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C/M PROGRAM (FY 74 – FYTQ) – SUMMARY REPORT

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OCEAN ENGINEERING AND CONSTRUCTION PROJECT OFFICE
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C. 20374

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EXECUTIVE SUMMARY

This report consists of two volumes concerning the Criteria and Methods (C&M) Program. Volume I is a summary report which discusses how the Program began, its objectives and goals, the structure and conduct of the program, and its accomplishments. Volume II is a user's guide for the Program archives. In addition to explaining how to locate a document in the files, the guide provides a complete listing of the contents of the file.

The Criteria and Methods Program was initiated in FY 74 to package the existing and evolving knowledge of ocean facilities engineering into manuals and handbooks to be used by ocean facilities engineers. The Program was to compare, evaluate, and document standard engineering criteria and methods based upon existing practices in specific support of the Naval Facilities Engineering Command's (NAVFAC) mission to design, construct and maintain fixed ocean facilities. The goal was to minimize unnecessary variance and overdesign, therefore maximizing reliability, safety and economy in meeting ocean engineering and construction requirements.

The Naval Material Systems Command (NAVMAT) funded the program from O&M,N money at approximately \$900,000 per year for three years. Within NAVFAC, program responsibility was assigned to the Program Coordination Office (PC-2) and responsibility to execute the program was delegated to the Ocean Engineering and Construction Project Office (FPO-1) of the Chesapeake Division. FPO-1 developed a multi-phased five-year execution plan to be performed by Navy Laboratories (CEL, NUC, NUSC and DTNSRDC initially) and selected academic institutions and contractors.

The multi-phased Program was divided into three parts. Part One was the systematic acquisition of existing and/or new information required for the development of criteria and methods. Part Two was the development and publication of official ocean facilities engineering handbooks and manuals. Part Three was the continuing review and updating of the publications.

Section I contains an overview of the Program. Section II discusses the evolution of the criteria and methods program capability development. Section III provides the approach taken to develop criteria and methods. Section IV presents accomplishments and funding data by fiscal year.

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The Criteria and Methods Program was initiated in FY 74 to package the existing and evolving knowledge of ocean facilities engineering into manuals and handbooks to be used by ocean facilities engineers. The Program was to compare, evaluate, and document standard engineering criteria and methods based upon existing practices in specific support of the Naval Facilities Engineering Command's (NAVFAC) mission to design, construct and maintain fixed ocean facilities. The goal was to minimize unnecessary variance and overdesign, therefore maximizing reliability, safety and economy in meeting ocean engineering and construction requirements.

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Section 1

INTRODUCTION

1.1 OVERVIEW

In FY 74 the Naval Facilities Engineering Command (NAVFAC) was chartered by NAVMAT INST 5460.2 to assume all fixed ocean facility engineering and construction projects. Concomitantly, NAVFAC was to reverse the 60 percent failure rate experienced by other Commands who had attempted ocean construction projects.

Upon assessment of initial operations, it became apparent that organized and ample technical documentation was not available to support NAVFAC planners and engineers in ocean facilities engineering (OFE). This was particularly true in the area of standardization. Consequently, the Naval Facilities Engineering Command (NAVFAC) Program Coordination Office, PC-2, was provided funds to establish a program element for the systematic development of standards and criteria. This element was to be level funded for a period of five years with an annual budget of \$900,000. Subsequently, the authority to define, plan and control the execution of this program was delegated to the Ocean Engineering and Construction Project Office, FPO-1, in the Chesapeake Division and the program got underway under the name of "Ocean Engineering and Construction Standards and Criteria Program".

FPO-1 developed a multi-phased five-year execution plan to be performed in conjunction with selected Navy laboratories, academic institutions and industry.

As the Program developed over the course of three years it underwent several stages of evolution (see Figure 1-1). The initial program scope was envisioned to influence national standards as they were applicable to ocean engineering and construction operations. Because of the broad interface requirements of this approach, the necessity for widespread agreement between existing standardization committees and members of industry who would be impacted by the changing standards, and the requirement for timely development of standards for near term Navy operations, this ambitious intent was ultimately discarded. The eventual program focused upon the specific needs and functions of NAVFAC in its role of ocean facility engineering and construction. This reduced scope of coverage required standards approval only within a limited community of concerned Navy groups and expedited the development of useful information. Consequently, in FY 75 the title of the program was changed to "Ocean Facilities Engineering Criteria and Methods" in order to more accurately describe the program's scope. It included the application of various engineering functions (design, construction, etc.) over the life cycle to the development of Naval Ocean

