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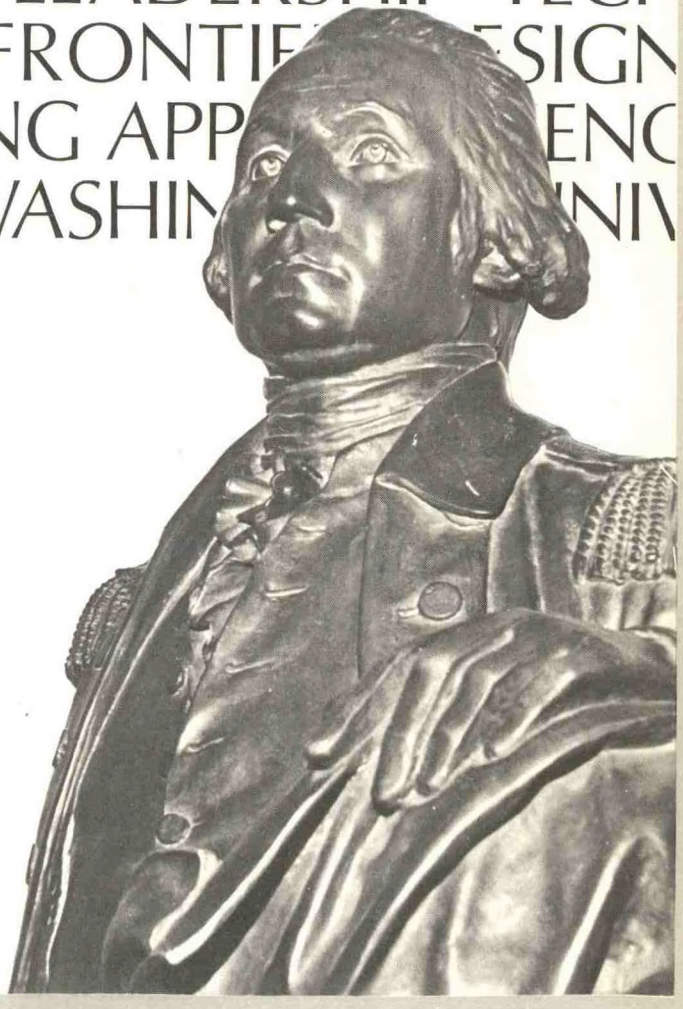

SCHOOL OF ENGINEERING
AND APPLIED SCIENCE

NATIONAL OCEANIC AND ATMOSPHERIC
ADMINISTRATION
OCEAN ENGINEERING
TECHNOLOGY TRANSFER OPERATION

FINAL REPORT

TO

DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
OFFICE OF OCEAN ENGINEERING
CONTRACT NO. 7-35282

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FOREWORD

The George Washington University conducted this work under Department of Commerce Contract No. 7 - 35282 dated August 19, 1977 and amended on March 10, 1978. This Report is submitted to the Office of Ocean Engineering, National Oceanic and Atmospheric Administration in fulfillment of the terms of the contract as amended.

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NATIONAL OCEANIC AND ATMOSPHERIC
ADMINISTRATION
OCEAN ENGINERING
TECHNOLOGY TRANSFER OPERATION

ABSTRACT

This Report presents a development plan, with supporting rationale, for a NOAA Ocean Engineering Technology Transfer operation. It proposes establishment of a Referral Service as the first step in the development to provide direct interaction between potential user groups and the Technology Transfer operation. Such interaction is necessary to identify specific user groups from the broad and multi-disciplinary ocean engineering field and users' technological needs around which the transfer operation should be designed. Later phases in the proposed development progressively expand the Technology Transfer operation capabilities, as needed, to where it would eventually provide an Information Analysis Center type operation for the targeted user groups.

As a related effort, the research showed that, although it is feasible to extract useful ocean engineering technology information from classified Navy reports, additional work is necessary before such a source can be used on a routine basis. A preliminary directory of Federal personnel involved in developing technologies with potential application to Marine Mineral Mining (Deep Ocean) was also prepared as a part of this project.

CHAPTER 1

INTRODUCTION, SUMMARY, AND RECOMMENDATIONS

1.1 INTRODUCTION

The increasing scope and magnitude of engineering support for the national efforts to utilize the living and non-living resources of the seas in a rational and environmentally sound manner requires a program of basic multipurpose ocean engineering directed toward support of the overall national requirements. This program must make provisions for timely transfer of ocean engineering related technologies developed for one purpose to other related activities to avoid unnecessary expenditures of resources in our national ocean endeavors. Recognizing the need for such a program, the Department of Commerce established within the National Oceanic and Atmospheric Administration (NOAA) an Office of Ocean Engineering (OOE) to provide the NOAA with the capability to coordinate the development of an Ocean Engineering Program at the national level. The OOE was assigned the following responsibilities:[1]

> The Office of Ocean Engineering shall exercise functional review over, and recommend policy and plans for, all of NOAA's ocean engineering and instrumentation programs. It shall conduct an integrated program of research, technology development, and services related to ocean engineering and undersea operations; and serve as a national focal point for knowledge related to civil ocean engineering, a catalyst for industrial ocean engineering development, and a mechanism for technology transfer from military and space fields.

Prior research conducted by the Marine Board, National Academy of Engineering has indicated the need for such a focal

point to which ocean engineers can communicate their technology needs and obtain comprehensive guidance on the availability of technologies to meet their needs.[19,20]

The primary objective of the research by GWU, reported herein, was to design an Ocean Engineering Technology Transfer operation to facilitate accomplishment of the OOE mission. Related objectives involved an effort to determine the feasibility of extracting useful unclassified technology information from Navy reports classified for reasons of national security; and the preparation of a preliminary directory of Federal personnel involved in ocean engineering related technology development. Because of time and resource limitations, the scope of these related efforts was limited to Marine Mineral Mining as the leading edge of an effort covering the entire ocean engineering field.

The Plan for Development of an Ocean Engineering Technology Transfer operation presented in this report, although specifically oriented toward OOE's technology transfer responsibilities, also provides mechanisms whereby the overall effectiveness of the OOE will be enhanced. For example, the "Broker" function of matching users' technological needs with available technologies will help to identify technological gaps. Such information will facilitate the development of an integrated program of research, technology development, and services relating to ocean engineering and undersea operations; and help classify those portions of the program requiring Federal government sponsorship from those more appropriately in the domain of private industry or requiring a joint government-industry effort.

1.2 OCEAN ENGINEERING TECHNOLOGY TRANSFER OPERATION

This research was initiated with the objective of identifying the clientele, technology requirements, and technology sources around which the Technology Transfer operation should be designed. As the research progressed, it became obvious that the broad scope and multi-disciplinary nature of ocean engineering made it impossible to provide a bounded definition of ocean engineering from which such variables as the number of users to be served and the amounts and types of technology to be transferred by an Ocean Engineering Technology Transfer operation could be determined.

Chapter 2 describes a Generalized Technology Transfer Process through which ocean engineering technology is now transferred. It was concluded that this is a random, ad hoc process lacking the necessary structure to provide technology support for all segments of the ocean engineering communities. There is a need for a central focal point within NOAA to which user groups and technology producers may refer and expect to receive authoritative ocean engineering technology information.

1.2.1 Ocean Engineering Technology Users and Producers

Chapter 3 describes the Governmental, Industrial, and Academic Ocean Engineering Communities which will be the source of clientele for the operation. Appendix A provides a description of the activities within nine Federal Departments and other Agencies involved in ocean engineering related endeavors. The

Industrial and Academic Ocean Engineering Communities are described in terms of the Directories available for reference which show the "what, who, and where" for various activities. It was not possible to identify a specific clientele for the Ocean Engineering Technology Transfer operation, nor is it considered feasible to do so without direct interaction between the broad and diversified potential user communities and the transfer operation. One means of providing a basis for realistic interaction would be to offer an Ocean Engineering Technology Referral Service as the first step in the development of the transfer operation. This would be a relatively low cost service designed to refer a user with a technology need to an appropriate technology producer who may be able to fulfill the need. Such a service would have to be widely and continuously publicized so that potential users would be kept aware of its existence. Use of the Referral Service would identify specific user groups in need of technology transfer support and would also help to highlight the principal technological needs. Such an approach is recommended in the time-phased plan for development of the Technology Transfer operation presented in Chapter 5.

1.2.2 Ocean Engineering Technology Information Sources

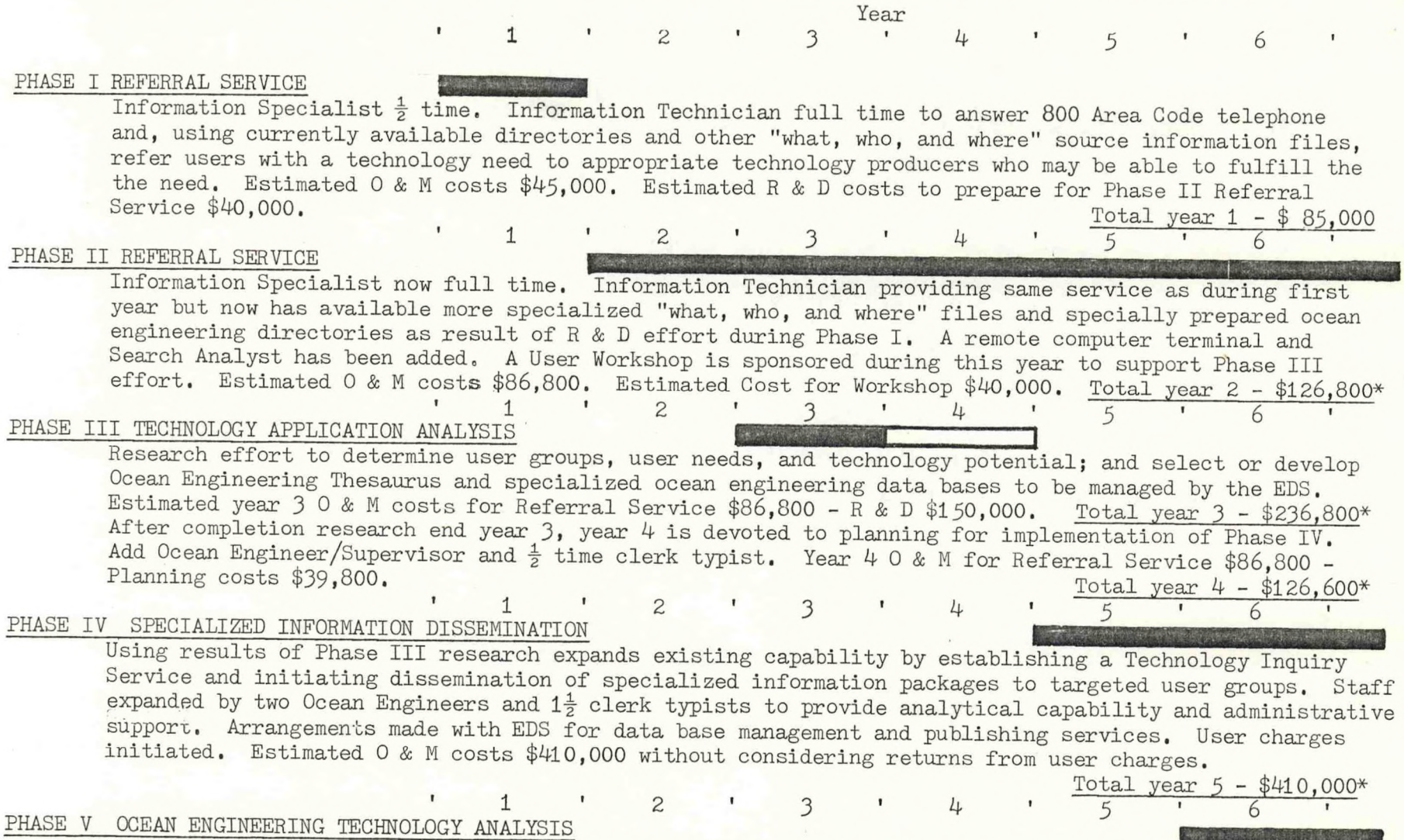
Chapter 4 discusses the various technology information sources to be used to support the Technology Transfer operation. Successful technology transfer in ocean engineering, as in any other discipline, requires efficient and effective communication

between the suppliers and the consumers of technology. While no single communication channel is sufficient in itself to effect transfer under all conditions, both research and operating experience clearly demonstrate that person-to-person contact is the most important means for transferring technology. The need for, and value of, personal contacts as a primary information source are emphasized throughout this report and implicitly recognized in the plan for development of the operation. Conventional media are recommended for facilitating person-to-person communication as well as suggestions for substituting teleconferencing techniques for some of the more expensive face-to-face meetings. The use of the existing NOAA Environmental Data Service computerized bibliographic information and data services (ENDEX/OASIS); library services; and editing, printing, and publishing capabilities would be exploited to the fullest to support the needs of the transfer operation. At a later stage of development in the operation, Ocean Engineering specific data bases would be established. Such data bases would be managed by the EDS to support the transfer operation.

1.2.3 Plan for Development of Ocean Engineering Technology Transfer Operation

Chapter 5 presents a recommended plan for development of the Technology Transfer operation. Specific recommendations and estimated resource requirements are reflected in Figure 1-1.

FIGURE 1-1 SUMMARY OF PLAN FOR DEVELOPMENT OF OCEAN ENGINEERING TECHNOLOGY TRANSFER OPERATION



*All figures based on 1978 costs without consideration for inflation

Management decisions for the plan are shown below:

Beginning year 1 minus 3 months

- Establish Referral Service Phase I and Phase II
- Conduct research to develop Ocean Engineering Directories (6 months effort)

End year 1

- Conduct User Workshop eighteenth month of operation
- Conduct Phase III Technology Application Analysis research to start beginning of year 3

End year 3

- Expand the Technology Transfer operation to include Specialized Information Dissemination beginning year 5

End year 4

- Expand the operation to include Ocean Engineering Technology Analysis beginning year 6

At any point in the development

- Alternative decisions could be made to modify the planned development to meet more effectively the needs of the users, continue the operation at its present level of service without further expansion, or terminate the operation.

1.2.4 Constraints to Technology Transfer Operations

All Federal Research and Development agencies have programs to transfer new scientific and technical information to their respective non-governmental constituencies and those with strong industrial orientation operate technology transfer programs as

well. Experience with these programs suggests many practical problems can be anticipated in developing any new transfer operation.

The brief review, presented in Chapter 6, of the most common constraints to successful technology transfer suggests that they are primarily social in nature rather than technical. Recent revolutionary advances in computer and communications technologies have provided ample technical capabilities for transfer operations. However, a number of organizational, legal, and economic issues remain and must be considered carefully to avoid serious errors in program planning and management.

1.3 UNCLASSIFIED TECHNOLOGY INFORMATION FROM CLASSIFIED NAVY REPORTS

Appendix B reports results of work accomplished with the assistance of the Naval Research Laboratory to determine the feasibility of extracting useful technology information from classified Navy reports. An important potential source of ocean engineering technology information is within Navy reports which are classified for national security reasons. These reports may include appreciable amounts of "unclassified" information for completeness of the report presented. Current Department of Defense regulations require that all classified documents contain classified designations on a paragraph-by-paragraph basis. Thus, in many instances a "classified report" may contain much unclassified technology information which might be extracted and passed on to ocean engineering technology users and producers. Study

results indicate that useful unclassified information exists within the classified reports which can be identified through use of the Defense Documentation Center's (DDCs) computerized bibliographic information files. Major problems are: (1) the large quantity of this information, (2) availability to NOAA, (3) availability to industry, and (4) cost-benefit analysis to the entire procedure. To answer these critical issues, it is recommended that:

1. Samples of unclassified information from classified reports be retrieved from the DDC classified data bank and examined to determine how much is already available in the open (unclassified) literature.

2. One or more groups of industrial personnel be convened to determine the usefulness to industry of this information.

3. Official procedures be established for the above.

4. Mechanisms to perform the above in cost-effective manner be developed.

1.4 MARINE MINERAL MINING DIRECTORY

Appendix C reports the research conducted to prepare a preliminary directory of Federal government personnel involved in developing technologies with potential application to marine mineral mining (deep ocean). Enclosure 1 to that Appendix shows the two-tier categorization of technology areas utilized in preparing the Directory and a definition of each of the areas. Enclosure 2, the Directory, is provided separately.

In the plan for the development of the Ocean Engineering Technology Transfer operation, it is recommended that a similar directory be prepared to cover the entire Ocean Engineering field. Such a directory would be necessary to support the recommended Phase II Referral Service.

CHAPTER 2

GENERALIZED OCEAN ENGINEERING TECHNOLOGY TRANSFER PROCESS

2.1 INTRODUCTION

There is in existence a generalized process whereby ocean engineering technology transfer takes place. For purposes of this paper, technology transfer is defined as the process whereby a user's technology need is matched with a producer's available technology to solve the user's problem. In the marketplace, industrial technology producers are continually searching out other applications for their existing products and services. Considerable sums of money are spent on marketing in order to stay abreast of consumer technology needs, identify consumer problems to which their technologies might be applied, and keep their capabilities known to a maximum number of potential users. Federal Technology Transfer, the application of results of Federal programs to State and local governments and private industry, is a mandated or implied function of all Federal agencies. Although the specific mechanisms for accomplishing transfer may vary, there is a general conceptual process for technology transfer whether it be within the industrial community or among governmental, industrial, and academic ocean engineering communities. This chapter examines that generalized process to identify functions associated with ocean engineering technology transfer

and existing shortcomings of the process which might be remedied or reduced in scope by establishing a more structured Ocean Engineering Technology Transfer operation. Figure 2-1 is a simplified representation of such a Generalized Ocean Engineering Technology Transfer Process.

2.2 PROCESS DESCRIPTION

The technology transfer process may be triggered by (1) a perceived need by a user looking for a technology to fulfill that need ("Technology Pull") or (2) a technology producer with a technology available to fulfill an as yet unspecified need ("Technology Push").

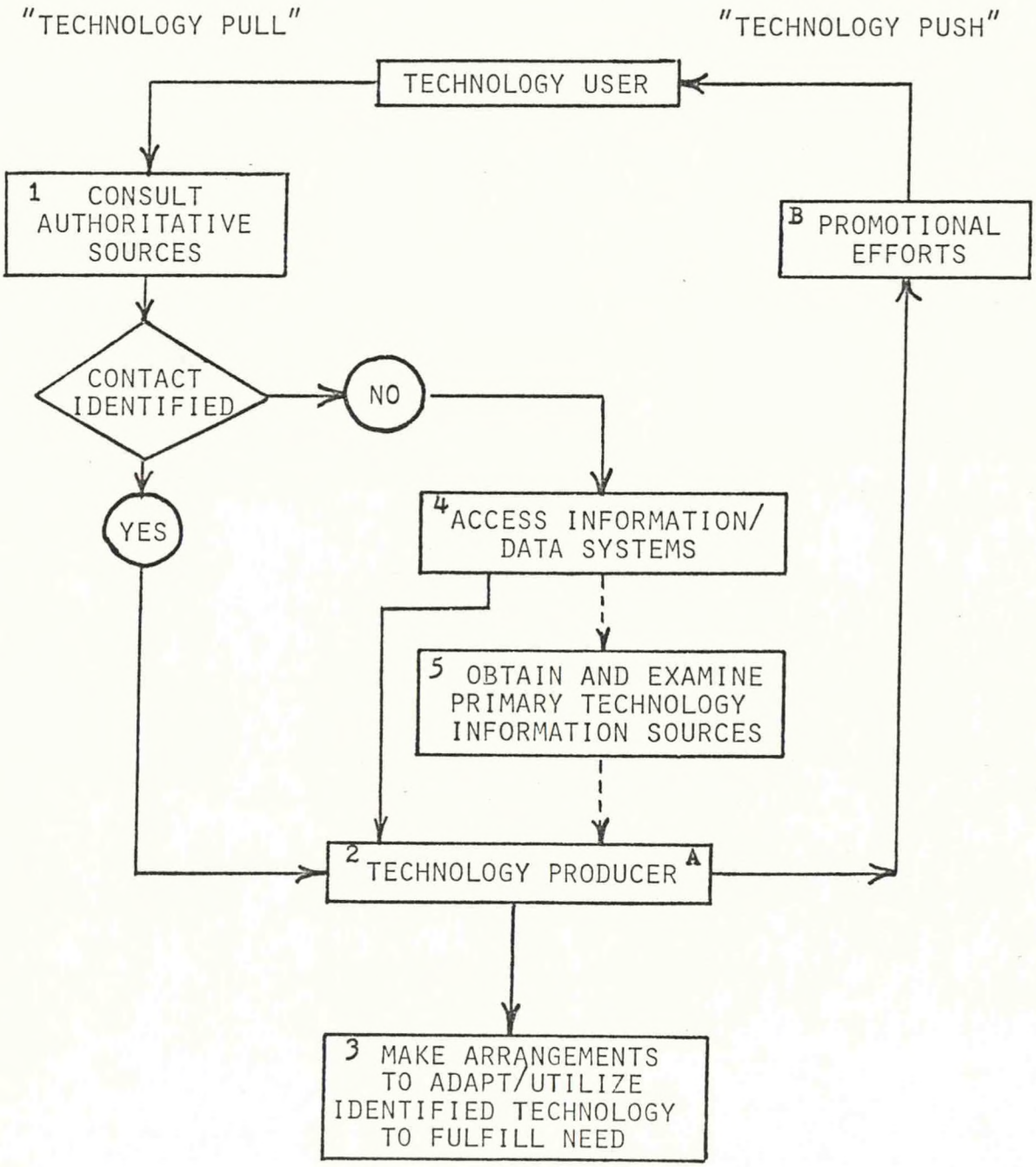
2.2.1 Technology Pull

The technology users exert technology pull when they encounter a problem beyond their capabilities and go elsewhere for the technology to solve the problem. Such users, through their previously established contacts may know an authoritative source who can point them toward the technology producer(s) who may be able to fulfill their need. If the user does not know such a source he may refer to various product and service directories such as The Sea Technology Buyers Guide/Directory, the Worldwide Directory of Offshore Contractors and Equipment, the Geophysical Directory, and others to identify specific contacts in the area of the technology need (Step 1 of the Process shown on Figure 2-1).

If such contacts are established, the user, through person-to-person liaison with the technology producer, determines the

FIGURE 2-1

GENERALIZED
TECHNOLOGY TRANSFER PROCESS



adaptability of a specific technology to fulfill the need (Step 2). If found adaptable appropriate negotiations are conducted to obtain the use of the desired technology (Step 3.)

This channel of the generalized technology transfer process represents an idealized operation which gets the user in contact with the producer through the minimum number of intervening steps. Meetings, such as the annual Offshore Technology Conference and other ocean engineering related meetings sponsored by the professional societies, the industrial associations, and governmental agencies provide important mechanisms to increase the efficiency of this idealized technology transfer channel. The essential step in the technology transfer process is the establishment of person-to-person contact between the user and the technology producer. It is the crucial step in the process with preceding steps designed to accomplish this end in the most direct manner.

If no contacts can be made or if contacts prove to be nonproductive, the user may elect to access information/data systems; that is search the Abstracting and Indexing Publications or query the computerized information/data services for references relating to the needed technology (Step 4). The Engineering Index, Oceanic Abstracts, NTIS Government Reports Announcements, Petroleum Abstracts, Pollution Abstracts, and others contain ocean engineering related abstracts of technical papers from professional and industrial journals; as well as proceedings, transactions, special publications of engineering

societies, scientific and technical associations, universities, laboratories and research institutions; government agencies; and industrial associations. Subscribers to one or more of these hard copy services have ready access to abstracts in the various ocean engineering subject areas through a manual search process which may not be as difficult or nonproductive as some may think. Unfortunately, the abstracted material is at best six months old and quite frequently a year or more old and not all pertinent publications are abstracted.

All of the significant unclassified Abstracting and Indexing Services are commercially available in computerized form. The Lockheed DIALOG, the Systems Development Corporation ORBIT, and the National Technical Information Service Bibliographic Data Files provide computerized services which cumulatively include abstracts of most of the published information on ocean engineering. The DIALOG Service provides access to 87 data bases which are listed and described in the Lockheed Information Systems DATABASE CATALOG. The ORBIT Search Service provides access to 35 data bases, described in the Systems Development Corporation publication covering SDC Search Service ORBIT DATABASES. The NOAA Environmental Data Service's Oceanic and Atmospheric Scientific Information System (OASIS) utilizes all three of the aforementioned services as well as other data bases to support the information needs of NOAA. These services are also utilized by other government agencies and the industrial and academic ocean engineering communities.

While these sources and others are readily available, the user is very frequently overwhelmed with the number of citations provided in response to a specific search question. This makes it necessary to cull the search results manually to identify the pertinent abstracts.

To better evaluate the utility of a specific technology to meet the user's need, it may be desirable to obtain and examine the primary technology information sources uncovered by the manual or computerized search of the various abstracting and indexing publications/data bases (Step 5). Many of the primary ocean engineering references are already maintained within the NOAA Library System. NTIS is the secondary distribution point for reports produced as the result of government research and development efforts. Copies of the full text of articles referenced in the Engineering Index Annual may be obtained from the Engineering Societies Library. Obtaining primary publications can be a time consuming process. Therefore, the ultimate goal should be abstracts which contain information to identify the technology producer in sufficient detail to facilitate person-to-person contact between the user and producer, thereby eliminating the obtain primary publications step.

Most of the ocean engineering information that gets abstracted is already abstracted and available for retrieval from existing hard copy and computerized services currently supporting NOAA information needs. Therefore, the bibliographic information and data base function for support of ocean engineering

technology transfer is already well established and available for use by the Technology Transfer operation.

