$526.0
RDT&E Larger SES Estimate	-0- <u>68.2</u>	262.0 <u>719.8</u>	262.0 <u>788.0</u>
Procurement	-0-	-0-	-0-
MILCON	1.8	11.0	12.8
Military Payroll - Navy	-0-	8.5	8.5
Operations and Maintenance - Navy	-0-	8.0 ^c	8.0
Total	\$ <u>70.0</u>	\$ <u>747.3</u>	\$ <u>817.3</u>

^a Includes \$9.1 million received from the Maritime Administration.

^b Includes \$32.1 million appropriated in fiscal year 1973.

^c Fiscal year 1979 funds.

SYSTEM SCHEDULE DATA

In November 1972, following the award of preliminary design contracts, the following schedule milestones were established for the 2,000-ton SES.

	<u>Start</u>	<u>Complete</u>
Preliminary design	11/72	7/73
Defense Systems Acquisition Review Council for detailed design	10/73	10/73
Detailed design	11/73	10/74
Defense Systems Acquisition Review Council For construction	10/74	10/74
Construction	11/74	12/76
Prototype testing:		
Platform	12/76	6/78
Combat suite	12/77	6/78

SYSTEM PERFORMANCE DATA

The following performance and design characteristics are projected for the 2,000-ton SES. The decision regarding the type of propulsion system to use, i.e., propeller, waterjet, or both, is being postponed until completion of the preliminary design studies and the 100-ton test and evaluation program.

Gross weight (includes payload)	2,200 tons
Payload (men and combat suite)	250 tons
Overall length	205 feet
Overall beam	105 feet
Cruise speed	80 knots
Cruise range	4,000 nautical miles in sea state 3 (at 65 knots)
Crew accommodations	15 officers, 125 enlisted
Propulsion engines	4 gas turbines, each 25,000 hp., maximum
Lift engines	2 gas turbines, each 12,500 hp., maximum

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SELECTED ACQUISITION REPORTING

As of September 30, 1972, there was no requirement for the SES to be included in the DOD Selected Acquisition Reporting System.

SCOPE

Information in this study was obtained by reviewing documents such as progress reports, studies and other internal Navy documents, and by interviewing project and contractor officials.

MATTERS FOR CONSIDERATION

Before substantial funds are committed to 2,000-ton and larger size SESs, the Congress should be provided information as to whether

- (1) test results on the 100-ton SESs show that deficiencies previously identified have been corrected,
- (2) the technology for scaling up from 100-tons to 2,000-tons is in hand and the risk is acceptable, and
- (3) the number of 2,000-ton SESs to be built is justified in light of tests results on the 100-ton SESs and preliminary designs of the 2,000-ton SESs.

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.