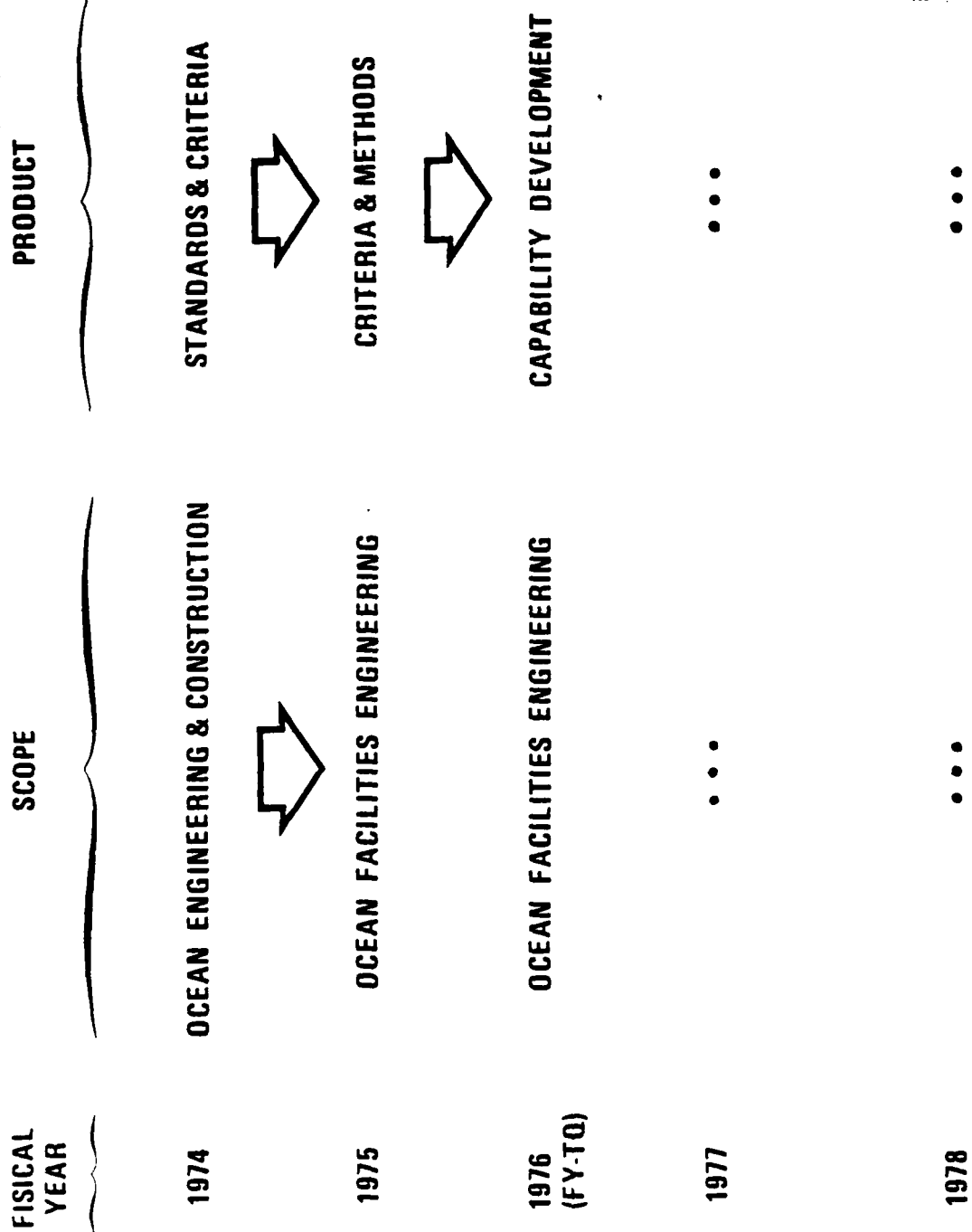


Figure 1-1. Criteria and Methods Program Evolution

Facilities. Also a distinction needed to be made between "Ocean Engineering" -- which is typically design oriented -- and "offshore construction engineering" which is more operations oriented. Ocean facilities engineering considers both. Concurrently, the NAVFAC Program Coordination Office, PC-2 adopted the title "Ocean Facilities Program" to better describe the ocean facilities' capability within NAVFAC.

Another nomenclature change was to substitute "Criteria and Methods" for "Standards and Criteria". Standards and Criteria was not truly descriptive of where the emphasis was being directed. The Program was attempting standardization, but within Navy ocean facilities engineering and of ocean facilities engineering criteria and methods. Furthermore, the Program was being confused with the DoD Standardization Program and other standardization efforts in academic and industry circles. Though the primary contribution was directed towards the Naval Ocean Facilities Engineering Program, it was anticipated that the program deliverables (products and services) would have significant impact and utility within the overall ocean engineering community.

Early in FY 76 the program was notified that funding would not be provided in FY 77 or FY 78. Consequently, the planned systematic development of a criteria and methods capability was terminated in order to more effectively utilize the remaining funds for FY 76 and TQ on higher priority capability requirements.

The title, therefore, was again changed to "Capability Development" to more accurately describe its purpose -- no longer to be limited to standardized criteria and methods.

1.2 OBJECTIVE

The program objective was to develop a criteria and methods capability consisting of those proven criteria and methods which had been selected and carefully developed, tested and documented for use by Navy planners and engineers in the design and construction of ocean facilities.

A firm data base was to be collected and/or developed to support the program recommendations.

Through utilization of standard criteria and methods (C&M) within Ocean Facilities Engineering (OFE), unnecessary variance and overdesign would be minimized and reliability, safety, and economy in meeting ocean facility requirements would be maximized.

1.3 PROGRAM PRODUCTS

Ultimately the products of the Program were to include an Ocean Facilities Engineering Publications Series consisting of handbooks and manuals. When required, guidelines would serve as the interim publication. Figure 1-2 shows the proposed structure of the publications.

The categories of products are summarized in the following paragraphs.

1.3.1 Data Base

A standardized data base was to be developed which would characterize the ocean environment and phenomena, i.e., the environmental loads and system interaction response. It would also provide physical and performance characteristics of C&M topics including effects of long term emersion of materials and facility components. Breakdown structures which would translate the generic mission requirements into specific capabilities requirements were another product to be developed.

1.3.2 Test/Calibration Procedures

Standardized test and calibration procedures were to be provided for various applications including testing programs to generate and update the aforementioned data base, standard acceptance testing of facility components after fabrication and the facility upon installation, and also tests and monitoring procedures as part of the inspection and maintenance function.

1.3.3 Engineering Design Methods

Standardized design formulas and procedures were to be provided including computer programs used to generate design curves appearing in the data base. The computer programs themselves would serve as design tools for non-standard cases.

1.3.4 Operational Procedures

Standardized operational procedures for installation, repair and maintenance were to be developed based on type and classification of facility.