2.2.2 Technology Push

Industrial technology producers utilize the technology push approach in their marketing efforts. The classical government example of technology push is the Department of Agriculture Extension Service which disseminates USDA supported research results, on a person-to-person basis, to every state and county of the nation using approximately 17,500 extension service employees nationwide. The NASA Technology Utilization Program is another example of technology push whereby the program attempts to ensure that new aerospace technology is brought to the attention of American industry and others, including Federal agencies, and state and local government agencies so that it may be adapted and applied for the user's benefit. The NASA program utilizes a network of Industrial Applications Centers that provide services specifically tailored to identify aerospace technology directly relevant to the users' technical needs. The Centers, located at universities and non-profit institutions, have access to a variety of computerized scientific and technical information bases including a wide range of Government sponsored R&D programs as well as the basic NASA results. The network of industrial applications centers serves industry both by searching the literature and by helping to evaluate and apply the results.

The Navy conducts a modest technology push program through the publication of a monthly Navy Technology Transfer Fact Sheet. This Fact Sheet consists of brief descriptions of selected Navy developed technologies which may have application to non-Navy private and public sector technology users. Back up packages providing additional technical details which may be used to implement new technology or assess its applicability to particular needs may be requested using the reader reply card provided with each fact sheet.

The NOAA Marine Advisory Service, employing about 275 extension agents within the coastal and Great Lakes States, has as one of its objectives to assist those who are interested in and responsible for development, utilization, and management of the ocean and its resources through a system whereby the results of research, availability of services, experience of industry and other sources of information are made available to users on a person-to-person basis. This is the currently available extension service within NOAA to support all the components of NOAA.

The technology push approach assumes, as experience has indicated, that the users either cannot or will not bother to articulate their technology needs and are more responsive to direct personal assistance to help identify their technology needs and be shown on the spot how a given technology can be applied to solve their problem. The ocean engineering communities, discussed in the following section, are probably more capable of expressing their technology needs than some of the State and local governments, making the technology pull approach more

acceptable for ocean engineering technology transfer than it is in such fields as agriculture or public services.

Technology push is initiated by a commercial producer motivated by the profit incentive. Federal agencies are motivated by the national policy to ensure that results of research and development sponsored by their agencies are made available to State and local governments in order to reduce duplication of effort; and to the private sector to stimulate growth and provide maximum contributions to the economy (Step A). Communication channels for promotional efforts to transfer technology include (Step B):

- Formalized marketing efforts
- Extension agents
- Symposia, conferences, and exhibits
- Selective Dissemination of Information
- Primary Publications
- Newsletters and Information Exchange Groups
- Research in Progress Reporting

2.3 PROCESS SHORTCOMING

This is a random, ad hoc process lacking the necessary structure to provide technology transfer support for all segments of the ocean engineering communities. Its principal shortcoming is that there is no central focal point to which user groups and technology producers may refer and expect to receive authoritative ocean engineering technology information.

2.4 APPROPRIATE NOAA ROLE

As the lead civil agency in ocean matters, NOAA is the logical governmental agency to provide focus for the ocean engineering technology transfer effort and function as the "technology broker" between the users and the producers. In essence, NOAA should function as the authoritative source for ocean engineering technology information in order to expedite bringing the technology user with a need together with the technology producer so that transfer may be effected. NOAA should further function in a promotional role to ensure that federally produced ocean engineering technology is made known to the private and public sectors of the economy. The succeeding two chapters discuss the potential user groups for ocean engineering technologies and the sources of technology information to be utilized by an Ocean Technology Transfer operation. Chapter 5 presents a plan for development of a Technology Transfer capability.

CHAPTER 3

OCEAN ENGINEERING TECHNOLOGY USERS AND PRODUCERS

3.1 THE OCEAN ENGINEERING COMMUNITIES

An examination of the governmental, industrial, and academic activities involved in ocean engineering related endeavors quickly reveals the broad scope and multi-disciplinary nature of ocean engineering. Because of this, it was not possible to provide a bounded definition of ocean engineering from which such variables as the number of users to be served and the amount and types of technology to be transferred by an Ocean Engineering Technology Transfer operation could be determined. The governmental, industrial, and academic ocean engineering communities involved in the generalized Technology Transfer Process are discussed below:

3.2 GOVERNMENTAL OCEAN ENGINEERING COMMUNITY

The Federal Ocean Program Agency Budgets shown below indicate the Federal agencies involved in ocean engineering related activities. Within each of these major agencies, there are activities with either a direct of peripheral association with ocean engineering. The activities are listed and described in Appendix A.

FEDERAL OCEAN PROGRAM
AGENCY BUDGETS
(In millions of dollars)

	FY-1976	TQ	FY-1977	FY-1978
Department of Defense — Military	195.5	52.3	242.6	243.7
Department of Defense — Civil Works	29.2	7.1	32.1	63.8
Department of Commerce	235.2	66.5	274.2	315.9
National Science Foundation	68.8	15.8	74.8	79.9
Department of Transportation	36.4	9.3	46.6	49.1
Department of Interior	142.0	37.5	153.8	161.7
Environmental Protection Agency	24.3	6.1	25.1	22.7
Department of State	12.7	5.9	14.9	18.2
Department of Health, Education & Welfare	16.4	2.8	17.3	18.0
Energy Research and Development Admin.	18.9	6.2	28.9	49.3
National Aeronautics and Space Admin.	20.9	8.0	30.2	18.5
Smithsonian Institution	2.6	0.7	2.8	2.9
Total	802.9	218.2	943.3	1044.3

FEDERAL OCEAN PROGRAM
MAJOR PURPOSE CATEGORIES
(In millions of dollars)

	FY-1976	TQ	FY-1977	FY-1978
International Cooperation and Collaboration	12.7	5.9	14.9	18.2
National Security	81.8	21.6	99.6	94.4
Living Resources	87.6	20.4	106.4	114.4
Transportation	31.9	6.2	38.1	47.0
Development and Conservation of the Coastal Zone	124.8	31.1	133.4	188.3
Non-Living Resources	121.2	31.9	131.4	140.5
Oceanographic Research	129.3	37.7	146.4	158.4
Education	10.5	4.7	12.6	14.2
Environmental Observation & Prediction	40.0	11.4	47.8	46.6
Ocean Exploration, Mapping, Charting and Geodesy	87.7	22.4	111.4	111.9
General Purpose Ocean Engineering	62.6	20.0	86.5	98.4
National Centers and Facilities	12.8	4.9	14.8	14.0
Total	802.9	218.2	943.3	1044.3

The governmental activities described in Appendix A have responsibility for providing for technology transfer in their functional areas. The Directory of Federal Technology Transfer[2] covers in some detail the mechanisms for technology transfer utilized by the various Federal agencies. The Directory provides a description of an agency's program, including the agency's research base, its technology transfer policy and objectives, areas of responsibility, methods of implementation, accomplishments and user organizations. Each agency relies on one or more information services to support its technology transfer information needs. Such information services are described in the GAO Congressional Sourcebook Series on Federal Information Sources and Systems[3] and the Federal Government Directory of Information Resources in the United States.4

3.3 INDUSTRIAL OCEAN ENGINEERING COMMUNITY

The Industrial Ocean Engineering Community includes firms involved in and supporting the following offshore industries.

Marine Construction

Offshore Oil and Gas

Other Energy

Dredging

Marine Mineral Mining

Geophysical Exploration and Survey

Marine Exploration and Research

Commercial Fisheries

Aquaculture

Pollution Control and Waste Disposal

Search, Recovery, and Salvage

The 1976 Edition of the Sea Technology Handbook/Directory[5] lists approximately 560 firms* providing ocean/marine products and services. The types of services involved and that number of firms listed as having the capability to provide these services are as follows:

	No. of Firms
Construction, Maintenance, and Repair	65
Data Processing	48
Design Engineering Services	96
Diving Services	30

*The 1977 Edition listed approximately 630 firms.[6]

	No. of Firms
Equipment Lease and Rental	34
Marine/Ocean Engineering	93
Oil Pollution Cleanup	3
Photography, Underwater	32
Positioning and Navigation	32
Research and Development	117
Search, Recovery, and Salvage	35
Survey and Exploration	87
Testing and Evaluation	56
Vessels and Boats, Lease and Charter	23

The Sea Technology Handbook/Directory is by no means a complete listing of industrial firms involved in offshore operations.

The Worldwide Directory of Offshore Contractors and Equipment,[7] oriented toward oil and gas industry support, lists more than 6,500 personnel, 1,200 companies and 2,800 locations. Worldwide coverage of the offshore industry is shown in five sections: drilling contractors and rig owners, construction-equipment contractors, geophysical companies, diving contractors, and transportation companies. Sixty-three of the firms listed in the Offshore Contractors Directory are also listed in the Sea Technology Handbook/Directory

The Geophysical Directory[8] includes listings of personnel and firms involved in both land and offshore operations, again primarily in support of the oil and gas industry. One hundred

two of the firms listed in the 1976 Geophysical Directory are also listed in the Sea Technology Handbook/Directory

Worldwide industrial firms involved in marine research are listed in the Ocean Research Index - A Guide to Ocean and Freshwater Research Including Fisheries Research[9] (May 1976).

These Directories, except for the Ocean Research Index, are usually updated annually and provide information on "who-to-contact" and "where-to-get-what" for the ocean industries.

The Industrial Ocean Engineering Community includes many diverse segments, some of which are, for practical purposes technologically self sufficient. The Offshore Oil and Gas Industry and its supporting components are prime examples of such segments. The Directories mentioned above list firms with capabilities to meet the full spectrum of technological needs of some of the ocean industries. The probability is very high that if a member of one of the industries has some specialized ocean engineering task to be accomplished, there is a firm available to provide the desired product or service. These firms operate within the context of the Generalized Technology Transfer Process where transfer is controlled by the market-place

There are also ocean industries already being supported by NOAA line components in meeting their technology needs. For example, the members of the Fisheries Industry rely heavily on the National Marine Fisheries Service (NMFS) for needed engineering technology support. Although their direct use of a

centralized technology transfer operation might be minimal, such an operation could well provide substantial support to the NMFS.

The Department of Defense makes technology information available to those industrial firms, who have a contractual affinity with DOD, through the Defense Documentation Center and the Navy Research and Development Information Center (NARDIC). These information sources are not readily available to the entire industrial community. However, all DDC unclassified and unrestricted distribution reports are available to the public through the National Technology Information Service (NTIS).

The Navy is a major producer of ocean engineering technology. Although the Oceanographer of the Navy plans to have eventually an Ocean Engineering Technology Information Center established at the Naval Oceanographic Center in Bay St. Louis, Mississippi; there is currently no such system to support a technology transfer operation.* There is therefore an important role for the Office of Ocean Engineering, working with the Navy, to know whom to contact relative to specific technology questions in order to act as a technology transfer agency between the ocean industries and the Navy.

3.4 THE ACADEMIC OCEAN ENGINEERING COMMUNITY

The academic marine community is partially identified in the Sea Technology Handbook/Directory which lists and describes

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*See Enclosure 2 to Appendix A for more detail.

some 124 such educational institutions. The University Curricula in Marine Sciences and Related Fields[10] produced by the Interagency Committee on Marine Science and Engineering and the Federal Council for Science and Technology provides the following information for about 300 universities, giving for each: description of the facilities including vessels, a description of the degree program, a listing of marine related courses, with a brief description of each, a list of faculty, and the name of a contact. The Marine Research Index also lists educational institutions involved in ocean research.

The Sea Grant Program administered by the NOAA Office of Sea Grant provides grants to public and private universities, institutions, laboratories, and agencies engaged in or concerned with the development of marine resources. The NOAA Marine Advisory Services, an extension service to the marine communities analogous to the Department of Agriculture's service to the agricultural communities, constitutes a technology transfer channel by which the results of the supported research, development, and analyses by all NOAA components are introduced into the marine and coastal business and industry. (See page A-1-11 for a more detailed discussion of the role of the NOAA Marine Advisory Service.)

3.5 CLIENTELE FOR THE TECHNOLOGY TRANSFER OPERATION

The specific clientele for the Ocean Engineering Technology Transfer operation must be identified and their needs established in some detail before a full fledged technology

transfer operation can be initiated. The clientele of the Ocean Engineering Technology Transfer operation would come from the communities discussed above. The broad and diverse nature of ocean engineering and the relative technological self-sufficiency of certain elements of the ocean engineering communities makes it difficult to identify specific users and their technological needs around which a technology transfer operation can be designed. To do this, an extensive user survey would be necessary. The scope of this research did not provide for such a survey or any other direct interaction with the various segments of the ocean engineering communities.

There is virtually no hard information on what users perceive as their technological needs. Some brief discussions were held with representatives of industry by NOAA and GWU personnel, the results were scattered but indicate a great desire for being kept informed of technology developments in the government area. There are many differences of opinion about frequency, format, content, source, and availability of technological information to support transfer operations. The problems are complex because the industrial community is vast, composed of large and small organizations, each having different interests and local resources for obtaining technology information. A user survey, in conjunction with an established OOE service, would serve to resolve some of the variables by defining the users and their current technology needs to ensure a proper time-phased development of the technology transfer operation.

A considerable period of interaction with potential users would be necessary to identify the specific user groups to be supported and their technological needs. It is concluded that this identification process can best be accomplished through a direct interaction between the OOE and potential customers using as a vehicle some relatively inexpensive level of service to be provided by the OOE, supplemented by detailed user surveys. One means of providing a mechanism for such interactions would be to offer an Ocean Engineering Technology Referral Service as the first step in the development of the transfer operation. Use of this referral service, designed to refer a user with a technology need to an appropriate technology producer, would identify user groups in need of such technology transfer support and would also highlight the principal technological needs. Such a procedure is proposed in the Plan for Development presented in Chapter 5.

CHAPTER 4

OCEAN ENGINEERING TECHNOLOGY INFORMATION SOURCES

4.1 INTRODUCTION

To provide for effective technology transfer, it is necessary that all information transfer systems be brought together in an optimal way to ensure ready access to useful information from all the various sources. Information transfer and technology transfer are not synonomous. While technology transfer always implies information transfer, the reverse is not true. The technology information sources implicit in the generalized technology transfer process include:

- Informal personal contacts
- Symposia, conferences, and exhibits
- Teleconferencing
- Primary publications
- Unclassified Information from Classified Reports
- Bibliographic information and data bases
- Information Analysis Centers

4.2 INFORMAL PERSONAL CONTACTS

The most important means for transferring technology is through direct person-to-person contacts. Allen[18] and his colleagues at MIT have demonstrated this during several years' study of technical communication in a variety of small industrial firms.

He discovered that the major part of the information coming into an organization is obtained indirectly through technological "gatekeepers." These communicators are key people within the organization who appear to read more, have superior contacts with colleagues and are better oriented toward outside information sources.

Unfortunately, it does not appear possible to organize these gatekeepers effectively into a formal management structure. Indeed, the success of the communication channels seems to depend in large measure on the informal nature of the process. Similar informal systems of personal contact exist in the academic community where they are referred to as "invisible colleges." Efforts to formalize these unstructured networks also have been unsuccessful.

The best approach to strengthening person-to-person contacts while maintaining the essential informality of the system is to provide the maximum opportunity for these contacts. Within individual organizations, for example, more frequent interdepartmental meetings, company seminars and similar affairs increase the probability of person-to-person communications.

The implications for any technology transfer operation in ocean engineering are clear. The highest priority must be given to developing programs for maximizing informal personal contacts within the community of technology users and producers. The importance of this objective cannot be stressed too much. In every case, some option should be provided for facilitating these personal contacts.

4.3 SYMPOSIA, CONFERENCES AND EXHIBITS

Traditionally, the technical conference has provided scientists and engineers with the opportunity for both formal and informal personal contact. The growth in number, size and cost of these meetings has been phenomenal. The annual number of international scientific meetings alone now exceeds 2,000. The Offshore Technology Conference provides an excellent example and one which combines a major technical exhibit as well.

Every Federal technology transfer program promotes or actively supports symposia, demonstrations and conferences at the state, regional or national levels. These range from regional minority business seminars and national professional meetings to open industry briefings and displays at major industry trade shows. All of these efforts are in recognition of the fact stated previously--the personal meeting is the very best way to enhance communication.

Technology transfer in ocean engineering will require broad utilization of these conventional communication techniques. The expanded participation made possible by these meetings is particularly important because of the interdisciplinary nature of the field. To encourage the widest-possible involvement of all interested parties, interagency cooperation and joint sponsorship of meetings with concerned non-Federal groups are recommended wherever possible.

4.4 TELECONFERENCING

As valuable as these conventional meetings are for enhancing technology transfer, they are not without problems. In particular, the cost of transporting many individual participants over hundreds of miles to central locations can reach staggering proportions in a very short time. Through revolutionary advances in communications technology, alternatives are now available for promoting person to person contact at lower cost and, in some cases, with little loss in effectiveness.

Teleconferencing consists of any of several electronic means that permit groups of physically separated users to communicate with one another. These techniques can be employed to reduce travel to meetings, to encourage participation by those who otherwise might not be able to attend, to reach remote groups and even to allow individuals to participate from their own homes. The most common teleconferencing method is the telephone conference call but most recent techniques include television based conferencing and computer conferencing.

The use of the telephone conference call is gaining with the improvements in conferencing circuits and with the development of better loudspeaking phones. Telephone conferencing allows inexpensive and convenient interconnection of users. Further, the audio system can be augmented easily by use of telewriters, telefacsimile, slow-scan video and similar devices that utilize the telephone circuit. However, the problem of providing stable sound systems persists and high quality audio transmission channels are necessary for successful teleconferences.

Video teleconference facilities were installed in New York City as early as 1961 and for several years a major effort was made by the Bell System to introduce the videotelephone into general service. For various reasons, the videophone was unsuccessful but television-based conferencing systems are widely used today in many parts of the world. The Bell System maintains specially designed teleconference rooms in several American cities and similar systems are operated by the British Post Office, Bell Canada and the Nippon Telegraph and Telephone Corporation.

To date, television networking has been extremely costly but with the advent of satellites, low-cost ground stations and video compression, the economic barriers to video teleconferencing may be eliminated. There is every reason to believe that this technique will play an important future role in successful technology transfer programs.

The first practical application of computer conferencing occurred in the Office of Emergency Preparedness in 1970. This type of teleconferencing is accomplished by a form of written communiation utilizing computer terminals tied into a central computer via telephone. The computer acts as a store-and-forward message center, allowing individual users to communicate when and where they choose and at their own speed. At this most basic level, the system resembles a form of "electronic mail." Most importantly, however, the computer permits specialized communication structures and data processing functions

such as text editing, off-line printing, retrieval of messages based on key terms and provision for different levels of security and anonymity. A major advantage of the system is that it permits asynchronous conferencing (all participants not present simultaneously). In addition, a permanent record of the conference is generated automatically in machine--readable form.

A number of computer conferencing systems are operating today or are under experimental development. These include the PLANET system developed by the Institute for the Future and offered on TYMNET, the EIES system being developed by the New Jersey Institute of Technology and available through TELENET, and a commercial application, MAILBOX, available from the Scientific Time Sharing Corporation.

Computer conferencing appears to be one of the major computer applications of the next decade. It has particular potential for new technology transfer programs since it permits continuing conferences on many different topics with individuals and organizations over a broad geographic area. The ready availability of operating networks, especially the New Jersey experimental program sponsored by the National Science Foundation, makes the technique attractive.

Of course, the actual choice of appropriate teleconferencing media or media combinations will depend on several factors including number and location of users, the value assigned to successful transfer operations and available funding. In any

event, the advantages inherent in real-time communications and directory updating makes adoption of these new media essential to future technology transfer programs.

4.5 PRIMARY PUBLICATIONS

Publications that contain new scientific information or data that describe new or innovative engineering applications are classed broadly as primary publications. The four principal categories of primary publications are scientific and technical periodicals, technical reports, patents and conference proceedings.

The scientific and technical periodical is the oldest and most prestigious, dating back to the mid-17th century. Currently, there are more than 35,000 significant periodical titles in science and engineering worldwide. The importance of the periodical in this field has diminished somewhat in recent years with the growth of other primary media, particularly the technical report and conference proceedings.

The technical report is a specialized form of primary documentation usually produced in limited copies per title and by a near print process by government agencies or their contractors reporting the results of research and development. The first technical reports were those issued by the National Advisory Committee for Aeronautics in 1915. World War II significantly increased the technical report literature until today there are well over 1 million report titles extant and upwards of 50,000 new titles being added to the file annually. The

limited production and distribution of these documents increased the difficulty of retrospective identification and recovery of the information although the Defense Documentation Center (DDC) and the National Technical Information Service (NTIS) are two agencies that specialize in collecting and providing service on this material.

Patents are issued by nearly all the principal national governments granting certain rights and privileges to inventors. An important part of this process usually takes the form of a published document describing the patentable idea in each invention. These published patents form an important part of the primary scientific and technical literature. Some 4 million patents have been issued in the U.S. alone and well over 10 million have been published worldwide. Patents often constitute a unique source of information, particularly in the fields of chemical, electrical and mechanical engineering.

Papers formally presented at conferences often contain original scientific and technical information. Many of these papers are published for the first time, and occasionally only twice, in the formal records of the conferences which are referred to generically as conference proceedings. It is often difficult to know where or when a conference on any given subjects may occur and even more difficult to determine the existence of any formal proceedings.

As suggested earlier, even the best primary publications do not guarantee effective technology transfer. In fact, it is

unlikely that in the majority of cases the primary literature plays the major role. However, each of these categories of primary documentation contains potentially useful and valuable information and must be considered in any program designed to enhance technology transfer.

Obviously, the sheer volume of publication precludes any one library from collecting all of it. One can see from the numbers cited that well in excess of 2 million pages of primary technical documentation is produced in the world annually. Collectively, for all practical purposes, the best special libraries in the world will hold all the primary material. However, organizing these independent storehouses into effective retrieval and delivery service centers remains a major problem in information handling.

4.6 UNCLASSIFIED TECHNOLOGY INFORMATION FROM NAVY CLASSIFIED REPORTS

An important potential source of ocean engineering technology information is within Navy reports which are classified for national security reasons. These reports may include appreciable amounts of "unclassified" information for completeness of the report presented. Current Department of Defense regulations require that all classified documents contain classification designations on a paragraph-by-paragraph basis. Thus, in many instances a "classified" report may contain much unclassified technology information which might be extracted and passed on to ocean engineering technology users and producers. As a part of

the research for which this report is written, a study was conducted to determine whether or not it would be feasible to extract useful unclassified technology information from Navy classified reports. Although study results indicate that such useful unclassified information exists within the classified reports, the resolution of administrative problems of releasing such information to the public and additional more detailed research will be required before it can be considered a readily available information source for support of Technology Transfer operations. Appendix B reports the results of this feasibility study.

4.7 BIBLIOGRAPHIC INFORMATION AND DATA BASES

While document delivery remains a troublesome problem, real progress has been made in the area of identifying, by subject and other appropriate means, the existence of documents that have a high probability of topical relevance in any given search situation. The files of document identifiers are known collectively as bibliographic information and data bases. These secondary information services (so-called) because their main objective is to refer users to appropriate primary information sources) are indispensable if we hope to provide a means of selecting out the relatively few documents of interest in any given case from the plethera of publications.

There are more than 3,500 bibliographic data bases in the natural sciences and engineering and many thousands more of

special-purpose bibliographic files maintained by government agencies, private corporations and others.

Many Federal agencies with information-oriented missions have attempted to create these special-purpose files by selecting out relevant material from the large number of broader-based information files. In other cases, an agency will make administrative arrangements to permit access to a number of subject-related computerized files thus simplifying the problems from the user's viewpoint. The Environmental Data Index and the Oceanic Atmospheric Scientific Information System (ENDEX/OASIS) is an example of the latter arrangement.

4.7 INFORMATION ANALYSIS CENTERS (IAC)

The IAC represents the most efficient organizational form for transferring scientific and technical information. These specialized information activities originated with the handbooks and data centers of the 19th century scientists Beilstein and Gmelin. By 1970, according to COSATI, the Federal government supported 119 IACs. Many private companies promote their own IAC programs to help direct the development of new products and technological processes.

The products and services of IACs generally are similar and, operationally, they function much like other specialized information services with one notable exception. The principal

distinguishing characteristic of IAC programs is one of providing critical evaluation of the available information. This added dimension of careful judgment and judicious evaluation by professionals with expertise in the field or mission of the IAC is reflected in the center's output products which range from critical reviews and state-of-the-art monographs to substantive evaluated responses to queries.

The IAC approach, in theory at least, represents the ultimate system for managing and promoting technology transfer. The key activities of information collection, interpretation, evaluation and repackaging are performed by subject and mission specialists working in a research-oriented environment. Successful programs following this pattern guarantee timely access to the best available information in convenient form.

This approach is the basis for the final phase of the system design presented in this report an Ocean Engineering Technology Transfer operation.

CHAPTER 5

PLAN FOR DEVELOPMENT OF OCEAN ENGINEERING TECHNOLOGY TRANSFER OPERATION

5.1 INTRODUCTION

The preceding three chapters have discussed the Generalized Ocean Engineering Technology Transfer Process, the difficulty of identifying user groups for the transfer operation, and the sources of technology information for support of technology transfer. The generalized process lacks structure and can be improved by providing a "broker" (central focal point) between the users and producers to more quickly match the needs with the available technologies and ensure that available technologies are made known to potential users where needs have not yet been expressed.

To identify specific user groups for the operation, it will be necessary that there be an opportunity for interaction between potential users and the Ocean Engineering Technology Transfer operation. Such interaction can most quickly be accomplished by initiating the Technology Transfer operation at a relatively low level of effort providing Referral Services in a technology pull mode to those segments of the ocean engineering communities indicating the need for such services (i.e., by utilizing the mechanism provided to query the service). Experience gained with users through the operation of the Referral Service, supported by additional analytical research, can be utilized to point the

development of the technology transfer operation toward an appropriate level of capability to best serve the needs of the user groups. The development of the Ocean Engineering Technology Transfer operation in this phased fashion is an alternative to the generalized process described in Chapter 2.