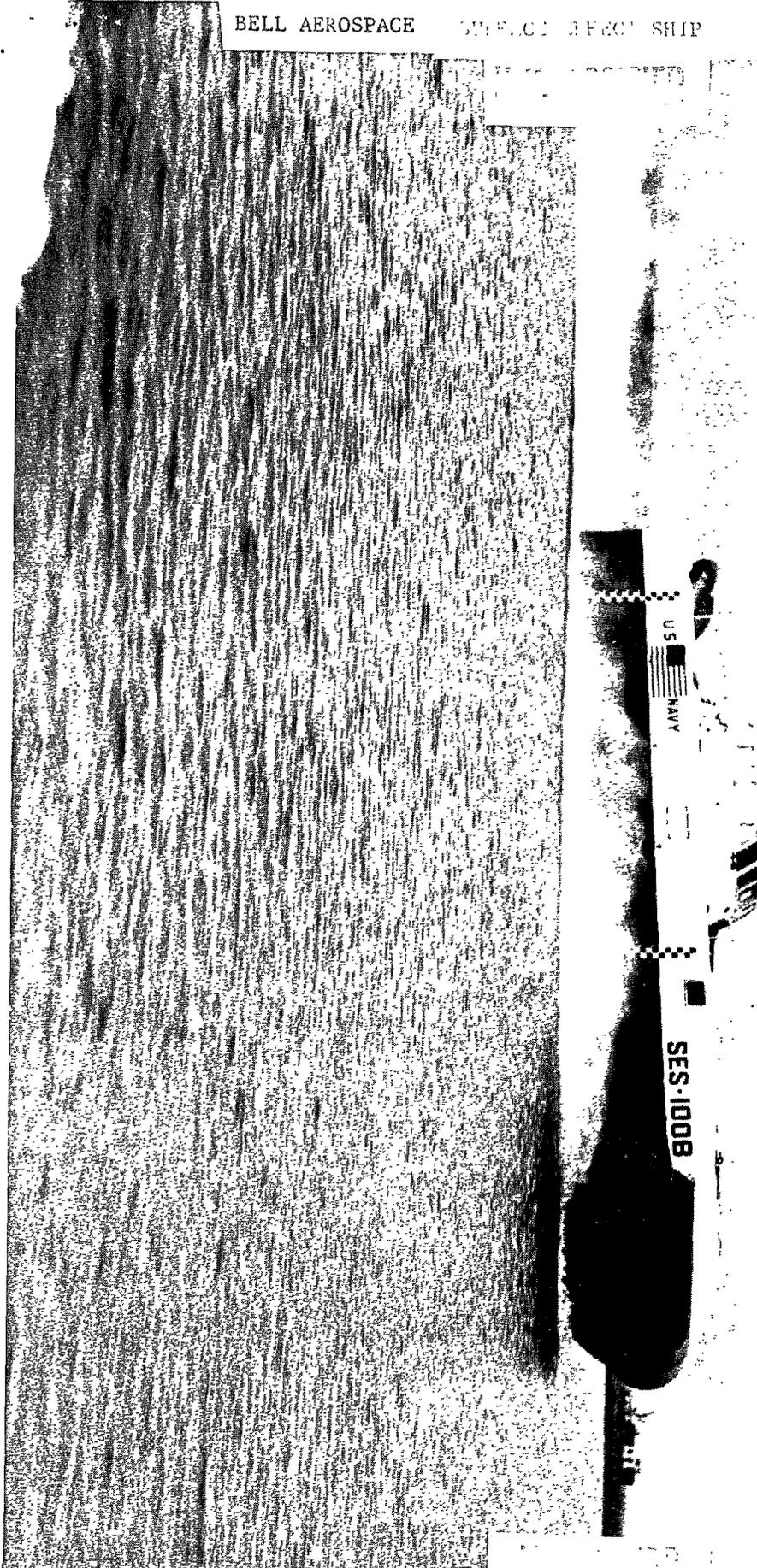
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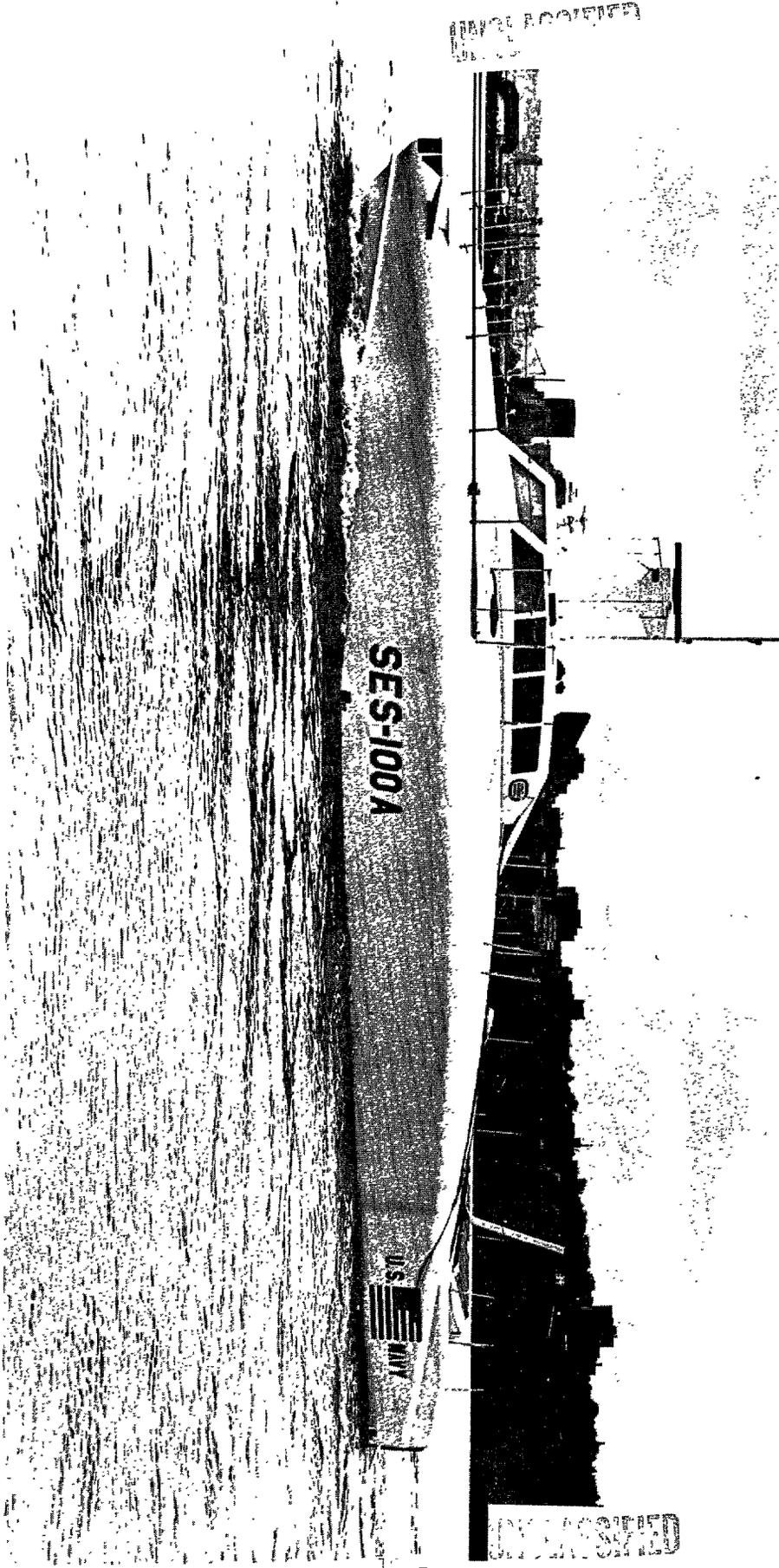
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APPENDIX

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