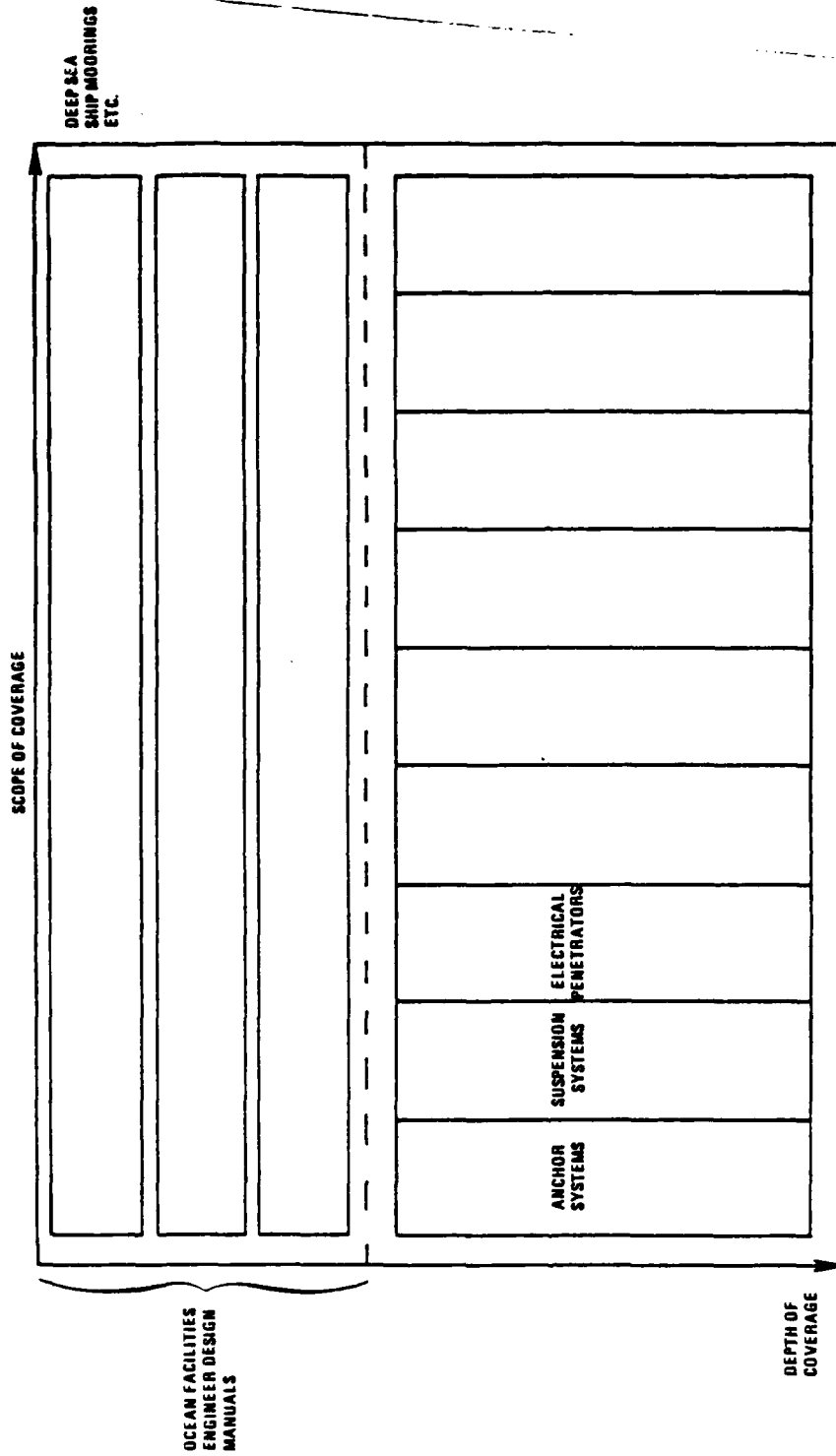


Figure 1-2. Proposed Structure of NAVFAC Ocean Facilities Engineering Publications

1.3.5 Documentation Guidelines

Documentation guidelines would be standardized to provide a continuous feedback of field experience -- thus building the data base. Documentation guidelines would include:

- Facilities Planning Documents -- These were to be the advanced concepts and feasibility studies which serve to define the scenario of the entire life cycle of the facility.
- Facility/Component Specifications -- These documents would serve as guidelines for the specification of component fabrication, procurement or construction as well as quality assurance tests.
- Project Execution Plans (PEP) -- Guidelines for the generation of PEP's would aid the ocean facilities engineer in considering and planning the functions necessary to complete the project (e.g., site survey plan, construction/installation plan, inspection plan, etc.).
- Project Completion Reports (PCR) -- These reports would document the project after completion. An analysis of the effectiveness of techniques and procedures as used would be included and recommendations made for future projects of a similar nature.

1.3.6 OFE Glossary

The glossary would standardize definitions, symbols and abbreviations, as they are used in ocean facilities engineering (OFE) and construction.

1.3.7 OFE Master Index/File

A master index/file was also to be developed. The index should include the following:

- C&M Development Organizations -- A master (keyword) index/file of professional societies, trade associations, standards institutes, government organizations, etc., involved in the development of criteria and methods or otherwise having an impact on the program. Included within this "category" was special committees, programs, offices, etc., involved with or having an interest in

the development of criteria and methods in ocean facilities engineering.

- Existing (applicable) Criteria and Methods Publications -- This would include a master index of existing ocean engineering type manuals/handbooks in addition to standards, laws, regulations, codes, specifications, etc. This would only include official C&M's or those published by a recognized authority (C&M development organizations). Thus technical reports, textbooks, etc., that present C&M's would not be considered as an "existing C&M".
- Ocean Facilities Engineering Documentation (Source Documents) -- The intent here was to have a keyword index of ocean engineering and construction-type documents (technical reports, texts, etc.). However, this was not in the C&M charter and other "services" did exist such as DDC and NTIS thus the Program addressed "source documents" which are those DDC's used in the development of the Ocean Facilities Engineering C&M's.
- Products/Capabilities -- This general category was to contain a number of separate files:
 - Form 251 (new Form 254): File would contain capabilities on industry, academic institutions, etc.
 - Product File: (For use primarily by Ocean Construction Equipment Program.)
 - Form 1498 File: A keyword index file of 1498's (both proposed and funded) -- used by R&D and C&M programs.
 - Library/Information Services File.
 - Computer facilities file (within or otherwise available to the Navy).
 - Test Facilities -- Initially the NAVMAT publication on "Inventory of Technical Facilities" was to be used. A new file of facilities concerned with ocean facilities engineering was to be developed as the program progressed.