The five phases of the development plan are:

I PHASE I REFERRAL SERVICES
II PHASE II REFERRAL SERVICES
III TECHNOLOGY APPLICATION ANALYSIS
IV SPECIALIZED INFORMATION DISSEMINATION
V OCEAN ENGINEERING TECHNOLOGY ANALYSIS

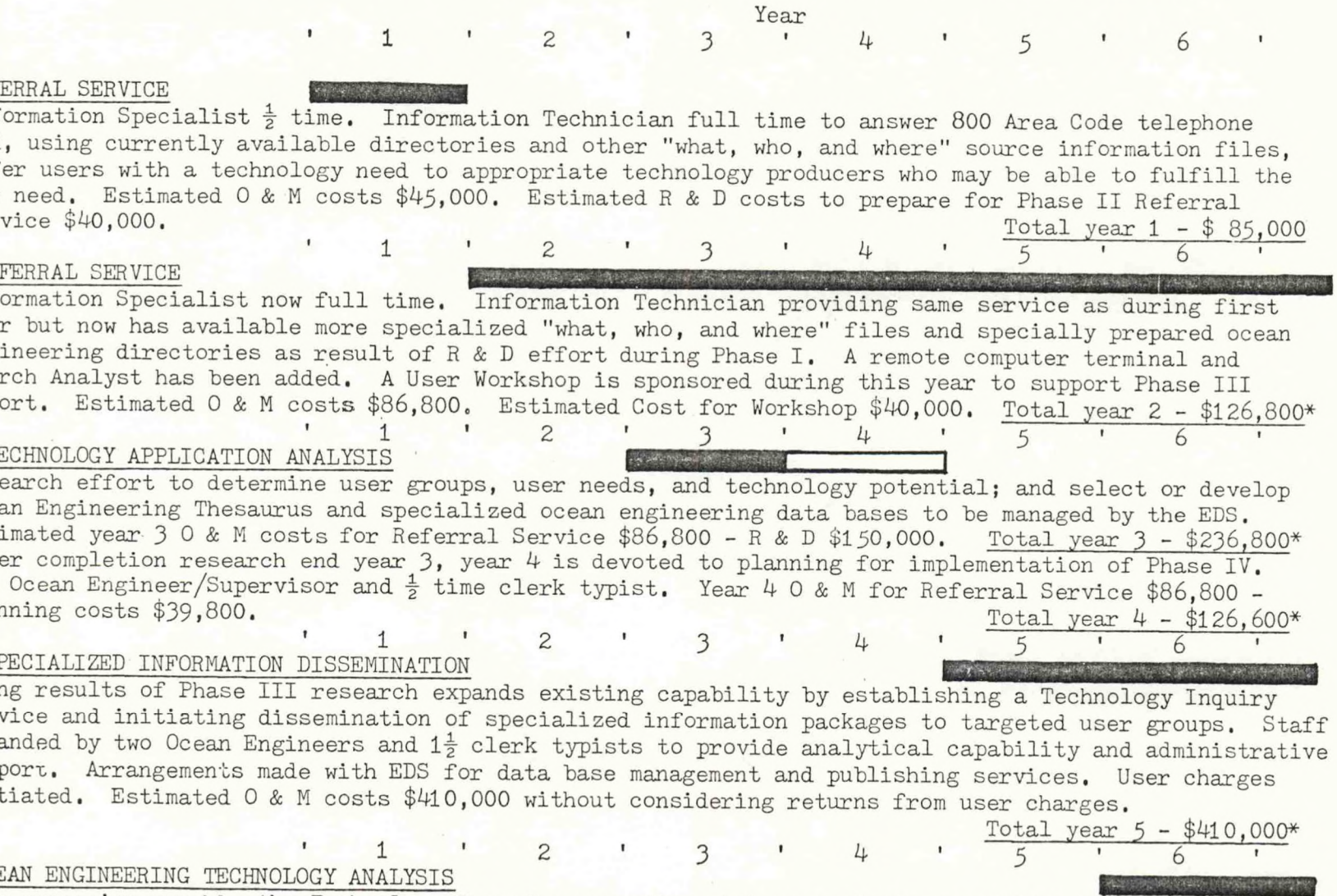
Each phase will be monitored and evaluated to determine the utility of the services to the users and help the decision maker to decide whether or not the phased development of the Ocean Engineering Technology Transfer operation should be continued as planned, modified to meet more effectively the needs of the users, continued at its present level, or terminated completely.

This chapter discusses each development phase, describing the development steps and estimating the resource requirements for the level of service to be achieved in each phase. (Figure 5-1 is a summary of the Plan).

5.2 PHASE I REFERRAL SERVICE

This involves a formalizing and structuring of the type of service which is provided whenever a member of an office receives an ocean engineering technology question from an outside source. The individual receiving the question calls on his knowledge of

FIGURE 5-1 SUMMARY OF PLAN FOR DEVELOPMENT OF OCEAN ENGINEERING TECHNOLOGY TRANSFER OPERATION



*All figures based on 1978 costs without consideration for inflation

who is doing what and refers the questioner (technology user) to the information source that may assist the user to fulfill his technology need. The formalization and structuring would involve providing a central focal point to which technology need questions can be addressed. Additional resources required would include an "800" area code" telephone number at the focal point and an individual to answer this phone. This individual, an information technician, would refer the questioner to an information source which may have the answer to his need. The focal point would use currently available directories and a knowledge of the areas of ocean engineering expertise possessed by the various NOAA ocean engineering activities as a basis for making referrals. The Referral Service would rely heavily on the locally available NOAA staff members who have established personal contacts and possess knowledge in specialized aspects of ocean engineering. This would be a passive (technology pull) service relying on the users' abilities to articulate their needs.

5.2.1 Steps for Phase I Referral Service Development

A. Assemble available directories and source information files to establish readily accessible information on the what, who, and where of the ocean engineering technology producers. These would include:

- Telephone Directories of governmental activities involved in ocean engineering endeavors
- Congressional Sourcebook Publications such as the Federal Information Sources and Systems directory
- Locally prepared directories based upon existing contacts of various NOAA staff members involved in ocean engineering

- Product and service directories such as the Sea Technology Buyers Guide/Directory, the Worldwide Directory - Offshore Contractors and Equipment, and the Geophysical Directory
- Directories of ocean engineering related professional and industrial associations such as the Marine Technology Society and the National Ocean Industries Association

B. Publicize the Phase I Referral Service through such media as the Ocean Science News, NOAA EDS publications, The Marine Technology Society Journal and other ocean engineering related professional and industrial journals.

C. After completion of Step A above, within three months after the decision to establish the Phase I Referral Service, be prepared to refer users with a specified ocean engineering technology need to the best known technology information source (listed in order of preference):

- People
- Organizations
- Publications
- Bibliographic Information and Data Bases

Although there will be no formal feedback mechanisms to determine whether or not a user need was satisfied by the given information source, a quick qualitative judgment may be made from the informal feedback of some dissatisfied customers and repeat business from those users whose need was met by the referral.

5.2.2 Phase I Referral Service Estimated Resource Requirements

Assuming full cooperation and support from the existing ocean engineering expertise within NOAA, the additional resources required to establish the Phase I Ocean Engineering Technology Transfer Referral Service are estimated to be:

Personnel	Annual Cost
Information Specialist/Supervisor (GS-13) 1/2 time	$14,000
Information Technician (GS-9)	17,000
Purchase of Directories	2,000
Wide Area Telecommunication Service (WATS) (800 Area Code number - $1,645/month for 240 hours or $245/month for 10 hours plus $18.38 for each additional hour)	12,000
Computerized Information and Data Services (*The non-NOAA users would pay the charges specified in the USERS' GUIDE TO ENDEX/ OASIS)	*
Total Estimated Year 1 Referral Service O&M Costs	$45,000
Year 1 R&D Costs to Establish Phase II Referral Service Beginning Year 2 (See par. 5.3)	40,000
Total Year 1 Costs	$85,000

5.2.3 Phase I Referral Service Monitoring and Evaluation

The primary indication of the utility of the referral service will be the frequency of usage and the nature and breadth of the clientele established. These factors would be monitored continuously and evaluated to determine whether or not the service is being utilized and is meeting the users' needs. The serendipitous effects of this service on the ability of NOAA to fulfill better its ocean engineering related responsibilities should also be considered as a part of the evaluation procedure.

5.3 PHASE II REFERRAL SERVICE

At the beginning of the Phase I Referral Service, existing directories and information sources were utilized. As experience with users is gathered through this initial service, the Technology Transfer operation will begin to build its own specialized directories by revising existing directories, identifying and filling the missing links, eliminating the out of date, and in general starting to tailor the what, who, and where information to enable the operation to be more responsive to the groups utilizing the service. This internal operational effort would need to be supplemented by outside assistance to develop specific directories for the various segments of ocean engineering similar to what has been done, on a pilot basis, for the Marine Mineral Mining segment.

The Phase I Referral Service would be of about one year's duration, with preparations for the more refined Phase II Referral Service commencing within three months after the start of Phase I Service.

5.3.1 Steps for Phase II Referral Service Development

A. Analysis of Phase I Service

This is essentially a follow-on to the Phase I evaluation procedure indicated in paragraph 5.1.3. It picks up at the point in the evaluation where it has been determined that the service is of utility to the ocean engineering communities. The objective of this analysis would be to determine what modifications should be made to the service to increase its utility to the users. It will rely heavily on usage experience to date.

B. Specialized File Development

This step involves the development of more specialized what, who, and where information files to better support the referral service. A key part of this specialized file development would be the internal effort utilizing experience gained. As the priority target segments for the Ocean Engineering Technology Transfer operation are more clearly defined, specific directories would be developed similar to the pilot Marine Mineral Mining Directory developed as a part of this study effort. This would require external assistance, since the effort would be beyond the capabilities of the austere staffing for the Technology Transfer operation. Since the Navy is the prime producer of ocean engineering technologies, one most useful directory would be a properly organized listing of ongoing Navy ocean engineering research and development projects.

C. Access to Computerized Information and Data Bases

At this stage in the development of the referral service, it will be beneficial to the operation to have direct access to the various Bibliographic Information and Data Bases of the NOAA ENDEX/OASIS system. A remote computer terminal with hard copy print out capability will facilitate identifying people and organizations with specific technology capabilities. The terminal would enable the referral service to identify and reccommend specific searches to the users to provide them with needed technology information. Such searches could then be requested by the user and paid for in accordance with the Users' Guide to ENDEX/OASIS. This remote terminal would also have

utility to the NOAA staff members involved in ocean engineering activities to meet their information and data needs and better equip them to provide expert support of the Ocean Engineering Technology Transfer operation.

D. Travel to Ocean Engineering Related Meetings

In this stage of the operation, provisions should be made for the personnel directly and indirectly associated with the Technology Transfer operation to attend various ocean engineering related meetings such as the Offshore Technology Conference, the MTS Oceans Conference, etc. This will provide for establishment of personal contact to improve the Referral Service as well as to lay the groundwork for future phases of development.

5.3.2 Phase II Referral Service Estimated Resource Requirements

Personnel - (October 1977 pay scales)	Annual Costs*
Information Specialist/Supervisor (GS-13) Full Time	$ 29,000
Information Technician (GS-9) Full Time	17,000
Search Analyst (GS-9) Full Time	17,000
Equipment Lease	
Remote Computer Terminal ($150 per month)	1,800
Wide Area Telecommunication Service	12,000
Directories	2,000
Travel to Ocean Engineering Related Meetings	8,000
Total Estimated Year 2 Referral Service O&M Costs	$ 86,800
User Workshop During Year 2 to Support Phase III Effort	40,000
Total Year 2 Costs	$126,800

*1978 Costs not adjusted for inflation

5.3.3 Evaluation and Monitoring

As previously indicated, the Phase I Referral Service would be of about one year's duration after which the more refined Phase II Referral Service would have been established to continue as an integral part of the Ocean Engineering Technology Transfer operation. If experience with technology users and producers so indicated this might well be the appropriate ultimate level of governmental services required to support the ocean engineering communities.

Operation of the Referral Service will provide the basis for better identification of the segments of the ocean engineering communities in need of a government sponsored technology transfer operation. This in turn will provide a better focus for the operation as specific users of the system are identified. The ocean engineering field is so broad and diverse that identification of users and the specific types of technology to be transferred cannot be determined without interaction between the transfer operation and the users. Such interaction will occur during the first year or so of the Referral Service. The operation must be carefully monitored and evaluated to determine whether or not experience indicates that the Technology Transfer operation should expand from a technology pull only service to a combination technology pull/push operation. If a decision is made to proceed with such further development of the operation, then the phases of development discussed below should be considered.

5.4 PHASE III - TECHNOLOGY APPLICATION ANALYSIS

This phase of the development would commence after a management decision that the monitoring and evaluation of the operation and the users' reactions to the service indicated that the Ocean Engineering Technology Transfer operation should be expanded from the passive "technology pull only" Referral Service to a more active combination of "technology pull/push" mode. Its purpose would be to make some evaluations and judgments as to who are the important users and where is the important technology; where is the greatest potential for service and what are the problems to be resolved? This phase would be primarily a study effort, utilizing experience with the operation to date, to identify those segments of the ocean engineering communities requiring more technology transfer support (i.e., establish the priority target user groups for the operation) and identify specific users, users' technology needs, and the mechanisms for locating needed technologies or determining that the needed technology is not available. The non-availability information would provide the basis for causing appropriate research and development efforts to be initiated. This research would also explore mechanisms for presenting potentially useful ocean engineering technology information in a format which the user can peruse to identify a technology which may be useful to him, even though he could not express or recognize such a need prior to examining the "catalog."

During the year this effort is underway, the Ocean Engineering Technology Transfer operation would continue to provide and improve the Phase II Referral Services.

5.4.1 Phase III Actions/Objectives

A. Conduct Users' Workshop

As a preliminary step in the Technology Applications Analysis phase, a Users' Workshop should be sponsored by the Ocean Engineering Technology Transfer operation after about eighteen months of operation in the Referral Service mode. This Workshop would provide a vehicle to supplement the in-house evaluation of the service by obtaining the principal users' views on the utility of the service as a basis for determining the ultimate level of capability which the Ocean Engineering Technology Transfer operation should develop.

B. Policy Analysis and Determination

The objective of this portion of the analysis would be to determine the broad issue of which user groups within the ocean engineering communities should receive priority attention. The usage statistics for the Referral Service will help to identify those groups most frequently asking for ocean engineering technology transfer support.

The fundamental question is: where can the transfer operation provide the greatest contributions to the National Ocean Program? Since it is not possible and probably not necessary for the transfer operation to cover all aspects of ocean engineering,

what policy should NOAA adopt relative to the scope of ocean engineering technology transfer operation?

C. Users' Needs Determination

Assuming that the action suggested in B above results in a delineation of the user groups to which priority effort should be devoted, then it should be possible to develop procedures whereby their technology needs can be determined on a continuing basis and maintained as a part of the Technology Transfer operation files.

D. Technology Potential Determination

This phase of the research effort would be directed toward identifying existing useful technologies and potential sources which are developing future needed technologies. This information would need to be updated on a continuing basis and become a part of the Ocean Engineering Technology Transfer operation files for use in matching to users' needs as they arise. The fact that certain needed technologies do not exist or are not being developed would also be of value to the operation for the purpose of establishing priorities for ocean engineering research and development.

E. Data Base Development

This step in the research effort would select or develop a Thesaurus for use in ocean engineering. Specialized ocean engineering data bases containing the types of information gained during this Phase III research would be developed for use to support the subsequent expansion of the functions of the

Technology Transfer operation. The management of these data bases by the Environmental Data Service is covered in the Phase IV discussion.

F. Design for Expanded Technology Transfer Operation

A detailed design would be developed for the combination technology pull/push Technology Transfer operation based upon the needs determined during the initial steps of the Phase III analysis effort.

5.4.2 Phase III Technology Application Analysis and Continued Referral Service Estimated Costs

During Phase III, the Phase II level Referral Service would be continued while the Technology Application Analysis is being accomplished. Estimated costs in 1978 dollars are:

Referral Service O&M	$ 86,000
Technology Application Analysis R&D	150,000
Total Year 3 Estimated Costs	$236,000

5.4.3 Phase III Planning for Implementation of Research Recommendations

Assuming the research conducted during the third year indicates the desirability of proceeding to Phase IV, the second year of Phase III would be devoted to in-house planning for implementation. This planning would be conducted by the designated Ocean Engineer/Supervisor for the Ocean Engineering Technology Transfer operation assisted by personnel operating the Referral Service and other available ocean engineering expertise. Estimated costs for this fourth year of operation would be:

Referral Service	$ 86,800
Additional Personnel	
Ocean Engineer/Supervisor (GS-14)	33,800
Clerk-typist (GS-6) 1/2 time	6,000
Total Estimated Year 4 Costs	$126,600

5.5 PHASE IV SPECIALIZED INFORMATION DISSEMINATION

Phase IV builds on the results of the Phase III research effort and the experience gained with almost four years of referral service. It presumes that the program priorities are clear, users and needs identified, and potential technology being tracked. With these in hand, the operation adds the dimension of an aggressive delivery of specialized information packages to targeted user groups. The emphasis would be on moving current technology on a continuing basis to users with relevant needs. This is a significant expansion in the capability from the technology pull referral service to a combination pull/push mode.

This would involve an increase in the resource requirements to cause pertinent current technological information to be acquired and organized for efficient retrieval to support the Technology Transfer operation. Now that we know the information that we need in the files to support the targeted user groups, it will be advantageous to create ocean engineering specific computerized information/data files to facilitate the retrieval of the pertinent information, using the data bases developed in Phase III. This technology push effort will also

require the addition of technical writing, editing, and publishing services. Support to all of NOAA in these functions is the responsibility of the Environmental Data Service. While the Technology Transfer operation should function in the environment with the extant ocean engineering expertise which has frequent contact with members of the ocean engineering communities, arrangement should be made with the NOAA EDS to provide information and data management and publishing support. (See Appendix A, page A-1-18 for coverage of EDS functions.) This would be analogous to some of the Department of Defense Information Analysis Centers (IACs) whose computerized data bases are maintained by the Defense Documentation Center based upon inputs from the IAC.

Ocean Engineering Specialists would be added to the Technology Transfer operation staff to screen and filter information to be included in the supporting data bases; and coordinate the preparation of responses to Technology Inquiries and specialized dissemination of information to ensure that relevant information is provided to the user in the format to meet his requirements. This would be a minimal staffing with reliance on the local ocean engineering expertise to support the Technology Transfer operation in their respective fields of knowledge.

5.5.1 Information Products and Services - Phase IV Operation

A. Referral Service

The Technology Transfer operation would continue to provide the basic referral service as it had in the past four years.

B. Technology Inquiry Service

The operation would now be in a position to provide authoritative advice in response to technology questions posed by a user. Each response would be tailored to the needs of the user. The responses to technology inquiries would utilize the ocean engineering expertise resident in or near the Technology Transfer Operation.

C. Current Awareness

This element of the technology push effort would be directed toward providing newsletters and reviews to keep user groups apprised of the latest and most significant technological developments within ocean engineering fields of interest.

D. Selective Dissemination of Information (SDI)

This would be a periodic distribution of relevant (i.e., screened) information in accordance with the needs profile of each user group. It would include results of recently completed research as well as information on pertinent ongoing research. This SDI would utilize ocean engineering specific files rather than the more comprehensive technical and scientific bibliographic information and data files in order to limit the citations provided to those pertinent to the user group.

E. NOAA Marine Advisory Service

Now that the user groups have been identified for the Ocean Engineering Technology Transfer operation, there is a basis for some programmed effort and funding to exploit the technology push and needs determination capabilities of the NOAA Marine Advisory Service.

5.5.2 User Charges

At this Phase user charges would be necessary to recoup certain of the costs of the operation. Such service charges could be based upon recovery of the cost of the output function which includes publications, Technology Inquiries, Selective Dissemination of Information, and literature searches. A subscription plan whereby users pay an annual fee for a fixed level of service and additional charges when that level is exceeded is utilized by certain of the DOD Information Analysis Centers. Such a system could be adapted for use by the Ocean Engineering Technology Transfer operation.

5.5.3 Phase IV Estimated Resource Requirements

Implementation of this level of capability would involve increased costs for ocean engineers to coordinate the accomplishment of the analysis function, data base management and publishing support by the EDS, additional facilities (primarily office space), and administrative personnel. The resource requirements would be determined more accurately during the Technology Application Analysis research in Phase III. Only a very rough estimate can be made at this time. A portion of the costs shown below would be recovered through user charges.

Personnel

Ocean Engineer/Supervisor	GS-14	$ 33,800
Information Specialist	GS-13	29,000
Ocean Engineer/Technical Writer	GS-12	24,000
Ocean Engineer/Technical Writer	GS-12	24,000

Information Technician	GS-9	$ 17,000
Search Analyst	GS-9	17,000
Clerk-Typist	GS-6	12,000
Clerk-Typist	GS-6	12,000
Environmental Data Service Support (Data base management, technical editing and publishing)		200,000
Equipment Lease		
WATS (Area Code 800 telephone)		12,000
Remote Computer Terminal		1,800
Travel to Ocean Engineering Activities and Meetings		15,000
Additional Office Space		12,000
Total Estimated Year 4 O&M Costs (Referral Service and Specialized Information Dissemination)		$409,600

5.6 PHASE V - OCEAN ENGINEERING TECHNOLOGY ANALYSIS

Phase V is a further expansion of the capabilities of the Ocean Engineering Technology Transfer operation which goes beyond the "broker" function between the technology users and the technology producers. Through in depth critical assessments and analytical studies conducted in house and by contractors, the Technology Transfer operation identifies gaps in the technology --critical needs that current technology fails to meet or gives little appearance of meeting. Thus, the added program dimension provides for feedback to the technology producers to help them foresee what may be the future problems and to identify profitable areas for Research and Development.

This expansion would provide the Technology Transfer operation with an analysis capability for the targeted ocean engineering user groups, similar to that provided by an Informaion Analysis Center (IAC). The term analysis is used in the sense of the qualitative and/or quantitative evaluation of information or information sources requiring technical knowledge and critical assessment.

Information Analysis Centers are usually adjuncts to organizations engaged in technical work, and normally are assigned information analysis responsibility in all or part of the subject matter field in which the host organization specializes. A substantial part of the information analysis work of the centers is performed by personnel of the host organization and is in conjunction with their regular scientific or engineering work. This experience indicates that the Ocean Engineering Technology Transfer operation should be located in very close proximity to a center of ocean engineering expertise within NOAA.

5.6.1 Responsibilities of the Technology Transfer Operation at Phase V

The operation would be responsible for maintaining or closely supervising the following

A. Input

• Acquiring and storing, under bibliographic control, the available (1) worlds literature in the subject areas required to support the needs of the targeted user groups, (2) unpublished reports, memoranda, and miscellaneous documents related to technology needs of its user groups. (As mentioned in Phase IV,

discussion, EDS support would be required for this data management function.)

• Developing and maintaining periodic contact, through personal visits and correspondence with senior investigators or practitioners engaged in technology work related to the ocean engineering areas of interest

• Participating in and/or planning major technical conferences or symposia containing a sufficient number of competent papers in the ocean engineering technology areas of interest to attract the attendance of senior investigators and practioners

B. Processing

• Identifying, collecting, and retaining those documents and other source materials which provide useful additions to the knowledge and understanding of the ocean engineering technology areas of interest

• Abstracting and extracting each document retained or each source of information (personal contact, telephone call, letter, etc.) which provides information concerning a significant technical event of interest to the operation

• Preparing critical reviews, monographs, or equivalent publications on the state-of-the-art in selected segments of the ocean engineering field

C. Output

• Referral Service to establish contact between a technology user and an appropriate technology producer believed capable of meeting the user's needs

• Distributing periodically a list of new and significant ocean engineering technology developments, complete with abstracts or extracts and reflecting some evaluation of the work. (See phase IV discussion.)

• Answering inquiries for technology information from qualified persons

- Preparing and/or distributing state-of-the-art reports or equivalent publications on selected segments of ocean engineering

- Preparing engineering monographs in selected areas of ocean engineering which describe concisely current practices and identify actual and potential critical problem areas requiring additional research and development

5.6.2 Estimated Costs of the Phase V Level of Service

Service levels established in Phase II and Phase IV would be a part of the Phase V capability. Since, at the time of this writing, it is not possible to clearly define the subject fields to be covered by the Technology Transfer operation, only a very rough estimate of resource requirements can be made. However, by the beginning of year four of the operation, user groups, technology needs, and technology producers should have been fairly well defined to enable a more accurate estimate to be made at that time.

As an example of the level of costs which might be anticipated, the Chemical Propulsion Information Agency, a DOD Information Analysis Center with twenty personnel, has a budget on the order of $800,000, about 50% of which is recovered by user charges. This center has a clearly defined industrial clientele had has been in existence since 1946. With a less clearly defined clientele, it would likely be many years before the Ocean Engineering Technology Transfer operation could expect to recover such a significant portion of its costs through user charges. The costs of the Phase V Ocean Engineering Technology Transfer Operation would probably exceed this $800,000 figure and could well be on the order of $1,000,000.

5.7 MANAGEMENT DECISION POINTS

Beginning year 1 minus 3 months

- Establish Referral Service Phase I and Phase II
- Conduct research to develop Ocean Engineering Directories (6 month effort)

End year 1

- Conduct User Workshop eighteenth month of operation
- Conduct Phase III Technology Application Analysis research to start beginning of year 3

End year 3

- Expand the Technology Transfer operation to include Specialized Information Dissemination beginning year 5

End year 4

- Expand the operation to include Ocean Engineering Technology Analysis beginning year 6

At any point in the development

- Alternative decisions could be made to modify the planned development to meet more effectively the needs of the users, continue the operation at its present level of service without further expansion, or terminate the operation.

CHAPTER 6

CONSTRAINTS TO TECHNOLOGY TRANSFER OPERATIONS

6.1 INTRODUCTION

The experience gained from earlier Federal Technology Transfer operations enables us to identify a number of potential problems for this activity. It is not possible to predict with any degree of certainty which problem areas will prove to be most troublesome. However, experience to date suggests that any serious constraints will not be technological in nature. For convenience, we will discuss some of the barriers to a successful Technology Transfer operation under the following categories--organizational, legal, economic, and technical.