1.3.8 Compendiums/Catalogs

Finally, compendiums and/or catalogs are to be prepared of ocean facilities components and ocean construction platforms and equipment. These documents will be a selective compilation/publication of information in the master index/file. It is intended that these data be either on microfilm/microfiche or in published book form.

Section 2

PROGRAM CONSIDERATIONS

2.1 CRITERIA AND METHODS CAPABILITY EVOLUTION

Because existing C&M capability was minimal and inadequately organized it was necessary to provide proven C&M's as workable tools to the ocean facilities engineers as rapidly as possible in order to increase confidence and capability in ocean engineering and construction. Five program activities or courses of action were structured so that as each activity was accomplished the C&M capability would be commensurably increased and would finally evolve into a complete C&M capability. This evolution is graphically shown in Figure 2-1. Each path down shows the activity and the resulting documentation. Proper documentation was critical to the Program since it permitted both a transfer of technology and generation of a data base.

Initially an assessment was made of the status of a particular area of interest and the following actions were taken:

- Reviewed current information to determine if sufficient knowledge existed to develop an interim C&M capability. If not, recommend further R&D.
- If a determination was made to develop an interim C&M capability, the next step was to decide whether or not to adopt an existing C&M or develop new ones. Finally the decision was made whether the C&M was to be in the form of guidelines, recommended practices or a technical report depending upon confidence level.

The actions outlined below were not fully accomplished due to the early termination of the Program; however, they were planned and they follow the flow of activities shown in Figure 2-1. They are presented here to complete the discussion of the C&M evolution.

- Once an interim C&M was established it would be necessary to build confidence in it by obtaining additional data through actual experience in its utilization. The experience was to be obtained through a testing program and/or field application.
- When a data base was sufficiently developed, official C&M manuals and handbooks were to be developed and published.

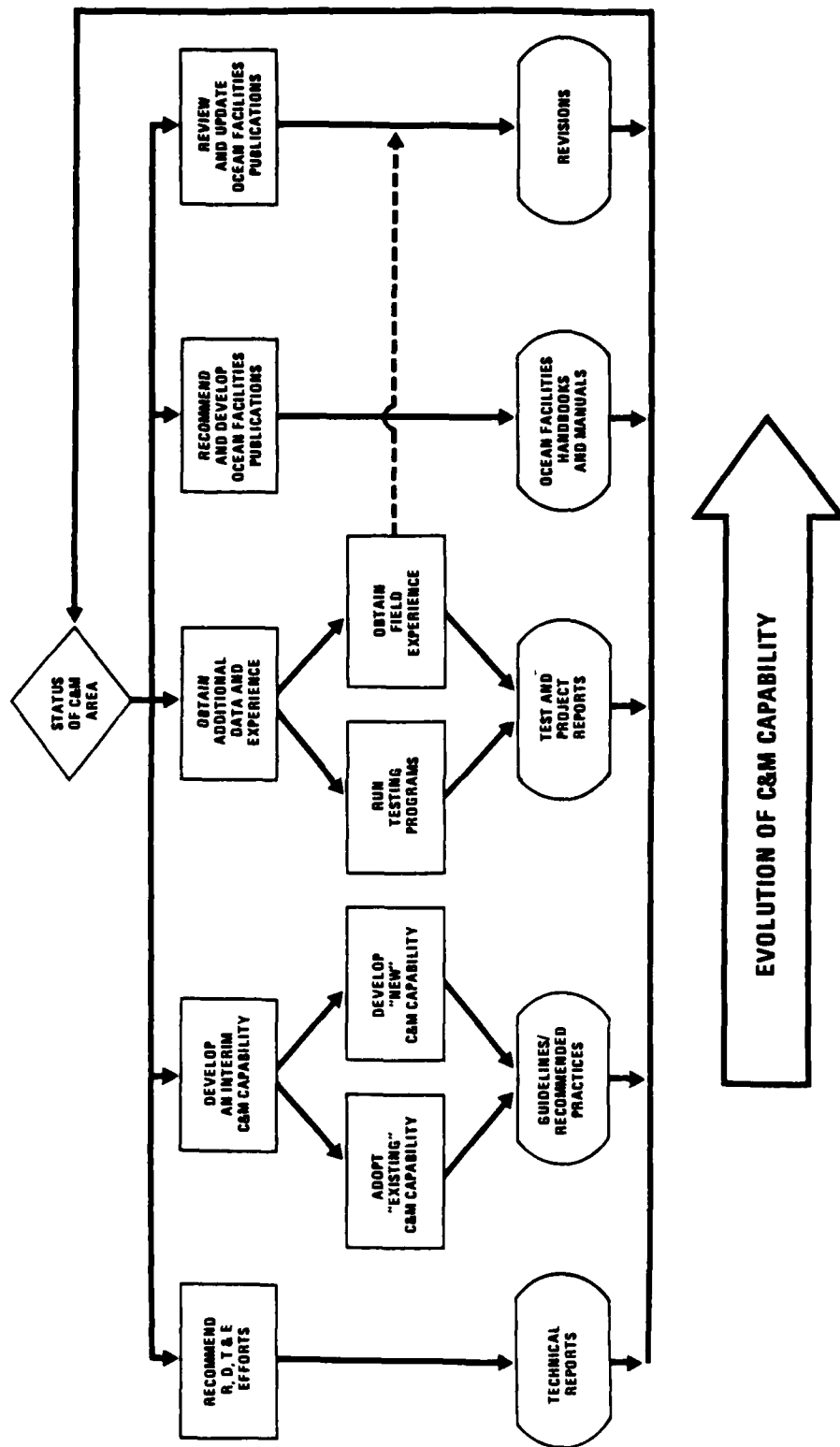


Figure 2-1. Criteria and Methods Capability Evolution

- Finally the publications and data base were to be continuously updated and/or revised as new information and additional experience were obtained.

2.2 PROGRAM STRUCTURE

2.2.1 Summary

The Criteria and Methods (C&M) Program was directed toward providing the technical basis for adopting criteria and methods to be used by Ocean Facilities Engineers (OFE). On the basis of a review of applicable technology areas, FPO-1 selected certain areas to be pursued through C&M studies. The actions required in the definition and performance of these studies are shown in Figure 2-2. First, FPO-1 provided a statement of each C&M problem to be pursued, scope of work involved and tasks to be performed in solution of the problem. Participants in the Program responded with a detailed proposal addressing the approach or methods to be used in performance of the C&M study. A description of the contents of the detailed proposal is contained in Section 3. The central part of this proposal was the participants' approach to the study of the particular C&M topic. Guidance for the formulation of the study plan was provided to the participants.

The detailed proposal submittal was reviewed and approved by FPO-1 prior to implementing the study. The output of the study was also reviewed and approved by FPO-1.

The Program was initially planned to extend over a five-year period and was structured into three parts for implementation as shown in Figure 2-2.

- Part One -- included those efforts evolving into proven/ documented criteria and methods.
- Part Two -- the development and publication of official handbooks and manuals.
- Part Three -- the continuing review and updating of these publications via maintenance of the criteria and methods data base.

2.2.2 Part One

Part One of the Program was the systematic acquisition of existing and/or new information required for the development of criteria and methods. It was further subdivided into three phases with Phase One conducted in two parts.

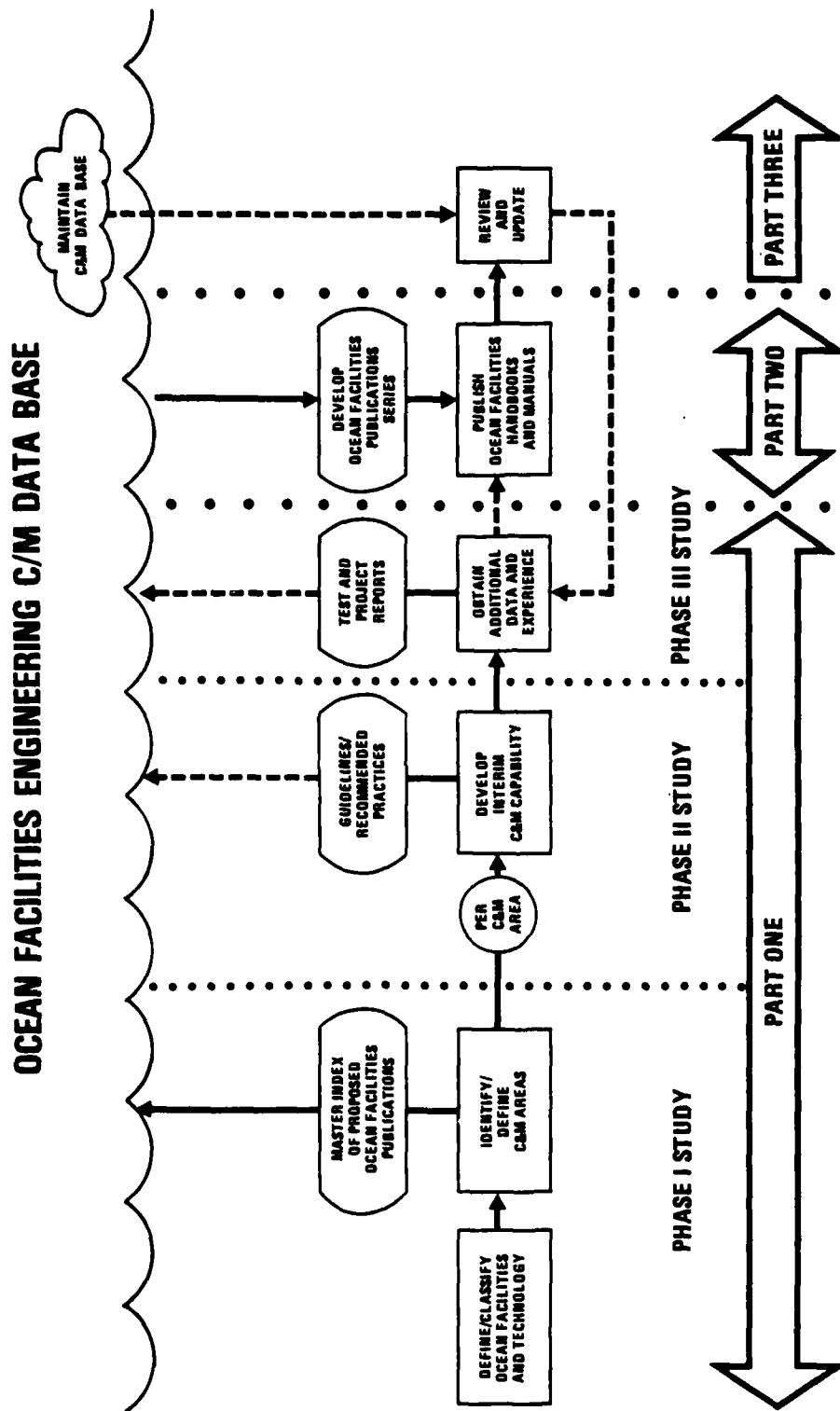


Figure 2-2. Program Structure

2.2.2.1 Phase I -- State-of-the-Art Assessment

Phase I assessed the need for development of specific ocean facilities engineering criteria and methods.

Twenty-one C&M areas of technology (see Figure 2-3) to be pursued were selected and assignments to the various participants were made. Participants were then requested to submit a detailed proposal which identified the work to be conducted during the study. The purpose of this request was threefold.