6.2 ORGANIZATIONAL CONSTRAINTS

The organizational placement of Technology Transfer Operations varies widely in existing Federal programs. Unfortunately, political constraints and other considerations often dictate operations placement in the hierarchy quite independent of the ideal system design. To the extent practicable, however, the operation should not be encumbered by organizational loyalties that deter its usefulness to the wide diversity of user groups outside the parent organization.

There is a somewhat unique organizational problem with respect to the NOAA Ocean Engineering Technology Transfer

operation. While NOAA is the lead civil agency in ocean related matters, it is clear that the bulk of the developing technology for potential transfer exists outside of the lead agency. This in effect doubles the problem for NOAA since not only does a broad community of technology users exist outside the parent agency but a major part of the technology is produced outside as well.

Most of the current Federal transfer operations have the more limited objective of moving their own organization's technology into a wider market. Parallel information transfer operations such as the SSIE, NTIS, and the National Referral Center at the Library of Congress illustrates one of the major problems to be anticipated. While each of these organizations has far reaching responsibility for collecting information of a given type from across the totality of Federal agencies, there is little in the way of enforcement measures to ensure government-wide cooperation. Thus, depending on the "expert" whose judgment is selected, input coverage will range from 50-80% efficiency. Stated another way, 20-50% of the government produced information that should be entered in one of these systems never gets entered.

It seems likely that given the vertical structure of Federal organization, no enforced cooperation is possible among the major Federal technology producers. In the light of this political reality, it is essential that a management-supported Advisory Committee consisting of qualified and respected persons

representing the major technology producers and the principal user communities be in place and operating at the earliest possible time.

6.3 LEGAL CONSTRAINTS

The boundaries between what constitutes desirable and undesirable invasion of privacy as between a government agency and an individual are difficult to define. It is likely that potential areas of conflict will develop between an individual's right to privacy and the legitimate rights to information of operators and users of technology transfer services. A good deal of information about users and about producers of technology will be developed over time and stored in various file systems. Care must be taken to ensure that all individuals so described are aware of, and consent to, this operation.

Further, one can foresee the possibility of an undue number of referrals being directed to certain individuals or organizations. If these go beyond the accepted limit for voluntary cooperation, some form of appropriate compensation may be necessary or steps may be required to limit access to the aggrieved parties.

Government agencies who make referrals or provide information must guard against placing a "stamp of approval" on the technical validity of information or suggesting any guarantee as to the correctness or value of the information.

Another important question here related to legal barriers has to do with security. Not only are problems of national

security important, but care must also be taken to properly safeguard any proprietary information that may be in the system.

6.4 ECONOMIC CONSTRAINTS

Government programs do not operate under the same economic constraints as those in the private sector. Nevertheless, there is at no time a limitless bankroll for new government services.

Probably the most difficult time for a new program is during the early start-up period when costs tend to be high as compared to the apparent productivity of the program. Once procedures have been developed and user needs begin to be met, improvement and expansion of services can take place. Realistically, three to five years' time is required to achieve any meaningful and measurable benefits from the program.

Pressures to minimize program costs and to demonstrate the real worth of the services provided are always present but these become particularly acute during periods of budget retrenchment. That is why steps should be taken in the beginning to militate against the negative aspects of these concerns. User charges should be actively considered, not only because recovery of at least the marginal costs is Federal policy but user charges provide one way to evaluate service and minimize nonsense use of the program. Good usage data should also be collected and maintained from the beginning in order to assist in subsequent cost-benefit analysis.

6.5 TECHNICAL CONSTRAINTS

There have been some notable technological failures in recent years such as the demise of the videophone. However, the expanding use of computer technology, improvements in telecommunications, and, above all, the successful marriage of these two technologies, have opened almost limitless possibilities for planning technology transfer operations.

The man/machine interface problem remains troublesome in some areas. Many individuals are reluctant to approach a terminal and still resist using computerized systems. The lack of a standardized vocabulary introduces a potential noise source which can be serious at times. Steps should be taken early to adopt a single thesaurus for ocean engineering in order to maximize communication effectiveness.

One can see readily that the principal barriers to a successful technology transfer operation are most likely to be people problems, not ones of technology. The social constraints originating in organizations, legal questions and economics are far more serious. This places a heavy burden on the planners of the program and emphasizes the special importance of some of the early management decisions.

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APPENDIX A

THE GOVERNMENTAL OCEAN
ENGINEERING COMMUNITY

This Appendix lists governmental activities with either direct or peripheral ocean engineering related responsibilities. The activities are described on the attached enclosures. An enclosure is provided for each major agency.

Enclosure

Information for preparation of these enclosures to Appendix A was obtained from:

- The Budget of the U.S. Government FY 1978, Washington, D.C.; Government Printing Office, March 1977.
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ENCLOSURE 1 TO APPENDIX A

DEPARTMENT OF COMMERCE
OCEAN ENGINEERING RELATED ACTIVITIES

1. Introduction

1.1 Role of Department of Commerce

The Department of Commerce encourages, serves, and promotes the Nation's economic development and technological development. The principal agencies within the Department of Commerce involved with ocean engineering related activities are:

- Assistant Secretary for Science and Technology
  - National Bureau of Standards
  - Patent and Trademark Office
  - National Technical Information Service
- Assistant Secretary for Maritime Affairs
  - Maritime Administration
- National Oceanic and Atmospheric Administration

2. Assistant Secretary for Science and Technology

The research and development activities pertaining to science and technology programs, as well as environmental impact statements of the Department are the responsibility of the Assistant Secretary for Science and Technology. Activities under the purview of the Assistant Secretary with some ocean engineering/ technology transfer related responsibilities are described briefly below.

2.1 National Bureau of Standards

The Bureau of Standards conducts fundamental and applied research spanning a broad variety of fields in the physical sciences. Research in the measurement sciences includes the application of scientific discoveries to improved accuracy of the national standards of measurement, the evaluation of new developments in measurement instrumentation, and the generation and evaluation of new calibration procedures. It is these areas of the NBS responsibilities which relate closely to the development of ocean instrumentation systems undertaken by the NOAA Ocean Instrumentation Engineering Office under the Office of Ocean Engineering.

2.2 Patent and Trademark Office

The administration of the patent laws is the responsibility of the Patent and Trademark Office. A patent is a grant issued by the U.S. Government giving an inventor the right to exclude all others from making, using, or selling his invention within the United States for a specified number of years. In return for this grant, the inventor discloses his invention so that anyone may study it, gain ideas for improving it, or even devise a wholly different solution to the problem. Thus, through the patent system the latest innovations in technology are made known to the public. The patent office publications such as the Official Gazette provides summary information on patents granted and could be one of the technology information sources for an Ocean Engineering Technology Transfer operation.

2.2.1 Office of Technology Assessment and Forecast (OTAF)

The Technology Assessment and Forecast program administered by the OTAF of the Patent and Trademark Office uses patent data to pinpoint most active areas of technology. OTAF produces general distribution publications, available through the NTIS, and prepares tailored reports on any technological area on a cost reimbursable basis.

2.3 National Technical Information Service (NTIS)

The NTIS is the Federal clearinghouse for the collection and distribution of scientific, technical, and engineering information produced by government-sponsored research and development reports and other related analyses prepared by Federal agencies or their contractors.

In addition to published bulletins and announcements, such as the Weekly Government Abstracts and the Government Reports Announcements and Index, summary descriptions of reports are stored in a computer data base, which can be searched to retrieve all of the reports on a given subject or by a given activity or author. Copies of whole research reports, on which the summaries are based, are sold by the NTIS in paper or microfiche.

NTIS holdings include all the unclassified, unlimited distribution reports held by the Defense Documentation Center. The NTIS can also retrieve descriptions of ongoing and recently terminated research compiled by the Smithsonian Science Information Exchange.

The NTIS would be a principal secondary distribution point for completed research reports necessary to support an Ocean

Engineering Technology Transfer operation. All services of the NTIS are fully available to the general public on a reimbursable basis.

3. Maritime Administration

The Maritime Administration (MarAd) promotes the development, operation, and maintenance of an efficient American-flag merchant marine capable of meeting the commercial and military shipping requirements of the United States. MarAD carries out a broad research and development program to improve the productivity and competitive posture of the U.S. merchant marine through technological innovations.

The Maritime Research Information Service (MRIS) is a computer-based information system for acquisition, selection, storage, retrieval, and dissemination of references to proposals, ongoing and completed research and development projects and to technical reports and journal articles in the maritime field.

4. National Oceanic and Atmospheric Administration (NOAA)

4.1 Role of the NOAA

NOAA was formed in 1970 to promote increased knowledge and rational use of the natural environment. It is the lead civil agency in ocean related matters. The mission of the NOAA involves:

- The development of programs to assure that the ocean environment and its resources are wisely used in a balanced way to enable their development and conservation for the national well being.

• The execution of such programs so that the ocean's resources can be effectively and economically developed by the private sector, providing an arena for the creation of new industries and revitalization of existing ones.

• The development and operation of systems to monitor and predict environmental conditions such as weather, ocean, earth and solar hazards so that through information services and hazard warnings, life and property are protected and the efficiency of commercial, industrial and agricultural activities are improved.

• The preservation and development of the nation's coastal resources by assisting the States and other public agencies in the wise management of the land and water resources of the coastal zone.

• The provision of basic maps, charts, surveys, and specialized data required for safe navigation and accurate location.

The principal Assistant Administrators in the NOAA are:

• Assistant Administrator, Fisheries

  National Marine Fisheries Service
  Office of Marine Mammals

• Assistant Administrator, Coastal Zone Management

• Assistant Administrator, Research and Development

  Environmental Research Laboratories
  Office of Sea Grant
  Office of Ocean Engineering

- Assistant Administrator, Oceanic and Atmospheric Services

  National Weather Service
  National Environmental Satellite Service
  National Ocean Survey
  Environmental Data Service

- Assistant Administrator, Policy and Planning

  Marine Minerals Division

A brief description of each activity is shown below:

4.2 National Marine Fisheries Service (NMFS)

Promotes the protection and rational use of living marine resources for their aesthetic, economic, and recreational value to the American people. Administers programs to determine the consequences of the naturally varying environment and man's activities on living marine resources, to provide knowledge and services to foster their efficient and judicious use, and to achieve domestic and international management, use and protection of living marine resources.

The NMFS is involved in various types of fishery systems research to develop: (1) more effective resources sampling systems; (2) means to increase the harvesting efficiency of the fishing industry--particularly where underutilized species are concerned; and (3) fishing methods that are more species selective for conservation purposes. Under the Office of Resource Research, five main fisheries research centers are maintained:

- Southeast Fisheries Center

  Miami, Florida

- Northwest Fisheries Center

  Seattle, Washington

- Southwest Fisheries Center

  Lo Jolla, California

- Northeast Fisheries Center

  Woods Hole, Massachusetts

- Atlantic Estuarine Fisheries Center

  Beaufort, North Carolina

Additional laboratories/centers are located at Galveston, Texas; the Middle Atlantic Coastal Fisheries Center at Sandy Hook, New Jersey; Tiburon Fisheries Laboratory, California; and the Auke Bay Fisheries Laboratory, Alaska. Fisheries product technology centers are located at Gloucester, Massachusetts; Seattle, Washington; and College Park, Maryland.

Tha National Fisheries Engineering Laboratory at the National Space Technology Laboratories, Bay St. Louis, Mississippi is a principal laboratory oriented toward satisfying the technological needs of the Fisheries Service, promote technological developments in fisheries management and use, and apply engineering expertise to fisheries problems when needed. The laboratory deals in remote sensing systems to assess the resources that are available to fishermen and develop sampling systems and fishing gear for latent species. The laboratory works closely with industry, other NOAA activities such as the Environmental Satellite Service, the NOAA Data Buoy Office, the Sea Grant Program, and the Marine Advisory Service; Naval activities such

as the Naval Ocean Research and Development Activity at Bay St. Louis, the Naval Ocean Systems Center at San Diego, the Naval Coastal Systems Laboratory at Panama City, Florida; NASA; the U.S. Coast Guard; and others in its engineering R&D work.

4.3 Assistant Administrator, Coastal Zone Management

The Office of Coastal Zone Management assists the coastal states in the development of their Coastal Zone Management plans, under the provision of the CZM Act which was passed by Congress and signed by the President in 1972. The act made it national policy:

- to preserve, protect, develop and, where possible to restore our coastal resources
- to help states manage their coast responsibilities wisely through the development of appropriate management programs
- for all federal agencies engaged in work affecting coastal areas to consult closely with the state agencies responsible for administering the coastal management programs
- to encourage cooperation among local, state and regional agencies

The Office of Coastal Zone Management operates the National Coastal Zone Information Center. There are currently being established nine Regional Coastal Information Centers (RCICs). Through the joint efforts of the Environmental Data Service, the Office of Sea Grant and the Office of Coastal Zone Management, the RCICs will improve the referral, delivery, and feedback systems for existing marine and coastal information utilizing existing NOAA files and systems (OASIS and ENDEX).

4.4 Assistant Administrator, Research and Development

4.4.1 Environmental Research Laboratories (ERL)

The ERLs conduct an integrated research program in accordance with their objectives at laboratories and field sites in locations suited to the problems under study. Approaches to research include theoretical and analytical studies, laboratory experiments, and observations in the field by all appropriate techniques including aircraft, balloons, rockets, and satellites. The ERLs perform research services for NOAA components and other agencies.

The laboratories disseminate results of research efforts and participate actively in the science community both nationally and internationally. The complex of laboratories includes:

- Atlantic Oceanographic and Meterological Laboratories
  Miami, Florida

  Physical Oceanography Laboratory
  Ocean Chemistry Laboratory
  Marine Geology and Geophysical Laboratory
  Sea-Air Interaction Laboratory

- Great Lakes Environmental Research Laboratory
  Ann Arbor, Michican

- Pacific Marine Environmental Laboratory
  Seattle, Washington

- Atmospheric Chemistry and Physics Laboratory
  Boulder, Colorado

- Air Resources Laboratories at various locations

- Geophysical Fluid Dynamics Laboratory
  Princeton, New Jersey
- National Severe Storms Laboratory
  Norman, Oklahoma
- Space Environment Laboratory
  Boulder, Colorado
- Aeronomy Laboratory
  Boulder, Colorado
- Wave Propagation Laboratory
  Boulder, Colorado

4.4.2 Office of Sea Grant

The Office of Sea Grant administers funding support for institutions engaged in comprehensive marine research, education, and advisory services aimed at assisting man in the intelligent utilization of the seas and Great Lakes of the United States and their adjacent coastal areas. The advisory services consititute the technology transfer mechanism by which the results of supported research, development, and analysis are introduced into marine and coastal business and industry.

Advisory service under Sea Grant funding includes publications, dissemination of information through audio and visual media, demonstrations, extension services, seminars, conferences, and other appropriate means. Advisory services include "repackaging" of information to make scientific or engineering data immediately useful to interested consumers.

4.4.3 NOAA Marine Advisory Service

Purpose and Objective - This program was established to promote and disseminate knowledge on use and development of the ocean and Great Lakes resources to industry, governmental and educational institutions, and the general public. The objective is to assist those who are interested in and responsible for the development, utilization, and management of the ocean and its resources through an efficient system whereby the results of research, availability of services, experience of industry, and other sources of information are quickly made available to the users.

Scope - The subject matter involved in the Marine Advisory Service includes the full range of information required by ocean activities and includes, in addition to technical information, social, legal, and economic aspects. The subject areas of concern include those for which NOAA and Sea Grant Programs are responsible and extends also to responsibilities of other Federal agencies where their missions can be facilitated by cooperation in the Marine Advisory Program.

Organization Structure and Responsibilities - The NOAA Marine Advisory Service is organized on the premise that States working via Sea Grant or other programs provide a means of coordinating marine advisory services on a local basis. The primary interface between the advisory program and the public is carried out at the local level by State or Sea Grant organizations. NOAA, in cooperation with other Federal agencies, works through

and supports the local organizations and at the same time assumes the basic responsibility for the continuity, completeness, and overall success of the advisory program.

Role of NOAA Elements

Office of Sea Grant - The Office of Sea Grant has responsibility for the leadership of the NOAA Marine Advisory Service. It manages marine advisory services provided and funded by NOAA Major Line Components (MLCs) and coordinates advisory programs supported under Sea Grant funds. The Office is responsible for the evaluation of the status of present advisory services on a state, regional, and national basis. It encourages establishment of state advisory programs, improvements in services, and implementation of new services where found necessary. It recommends increases and changes in NOAA's activities on advisory services.

Major Line Components (MLCs) - The principal responsibility of NOAA MLCs is to ensure that the marine advisory services relative to their mission are adequate on a national basis. The MLCs work with the Office of Sea Grant to assist State and Sea Grant organizations. They suggest actions to improve advisory services or to ensure that new services are provided where required. Responsiblity for this extends to furnishing of funds and personnel on a temporary basis to make certain that an adequate local organization is available through which the total service can be affected. MLCs provide a principal source of technical expertise, information, and assistance in accordance with their appropriate mission.

4.4.4 Office of Ocean Engineering

The Office of Ocean Engineering exercises functional review over, and recommends policy and plans for all of NOAA's ocean engineering and instrumentation programs. It conducts an program of research, technology development, and services related to ocean engineering and undersea operations; and serves as a national focal point for knowledge relating to civil ocean engineering, a catalyst for industrial ocean engineering development, and a mechanism for technology transfer from military and space fields.

The Office of Ocean Engineering has under its purview:

- Ocean Instrumentation and Advanced Engineering Office
- NOAA Data Buoy Office
- Manned Undersea Science and Technology Office

Ocean Instrumentation and Advanced Engineering Office (OIEO). The OIEO was established as a major OOE component to initiate and encourage advances in ocean engineering systems, information, instrumentation, and standards. The OIEO program consists of two elements: (1) Advanced Ocean Engineering Technology to address engineering problems inherent in developing systems for operation in the ocean environment and to improve communications between the national ocean engineering community and those that develop data and information; and (2) Advanced Ocean Measurement Technology to improve marine measurement and instrument capabilities, to develop necessary measurement standards and procedures, and to improve the reliability of data and the data gathering process.

NOAA Data Buoy Office (NDBO). The NDBO is located at the National Space Technology Laboratories, Bay St. Louis,

Mississippi. The NDBO has a twofold mission: (1) to develop buoy technology and test and evaluate buoy systems for acquisition of marine environmental data; and (2) to procure, deploy, and operate buoys on a reimbursable basis as specified by user organizations. To carry out this mission, NDBO budgets for and conducts the necessary research and development; contracts for the fabrication of prototypes; develops deployment and operational procedures; acquires information on reliability, data quality, and costs; and, in effect certifies the prototypes as operational buoy data acquisition systems. Procurement of operational buoys is funded by the user agencies. The term buoy data acquisition system is defined as a complete system consisting of the buoy hull with moorings and payload. The payload, which may be compatible with several types of buoys, includes environmental sensors, power supplies, signal processing and encoding circuits, and communications and antenna systems for telemetering the data directly or via satellite to a shore station. The NDBO assists the National Fisheries Engineering Laboratory, also located at Bay St. Louis, with certain of their projects such as the project for electronically tagging porpoises. NDBO also works closely with the Navy activities at Bay St. Louis. The U.S. Coast Guard provides at-sea and shore support and furnishes a number of officers and enlisted personnel to the NDBO staff.

Manned Undersea Science and Technology Office (MUS&T)

The basic objectives of the Manned Undersea Science and Technology (MUS&T) Program under the purview of the MUS&T Office are to:

- Provide manned underwater and operational support to NOAA and other agencies investigating marine resources and environmental problems for which subsurface observations and collection of data by man are required.

- Develop, support and manage a NOAA diving program to assure safe diving and more efficient operations for prolonged manned missions in coastal waters and on the continental shelf.
- Foster and coordinate manned undersea science projects with Federal and State agencies, industry, institutions, and universities.
- Develop scientific and technical criteria for the design of civilian undersea facilities and platforms, through experience gained by using available habitats and submersibles.
- Encourage and coordinate the transfer of undersea technology including advances in diver technology and all civilian, military and foreign undersea scientific and technological developments.

4.5 Assistant Administrator, Oceanic and Atmospheric Services

4.5.1 National Weather Service

The National Weather Service reports the weather of the United States and its possessions and provides weather forecasts to the general public, issues warnings against such destructive natural events as hurricanes, tornadoes, floods, and tsunamis and provides special services in support of aviation, marine activities, agriculture, forestry, urban air-quality control, and other weather-sensitive activities.

The National Weather Service operates the following laboratories under its Systems Development Office.

- Integrated Systems Laboratory
- Techniques Development Laboratory
- Equipment Development Laboratory

The Engineering Division under the Associate Director, Technical Services conducts the engineering work for the National Weather Service, including Instrument Engineering.

4.5.2 National Environmental Satellite Service (NESS)

NESS manages all operational satellite programs within NOAA. It reviews all existing and proposed research-oriented satellite programs in NOAA; and on request manages these programs. NESS conducts satellite systems engineering including the design and establishment of satellite data processing and analysis systems. It coordinates overall NOAA planning and budgeting--coordinates user requirements.

4.5.3 National Ocean Survey

The National Ocean Survey:

- Conducts source surveys to provide a basic network of geodetic control.
- Provides basic data for engineering, scientific, commercial, industrial, and defense needs.
- Supports the quest for more knowledge of our environment and undertakes a program of marine technology development to observe, measure, and chart oceanic phenomena and resources.
- Conducts surveys, investigations, analysis and research, and technology development.
- Provides charts for the safety of marine and air navigation.

- Disseminates data in the following fields; geodesy, gravity, astronomy, aeronautical charting, hydrography, oceanography, and marine technology.
- Operates and maintains ocean going ships, ship bases, mobile survey and observing parties and field offices.
- Operates a printing plant for reproduction of charts and maintains a system for chart distribution.

The National Ocean Survey operates the following laboratories:

- Geodetic Research and Development Laboratory within the National Geodetic Survey. The National Geodetic Survey also operates the National Geodetic Survey Information Center
- Two laboratories operate under the Office of Marine Technology.
  Engineering Development Laboratory
  Test and Evaluation Laboratory

The Office of Marine Technology is tasked to act as the focus of the NOS effort for technology related to testing, evaluation, and calibration of sensing systems for ocean use; and to enhance the quality of such systems by the dissemination of operational results and technical information to the national oceanographic community. The Office of Marine Technology is also tasked to provide NOAA, with marine systems technology, ocean engineering, sensor systems, buoy systems, data automation systems, and other technology functions as may be assigned, and assist with the design, development, and procurement in these technical areas. (D0025-5B, Amendment 2 of September 7, 1976)

4.5.4 Environmental Data Service (EDS)

The operations of the EDS contribute to technology utilization and exchange. The EDS consists of five centers involved in archiving the Nation's environmental data in the atmospheric, oceanic and solid earth disciplines; in indexing those environmental data nationally and internationally in the EDS centers and in providing members of the user community with environmental data summaries and products. The five centers are:

- Center for Climatic and Environmental Assessment
  Columbus, Missouri
- National Climatic Center
  Ashville, North Carolina
- National Geophysical and Solar Terrestrial Data Center
  Boulder, Colorado

  This center conducts a data and data information service in all aspects of solid earth geophysics and in the scientific and technical areas involving the high atmosphere. Disciplines included involve seismology, geomagnetism, marine geophysics (including bathmetry, seismic profiles, magnetic and gravity anomalies, ocean bottom cores, ocean bottom samples, geothermal measurements and similar parameters taken both from the ocean stations and underway), gravimetry, earth tides, crustal movements, goethermics, ionosphere, aurora, airglow, cosmic rays, magnetosphere, aeronomy and solar activity. The Center prepares systematic and special data products and performs data related research studies to enhance the utility of the service to the users.

• National Oceanographic Data Center (NODC)
Washington, D.C.

The NODC plans and directs activities concerned with the development of a national marine data base, including acquisition, processing, storage, and retrieval of marine data and information generated by domestic and foreign activities; maintains liaison with Federal, State, academic and industrial oceanographic activities; represents NODC, as an interagency activity, on various domestic panels, committees, and councils and represents the United States in various international organizations; represents EDS and NOAA to the general public, government agencies, private institutions, foreign governments, and the private sector on matters involving classified oceanographic data; and works with the Director, EDS and his Associate Director for Marine Sciences.

• Environmental Science Information Center (ESIC)
Washington, D.C.

The Environmental Science Information Center:

- Coordinates and supervises the scientific and technical information, documentation, publication, and library activities of NOAA and develops them into a comprehensive NOAA program.

- Conducts this program to serve all components of NOAA and to facilitate the transfer of scientific and technical information throughout NOAA and between NOAA and other government agencies, the scientific community, and other national and international interests.

- Analyze the transfer processes, improves the related techniques, procedures and facilities; and integrates them into an efficient, coordinated NOAA scientific information and documentation system com-

patible with interactivity systems both within and outside NOAA.

- Develops and maintains scientific publication policies, standards and procedures.

- Serves as the "Publication Clearance Office" for applicable NOAA scientific and technical publications.

- Coordinates scientific reviewing and clearing of manuscripts by NOAA editorial boards.

- Promotes technical writing, editing, and publishing services.

- Provides library services and operates a NOAA scientific information center.

- Provides a secretariat for the NOAA Scientific Information and Documentation Council and responds to its advice on matter of common interest.

• The Library and Information Services Division (LISD) of ESIC, Rockville, Maryland

• Promotes the transfer of environmental information to meet the interests and needs of both NOAA and the outside user community.

- Plans, develops, coordinates, and operates a system and library facilities to assure access to and the availability of the scientific and technical literature on the marine, atmospheric and geophysical sciences, engineering, and social sciences related to the coastal and marine environment.

- Develops new automatic techniques of organization, analysis, dissemination, and presentation of information to provide improved services.

- Operates a system for collecting, analyzing, storing, retrieving, announcing, and disseminating technical information and publications to ensure rapid and complete service to interested agencies and individuals.