- The submittal provided a formal, documented structure to be utilized in the administration and execution of the C&M study.
- The study plan submittal allowed participants to demonstrate their understanding of C&M studies and their understanding of the specific problem.
- The aggregate of all detailed proposals enabled FPO-1 to generate an overall schedule and total C&M program plan for the ensuing year.

After the proposals were approved by FPO-1 the participants began the C&M study effort in their particular assigned area of technology (AAT) with the purpose of providing a technical basis for adopting criteria and methods and providing new design models, operational procedures and data.

As a first step, an information search was performed by the participants in their AAT to identify existing criteria, methods, models and supporting data. Next an analysis was made to establish the worth of the existing data. Finally the analysis results were documented by work breakdown structures, narrative summaries and point papers which included recommendations for adopting the criteria and methods or identification of requirements for new models or data.

2.2.2.2 Phase II -- Develop a Criteria and Methods Capability

Phase II was to result in the establishment of an ocean facilities engineering criteria and methods technical data base consisting of a composite of interim criteria and methods established during Phase I. Phase II was to generate a master index of ocean facilities engineering publications and a detailed program plan defining the needs for, and methods of, obtaining new data items.

ASSIGNED
LABORATORY

FOF COMPONENTS

Anchor Systems
Electrical Penetrators
E-M Terminations
Submarine and E-M Cable
Suspension Systems

CEL
NUSC
NUSC
NUSC
DTNSRDC

PHENOMENA

Bottom Breakout Forces
Hydrodynamics of Subsurface Structures
Hydrodynamics of Suspension Systems
Motion of Floating Structures
Dynamics of Floating Structures

CEL
DTNSRDC
DTNSRDC
DTNSRDC
DTNSRDC

WORK ELEMENTS AND ASSOCIATED SYSTEMS

Bottom Navigation Systems
Cable Protection/Immobilization
Lowering/Lifting Systems
Recovery Systems
Remote Work Systems
Seafloor Soil Sampling and Testing
Search/Relocation Systems
Site Preparation (Clearing/Excavation)
Nearshore (Explosive Clearing and Excavation)
Surface Navigation Systems
Nearshore Site Surveying

NUC
CEL/NUC
CEL
NUC
NUC
CEL
NUC
CEL
CEL
CEL
CEL

Figure 2-3. Phase I Study Assigned Areas of Technology (AAT)

2.2.2.3 Phase III -- Acquire Additional Information

During Phase III additional information was to be acquired to increase the criteria and methods capability and data base. Discrepancies in the interim C&M capability were to be identified and corrected.

2.2.3 Part Two

Part Two of the Program was to establish and adopt criteria and methods, and to develop and publish handbooks and design manuals encompassing the methodologies, standard designs, and performance criteria related to each area of technology and facility type.

2.2.4 Part Three

Part Three of the Program was to maintain, review, and update the ocean facilities engineering data base, procedures, handbooks and design manuals.

2.2.5 Participants

The participants in the Criteria and Methods (C&M) Program were those responsible for developing the products and services and were grouped into three categories:

- C&M Program -- those participating within the program developing C&M's -- this included Navy laboratories, industry and academic institutions.
- Ocean Facilities Engineer (OFE) -- the "user".
- Other C&M-Type Organizations -- all other organizations/activities involved in the development/establishment of C&M's or otherwise having an impact on the program, i.e., trade associations, professional societies, standards institutes, and those government organizations cognizant in areas that overlap ocean facilities engineering.

The C&M Program was to provide the OFE proven and documented engineering criteria and methods to use in the field. The OFE, in turn, was expected to provide the program with documented field experience which would eventually culminate in new and improved criteria and methods.

Section 3

APPROACH

3.1 METHODOLOGY

The purpose of the C&M Study was to provide a technical basis for adopting criteria and methods and to provide new design models, operational procedures and data.

3.1.1 Proposal

To initiate the study, each participant submitted a proposal discussing his approach.

Each proposal included the following four major items discussed below: technical approach, staffing, time schedule and cost estimate.

3.1.1.1 Technical Approach

The technical approach provided a basis for the study. It described what was to be done and how it was to be accomplished. The overall goals and guidelines of the study were reflected in the technical approach. Some of the items that were addressed are:

- Statement of the Problem -- The C&M Program provided an initial analysis of the problem for each work unit assigned. The participants were tasked to expand upon the preliminary analysis and further assess the problem solution. The discussion generally included applications and limitations of the specific methods and criteria and any other specific questions which the investigator felt should be answered.
- Information Search -- An information search was necessarily an important step in gathering information to support the development of criteria and methods. This issue was addressed in the study plan by discussing what specific types of information were searched (e.g., existing criteria and methods, existing models, etc.) and the sources of information (e.g., what libraries, etc.).

3.1.1.2 Staffing

Key personnel (e.g., principal investigator, statistician, etc.) who were involved in the study effort were identified. This list also included any sub-contractor support which was used. Resumes for all technical personnel were furnished in most cases.

3.1.1.3 Schedule

The proposal included a schedule which showed the time required to execute each task of the study. Dates of all milestones were indicated including delivery dates, checkpoints, and reviews. It was anticipated that the studies would be of less than one year duration; however, several extended beyond 24 months.

3.1.1.4 Cost Estimate

An estimated cost to execute the study was provided. This included manhours (by job category) and cost, and other direct costs such as travel, publications, etc. Travel costs were itemized by purpose of the trip (e.g., data gathering), destination and person or institution visited. After the proposals were approved by FPO-1, the study efforts began.

3.1.2 Conducting the Study

Figure 3-1 is a flow diagram of the major elements of the C&M study. The study effort included:

- an information search to identify existing criteria, methods, models and supporting data;
- structuring and exercising the analysis procedures required to establish the worth of the existing criteria, method, or model;
- documentation of the analysis results, including recommendations for adopting criteria and methods or identification of requirements for new models or new data.

Quality of the data was an area requiring keen examination. Thus the data, as well as the test/calibration techniques underlying the data, were evaluated critically.

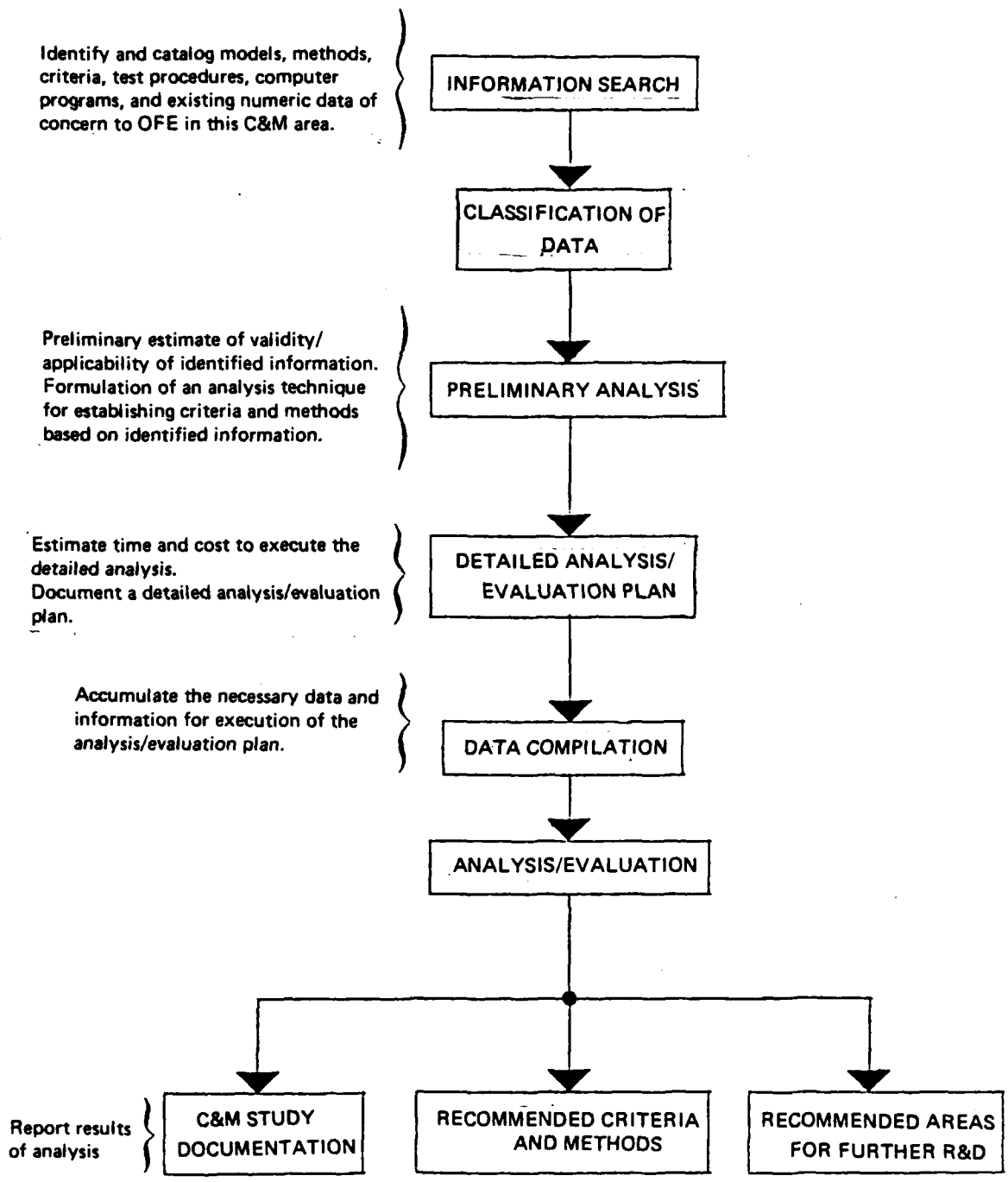


Figure 3-1 Study Components of the C&M Work Unit

A primary output of the C&M study was a report of the analysis/evaluation. Where adopting of criteria or a method was proposed, publication of a User's Guidelines document was to follow. In cases where adoption was not justified, the need for new data and models was identified for subsequent consideration.

3.1.2.1 Elements of the Study

The C&M study elements are identified in Figure 3-1 and are explained below.

3.1.2.1.1 Information Search. A search of possible sources of information was conducted to identify the existence, source and general character of models, data or operational procedures applicable to the particular C&M topic under study. The effort included a search of the literature, published and unpublished, interrogation of knowledgeable individuals and committees, etc. The detailed data was not accumulated, but its nature was identified to the degree necessary to assure its suitability in the formal analysis aimed at establishing the worth of postulated criteria or methods.

As part of the information search, definitions of encountered terminology were established. Definitions in general usage were used to a great extent, but clarity and internal consistency were the primary requirements and thus some definitions were unique.

- Identification of Existing Criteria and Methods (C&M) -- An existing C&M was defined as a design model or principle which had received wide acceptance or which had been endorsed by publication in authoritative literature such as a design manual, code or regulation. The identification of an existing C&M passed no judgment on its current value, but only on the degree of its current recognition and acceptance. For example, a C&M may have been supported by meager data or, in general practice, may have been misapplied or overextrapolated. This did not disqualify its identification as an existing C&M. Applications of the C&M, the limits of applicability, derivation, underlying assumptions and sources were also identified.
- Identification of Existing Models for Consideration -- These included any models treated in the literature having application to the C&M area but which could not be considered to be existing standards based on the above description. Applications of the model, the limits of

applicability, model derivation, the underlying assumptions, and source were identified.