- Selects, acquires, and maintains technical books, technical reports, periodicals, and other library materials of interest to NOAA elements in the Washington, D.C. area, in Miami, and in Detroit, identifying and marking those of pure interest to each element.

4.6 Policy and Planning - Marine Minerals Division

The Marine Minerals Division under the Assistant Administrator for Policy and Planning:

- Coordinates and implements NOAA marine mineral resources activities for furthering utilization of these resources by the United States, while providing adequate safeguards for the marine and coastal environments, and examines the plans and programs for related activities of other NOAA elements.
- Provides guidance on establishing NOAA policy to the operating elements, manages NOAA marine mining related programs to assess the environmental effects of resource development, evaluate resources, and analyze the economic implications of resource development.
- Provides technical advisory service to industry, the public, and other agencies.
- Assesses the implications of international and domestic legal regimes on resource development.

- Develops basic understanding of marine mining related processes through research.
- Maintains current projections of resources and existing programs; evaluates programs in terms of planned accomplishments and recommends alternates.
- Evaluates and develops legislative proposals pertaining to the above programs and participates with other NOAA organizations, groups, Federal and non-Federal and public organizations for appropriate program coordination and exchange of information.

ENCLOSURE 2 to APPENDIX A

DEPARTMENT OF DEFENSE
OCEAN ENGINEERING RELATED ACTIVITIES

1. Introduction

The Navy Department and the Army Corps of Engineers are the principal DOD elements involved in ocean engineering related activities. The Department of the Navy is the major Federal producer and user of ocean engineering technology. The Army Corps of Engineers with civil works responsibility in the coastal zone and nearshore ocean areas is also involved in ocean engineering activities. This enclosure provides a brief description of the DOD offices, commands, and RDT&E activities associated with ocean engineering.

2. Department of the Navy

2.1 U.S. Navy

The Navy's primary business is ocean engineering with such programs spread throughout the spectrum of naval activities. The principal involved commands, offices, and RDT&E Laboratories/ Centers are described below:

2.2 Office of the Chief of Naval Operations

The Chief of Naval Operations (CNO) commands the operating and support forces of the U.S. Navy. In carrying out these command responsibilities, he determines the needs of Naval

Forces and activities for research, development, test, and evaluation; plans and provides for the conduct of development, test, and evaluation which are adequate and responsible to long-range objectives, immediate requirements and fiscal limitations; and provides assistance to the Assistant Secretary of the Navy (Research, Engineering, and Systems) in the direction, review, and appraisal of the overall Navy RDT&E Program to ensure fulfillment of stated requirements. A large proportion of the Navy RDT&E Program is ocean engineering related.

2.2.1 Deputy Chiefs of Naval Operations Within the Office of the CNO

There are several Deputy Chiefs of Naval Operations and Directors of major staff offices which have RDT&E related responsibilities, particularly in the determination of requirements and acceptance for service use of new systems and equipment.

2.2.2 Director, Research, Development, Test and Evaluation

RDT&E matters within the Office of the CNO are a primary responsibility of the Director, Research, Development, Test and Evaluation. One of the many functions of the Director, RDT&E is that he:

> Coordinates exchange of intra-, inter-service, intergovernmental, and international RDT&E information to enhance RDT&E efforts, preclude duplication of effort where inappropriate, and benefit from commonality.

2.2.3 Oceanographer of the Navy

The Oceanographer of the Navy is the Naval Oceanographic Program Director for the Chief of Naval Operations. He receives policy direction from the Assistant Secretary of the

Navy (Research, Engineering, and Systems). Secretary of the Navy (SECNAV) Instruction 5430.79A of 23 May 1975 sets forth policy, relationships, and responsibilities for the Naval Oceanographic Program. It states that the Oceanographer of the Navy exercises centralized authority, direction and control of resources, in order to ensure an integrated and effective Naval Oceanographic Program.

The instruction indicates:

> The basic oceanographic policy of the Department of the Navy is to provide the oceanographic information and related technological base necessary for the Department of Defense to fulfill its assigned missions.

Hence the program is oriented toward primary military application. However, the Instruction mentions secondary objectives (Ancillary Benefits to the National Effort) as being:

> To advance knowledge of all aspects of the ocean, coastal, and seabed areas, to permit and encourage successful exploitation of these areas for economic, social, political and prestige gains. To cooperate in the preparation of plans for extending or developing international law concerning the ocean, coastal and seabed areas.

Although the Instruction makes clear that national defense takes priority over other goals, it also indicates the Navy Department's impression of its major roles in the national ocean effort, as follows:

> As the nation's foremost sea-oriented instrumentality with the most expertise in oceanography, the Navy recognizes its de facto position of leadership in the field and its obligation to support the nonmilitary objectives of the national oceanographic program. The most economical approach to meeting many nondefense national needs is the limited expansion of Navy programs and facilities, where practicable.

The largest portion of the knowledge gained from oceanographic activities and through the operations and facilities required to assure an appropriate level of oceanographic output for military use, is not classified and can be made available to national, international, and private organizations and programs. Consistent with its own established oceanographic effort, the Navy will cooperate with any national organization devoted to the study of the total environment, and/or any organization which attempts to provide a national focus to describe, understand, and predict environmental phenomena, and will also encourage the continued exchange of oceanographic data and knowledge with and between organizations.

2.2.3.1 Naval Oceanographic Center, Bay St. Louis, Mississippi

There is currently no central ocean engineering information processing capability within the Navy Department to facilitate accomplishment of the Technology Transfer inferred in the preceding quote from the SECNAV Instruction.

The Navy is establishing a Naval Oceanographic Center at the National Space Technology Laboratories, Bay St. Louis, Mississippi. This Center is being established to provide for increasing technical coordination of the Naval Oceanographic Program. It will consist of the Naval Oceanographic Office (NAVOCEANO), the Naval Ocean Research and Development Activity (NORDA), and the Office of the Director, Naval Oceanography and Meteorology (DIRNAVOCEANMET); all three of which are currently located at Bay St. Louis. Missions of the three components of the Naval Oceanographic Center are as follows:

- Naval Oceanographic Office. To enhance the performance of the Navy, analyzing, and displaying oceanographic data (including hydrographic, geophysical and acoustic data) to support Fleet Operations and Shore Establishment commands; to improve methods

of oceanographic prediction, data collection, and data analysis, and perform other related research, development, test, and evaluation; and to assist other DOD components, U.S. activities, and allied countries in training and in otherwise meeting their oceanographic requirements.

- Naval Ocean Research and Development Activity. To provide full spectrum ocean science support for overall Navy R&D programs; provide ocean science program management in oceanographic R&D; develop an annual recommended Navy plan in ocean science to the Chief of Naval Research for research, to Chief of Naval Development for exploratory development, and to the Chief of Naval Material Program managers as appropriate; and conduct related R&D programs as assigned by the Chief of Naval Research.
- Director, Naval Oceanography and Meteorology. To provide environmental prediction concerned with observing and collecting real-time oceanographic data; processing and disseminating these data as forecasts of sea, swell, surf, ice, sonar and relative environmental conditions. Provide guidance for the development and improvement of prediction techniques, and determine current and future requirements of the Navy Department for oceanographic forecasting service.

The Oceanographer of the Navy has indicated that there will be an ocean engineering technology information management capability within the Naval Oceanographic Center, although no detailed plans of exactly what such a capability might encompass are available. During an interview on 16 September, Captain Walker, USN, the Assistant Deputy Chief Naval Material (Acquisition),

stated that no personnel will be on board to start thinking about this projected capability until March 1978 at the earliest. During this conversation with the Assistant Deputy Chief Naval Material (Acquisition), he indicated that there is room for the Navy to work together with NOAA at a specified site or be interconnected by data link. He further indicated a willingness to provide available technical assistance on an ad hoc basis, but that the Navy would not be in a position to participate in the development of a design for a technology transfer operation during the time frame of this study. Navy efforts in this regard should be monitored by NOAA to enable the Ocean Engineering Technology Transfer operation to make maximum use of the Navy's planned system.

2.3 Office of Naval Research (ONR)

The mission of the Office of Naval Research is to encourage, promote, plan, initiate and coordinate naval research as related to the maintenance of future naval power and preservation of national security; - - - . Research programs within the ONR are organized along the following disciplinary lines:

Naval Applications and Analysis
Physical Sciences
Mathematical and Infomation Sciences
Biological Sciences
Psychological Sciences
Earth Sciences
Material Sciences
Ocean Science and Technology

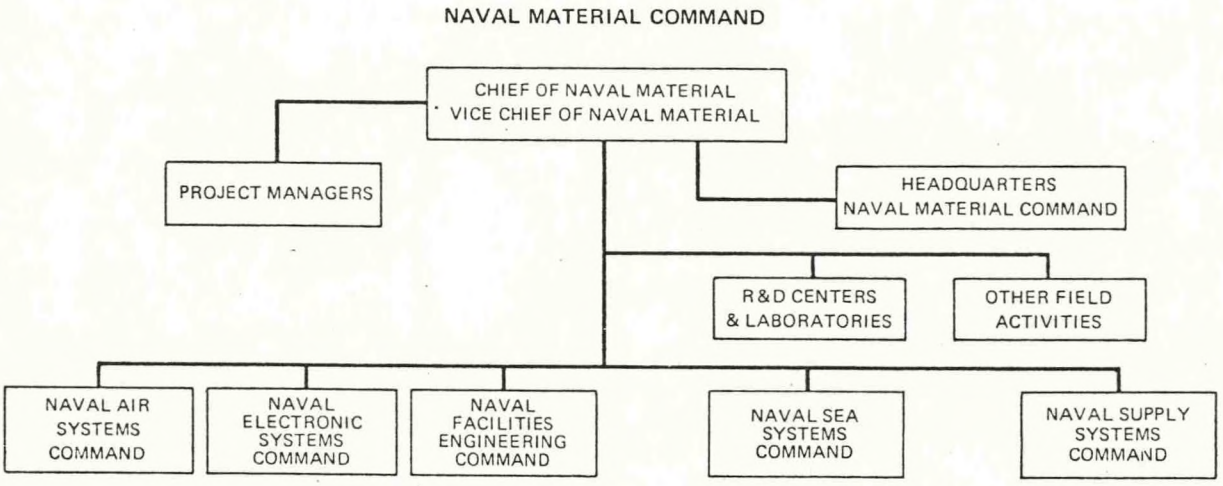
The Ocean Science and Technology Division is concerned with research into the physical, geological, chemical, and biological characteristics of the oceans. The Division has separate programs for physical oceanography, air-sea interactions, geology and geophysics, ocean biology, and ocean technology.

The Chief of Naval Research, who heads the ONR, is also assigned additional duties as the Assistant Oceanographer for Ocean Science.

2.4 Naval Material Command

2.4.1 Chief of Naval Material

The Chief of Naval Material under the Command of the CNO provides for the total support needs and material support of the Operating Forces of the Navy for equipment, weapons and weapon systems, materials, supplies, facilities, maintenance, and supporting services, including the development, acquisition, procurement, construction, maintenance, alteration, repair, and overhaul of ships, aircraft, surface and undersea craft, space and oceanographic systems, and equipment; training and equipment devices; land vehicle systems and equipment, fixed ocean systems; and shore facilities and utilities, all consistent with approved programs. The Naval Material Command consists of the elements shown in the following block diagram:



2.4.2 The Naval Systems Commands

Material Support Responsibilities of all Systems Commanders

Each System Command shall provide for and meet those material support needs of the Department of the Navy that are within the assigned "material support" responsibility of such command. This general responsibility includes specific responsibility for the research, design, development, logistics planning test, technical evaluation, acquisition, procurement, contracting, production, construction, manufacture, inspection, fitting out, supply, maintenance, alteration, conversion, repair, overhaul, modification, and advance base outfitting of naval material for which the command is assigned responsibility. Representative material support responsibilities are listed in the following sections.

2.4.2.1 Naval Air Systems Command

- Navy and Marine Corps aircraft systems and components (including fuels and lubricants).
- Air-launched weapon systems and components (excluding torpedoes and mines).
- Other airborne and air-launched systems and components such as electronic, underwater sound, astronauts, mine countermeasure, targets, pyrotechnics and photographic and meteorological equipment.

2.4.2.2 Naval Electronic Systems Command

- Command/control/communications (platform to platform) complete.
- Underseas and space surveillance
- Navigation aids, airtraffic control and automatic landing systems, less airborne.
- Marine Corps expeditionary and amphibious electronics
- ESM and ECM systems (less airborne and ECCM applicable to other assigned systems
- Multi-platform electronic systems not otherwise assigned.

2.4.2.3 Naval Facilities Engineering Command

- Public works, fixed surface and subsurface ocean structures, utilities and mobile ground equipment (except that assigned to another command or office).
- Materials and appliances for defense ashore against chemical, biological and radiological warfare.

2.4.2.4 Naval Sea Systems Command

- Ships, submersibles, amphibious craft and vehicles, boats and manned surface and manned submersible targets (except service craft assigned to NAVFAC).
- Shipboard weapon systems, missiles and ammunition.
- Air-launched mines and torpedoes.
- Towing and salvaging equipment.
- Shipboard components not otherwise assigned, including propulsion, auxiliary power-generating and distribution systems, tactical data systems, surveillance, interior communications, radar, sonar and auxiliary equipment.

2.4.3 Naval Research and Development Laboratories/Centers

The principal Naval R&D Laboratories/Centers involved in ocean engineering are described briefly below.

2.4.3.1 Naval Research Laboratory (NRL), Washington, D.C.

The mission of this laboratory is to conduct a broadly based multidisciplinary program of scientific research and advanced technological development directed toward new and improved materials, equipment, techniques, systems and related operational procedures for the Navy. Under the Associate Director of Research for Oceanology are an Acoustics Division, an Ocean Science Division and an Ocean Technology Division. The Acoustics Division is concerned with the research relating to generation, transmission, reception and analysis of underwater sound. The Ocean Sciences Division provides for research relating to the physics, chemistry geology and biology of the oceans. The Ocean Technology Division

is involved with research, development, and application of techniques for conducting ocean and ocean floor operations.

2.4.3.2 Naval Ocean Systems Center (NOSC)
San Diego, California and Hawaii

The Naval Ocean Systems Center comprises what used to be the Naval Undersea Center and the Naval Electronics Laboratory Center. The mission of this center includes the former Naval Undersea Center mission as the principal Navy RDT&E Center for undersea surveillance, surface and air launched undersea weapons systems, and for deep ocean technology; and the former Naval Electronics Laboratory Center mission to be the principal Navy RDT&E Center for command, control, and communications concepts and systems; standardized electronic modules, and for computers and machine languages.

2.4.3.2 Naval Air Development Center (NADC)
Warminster, Pennsylvania 18974

The mission is to be the principal Navy RDT&E Center for Naval aircraft systems less aircraft launched weapons systems. Product areas related to ocean engineering include:

- Acoustical Search and Surveillance Systems
- Airborne Magnetic Anomaly Detection
- Navigation

2.4.3.3 Naval Coastal Systems Laboratory (NCSL)
Panama City, Florida 32401

The principal Navy activity for conducting RDT&E in support of Naval missions and operations that take place primarily in the coastal (continental shelf) regions. This includes, in

particular, RDT&E for mine countermeasures, diving and salvage, coastal and inshore defense (less ASW), swimmer operations, and amphibious operations.

2.4.3.4 Naval Ship Research and Development Center
Bethesda and Annapolis, Maryland

The principal Navy RDT&E center for Naval vehicles and logistics, and to provide RDT&E support to the U.S. Maritime Administration and the maritime industry. The Annapolis Laboratory is heavily involved in materials research.

2.4.3.5 Naval Surface Weapons Center
Silver Spring, Maryland and Dahlgren, Virginia

The principal Navy RDT&E Center for surface ship weapons systems, ordnance, mines and strategic support systems.

2.4.3.6 Naval Underwater Systems Center
Newport, Rhode Island and New London, Connecticut

The principal RDT&E Center for submarine warfare and submarine weapons systems.

2.4.3.7 Naval Weapons Center
China Lake, California

The principal Navy RDT&E Center for air warfare systems (except anti-submarine warfare systems) and missile weapon systems.

2.4.3.8 Naval Civil Engineering Laboratory, Naval Construction Battalion Center, Port Hueneme, California

The principal Navy RDT&E Center for fixed surface and subsurface ocean facilities for the Navy and Marine Corps Construction forces.

2.4.4 Navy Research and Development Information Center (NARDIC)

NARDIC is the Navy focal point for making information regarding ongoing Navy Research and Development available to industry. The services of NARDIC are available to representatives of industrial, scientific or other organizations that:

1. Have a demonstrable capability of engaging in research and are participating in the Navy/Industry Cooperative R&D (NICRAD) Program.

2. Have been registered for access to DOD information services by a DOD component, based on a current DOD contract or participation in the potential contractor program of the Army or Air Force.

The orientation of the NARDIC is toward DOD contractors or potential contractors and it is not manned or prepared to provide similar service to non-DOD Federal agencies, their contractors, or the general industrial community.

NARDIC has available for review by eligible organizations, Science and Technology Objectives, Operational Requirements, Specific Operation Requirements, Research and Development Planning Summaries, Research and Technology Work Unit Summaries, Laboratory Program Summaries, Proceedings of Advanced Planning Briefings for Industry and various other requirements/ planning documents.

The classified and unclassified Research and Technology Work Unit Summaries for each Navy Laboratory are provided to NARDIC by the DDC.

2.4.5 The U.S. Naval Postgraduate School, Monterey, California

This school offers graduate education for active duty military officers in oceanography and various engineering disciplines. It conducts extensive oceanographic and ocean engineering research in support of Navy needs. The Naval Fleet Weather Center is located with the USNPGS at Monterey.

3. U.S. Army Corps of Engineers

3.1 Army Coastal Engineering Research Center
Kingman Building, Fort Belvoir, Virginia

Research and development in the field of coastal engineering to bring about a better understanding of winds, waves, tides and currents as they apply to navigation; flood and storm protection; beach erosion and shore structures.

3.2 Waterways Experiment Station
P. O. Box 631, Vicksburg, Mississippi 39180

Development and improvement of rivers and harbors; shore protection; water conservation hydraulics; water quality; aquatic needs; dredged material research; environmental relationships; sand bypassing (coastal).

3. Defense Documentation Center (DDC)

The Defense Documentation Center is the primary R&D information/data service within the Department of Defense. The DDC makes available scientific and technical reports produced by DOD organizations and their contractors. The Center operates

computer based data banks of management and technical information concerning R&D projects. DDC services are provided to all Federal Government agencies. The NOAA Environmental Data Service has access to DDC files.

DDC does not serve the general public directly, but the scientific and industrial community has access to reports having no security or other distribution restrictions. Such reports are sent to the National Technical Information Service (NTIS) of the Department of Commerce where they are made available and sold in hard copy or microfiche to the general public.

DDC also provides status information on Defense R&D in progress through its Research and Technology Work Unit Information System. There are more than 20,000 active work unit summaries in the system. Information on approximately 13,000 of these work units is available to the general public through the Smithsonian Science Information Exchange (SSIE) which also maintains for public use, similar information about ongoing research supported by other Federal agencies as well as many non-Federal organizations.

ENCLOSURE 3 TO APPENDIX A

DEPARTMENT OF THE INTERIOR
OCEAN ENGINEERING RELATED ACTIVITIES

1. Introduction

1.1 Role of the Department of the Interior

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of our people.

The Department of the Interior plays a major role in the Federal Ocean Program. DOI has approximately 15.5% of the Federal Ocean Program FY 78 Budget of 1,044 million dollars. This percentage is exceeded only by the DOC 30.2% and the Department of Defense 29.4%. The principal activities/Bureaus of the DOI involved in work which could be considered ocean engineering related are:

- Office of Minerals Policy and Research Analysis
  Ocean Mining Administration
- Office of Water Research and Technology
- Geological Survey
- Bureau of Mines
- Bureau of Reclamation
- U.S. Fish and Wildlife Service
- National Parks Service
- Bureau of Outdoor Recreation

2. Office of Minerals Policy and Research Analysis

The Office is the primary minerals policy analysis office for the Assistant Secretary--Energy and Minerals, and is the focal point for minerals policy development and coordination in the Department of the Interior. The Office is responsible for the overall coordination of the analyses conducted by Departmental minerals organizations, development of comprehensive minerals policy, overseeing the development of new minerals research and development programs, evaluating the progress and results of all minerals research and development conducted or sponsored by the Department of the Interior, and advising the related organizations reporting to the Assistant Secretary--Energy and Minerals in the development of their minerals programs, associated and research programs, and in the formulation of their minerals research and development budgets.

Ocean Mining Administration

The Ocean Mining Administration, under the supervision of the Assistant Secretary--Energy and Minerals, was established by Secretarial Order 2971 of February 24, 1975. It is responsbible for policy development for the promotion and continuation of a domestic ocean-mining capability in deep seabed areas. Additional responsibilities include jurisdictional issues in international negotiations relating to the resources of the Continental Shelf; the implementation of a domestic ocean mining program with special emphasis on its relationship to ongoing and future negotiations on the law of the sea and ocean mining; supervision of ocean minerals economic, technology and resource assessments: supervision of ocean mineral resources environmental studies; and liaison with other Federal agencies concerned with ocean mineral resources development and regulatory aspects of ocean mining.

The Ocean Mining Administration provides central management focus for Department of the Interior activities relating to seabed mineral resources beyond national jurisdiction by reviewing budget and program activities of other departmental organizational units for consistency with overall ocean mineral resource policy and program objectives.

3. Office of Water Research and Technology (OWRT)

The fundamental purposes of the OWRT are to develop new or improved technology and methods for solving or mitigating existing and projected State, regional, and nationwide water resources problems. Included with its other functions is the conduct of research and development and related studies directed toward developing methods, equipment, and processes that will establish practical means for economical production from sea and other saline or chemically contaminated water, of water suitable for agricultural, industrial, municipal and other beneficial uses.

The OWRT is further responsible for water resources scientific information and technology transfer programs to furnish summary information to the nation's water resources community about ongoing research projects and results of completed projects.

The Water Resources Scientific Information Center publishes "Selected Water Resources Abstracts" which covers documents on all aspects of water resources, including the life, physical, and social sciences as well as related engineering and legal aspects. Coverage includes the near shore, coastal, and estuarine waters and oil spillage in the ocean. It also produces the "Water Resources Research Catalog", which includes description of research in progress in the U. S. and sixty seven other countries. The WRSIC operates a network of on-line search terminals using the above data bases.

4. Bureau of Land Management

The Bureau of Land Management is responsible for the conservation, management, and development of 470 million acres of national resource lands, including 296 million acres in Alaska. The Bureau also administers mining and mineral leasing on 396 million acres of mineral estate underlying other ownerships, and approximately 1.1 billion acres of the Outer Continental Shelf.

5. Geological Survey

The Geological Survey is responsible for the classification of the public lands and the examination of the geological structure, mineral resources, and products of the national domain and the Outer Continental Shelf.

Research carried out includes marine geology and hydrology, marine sedimentology, limnology, floods, water quality and contamination. Through the Office of Marine Geology of the Geological Division, Geological and Geophysical investigations are made of Federal portions of the Outer Continental Shelf. Data gathered are prerequisites to eventual exploration and production activities. The Conservation Division has responsiblities for supervision of oil, gas and mineral operations on all Federal lands, including the Outer Continental Shelf.

6. Bureau of Mines

The Bureau of Mines is primarily a research and fact finding agency. Its goal is to stimulate private industry

to produce a substantial share of the nation's mineral needs in ways that best protect the public interest. The Bureau conducts research to develop techniques and practices for safe and environmentally sound mining and processing of mineral resources, including those located in offshore areas. Aspects of coastal and offshore mine health and safety are handled by the Department's Mining Enforcement and Safety Administration.

7. Bureau of Reclamation

The Bureau of Reclamation has responsibility for the conservation, development, and use of water and related land resources in the 17 western states, and is involved, in some cases, with marine related activities in coastal areas in the West.

8. U. S. Fish and Wildlife Service

The U. S. Fish and Wildlife Service has lead responsibility within the Department for the conservation and enhancement of wildlife and "non-marine" gamefish, including all fisheries of the Great Lakes and many species of fish also found in the oceans. It manages the National Wildlife Refuge System, operates fish hatcheries, and conducts research on coastal habitats and ecosystems and on the environment impact of natural and man-induced phenomena on shoreline and marine birds and mammals, with emphasis on endangered species.

9. National Parks Service

The Department's National Park Service conducts and supports marine-related research in both the social and natural sciences to aid in management of coastal areas within the National Park System. These coastal areas offer a range of natural environments for marine investigations supported by others.

10. Bureau of Outdoor Recreation

As the federal focal point for coordination of outdoor recreation programs, the Bureau of Outdoor Recreation supports research to improve these programs. It administers the Land and Water Conservation Fund, which constitutes a source of matching grants to state and local jurisdiction for research in planning and developing marine-related recreational programs and facilties.

11. Bureau of Indian Affairs

The Bureau of Indian Affairs, through grants to tribal councils and others, supports marine-related research advantages to Indian interests.

ENCLOSURE 4 TO APPENDIX A

NATIONAL SCIENCE FOUNDATION
OCEAN ENGINEERING RELATED ACTIVITIES

The Division of Ocean Sciences of the National Science Foundation supports two research programs and a third program for acquisition and operation of research facilities.

Oceanography Project Support provides grants for developing fundamental knowledge about the oceans, primarily for studies in physical and biological oceanography, submarine geology and geophysics, and marine chemistry.

The International Decade of Ocean Exploration supports large-scale international investigations of the role of the ocean as related to climate, food production, pollution, energy, and natural resources. Four projects are incorporated in this program: (1) Environmental Forecasting, which is aimed at improved environmental prediction through better understanding of climate changes, the influence of the oceans on the atmosphere, and the part played by ocean circulation in shaping weather and climate; (2) Environmental Quality, which deals with the impact of man-made chemicals on the marine environment through study of the effects of pollutants on marine organisms, transfer of pollutants to the marine environment, and the worldwide distribution of geochemical features of ocean waters; (3) Seabed Assessment, which supports studies of the natural processes

that result in formation and distribution of metal-rich manganese nodules, petroleum, and gas; and (4) Living Resources, which sponsor basic research in ocean processes that affect the development of living marine resources.

The Oceanographic Facilities and Support Program provides major support for 30 research ships and several facilities operated by 15 academic oceanographic laboratories. The continuing objectives of this program are to maintain, improve, and effectively manage a cooperative system of oceanographic facilities at key locations in the academic community, and promote their shared use through the University National Oceanographic Laboratory System (UNOLS), an organization within that community.

Other divisions within the Foundation also sponsor projects relating to the marine environment, including research in ocean engineering, marine resource management, and the influence of the oceans on weather and climate.

ENCLOSURE 5 TO APPENDIX A

DEPARTMENT OF ENERGY
OCEAN ENGINEERING RELATED ACTIVITIES

In order to gain an understanding of the coastal zone environment as a complete system, the Energy Research and Development Administration, now a part of the Department of Energy, in 1975 began supporting long-term research programs covering six geographic areas: the Southeast, the Northeast (Mid-Atlantic Bight), Pacific Northwest, Gulf of Mexico, the California coast, and the Great Lakes. Of these programs, the one covering the Southeast area is coordinated and underway; the others are being established. Research being supported includes the following:

Distribution and dispersion of trace metals from rivers through estuaries and onto the Continental Shelf and the effects of air pollutants on the coastal ecosystems (Skidaway Institute of Oceanography, University of Georgia).

Processes that trigger the production of microscopic plant life, which is the first step in the food chain, in order to assess potential effects of energy developments (Brookhaven National Laboratory).

Influence of the Gulf Strean and winds on current patterns to determine the transfer of pollutants and nutrients along the Continental Shelf (Skidaway Institute, University of Miami, and North Carolina State University).

Movement of plutonium and tritium in coastal waters and resulting concentrations in marine life, and developments of a computer model to help predict future effects of energy development (Savannah River Ecology Laboratory, University of Georgia).

Microbial, invertebrate, fish populations, and the movement of trace elements and radionuclides in the estuaries and coastal waters near Beaufort, North Carolina (National Marine Fisheries Service, National Oceanic and Atmospheric Administration).

Basic biological processes that affect the survival of plant and animal communities on the Continental Shelf, including examination of microorganisms, to assess possible polluting effects of oil spills and heated water releases on these processes (Scripps Institution of Oceanography, University of Washington, Brookhaven National Laboratory, and Pacific North-West Laboratory).

In addition, the Department of Energy, Division of Solar Energy is working on marine-related energy conversion technology, particularly ocean thermal energy conversion (OTEC) to harness thermal gradients between surface and deep ocean water. As part of the OTEC program, heat exchangers are being developed at laboratory and bench scales preliminary to ocean testing. OTEC is one of the principal ocean engineering related programs. Through a NOAA-ERDA (DOE) Interagency Agreement, the NOAA/OOE is providing project management and systems engineering

support to DOE's OTEC program in the technical management of two subsystems: the Sea Water System and the Position Control/ mooring systems. In bioconversion, growth experience in kelp mariculture is underway; in wind energy conversion, studies of offshore windmills are beginning; and technological assessment of other ocean energy options is in process, especially as related to waves, tides and salinity gradients.

ENCLOSURE 6 TO APPENDIX A

DEPARTMENT OF TRANSPORTATION
(U.S. COAST GUARD)
OCEAN ENGINEERING RELATED ACTIVITIES

The U.S. Coast Guard's research and development effort is directed to provide research, development, testing and evaluation of equipment, techniques, systems, and materials in support of the myriad operations and regulatory programs of the service. Missions include search and rescue, icebreaking, enforcement of laws and treaties, aids to navigation, commercial vessel safety, marine environmental protection, and recreation-boating safety. The productivity and performance for these mission areas include such activities as the development of pollution spill detection, identification, and quantification methods; new procedures for the control and cleaning of oil and other hazardous substances in the coastal and Arctic regions; testing and evaluation of new marine sanitation devices; advancement of wide-area surveillance systems; and new impact assessment techniques and information systems.

To meet the challenges posed by increased congestion of U.S. ports and waterways, research is being done on systematic identification and analysis of cargo, terminal facility, inspection procedures, and vessel structural and design problem areas; development of a marine safety information system; recreational

boating safety education; improvement of port fire fighting equipment and techniques; and technology to minimize the environmental impact of deepwater ports. Continued expansion of marine activity in the coastal zone and polar regions has led to increased efforts to develop sophisticated surveillance methods and equipment to protect offshore resources, to enforce pollution and fisheries laws, to provide more effective search and rescue assistance, to facilitate waterborne transportation, and to support the regional national security needs.

In the area of aids to navigation and ocean operations, research is directed toward improved methods for positioning aids, a precision all-weather Loran-C navigation capability, system standards for audio-visual aids, development of solar energy for aids to navigation, and continued refinement of ice-breaking techniques and facilities.

In addition to these direct operating program support activities, long-range projects include technology forecasting for underwater activity, feasibility studies of unmanned vehicles and underwater sensing, and development of vehicles and marine transportation requiring low energy use.

ENCLOSURE 7 TO APPENDIX A

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)
OCEAN ENGINEERING RELATED ACTIVITIES

NASA, through its Office of Applications, supports oceanography related research efforts leading to the demonstration of applying aerospace technology and visible, infrared, and microwave remote sensing techniques to repetitive synoptic observations and measurements of ocean conditions and the quality of the marine environment on a global basis. To ensure that these activities are responsive to the needs or desires of other federal agencies for new or improved ocean data and information acquisition systems, the Office of Applications maintains a close cooperative working arrangement with those agencies during research planning, implementation, and assessment of accomplishments. To date, efforts have culminated in successful oceanography remote sensing experiments of NASA's series of Nimbus, Landsats-1 and -2, GEOS-3, Apollo, and Skylab orbital space flight missions. These experiments have demonstrated the utility of visible and infrared remote sensing techniques in providing information on circulation patterns, currents, sediment transport, pollutants, bioproductivity, sea ice conditions, and sea surface topography associated with sea mounts or deep ocean trenches. Emphasis is now being placed on the development and field testing of passive and

active microwave remote sensors and a multispectral visible and near-infrared scanner to be used on Seasat-A and Nimbus-G respectively, which are to be launched during 1978. Seasat-A, the first in a series of Ocean Dynamics Satellites, will be placed in a nearly polar orbit to permit the acquisition of data relative to sea state, sea surface topography, wave directional spectra, sea surface wind speed and direction, ocean currents, ice cover, and geoidal variations every 36 hours. Investigations will be conducted to assess the utility of the Nimbus-G ocean color scanner for detecting, identifying, mapping and quantifying ocean pollution, nutrient rich areas related to fisheries, coastal zone circulation patterns, and shoreline alterations.

ENCLOSURE 8 TO APPENDIX A

ENVIRONMENTAL PROTECTION AGENCY (EPA)
OCEAN ENGINEERING RELATED ACTIVITIES

EPA's marine programs are based on two legislative mandates, namely the Water Pollution Control Act, P.L. 92-500, and the Marine Protection Research and Sanctuaries Act, P.L. 92-532. Marine research activities are conducted at three laboratories located in Corvallis, Oregon; Narragensett, Rhode Island; and Gulf Breeze, Florida. In addition, research is carried out at field stations in Newport, Oregon; Johns Island, South Carolina; and other locations under an active grant and contract program.

Research at the Corvallis Environmental Research Laboratory is directed toward diffuse ocean outfall discharges and nonpoint sources. The objectives of this research include the development of assessment techniques and methods, the determination of ecosystem effects, and the development of the scientific base necessary to regulate such discharges for optimal ecosystem protection. Mathematical and simulation modeling for predicting pollutant dynamics and the potential for ecosystem alterations is an integral part of this research effort.

Research at the Narragansett Environmental Research Laboratory responds directly to a legislative mandate to develop marine water quality criteria as a defensible decision base for setting and enforcing marine water quality standards. Additional research

seeks to assess the environmental impact of ocean dumping of materials, such as dredge spoils, sewage sludge, and industrial wastes. Other programs examine the effects of petrochemicals discharged into the marine environment, the human health risks of recreational environment, the human health risks of recreational water microbial populations, and the risks associated with shellfish exposure to polluted effluents.

At the Gulf Breeze, Florida, Laboratory research is conducted on the ecological effects of pesticides and other synthetic organic compounds on marine and estuarine organisms and ecosystems. Studies are also conducted to determine the pathways, biological effects, and fate of hazardous organic and inorganic pollutants in estuarine ecosystems, simulated as well in natural. Research concerned with the effects of toxicants on marine and estuarine species at the subcellar, cellular, tissue, and organ level is ongoing and integrated into the overall research effort.

ENCLOSURE 9 TO APPENDIX A

DEPARTMENT OF STATE
OCEAN ENGINEERING RELATED ACTIVITIES

Marine-related research conducted by, or under contract to, the Department of State is mainly concerned with economic, legal, political, and social aspects, and consists chiefly of ad hoc projects of short duration dealing with timely issues.

The Department also maintains an inventory of government-supported research related to foreign affairs, to which all federal agencies are invited to contribute and which includes marine research as it pertains to foreign affairs. The contact point for information of Department of State Marine research is:

Office of External Research
Bureau of Intelligence and Research
U. S. Department of State

ENCLOSURE 10 TO APPENDIX A

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OCEAN ENGINEERING RELATED ACTIVITIES

Public Health Service

The Public Health Service participates in the federal marine science and engineering effort by (1) conducting research aimed at an understanding of factors in the marine environment that have an adverse effect on human health, and investigating the mechanisms through which that toxicity is expressed; and (2) making its research findings available and providing technical assistance, training, and consultation to regulatory agencies, industry, and the general public.

At the National Institutes of Health (NIH), scientists of the National Institute of Environmental Health Sciences have been concerned with studies of the physiological mechanisms of transport, accumulation, metabolism, and excretion of pollutants by a variety of marine and estuarine organisms. The results of such studies are made available to regulatory agencies, such as the Environmental Protection Agency and the Food and Drug Administration. The National Heart, Lung, and Blood Institute, NIH, is engaged in two ambitious research programs, the first of which deals with a research effort toward dealing with tolerance to respiratory gases under conditions of environmental stresses and extremes. One result of this program has been the

establishment of a basis for the development of systems of decompression intended for use following exposure to high inert gas pressures. The aim of the second program is the study of (1) the effects of increased hydrostatic pressure on cells, tissues, organs, and intact organisms; (2) the mechanics underlying inert gas narcosis and anesthesia; (3) liquid breathing a potential method of diving to great depths; (4) metabolic effects of compressed gases, including oxygen toxicity; and (5) the pathophysiology of decompression sickness and possible means of prevention.

The Food and Drug Administration (FDA) both conducts and cooperates in special projects aimed at improving the quality of the nation's marine food supply. Based on the results of such studies, FDA develops shellfish cultivation, harvesting, processing, and shipping standards, and promulgates appropriate regulations. Enforcement of such regulations rests with state authorities.

In view of the expanding federal sea floor leasing program and the attendant need to protect the health and safety of divers, the National Institute for Occupational Health and Safety (NIOSH) of the Center for Disease Control organized a Diving Task Force, with representatives from government agencies, professional societies, and universities, to develop a "National Plan for the Safety and Health of Divers." The Plan was published in January 1976. In September 1976, NIOSH released a preliminary report entitled "Recommended Medical and Operating

Standards for Divers," intended to help assure the safety and health of commercial divers. The final document will be advisory only to the Occupational Safety and Health Administration.

ENCLOSURE 11 TO APPENDIX A

SMITHSONIAN INSTITUTION
OCEAN ENGINEERING RELATED ACTIVITIES

The Smithsonian Institution's Museum of Natural History maintains the largest collection of biological specimens and geological samples in the world, an important resource for research on current and historical environmental conditions. An example of research projects carried out under the auspices of the Museum is Investigations of Marine Shallow Water Ecosystems, a study of the physical, chemical, and biological aspects of an undisturbed reef adjacent to Belize, British Honduras, which can be used as a baseline for comparison with polluted or otherwise disturbed reef systems.

Other activities in marine science include the following:

Scientific Event Alert Network, established in 1975 to serve as a clearinghouse for information on transient, biological, astronomical, and geological events.

Smithsonian Oceanographic Sorting Center, which receives, sorts, records, and curates aquatic collections, makes specimens available to specialists, and maintains a data bank on the collections.

Chesapeake Bay Center for Environmental Studies, a long-term ecosystem study of the Rhode River estuary and watershed located on the western shore of Chesapeake Bay.

Smithsonian Tropical Research Institute, located in Panama, which is concerned with basic scientific questions of the evolutionary and ecological adaptations of tropical organisms.

Fort Pierce Bureau, located at Link Port on the Indian River between Fort Pierce and Vero Beach, Florida, where studies include a baseline survey of the Indian River, life history investigations of marine animals, and development of rescue systems for small research submarines.

ENCLOSURE 12 TO APPENDIX A

NATIONAL ACADEMY OF SCIENCES-
NATIONAL ACADEMY OF ENGINEERING
OCEAN ENGINEERING RELATED ACTIVITIES

The National Academy of Sciences (NAS) is an organization of distinguished scientists and engineers dedicated to the furtherance of science and its use for the general welfare. The National Academy of Engineering (NAE) shares in the objectives and responsibilities of the NAS by bringing to bear the Nation's most eminent engineers in sponsoring engineering programs aimed at meeting the national needs, encouraging engineering research and advising the Federal Government upon request in matters of engineering. The National Research Council serves as the principal operating agency of the NAS and NAE. The purpose of the Council is to stimulate scientific research and to foster application of research findings to engineering, agriculture, medicine, and other useful arts, with the object of increasing knowledge and of contributing in other ways to the public welfare. No Federal funds are appropriated directly to the academies, the principal funding mechanism typically being the negotiation of contracts with Government agencies.

The Marine Board is the principal ocean engineering related activity within the Assembly of Engineering of the National Research Council. The June 1, 1977 Statement of Task for the Marine Board is quoted.

Purpose: The Marine Board was established to provide, from an engineering viewpoint "...advice as to the organizations, facilities, and programs that would be most appropriate for executing the statutory responsibilities of the government with respect to utilization of the resources of the ocean and to the technological application of oceanographic knowledge for the public welfare and defense."

Objective: The achieve this purpose, the Board will:

1. Maintain an active membership of recognized experts as the marine focus within the Assembly of Engineering for the formulation of engineering opinion and judgment, on the initiative of the Board, and at the request of the United States government agencies.

2. Identify and maintain communications with the recognized experts in the U.S. engineering community and related professions who are available to assist the Board, through its elements, in specific areas of the Board's activity.

3. Maintain active communication with the U.S. and foreign engineering communities; the scientific community, the local, state, and U.S. governments; national, international and inter-governmental marine agencies.

Function: Within its assigned area of responsibility, the Marine Board is expected to:

1. Initiate investigation of issues considered to be appropriate by the Board and the National Research Council.

2. Respond, as appropriate and approved, to specific requests by governmental agencies.

3. Make available members of the Board and its committee and panels as observer-participants in government boards and committees.

4. Review the state-of-the-art in engineering related to the ocean, especially in relation to the national goals.

5. Project future needs and capabilities of marine related engineering.

6. Appraise prospects and limitations for utilization of the oceans, and review alternatives for intermediate and long-range U.S. government policies and programs.

7. Maintain communications with the Ocean Sciences Board (formerly the Ocean Affairs Board) and other marine-related committees of the NRC, as well as other advisory groups.

8. Maintain and foster communications with the professional engineering communicaties in the U.S.; scientists; engineers; and government officials and the public on national ocean engineering problems and provide a forum to facilitate the exchange of information.

9. Review and evaluate international and intergovernmental marine-related engineering developments.

ENCLOSURE 13 TO APPENDIX A

STATE GOVERNMENTAL OCEAN ENGINEERING RELATED AGENCIES

The below listed State agencies have a potential association with ocean engineering programs. This listing was obtained from Ocean Research - A Guide to Ocean and Freshwater Research Including Fisheries Research* and the National Directory of State Agencies 1976-1977.** The latter provides the address and telephone number of each listed agency.

Alabama Department of Conservation and Natural Resources
Alabama Geological Survey
Alaska Department of Environmental Conservation
California Department of Conservation
California Department of Fish and Game
California Department of Navigation and Ocean Development
California Water Resources Central Board
Connecticut Department of Environmental Protection
Delaware Department of Natural Resources and Environmental Control
Delaware Geological Survey

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*Allen Varley, ed, Ocean Research - A Guide to Ocean and Freshwater Research Including Fisheries Research. (Cambridge, G.B.: University Printing House, 1976)

*Nancy D. Wright and Gene P. Allen, The Natural Directory of State Agencies 1976-1977, (Washington, D.C., Information Resources Press, Herner & Co., 1977)

Florida Department of Natural Resources
Georgia Department of Natural Resources
Georgia Environmental Protection Division
Hawaii Department of Land and Natural Resources
Hawaii State Department of Health
Louisiana Geological Survey
Marine Department of Environmental Protection
Maryland Department of Natural Resources
Maryland Geological Survey
Mississippi Air and Water Pollution Control Commission
Mississippi Game and Fish Commission
Mississippi Marine Conservation Commission
New Hampshire Water Resources Board
New Hampshire Water Supply and Pollution Control Commission
New Jersy Department of Environmental Protection
New York State Department of Environmental Conservation
North Carolina Department of Natural and Economic Resources
Oregon Environmental Quality Commission
Pennsylvania Department of Environmental Resources
South Carolina Department of Health and Environmental Control
Texas Parks and Wildlife Department
Texas Environmental Protection Division, Office of Adjutant General
Virginia Department of Conservation and Economic Development
Washington State Department of Natural Resources
Washington State Department of Ecology

APPENDIX B

DETERMINE FEASIBILITY OF EXTRACTING USEFUL UNCLASSIFIED TECHNOLOGY INFORMATION FROM CLASSIFIED NAVY REPORTS.

1. INTRODUCTION

Industry involved in new products, processes or procedures is particularly interested in technology which may lead to improved capabilities. The Federal government created specialized information centers (i.e. NTIS, DDC) in order to make government generated technology information more readily available to interested industry. Taken that one is dealing with a relatively new and high technology industry--such as marine mineral mining--it is reasonable to assume that industry would wish to become aware of all possible relevant technology. Large organizations generally have the capability to, and in practice do, query government sources for pertinent information. Smaller organizations, however, tend to depend on technology transfer forums and technical & industrial journals. In either case, the marine mineral mining industry is usually restricted to those sources which are exclusively identified as "unclassified" in the security sense. This is unfortunate since an important source of Federal government information lies within classified documents which well may include appreciable amounts of "unclassified" information. Current Department of Defense regulations require that all classified materials contain classification designations on a paragraph-by-paragraph basis.

Thus, in most instances, it is a simple matter to extract and pass that unclassified information which might be useful to the industrial marine mineral mining community.

If one accepts the thesis that significant "unclassified" information resides in "classified" documents, then several questions should be addressed:

(a) Is the information accessible?

(b) Is the information readily identifiable?

(c) How much (quantity) information is involved?

(d) Is the "unclassified" information unique, or is it duplicated in the available "unclassified" literature?

(e) Can the retrieved information be reproduced and disseminated by NOAA? What is the procedure

(f) Can the information be made available to U.S. industry?

2. METHODOLOGY

As previously mentioned, this task was basically a feasibility study to determine, whether "unclassified" technological information useful to the marine mineral mining industry could be gleaned from Department of Defense "classified" reports. The study was not intended to be an exhaustive determination of what "unclassified" technology information (potentially applicable to marine mineral mining) resides within those reports having "classified" covers. It was a test approach to guage the situation and determine if a more extensive effort is warranted.

The Naval Research Laboratory (NRL) was chosen by NOAA and GWU as a logical and convenient focus for this experiment--NRL is

in Washington, D.C.; it is involved in a fairly extensive program of ocean science and technology; and professionals within that organization could be of useful technical assistance. A senior scientist was designated by the Director of Research to be the Laboratory contact and to assist in the experiment as necessary. NOAA transferred funds directly to the Laboratory to pay for time and related effort required.

3. DISCUSSION

Representatives from NRL and GWU met at the Laboratory to discuss the problem and develop a mutually agreeable plan upon which to proceed. The specialist in charge of the NRL Documentation Room suggested that the Defense Documentation Center (DDC) (an immense data bank of defense related technical reports) would be the logical source from which pertinent classified documents could be obtained for examination. Procedures exist which permit search of the DDC data bank directly from the NRL Documentation Room. A console which has remote access to the DDC on a time sharing basis provides this capability. The search mechanism and the obvious feasibility of its use in the experiment led to the generation of interest as to the actual amount of "unclassified" information which might reside within the "classified" documents. As a first approach, certain terms significant to the broad area of ocean engineering were selected from the DDC Thesaurus to be used in a complementary fashion in the experimental document search. These terms are included in Enclosure 1.

Using the specially equipped console at NRL, the specialist identified those relevant "classified" documents in the data bank which had been submitted during the previous three years (CY 75-77). Seven of these documents were noted. The abstracts were first examined on the optical readout and then printed in hard copy. Search totals and related administrative information were included. Titles, authors and accession numbers are listed in Enclosure 2. The abstracts are not included in this report due to Laboratory administrative controls.

The document specialist then searched the system for reports which were submitted during the previous five years (CY 69-CY 75), and 83 reports, having "classified" designations, were found in storage. Since the system is on a time-shared basis and only three minutes are permitted for a direct readout, written information for the 83 documents was requested through channels. The information has been received and is being retained by the Laboratory.

To follow through and determine whether a mechanism actually does exist to identify and extract the "unclassified" information, the microfiche of the initial seven documents were retrieved from the NRL Library and examined on the microfiche reader. In accordance with recent security designation regulations, the paragraphs were identified as to their classification, and, it was a simple matter to note all sections which were "unclassified"

In discussion with the documentation specialist, it was agreed that there is a high probability that large sections of a confidential document in the data bank would be unclassified;

a rough estimate is 60-75%. The mechanism for identifying this information is available and requires only that one has access to the appropriate remote console, a microfiche reader, and an accompanying printout capability.

On February 8, 1978, representatives of NOAA and GWU visited the Laboratory to observe a demonstration of the equipment and attempt to identify information of direct interest to the NOAA Marine Minerals Division. At the Documentation Room, the specialist discussed the NRL capability, the DDC storage and retrieval system, and then proceeded to perform an experiment. Terms were selected from the Thesaurus which, hopefully, would retrieve relevant information--"replenishment," "transfer," and "ship" seemed appropriate to the transfer of material from one ship to another on the open ocean. The initial research was limited to unclassified information. Using the first term, "replenishment," 176 documents were identified. With the terms, of "transfer" and "ship" added, only six documents were identified (see enclosure 3). An interesting and unanticipated fact emerged during this search--a document was identified which was designated "For Government Use Only." This identification raises another question as to availability of pertinent information. A detailed discussion of the limited distribution category is contained in the NOAA Office of Marine Minerals Technology Transfer Study Final Report completed by GWU on February 16, 1977.

4. CONCLUSIONS

The results of both experimental searches are that; a mechanism does exist, and "unclassified" information can be identi-

fied and retrieved using the remote console linked to the DDC data bank. However, there are some very significant problems which could complicate any extensive search effort: (1) Selection of the terms to use in the search procedure is extremely crucial and it takes a documentation specialist and an individual knowledgeable in the appropriate technical field to make an intelligent selection. (2) There are a very large number of documents in the storage and, therefore, a search, document by document, could be an extremely laborious procedure. A system would have to be devised to optimize the time of the documentation specialist and the technical specialist. Several searches of an experimental nature would have to be made to determine the most practical procedure.

5. RECOMMENDATIONS

The feasibility study completed as Task B, in itself, should not lead to full scale retrieval attempts. Results have shown that relevant "classified" documents are available to those with proper clearances via a remote access console. Major problems are: (1) the large quantity of this information, (2) availability to NOAA, (3) availability to U.S. industry, and (4) cost-benefit analysis of the entire procedure.

To answer these critical issues, it is recommended that:

(a) Samples of unclassified information from classified reports be retrieved from the DDC classified data bank and examined

to determine how much is already available in the open (unclassified) literature.

b. Official procedures be established for the above.

c. One or more groups of industrial personnel be convened to determine the usefulness of this information.

d. Mechanisms to perform the above in a cost-effective manner be developed.

ENCLOSURES:

(1) Search Strategy

(2) References and Abstracts

(3) Ship-to-ship Transfer of Material

ENCLOSURE 1 TO APPENDIX B

SEARCH STRATEGY

@13234

--------- 0 OTHER- 0
R OF ACCESSIONS RETRIEVED
-- TECHNICAL REPORTS STATISTICS PAGE 1 OF 5 NOV 08, 1977

--TOTAL-SEARCH FINDS**---------- 7 ARMY-- 0
-- FIRST LEVEL FINDS**---------- 443 NAVY-- 0
-- FIRST AND SECOND LEVEL FINDS**--- 7 AF---- 0
-- 1+2+3 LEVEL FINDS**---------- 0 OTHER- 0
-- 1+2+3+4 LEVEL FINDS**-------- 0

--SEARCH AWK12B FINDS- 7
--TIME OF DAY 10:12:25 COMPUTER TIME 5.8

--FINDS** REPRESENT NUMBER OF ACCESSIONS RETRIEVED
--EXCLUDING DUPLICATES

-- TECHNICAL REPORTS STATISTICS PAGE 2 OF 5 NOV 08, 1977

ENGINEERING	14
AERONAUTICAL ENGINEERING	0
AUTOMOTIVE ENGINEERING	0
BIOENGINEERING	0
CHEMICAL ENGINEERING	0
CIVIL ENGINEERING	0
ELECTRICAL ENGINEERING	0
POWER ENGINEERING	0
RADIO ENGINEERING	NOT IN FILE
ENGINEERING GEOLOGY	1
ENVIRONMENTAL ENGINEERING	9
MANAGEMENT ENGINEERING	7
MANAGEMENT PLANNING AND CONTROL	59
PRODUCTION ENGINEERING	34
MARINE ENGINEERING	40
MECHANICAL ENGINEERING	1
MEDICAL ENGINEERING	0
MILITARY ENGINEERING	23
MINING ENGINEERING	1
NUCLEAR ENGINEERING	0
PROPULSION ENGINEERING	0

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--  TECHNICAL REPORTS STATISTICS  PAGE  3 OF  5  NOV 08, 1977
--     SANITARY ENGINEERING ..........                      1
--     SEPTIC TANKS ..................                      0
--     STRUCTURAL ENGINEERING ........                     15
--     SYSTEMS ENGINEERING ...........                    266
--     VALUE ENGINEERING .............                      2
--     - -AND
--     UNDERSEA ..................... NOT IN FILE
--     UNDERWATER ....................                     40
--     SEMISUBMERGED .................                      1
--     OCEANS ........................                     29
--     ADRIATIC SEA ..................                      3
--     AEGEAN SEA ....................                      2
--     ARABIAN SEA ...................                     10
--     ARCTIC OCEAN ..................                      8
--     ATLANTIC OCEAN ................                     28
--     NORTH ATLANTIC OCEAN ..........                     61
--     SOUTH ATLANTIC OCEAN ..........                      1
--     BALTIC SEA ....................                      8
--     BARENTS SEA ...................                     26
--     BERING SEA ....................                      7
--     BLACK SEA .....................                      4
--           <<P FOR ADDITIONAL STATISTICS>>

--  TECHNICAL REPORTS STATISTICS  PAGE  4 OF  5  NOV 08, 1977
--     CARIBBEAN SEA .................                      6
--     CHUKCHI SEA ...................                      5
--     DEEP OCEANS ...................                     19
--     EAST CHINA SEA ................                      2
--     GREENLAND SEA .................                      4
--     INDIAN OCEAN ..................                     29
--     BENGAL BAY ....................                      1
--     IONIAN SEA ....................                      1
--     JAPAN SEA .....................                     11
--     JAVA SEA ......................                      6
--     KARA SEA ......................                      1
--     LIGURIAN SEA ..................                      1
--     MEDITERRANEAN SEA .............                     11
--     NORTH SEA .....................                     86
--     NORWEGIAN SEA .................                     11
--     OCEAN BOTTOM ..................                     32
--     OCEAN SURFACE .................                    171
--     OCEAN WAVES ...................                     43
--     OCEANIC CRUST .................                    124
--     SEAFLOOR SPREADING ............                      0
--     OKHOTSK SEA ...................                      0
--     PACIFIC OCEAN .................                      2
--           <<P FOR ADDITIONAL STATISTICS>>

--  TECHNICAL REPORTS STATISTICS  PAGE  5 OF  5  NOV 08, 1977
--     PACIFIC OCEAN .................                     68
--     NORTH PACIFIC OCEAN ...........                     32
--     SOUTH PACIFIC OCEAN ...........                     13
--     RED SEA .......................                      0
--     SARGASSO SEA ..................                      1
--     SOUTH CHINA SEA ...............                      6
--     TASMAN SEA ....................                      0
--     TYRRHENIAN SEA ................                      1
--     WHITE SEA .....................                      8
--     YELLOW SEA ....................                      2
--     SEA WATER .....................                    176
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--   TECHNICAL REPORTS STATISTICS  PAGE  1 OF  2  NOV 08, 1977

--TOTAL-SEARCH FINDS**---------------     10     ARMY--       0
--  FIRST LEVEL FINDS**---------------   9351     NAVY--       0
--  FIRST AND SECOND LEVEL FINDS**----     47     AF----       0
--  1+2+3 LEVEL FINDS**---------------     10     OTHER-       0
--  1+2+3+4 LEVEL FINDS**-------------      0

--SEARCH              AUL03C                      FINDS-      10
--TIME OF DAY     11:04:10                 COMPUTER TIME    45.6

--FINDS** REPRESENT NUMBER OF ACCESSIONS RETRIEVED
--EXCLUDING DUPLICATES



--                                  **********
--20 - REPORT CLASSIFICATION:       RESTRICTED
--                                  **********
-- 5 -  CORPORATE AUTHOR: MINISTRY OF DEFENCE  LONDON (ENGLAND)
--11 -  REPORT DATE:       OCT   , 1974
-- 1 -  AD NUMBER: C950264L
--******
--                                  **********
--20 - REPORT CLASSIFICATION:       RESTRICTED
--                                  **********
-- 5 -  CORPORATE AUTHOR: ROYAL NAVAL SCIENTIFIC SERVICE LONDON (ENGLAND)
--11 -  REPORT DATE:       SEP   , 1972
-- 1 -  AD NUMBER: 596204L
--******
--                                  **********
--20 - REPORT CLASSIFICATION:       RESTRICTED
--                                  **********
-- 5 -  CORPORATE AUTHOR: MINISTRY OF DEFENCE  LONDON (ENGLAND)
--11 -  REPORT DATE:       JUN   , 1972
-- 1 -  AD NUMBER: 596106
--******
--                                  **********
--20 - REPORT CLASSIFICATION:       RESTRICTED
--                                  **********
-- 5 -  CORPORATE AUTHOR: MINISTRY OF DEFENCE  LONDON (ENGLAND)
--11 -  REPORT DATE:       DEC   , 1970
-- 1 -  AD NUMBER: 594505L
--******
--                                  **********
--20 - REPORT CLASSIFICATION:       CONFIDENTIAL-RD
--                                  **********
-- 6 -  UNCLASSIFIED TITLE:         ABSTRACT OF OEG CONSULTANT'S MEETING ON AIR
--      CUSHION SHIPS.
-- 5 -  CORPORATE AUTHOR: CENTER FOR NAVAL ANALYSES ARLINGTON VA OPERATIONS
--      EVALUATION GROUP
--11 -  REPORT DATE:       FEB 07, 1963
-- 1 -  AD NUMBER: 524893
--******
```

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--                                  ********************
--20 - REPORT CLASSIFICATION:        CONFIDENTIAL
--                                  ********************
-- 6 -  UNCLASSIFIED TITLE:         ANNUAL REPORT OF THE NAVAL ORDNANCE
--      HYDROBALLISTICS ADVISORY COMMITTEE TO COMMANDER, NAVAL ORDNANCE
--      SYSTEMS COMMAND, 1971.  VOLUME 2.  ABSTRACTS OF PAPERS PRESENTED AT
--      THE 1971 ORDHAC MEETING.
-- 5 -  CORPORATE AUTHOR: NAVAL ORDNANCE SYSTEMS COMMAND WASHINGTON D C

--11 -  REPORT DATE:          DEC    , 1971
-- 1 -  AD NUMBER: 520316
--******
--                                  ********************
--20 - REPORT CLASSIFICATION:        CONFIDENTIAL
--                                  ********************
-- 6 -  UNCLASSIFIED TITLE:         ANNUAL REPORT OF THE NAVAL ORDNANCE
--      HYDROBALLISTICS ADVISORY COMMITTEE TO COMMANDER, NAVAL ORDNANCE
--      SYSTEMS COMMAND, 1971. VOLUME 1.  REPORT OF THE COMMITTEE AND ITS
--      MONITORS.
-- 5 -  CORPORATE AUTHOR: NAVAL ORDNANCE SYSTEMS COMMAND WASHINGTON D C
--11 -  REPORT DATE:          DEC    , 1971
-- 1 -  AD NUMBER: 520315L
--******
--                                  ********************
--20 - REPORT CLASSIFICATION:        SECRET
--                                  ********************
-- 6 -  UNCLASSIFIED TITLE:         PROCEEDINGS OF THE U. S. NAVY SYMPOSIUM ON
--      MILITARY OCEANOGRAPHY (7TH), 12-14 MAY 1970, ANNAPOLIS, MARYLAND.
--      VOLUME II.
-- 5 -  CORPORATE AUTHOR: OFFICE OF THE OCEANOGRAPHER OF THE NAVY
--      ALEXANDRIA VA
--11 -  REPORT DATE:                , 1970

-- 1 -  AD NUMBER: 512237L
--******
--                                  ********************
--20 - REPORT CLASSIFICATION:        RESTRICTED
--                                  ********************
-- 5 -  CORPORATE AUTHOR: MINISTRY OF DEFENCE  LONDON (ENGLAND)
--11 -  REPORT DATE:          DEC    , 1968
-- 1 -  AD NUMBER: 398922L
--******
-- 1 -  AD NUMBER (10+ YEARS OLD):    380932
-- 6 -  UNCLASSIFIED TITLE:         PROCEEDINGS OF DAVID TAYLOR MODEL BASIN
--      SPECIAL GUEST DAYS 15-16 NOVEMBER 1966.
--******
```

ENCLOSURE 2 TO APPENDIX B

REFERENCES AND ABSTRACTS

```
--END          <<ENTER NEXT COMMAND>>                    END --

--                                  ******************
--20 - REPORT CLASSIFICATION:       RESTRICTED
--                                  ******************
-- 5 -  CORPORATE AUTHOR: MINISTRY OF DEFENCE  BATH (ENGLAND)
--11 -  REPORT DATE:       DEC    , 1974
-- 1 -  AD NUMBER: C950075L
--******
--                                  ******************
--20 - REPORT CLASSIFICATION:       CONFIDENTIAL
--                                  ******************
-- 6 -  UNCLASSIFIED TITLE:         OCEAN MEASUREMENTS AND ARRAY TECHNOLOGY
--      (OMAT) PROGRAM:  STATUS OF ARRAY STRUCTURE ENGINEERING EFFORT.
-- 5 -  CORPORATE AUTHOR: NAVAL UNDERWATER SYSTEMS CENTER NEW LONDON CONN
--      NEW LONDON LAB
--11 -  REPORT DATE:       DEC 30, 1976
-- 1 -  AD NUMBER: C009080L
--******
--                                  ******************
--20 - REPORT CLASSIFICATION:       SECRET
--                                  ******************
-- 6 -  UNCLASSIFIED TITLE:         ANNUAL REPORT.  1975
-- 5 -  CORPORATE AUTHOR: DEFENCE RESEARCH ESTABLISHMENT ATLANTIC DARTMOUTH
--      (NOVA SCOTIA)

--11 -  REPORT DATE:          , 1975
-- 1 -  AD NUMBER: C008420L
--******
--                                  ******************
--20 - REPORT CLASSIFICATION:       SECRET
--                                  ******************
-- 6 -  UNCLASSIFIED TITLE:         DIRECTIONS FOR NAVAL OCEANOGRAPHY:  AN
--      ASSESSMENT OF THE CHANGING ENVIRONMENT OF THE NAVY AND ITS IMPACT
--      ON THE NAVY'S OCEAN SCIENCE AND ENGINEERING PROGRAM.
-- 5 -  CORPORATE AUTHOR: NATIONAL ACADEMY OF SCIENCES WASHINGTON D C
--11 -  REPORT DATE:       JUN    , 1976
-- 1 -  AD NUMBER: C006767
--******
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--                                  **********
--20 - REPORT CLASSIFICATION:        CONFIDENTIAL
--                                  **********
-- 6 -  UNCLASSIFIED TITLE:         OPERATION DIVE UNDER.  UNDERWATER SHOCK
--      TESTS OF THE EX USS ATLANTA.
-- 5 -  CORPORATE AUTHOR: NAVAL SHIP ENGINEERING CENTER HYATTSVILLE MD
--11 -  REPORT DATE:        OCT   , 1970
-- 1 -  AD NUMBER: C006612
--******
--                                  **********

--20 - REPORT CLASSIFICATION:        CONFIDENTIAL
--                                  **********
-- 6 -  UNCLASSIFIED TITLE:         GUIDE TO THE ANALYSIS OF ENVIRONMENTAL
--      REQUIREMENTS FOR NAVAL COASTAL OPERATIONS.
-- 5 -  CORPORATE AUTHOR: NAVAL COASTAL SYSTEMS LAB PANAMA CITY FLA
--11 -  REPORT DATE:        MAR   , 1976
-- 1 -  AD NUMBER: C006509
--******
--                                  **********
--20 - REPORT CLASSIFICATION:        SECRET
--                                  **********
-- 6 -  UNCLASSIFIED TITLE:         SYSTEM ENGINEERING SUPPORT TO THE LONG
--      RANGE ACOUSTIC PROPAGATION PROJECT.
-- 5 -  CORPORATE AUTHOR: TRW SYSTEMS GROUP  MCLEAN VA WASHINGTON
--      OPERATIONS
--11 -  REPORT DATE:        AUG 01, 1975
-- 1 -  AD NUMBER: C002793
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--                  <<ENTER NEXT COMMAND>>
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--   TECHNICAL REPORTS STATISTICS  PAGE  1 OF  4  FEB 08, 1978

--TOTAL-SEARCH FINDS**--------------      6     ARMY--      0
--  FIRST LEVEL FINDS**--------------    176     NAVY--      0
--  FIRST AND SECOND LEVEL FINDS**---      6     AF----      0
--  1+2+3 LEVEL FINDS**--------------      6     OTHER-      0
--  1+2+3+4 LEVEL FINDS**------------      0

--SEARCH              AUL44D                    FINDS-      6
--TIME OF DAY      11:44:41              COMPUTER TIME     8.4

--FINDS** REPRESENT NUMBER OF ACCESSIONS RETRIEVED
--INCLUDING DUPLICATES

Categories that apply: Replenishment - Transfer - Ships

-- 1 - AD NUMBER: B001028L
-- 2 - FIELDS AND GROUPS: 5/9, 15/5
-- 3 - CATALOG CARD CLASSIFICATION: UNCLASSIFIED
-- 5 - CORPORATE AUTHOR: NAVAL COASTAL SYSTEMS LAB PANAMA CITY FLA
-- 6 - UNCLASSIFIED TITLE: NAVY SUPPORT TECHNOLOGY FOR SMLS-CARGO
--     HANDLING: PHASE II - CARGO HANDLING BETWEEN MERCHANT AND AMPHIBIOUS
--     SHIPS DURING THE REPLENISHMENT PHASE.
-- 8 - TITLE CLASSIFICATION: UNCLASSIFIED
-- 9 - DESCRIPTIVE NOTE: INFORMAL REPT. JAN 73-MAR 74,
--10 - PERSONAL AUTHORS: SHUMAKER,G. L. ;BOHANICK,L. R. ;
--11 - REPORT DATE: DEC , 1974
--12 - PAGINATION: 61P
--14 - REPORT NUMBER: NCSL-225-74
--20 - REPORT CLASSIFICATION: UNCLASSIFIED
--22 - LIMITATIONS (ALPHA): DISTRIBUTION LIMITED TO U.S. GOV'T.
--     AGENCIES ONLY; TEST AND EVALUATION; DEC 74. OTHER REQUESTS FOR THIS
--     DOCUMENT MUST BE REFERRED TO COMMANDER, NAVAL SUPPLY SYSTEMS
--     COMMAND, ATTN: CODE 01A1, WASHINGTON, D. C. 20376.
--23 - DESCRIPTORS: (*MANPOWER, REPLENISHMENT AT SEA),
--     (*REPLENISHMENT AT SEA, AMPHIBIOUS OPERATIONS), LOGISTICS SUPPORT,
--     NAVAL PERSONNEL, CARGO, LOADING(HANDLING), TRANSFER, CARGO SHIPS,
--     MERCHANT VESSELS, LIGHTERS(BOATS), AMPHIBIOUS SHIPS, NAVAL VESSELS,
--       <<P FOR NEXT PAGE>> OR <<ENTER NEXT COMMAND>>

--     CONTAINERIZING, BARGES, NAVAL TRAINING, HELICOPTERS, MARINE CORPS
--24 - DESCRIPTOR CLASSIFICATION: UNCLASSIFIED
--25 - IDENTIFIERS: *CARGO HANDLING, BRIGADE LEVEL ORGANIZATIONS,
--     CONTAINERSHIPS, SMLS(SEABORNE MOBILE LOGISTIC SYSTEM), SEABORNE
--     MOBILE LOGISTIC SYSTEM
--26 - IDENTIFIER CLASSIFICATION: UNCLASSIFIED
--27 - ABSTRACT: THIS REPORT INVESTIGATES THE NAVAL CREW REQUIREMENTS
--     NECESSARY TO TRANSFER MILITARY CARGO IN THE OFFSHORE AMPHIBIOUS
--     OPERATING AREA FROM MERCHANTSHIPS TO LIGHTERAGE OR DIRECTLY INTO U.
--     S. NAVY AMPHIBIOUS AND COMBATANT SHIPS. FOUR BASIC TYPES OF
--     MERCHANTSHIPS AND THEIR CARGO HANDLING GEAR ARE EXAMINED TO
--     DETERMINE THE CREW REQUIREMENTS FOR CARGO HANDLING. IN THE CASES OF
--     CONTAINER AND BARGE SHIPS, CREW REQUIREMENTS ARE DEVELOPED ON THE
--     BASIS OF CURRENT STUDIES AND TESTS BEING DEVELOPED BY NSRDC AND
--     NCEL. THIRTY-DAY CARGO QUANTITIES ARE DEVELOPED FOR A MARINE
--     AMPHIBIOUS BRIGADE (MAB) ALONG WITH THE AMPHIBIOUS SHIPS REQUIRED
--     TO TRANSPORT THE MAB. PERSONNEL AND TRAINING CHANGES ARE
--     RECOMMENDED FOR THE U.S. NAVY CARGO HANDLING AND PORT GROUP TO
--     ALLOW THIS UNIT TO MEET THE REQUIREMENTS GENERATED BY THE USE OF
--     MERCHANTSHIPS IN THE FLEET RESUPPLY ROLE.
--28 - ABSTRACT CLASSIFICATION: UNCLASSIFIED
--29 - INITIAL INVENTORY: 12
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--          <<P FOR NEXT PAGE>> OR <<ENTER NEXT COMMAND>>

-- 1 - AD NUMBER: B000376L
-- 2 - FIELDS AND GROUPS: 5/9, 17/2
-- 3 - CATALOG CARD CLASSIFICATION:  UNCLASSIFIED
-- 5 - CORPORATE AUTHOR: NAVAL ELECTRONICS LAB CENTER SAN DIEGO CALIF
-- 6 - UNCLASSIFIED TITLE:     MANPOWER REDUCTION VIA IMPROVED INTERSHIP
--     COMMUNICATIONS DURING CONNECTED REPLENISHMENT AT SEA (CONREP).
-- 8 - TITLE CLASSIFICATION:   UNCLASSIFIED
-- 9 - DESCRIPTIVE NOTE: TECHNICAL REPT. MAY-SEP 74,
--10 - PERSONAL AUTHORS: HENRY,F. G. ;DAVENPORT,E. W. ;
--11 - REPORT DATE:     NOV 01, 1974
--12 - PAGINATION:      49P
--14 - REPORT NUMBER:    NELC-TR-1936
--16 - PROJECT NUMBER:   NELC-B506
--20 - REPORT CLASSIFICATION:  UNCLASSIFIED
--22 - LIMITATIONS (ALPHA):    DISTRIBUTION LIMITED TO U.S. GOV'T.
--     AGENCIES ONLY; TEST AND EVALUATION; 1 NOV 74.  OTHER REQUESTS FOR
--     THIS DOCUMENT MUST BE REFERRED TO COMMANDER, NAVAL ELECTRONICS LAB.
--     CENTER, SAN DIEGO, CALIF.  92152.
--23 - DESCRIPTORS:      (*MANPOWER, REDUCTION), (*MANPOWER UTILIZATION,
--     *REPLENISHMENT AT SEA), (*COMMUNICATION AND RADIO SYSTEMS,
--     PERSONNEL MANAGEMENT), (*INTERCOMMUNICATION SYSTEMS, REPLENISHMENT
--     AT SEA), NAVAL VESSELS, TANKERS, FUELS, SHIP TO SHIP, TELEPHONE
--     SYSTEMS, SECURE COMMUNICATIONS, SHIP TELEPHONE SYSTEMS, FREQUENCY

--     MODULATION, CARGO, TRANSFER, TRANSMITTER RECEIVERS, JOB ANALYSIS,
--     NAVAL PERSONNEL, SHIPBOARD, LOGISTICS SUPPORT, ACOUSTIC EQUIPMENT.
--     HEADGEAR, INTERFERENCE, SAFETY, QUESTIONNAIRES
--24 - DESCRIPTOR CLASSIFICATION:    UNCLASSIFIED
--25 - IDENTIFIERS:       AOR 5 VESSEL, RIG TEAMS, WIRE FREE COMMUNICATIONS,
--     CONNECTED REPLENISHMENT, AO 177 VESSEL
--26 - IDENTIFIER CLASSIFICATION:    UNCLASSIFIED
--27 - ABSTRACT:    A COMPREHENSIVE STUDY WAS UNDERTAKEN ABOARD USS WABASH
--     (AOR 5) TO DETERMINE WHETHER RIG TEAM MANNING LEVELS COULD BE
--     REDUCED AT LIQUID CARGO TRANSFER STATIONS. PRIMARY EMPHASIS WAS
--     PLACED ON ELIMINATING STATION-TO-STATION SOUND-POWERED TELEPHONE
--     TALKERS AND SIGNALMEN DURING CONREP. AS A SUBSTITUTE FOR THESE
--     CONVENTIONAL VOICE ANDD VISUAL LINKS, AN EXPERIMENTAL WIRE-FREE
--     COMMUNICATION (WFC) PATH BETWEEN RIG CAPTAINS WAS USED. A VARIETY
--     OF TESTS CONDUCTED BETWEEN WABASH AND VARIOUS CUSTOMER SHIPS
--     UTILIZED COMMERCIAL NARROWBAND FM TRANSCEIVERS AT VHF TO SIMULATE A
--     COVERT INTERSHIP WFC SYSTEM. IT WAS ESTABLISHED THAT (1) THE
--     ADDITIONAL TASK OF COMMUNICATING DID NOT INTERFERE WITH THE RIG
--     CAPTAIN'S PRIMARY JOB AND (2) IT IS OPERATIONALLY FEASIBLE AND SAFE
--     FOR RIG CAPTAINS TO UTILIZE WFC BETWEEN SHIPS DURING CONREP AS A
--     SUBSTITUTE FOR STATION-TO-STATION TALKERS AND SIGNALMEN.  (AUTHOR)
--28 - ABSTRACT CLASSIFICATION:      UNCLASSIFIED
--29 - INITIAL INVENTORY:     2

--33 - LIMITATION CODES:      3
--35 - SOURCE CODE:      403940
--36 - DOCUMENT LOCATION:        DDC
--40 - GEOPOLITICAL CODE:      0638
--41 - TYPE CODE:  N
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-- 1 - AD NUMBER: 917545L
-- 2 - FIELDS AND GROUPS: 13/10, 12/1
-- 3 - CATALOG CARD CLASSIFICATION: UNCLASSIFIED
-- 5 - CORPORATE AUTHOR: NAVAL SHIP ENGINEERING CENTER PHILADELPHIA PA
--       PHILADELPHIA DIV
-- 6 - UNCLASSIFIED TITLE: MATHEMATICAL ANALYSIS AND SIMULATION OF A
--       FUEL-RIG UNDERWAY REPLENISHMENT-AT-SEA SYSTEM.
-- 8 - TITLE CLASSIFICATION: UNCLASSIFIED
-- 9 - DESCRIPTIVE NOTE: FINAL REPT.,
--10 - PERSONAL AUTHORS: ARTICOLO,G. A. ;
--11 - REPORT DATE: JAN 17, 1974
--12 - PAGINATION: 94P
--14 - REPORT NUMBER: NAVSECPHILAD-FT-2547
--20 - REPORT CLASSIFICATION: UNCLASSIFIED
--22 - LIMITATIONS (ALPHA): DISTRIBUTION LIMITED TO U.S. GOV'T
--       AGENCIES ONLY; TEST AND EVALUATION; 18 MAR 74. OTHER REQUESTS FOR
--       THIS DOCUMENT MUST BE REFERRED TO COMMANDER, NAVAL SHIP ENGINEERING
--       CENTER, ATTN: CODE 6163, HYATTSVILLE, MD. 20782.
--23 - DESCRIPTORS: (*REFUELING, SHIPS), (*MATHEMATICAL MODELS,
--       REFUELING), (*REPLENISHMENT, RIGGING), SIMULATION, TANKERS,
--       EQUATIONS OF MOTION, HYDRAULIC EQUIPMENT, DYNAMICS, LIQUIDS, FUELS,
--       FUEL HOSE, TRANSFER, SEA STATES, DENSITY, CABLE ASSEMBLIES, WINCHES,
--       MATHEMATICAL ANALYSIS, TURBULENCE, MASS, SHIP MOTION, COMPUTERS
--24 - DESCRIPTOR CLASSIFICATION: UNCLASSIFIED
--25 - IDENTIFIERS: LIQUID FUELS, FUEL TRANSFER, LUMPED MASSES,
--       REPLENISHMENT AT SEA
--26 - IDENTIFIER CLASSIFICATION: UNCLASSIFIED
--27 - ABSTRACT: A DETAILED ANALYSIS IS PRESENTED FOR THE MATHEMATICAL
--       SIMULATION OF THE FUEL-RIG-UNDERWAY-REPLENISHMENT-AT-SEA-SYSTEM. A
--       QUASI-STATIC APPROXIMATION IS UTILIZED TOWARDS CONVERSION OF THE
--       DISTRIBUTED MASS SYSTEM TO THAT OF AN EQUIVALENT LUMPED-MASS-SYSTEM.
--       THE HYDRAULIC EQUATIONS OF MOTION OF THE POINT MASSES IN THE
--       EQUIVALENT LUMPED MASS SYSTEM CONSTITUTE THE CORE OF THE
--       MATHEMATICAL SIMULATION. THE ADDITIONAL MATHEMATICAL RELATIONS
--       NEEDED TO COMPLETE THE SYSTEM ARISE FROM MATHEMATICAL STATEMENTS OF
--       CERTAIN CONSTRAINT CONDITIONS WITHIN THE MECHANICAL SYSTEM. THE
--       QUALITY OF CHARACTER OF THESE CONSTRAINT RELATIONS ARE SHOWN TO BE
--       DEPENDENT UPON THE MODE OF CONTROL PROVISIONS UNDER WHICH THE
--       SYSTEM IS OPERATED. (AUTHOR)
--28 - ABSTRACT CLASSIFICATION: UNCLASSIFIED

--29 - INITIAL INVENTORY: 2
--32 - LIMITATION CODES: 3
--34 - SOURCE SERIES: F
--35 - SOURCE CODE: 402180
--36 - DOCUMENT LOCATION: DDC
--40 - GEOPOLITICAL CODE: 4203
--41 - TYPE CODE: N
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--          WUIS STATISTICS PAGE  1 OF  4  FEB 08, 1978

--TOTAL-SEARCH FINDS**----------          1      ARMY--      0
--  FIRST LEVEL FINDS**------------         59      NAVY--      1
--  FIRST AND SECOND LEVEL FINDS**---        1      AF----      0
--  1+2+3 LEVEL FINDS**------------          1      OTHER-      0
--  1+2+3+4 LEVEL FINDS**----------          0

--SEARCH              AUM02A                      FINDS-      1
--TIME OF DAY      12:02:15                COMPUTER TIME    4.7

--FINDS** REPRESENT NUMBER OF ACCESSIONS RETRIEVED
--EXCLUDING DUPLICATES
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One man unit

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--    1 - AGENCY ACCESSION NO:   DN478060
--    2 - DATE OF SUMMARY: 15 FEB  77
--    3 - DATE OF PREV. SUMMARY: 01 AUG  76
--    4 - KIND OF SUMMARY: TERMINATED
--    5 - SUMMARY SECURITY IS:   UNCLASSIFIED
--    6 - SECURITY OF WORK:      UNCLASSIFIED
--8A1 - DIST. LIMITATION: UNLIMITED
--   8B - CONTRACTOR ACCESS:     YES
--10A1 - PRIMARY PROGRAM ELEMENT:     63705N
--10A2 - PRIMARY PROJECT NUMBER:      S0378
--10A2A - PRIMARY PROJECT AGENCY AND PROGRAM:     S0378
--10A3 - PRIMARY TASK AREA:      S0378
--10A4 - WORK UNIT NUMBER:       1175-126-19364
--   11 - TITLE:      (U)  MERCHANT SHIP NAVY SUPPORT
-- 11A - TITLE SECURITY: U
--   12 - S + T AREAS:
--                  009500 MARINE ENGINEERING
--                  009100 LOGISTICS
--                  004400 CONTAINERS AND PACKAGING
--   13 - WORK UNIT START DATE:  JUL 75
--   14 - ESTIMATED COMPLETION DATE:   DEC 76
-- 15A - PRIMARY FUNDING AGENCY:  NAVY
--   16 - PERFORMANCE METHOD:    IN-HOUSE
```

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--                    RESOURCE ESTIMATES
--1844 MANYRS CFY-4:      3.0   18B4 FUNDS CFY-4:     $ 245,000
--1843 MANYRS CFY-3:      2.0   18B3 FUNDS CFY-3:     $ 150,000
--1842 MANYRS CFY-2:      2.2   18B2 FUNDS CFY-2:     $ 400,000
--1841 MANYRS CFY-1:        +   18B1 FUNDS CFY-1:             +
--184  MANYRS CFY:          +   18B  FUNDS CFY:               +
-- 19A - DOD ORGANIZATION:        NAVAL SEA SYSTEMS COMMAND 0322
-- 19B - DOD ORG. ADDRESS:        WASHINGTON, D.C. 20362
-- 19C - RESPONSIBLE INDIVIDUAL:      BENEN, L
-- 19D - RESPONSIBLE INDIVIDUAL PHONE:  202-692-8540
-- 19U - DOD ORGANIZATION LOCATION CODE:  1100
-- 19S - DOD ORGANIZATION SORT CODE:  31714
-- 19T - DOD ORGANIZATION CODE: 391345
-- 20A - PERFORMING ORGANIZATION:     NAVAL SHIP R+D CENTER SYSTEMS DEVELOP.
--     DEPT. 1175
-- 20B - PERFORMING ORG. ADDRESS:     BETHESDA, MD. 20084
-- 20C - PRINCIPAL INVESTIGATOR:      MANSFIELD, T E
-- 20D - PRINCIPAL INVESTIGATOR PHONE:  301-267-2261
-- 20F - ASSOCIATE INVESTIGATOR (1ST):  KRAWZUN, J
-- 20G - ASSOCIATE INVESTIGATOR (2ND):  STEVENS, C C
-- 20U - PERFORMING ORGANIZATION LOCATION CODE: 2408
-- 20N - PERF. ORGANIZATION TYPE CODE:  N
-- 20S - PERFORMING ORG. SORT CODE:   13030

-- 20T - PERFORMING ORGANIZATION CODE:      404699
-- 21E - MILITARY/CIVILIAN APPLICATIONS:    CIVILIAN
--  22 - KEYWORDS:  (U)  NON-MILITARY APPLICATION;(U)  MERCHANT SHIP     ;(U)
--     MSNAP ;(U)  CONTAINERSHIP     ;(U)  CARGO HANDLING     ;(U)  UNREP ;
--  23 - TECHNICAL OBJECTIVE:  (U) THE OBJECTIVE OF THE MERCHANT SHIP NAVY
--     AUXILIARIES PROGRAM IS TO DEVELOP CAPABILITIES FOR CONTEMPORARY MERCHANT
--     SHIPS TOAUGMENT OR SUBSTITUTE FOR NAVY UNDERWAY REPLENISHMENT SHIPS IN
--     SUPPORT OF FLEET OPERATIONS.
--  24 - APPROACH:  (U)  THIS PROGRAM IS BASED ON THE ADVANCED DEVELOPMENT OF A
--     SYSTEM OF MODULAR COMPONENTS TO IMPART CARGO ACCESSABILITY, MOBILITY AND
--     TRANSFER FUNCTIONAL CAPABILITIES TO CONTAINER -CAPABLE MERCHANT SHIPS.
--     THE MODULES WILL GENERALLY BE SUITABLE FOR INSTALLATION BY DOCKSIDE
--     CARGO HANDLING EQUIPMENT AND WILL NOT INVOLVE MODIFICATIONS TO EITHER
--     THE MERCHANT OR NAVY SHIP. THIS PROGRAM WILL DEVELOP AND TEST THEMODULAR
--     COMPONENTS ASHORE AND AFLOAT TO DEMONSTRATE TECHNICAL FEASIBILITY AND
--     DETERMINE DEFICIENCIES FOR FURTHER DEVELOPMENT.
--  25 - PROGRESS:  (U)  (7607-7612) PROGRAM DEFERRED BY OP-03 IN NOVEMBER 1975
--     DUE TO CHANGE IN PRIORITIES. INITIATED CONCEPT ANALYSIS CONTRACTS FOR
--     CONTAINERSHIP VERTICAL LIFT DEVICE, UNIVERSAL HATCHCOVER; VERTICAL
--     REPLENISHMENT COMPATIBILITY AND TEST FACILITY MODIFICATIONS. EXPLORATORY
--     DEVELOPMENT EFFORT IS CONTINUING AT A REDUCED LEVEL. PROGRAM DEFERRED
--     DUE TO CHANGE IN PRIORITIES.
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--  37 - DESCRIPTORS:     (U) *MERCHANT VESSELS  ;(U) *LOGISTICS SUPPORT ;(U)
--      *REPLENISHMENT     ;(U)  NAVAL OPERATIONS  ;(U)  AMPHIBIOUS OPERATIONS
--      ;(U)  CARGO ;(U)  HANDLING     ;(U)  FLEETS(SHIPS)     ;(U)  CARGO SHIPS ;
--      (U)  NAVAL VESSELS     ;(U)  MARINE TRANSPORTATION   ;(U)  STORAGE RACKS
--      ;(U)  ELEVATORS(LIFTS)  ;(U)  MOBILITY     ;(U)  TRANSFER     ;(U)
--      HORIZONTAL ORIENTATION  ;(U)  VERTICAL ORIENTATION    ;(U)  SHIPBOARD   ;
--      (U)  HARBORS     ;(U)  DOCKS ;(U)  PLATFORMS   ;(U) *MATERIALS HANDLING
--      VEHICLES   ;
--  38 - IDENTIFIERS:     (U) *CONTAINERSHIPS    ;(U)  UNREP(UNDERWAY
--      REPLENISHMENT) ;(U)  UNDERWAY REPLENISHMENT .;(U)  REPLENISHMENT AT SEA
--      ;(U)  SEALITY     ;(U) *MATERIALS HANDLING EQUIPMENT  ;(U)
--      TRANSFERABILITY   ;
--  39 - PROCESSING DATE (RANGE):     09 MAR  77
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APPENDIX C

MARINE MINERAL MINING DIRECTORY

1. INTRODUCTION

As stated in Appendix B, marine mineral mining is a relatively new industry. As such, it is dependent upon, and actively engaged in, exploring new technology to provide an improved ocean mining capability. Timely dissemination of pertinent technical information is important to save time and money, and to insure the rapid advance of related technology.

In most instances the community follows the time honored and readily available sources such as information (documentation) centers, technical and industrial journals, professional society meetings, and consultants. Most of these sources, however, suffer from the same basic deficiencies. Often, information is not current, and it may be even obsolete. This is due primarily to the time lapse from data development to its publication. Even more critical, however, is the fact that the marine mineral mining community appears to be not yet attuned to the range of technology it requires, nor has it identified fully the participants. As a result, it may not be aware of relevant technology or of technology which may be transferred to advance marine mineral mining.

Because the marine mineral mining industry is so diversified technologically, and in order to alleviate some of the basic

problems in information dissemination, the Marine Mineral Division (NOAA) desired to explore the possibility of preparing a directory. This directory would identify key players in those Federal government organizations engaged in technology exploration which may be of potential interest to the marine mining industry.

2. DISCUSSION

A personnel directory which includes all individuals involved in all aspects of technology related to maring mineral mining would be extremely extensive. In recognition of the fact that an effort of that nature would be very time consuming, costly, and exploratory (concerning its effectiveness), the Marine Minerals Division decided to illustrate the feasibility of the directory by limiting it to deep ocean mining, to restricted areas of technology, and to only those government employees directly involved. Requirements included the establishment of a two-tier structure of the technology areas of principal interest to industry. The presentation is in sections:

(a) Alphabetically by personnel,
(b) Alphabetically by organization, and
(c) By technical areas of interest.

To execute this task, the two-tier structure was first established using topical terms considered important to the deep ocean mining industry. The initial categorization was broad-based and included virtually all conceivable areas. After several iterations between NOAA personnel and the GWU staff, a final two-tier structure with definitions was established and is attached as enclosure 1.

An examination was made of the Department of Defense work units using the Defense Documentation Center data bank as a principal source of information. The content of each work unit was examined to determine whether technology was underway which had relevance to deep ocean mining. Each pertinent task first was related to the two-tier structure and, then categorized within one or more relevant technological areas.

Other sources of relevant data were explored, including the U.S. Geological Survey, the Bureau of Mines, the National Science Foundation; and the Marine Board, Assembly of Engineering, National Research Council, NAS/NAE. A collection of more than 500 individuals were identified as being directly involved in such relevant technology. The preliminary directory is attached as Enclosure 2 to this Appendix.

3. CONCLUSIONS

Many sources exist from which individuals and organizations may be identified. These range from the simplest and most obvious telephone directories, to very sophisticated information systems. Several of those sources were used to complete the demonstration model. It is important to emphasize that there are several significant deficiences, limitations and errors in this directory, but bear in mind that it is intended to be only a demonstration model. To be more explicit, the directory listing is:

(a) Predominantly U.S. Navy employees with minor representation from non-Navy organizations.

(b) Due to the inability to visit and personally contact

contributing organizations, does not reflect recent or organizational changes which may have occurred.

(c) Telephone numbers may not be current.

(d) Does not list many non-Navy organizations which were contacted but which responded too late to be included.

There are several steps which can be taken to improve and update the directory. The directory should be reviewed for accuracy and relevancy. Accurate, in that people, organizations, addresses, etc., are correctly identified and relevant, in that the information source is correctly categorized within the proper technical area. This can be accomplished by visiting the organizations in question, and obtaining the real time information by direct, personal contact. The directory should be expanded. Additional information already at hand, can be added to the directory and will broaden its scope to include the many non-Navy organizations listed above. Finally, a user survey should be conducted to obtain feedback relevant to the format, scope, and content of the directory. One way this may be accomplished is to provide a select group within the ocean mineral mining community with a copy of the index and an appropriate questionnaire for review and comment.

4. RECOMMENDATIONS

As discussed under conclusions, there are several options open for improving the directory.

(a) Add information received since completion of document.

(b) Distribute the directory to referenced organizations to update listings.

(c) Discuss directory with representatives of industry to improve structure.

(d) Consider establishing a third tier.

(e) Explore problems associated with wide distribution of directory.

(f) Expand directory to all Marine Mineral Mining enter-enterprises.

(g) Place listings on computer to simply making changes.

ENCLOSURE:

(1) Two-tier Marine Mineral Mining Technology Structure and Definitions.

(2) Preliminary Directory of Federal Government Personnel Involved in Developing Technologies with Potential Application to Deep Ocean Mining (provided separately).

ENCLOSURE 1 TO APPENDIX C

MARINE MINING RELATED TECHNOLOGIES

A RESOURCE EXPLORATION	B SEAFLOOR CHARACTERISTICS	C OCEAN MINING TOOLS & METHODS	D MINING EQUIPMENT INSTRUMENTATION & CONTROL	E MATERIALS PERFORMANCE	F OCEAN STATIONING & ATTITUDE CONTROL	G MARINE ENVIRONMENT & ENVIRONMENTAL EFFECTS	H OCEAN TRANSPORT & COMMUNICATION SYSTEMS	I MINERAL PROCESSING
1. Ore Genesis Models	1. Topography (including Bathymetry)	1. Drilling Technology	1. Cables & Connectors	1. Corrosion (Protection)	1. Propulsion Control Systems	1. Marine Biology	1. Surface Vessels	1. Mineral Dressing Technology
2. Aerospace Remote Sensing	2. Geodesy (including establishment of benchmarks)	2. Extraction	2. Data Transmission & Telemetry	2. Cable Dynamics	2. Navigation & Positioning	2. Ocean Dynamics	2. Vessel to Vessel Transfer Systems	2. Ore Reduction
3. Surface & Undersea Remote Sensing	3. Engineering Properties	3. Seafloor Devices	3. Onboard Data Handling & Processing	3. Watertight Seals	3. Motion Control	3. Environmental Monitoring	3. Interaction of Ships	3. Reagent Recycling
4. Navigation	4. Geological Properties/ Sea Floor	4. Underwater Vehicles	4. Remote Control of Undersea Equipment	4. Structures	4. Automatic Station Keeping	4. Ocean Dumping	4. Slurry & Bulk Material Handling Systems	4. Waste Disposal
5. Core Sampling	5. Geological Properties/ Sub-floor		5. Power Systems	5. Welding Stresses				
			6. Viewing Devices	6. Metal Fatigue				
			7. Undersea Navigation	7. Strength of Materials				

MARINE MINERALS RELATED TECHNOLOGIES

A. Resource Exploration

The technologies and scientific principles related to the search for marine mineral deposits and their evaluation by means of delineation of their important characteristics.

1. Ore Genesis Modeling: Includes simulation modeling, math modeling, computer model to determine potential mineral resource deposits.

2. Aerospace Remote Sensors: Geophysical sensors employed from air and space vehicles.

3. Surface and Undersea Remote Sensors: Geophysical sensors and acoustic sensors for in-situ assay of mineral deposits.

4. Navigation: Precise location of ship in order to map areas containing actual or potential mineral deposits.

5. Core Sampling: Methods for obtaining core sample, core analysis (chemical/physical), mineral deposit potential and evaluation.

B. Seafloor Characterization

The techniques and equipment needed to determine and represent the geologic and topographic characteristics and engineering properties of the seafloor and to establish the exact geodetic position of specific points and/or areas of the ocean bottom.

1. Topography/Bathymetry: The graphical depiction of the physical and natural countours of the ocean bottom, including methods for depth determination and high resolution observation.

2. Marine Geodesy: Precise location and bench marking of mineral deposits on the ocean bottom.

3. Engineer Properties: Methods for determining the physical properties of the ocean bottom.

4. Geological Properties/Sea Floor: The methods, technology and equipment required to explore the geology and structure of the top soil of the ocean bottom at a mining site.

5. Geological Properties/Sub-Floor: The methods, technology and equipment required to explore the geology and structure of earth below the sediment on the ocean bottom.

C. Ocean Mining Tools and Methods

The equipment and methodologies used to recover marine minerals, at commercial rates of production, from the seafloor and for transporting them from the seafloor to a surface vessel.

1. Drilling Technology: The technology and equipment required for penetration of the seafloor.

2. Extraction and Recovery Techniques: The technology and equipment required for the removal and retrieval of minerals from the ocean bottom, e. g. mineral collection and pick-up, hoisting and lift systems, submersible pump, etc.

3. Seafloor Device: The technology and equipment required for mining operations that rest on the seafloor.

4. Underwater Vehicles: The technology and equipment required for the development and use of underwater self-propelled and or towed vehicles.

D. Mining Equipment instrumentation and Control

The techniques and equipment required to control the operation and to monitor the performance of mining equipment.

1. Power Cables and Connectors: Technology and equipment required for the transmission and distribution of power to support undersea mineral mining.

2. Data Transmission and Telemetry: Methods, cables, connectors, and instrumentation required to transmit data between the undersea vehicle/equipment and a surface ship.

3. Onboard Data Handling and Processing: Methods, and equipment that provides for the treatment, processing, storage, retrieval and display of electronics and acoustic information obtained in the mining process.

4. Remote Control of Undersea Equipment: Methods, instrumentation, and equipment required to control undersea mobility, vehicle mating, obstacle detection, and avoidance, including the overall operation of undersea equipment from a surface vessel.

5. Undersea Power Systems: Technology, equipment, systems which provide energy for ocean mining systems, e. g. ocean vehicles, platforms, vehicles and equipment for undersea exploration and mining.

6. Viewing Devices: Devices or instruments that permit careful visual examination of undersea objects.

7. Undersea Navigation: Methods, technology and equipment required for the transit and the determination of position of undersea vehicles.

E. Materials Performance

The technologies and associated scientific knowledge which deal with the performance characteristics of materials as they influence the design and use of ocean mining equipment.

1. Corrosion: Technology which deals with the corrosion and protection of materials in an undersea environment.

2. Cable Dynamics: Methods and technology related to the action and the effects of cable motion in an undersea environment.

3. Water-tight Seals: Technology and equipment required to provide water-tight seals for ocean mining systems.

4. Structure: Engineering and technology which deals with riser load conditions and structure stresses in an ocean environment.

5. Welding Stresses: Techniques and technology which provides for high quality welds in ocean mining systems.

6. Metal Fatigue: Techniques and Technology which deal with structural metal fatigue in an adverse ocean environment.

7. Strength of Materials: Engineering and technology related to the design and performance of materials in an ocean environment.

F. Surface Vessel Stationing and Attitude Control

The systems and methodologies required to maintain a surface vessel in a fixed position or on a fixed track in the open ocean and to provide a relatively stable platform from which to conduct the mining operation.

1. Propulsion/Control Systems: Methods, technology and equipment required for efficient power management to optimize fuel usage and minimize equipment wear.

2. Navigation and Positioning: Methods, technology and equipment that would permit a ship to locate its position or maintain a predetermined bearing relative to a mine site or benchmark.

3. Motion Control: Methods, technology and equipment that provides for ship and platform stabilization and attitude measurement and control.

4. Automatic Station Keeping: Methods, technology and equipment that provides for automatic, dynamic ship positioning capability, including low speed ship dynamics.

G. Marine Environment and Marine Environmental Effects

The equipment, techniques and scientific knowledge required to monitor and predict oceanographic conditions, the effects of mining activities on the environment, and the effects of the environment on mining activities.

1. Marine Biology: The effects of sea life on the mining operation.

2. Ocean Dynamics: Methods, technology and equipment required to measure and predict ocean behavior, and the effects of ocean forces on surface and undersea mining equipment systems.

3. Environmental Monetoring: Methods, technology and equipment required to track and monitor from an aero space and or ocean platform the effects of ocean mining on the ocean environment.

4. Ocean Dumping: The effects of metallurgical processing waste, dredged material dumping, and other waste products of the mining operation on the ocean environment.

H. Mineral Transportation

The equipment and techniques required to handle ores aboard a mining vessel, transfer it to an ore transport vessel, transport it to shore, and off-load it at a port facility.

1. Surface Vessel: Ship design for ocean mining vessels and transport vessels.

2. Vessel to Vessel Transfer Systems: Methods, technology, equipment for at sea slurry and bulk material transfer systems.

3. Interaction of Ships: Ship interaction, maneuvering, and coordinations while conducting at-sea transfer operations.

4. Slurry and Bulk Handling: Methods, technology and systems for shipboard handling and storage, and for loading/unloading of slurry and bulk cargoes.

I. Mineral Processing

The techniques for treatment of marine minerals to extract or concentrate metals or other useful minerals either on-shore or at-sea and for disposal of the resulting waste products.

1. Mineral Dressing: Methods, technology and equipment which permits the mechanical preparation of mineral ore either for direct use or for future processing.

2. Ore Reduction: Methods, technology and equipment concerned with marine ore reduction.

3. Reagent Recycling: Methods, technology and equipment for the recovery and reuse of reagents used in mineral processing.

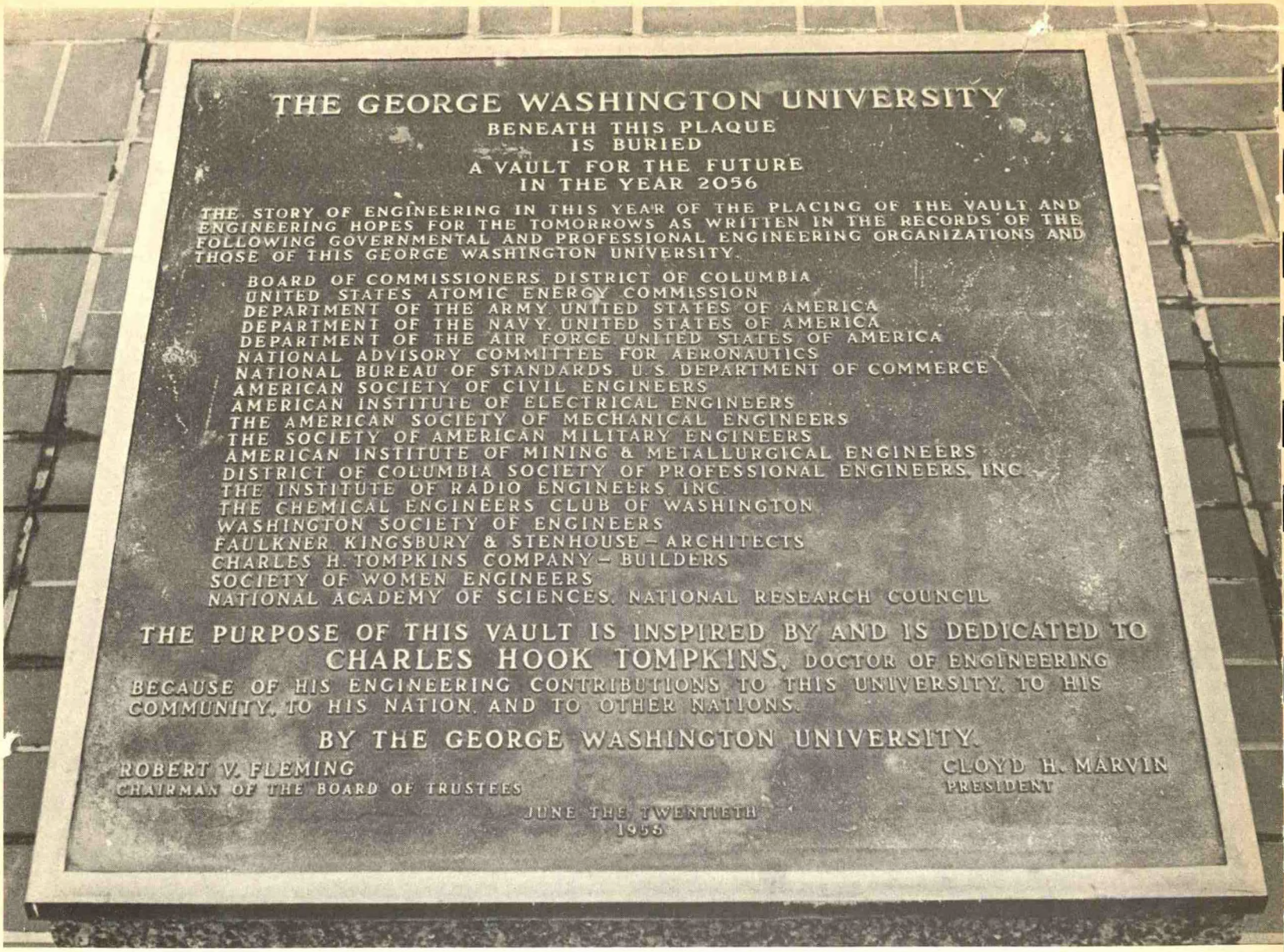
4. Waste Disposal: Methods, technology, and equipment which permits the treatment, containment and disposal of running waste without affecting the environment.

ENCLOSURE 2 TO APPENDIX C

DIRECTORY OF FEDERAL PERSONNEL

DEEP OCEAN MINING

This enclosure is the preliminary directory of Federal government personnel involved in developing technologies with potential application to deep ocean mining. Because of its size, it is being distributed separately.



To cope with the expanding technology, our society must be assured of a continuing supply of rigorously trained and educated engineers. The School of Engineering and Applied Science is completely committed to this objective.