- Identification of Existing Data -- All data with application to the analysis or validation of the C&M under investigation was identified. The intent was not to accumulate all the data, but to determine what it was, where it was, its source, its general quality and character, etc. The degree to which the data had been smoothed or reduced was indicated. Published and unpublished data were included. The generation of the data in all reduced forms was traced back to the basic measurement when possible.
- Identification of Test/Calibration Procedures -- The techniques used to obtain the data were identified. Any information which would support a judgment of the adequacy or deficiency of the test/calibration procedures was included.

3.1.2.1.2 Classification of Identified Data and Procedures. The data and procedures identified as the result of the information search were broken down into logical units or blocks of information. Taken as a whole, the blocks of information served as supporting data for the adoption of criteria and methods and/or the recommendation for R&D efforts. Each individual block of information constituted a complete description of a unique component of a C&M area such as a mathematical model, test procedure, etc. Each block of information was separately treated so that it could be extracted as a comprehensible and useful unit. The result of this effort was a categorization of information pertaining to the AAT under study.

3.1.2.1.3 Preliminary Analysis. For investigations performed for C&M Studies, a preliminary analysis was required. This was accomplished to establish preliminary estimates of the worth of C&M's, models, data and test procedures and also to assure the feasibility of the proposed analysis technique. From the C&M's and models, an Interim C&M was postulated if appropriate. Alternately, the test of a number of competing models against the data base was required. Next, some judgment as to the quality of the data base was made, and whether the data base supported the proposed analysis. If, for example, the data had been used to develop the model, it was disqualified from model validation (or goodness of fit test). Finally, a limited exercising of the analysis technique was accomplished using a small portion of the data base.

3.1.2.1.4 Detailed Analysis/Evaluation Plan. This plan included both the technical details for the analysis of the C&M Area and a schedule for accomplishing the investigation. The plan was simply a proposal for continuing the investigations.

The plan indicated the C&M or model(s) and the body of data to be used in the analysis. The analysis technique was described in detail and was to be based on sound statistical methods. The criteria for evaluation was also stated.

The analysis was to treat the model itself and its derivation. All aspects of the model were to be tested such as sensitivity to parameters, sensitivity to assumptions, range of applicability, etc.

The quality of the data base and its suitability for the proposed analysis was formally discussed. Adequacy of the test/calibration procedures and data reduction procedures was evaluated. Which data was used, which was not, and why were stated.

A schedule was developed for accomplishing the analysis/evaluation. It included:

- level of effort (personnel and cost)
- milestones
- outside support requirements
- interim report schedule

The effort scope and cost included all tasks from compiling the data through the analysis to publication of a User's Guidelines document.

3.1.2.1.5 FPO-1 Review/Approval of Plan. The aforementioned plan was submitted to FPO-1 for review/approval. Included was the detailed analysis/evaluation plan supported by the pertinent information blocks (and the preliminary analysis). The plan also included the schedule for accomplishing the study.

3.1.2.1.6 Compilation of Information and Data. After FPO-1 approval of the analysis/evaluation plan, the first task was to compile the data/information required and identified in the information search. A review of the data was made to assure that it conformed to the standards established for the analysis/evaluation.

3.1.2.1.7 Analysis/Evaluation. The Analysis/Evaluation was generally performed in accordance with the plan submitted and amended by FPO-1.

The output was a report or point paper documenting the Analysis/Evaluation and providing a recommendation either for or against adoption of the Interim C&M. Finally, a detailed outline for a User's Guidelines document was to be developed.

If, on the basis of the Analysis/Evaluation, the adoption of an Interim C&M could not be recommended, identification was made of the need for new models, information or data. Where the need for new data was recommended, test/calibration procedures for deriving the new data were also addressed.

3.1.3 Documentation of C&M Work Unit

Documentation requirements for the C&M studies were extensive and were of primary importance to the goals of the C&M Program. Several requirements for documentation were described in the previous sections and are summarized below. In addition, specific requirements for the preparation of the final report were enumerated.

3.1.3.1 Information Search Report and Preliminary Analysis

A report of the results of the information search and a limited analysis of identified models and data were required. The report included a comprehensive breakdown of the models, test and calibration procedures, and existing data applicable to Ocean Facilities Engineering. The breakdown, called Technology Breakdown Structures (TBS), provided a title or identification, a brief description of the information contained in the block diagram, a statement of its applicability and/or limitations, and the source of the information. A preliminary analysis of identified information was included as an integral part of the point papers.

3.1.3.2 Technical Report

A report of the results of the performance of a detailed analysis was required. Reports were to be prepared in the format specified in "Guidelines for the Preparation of Ocean Facilities Engineering Technical Reports," furnished as GFI; however, this format was provided too late in the Program to be followed in all cases. The reports did include the following information as applicable:

- Description of the physical system analyzed with illustrations for clarity;
- Discussion of the system's application(s) in Ocean Facilities Engineering;

- Description of analytic or physical models;
- Listing of assumptions;
- Description of test methods including:
 - Objective of test(s)
 - Scope of test(s)
 - (1) Controlled variables
 - (2) Variables held constant
 - (3) Uncontrolled but measured variables
 - (4) Uncontrolled, unmeasured variables which are not considered significant to test results
 - Calibration techniques
 - Variance from analytic model
 - Test setup diagram(s) and description, including discussion of physical limitations
 - Description of test procedure(s)
 - Methods of measurement
 - Data reduction technique(s)
- Validation of the results of tests:
 - Statistical analysis
 - Comparison with other experimental data
- Interpretation of the results of the analysis:
 - Sensitivity analysis
 - Limitations/applicability/confidence limits
 - Design curves
- Recommendations for use of the results.

The foregoing is the methodology set forth for the investigations and studies. As this was a dynamic program, many of the procedures evolved as the studies developed. The following paragraphs discuss how this methodology was applied.

3.2 APPLICATION

Initially (FY 74) the Program performed an analysis of the NAVFAC mission in ocean engineering and construction. A definition of fixed ocean facilities was developed as well as definitions of standards, criteria, assigned areas of technology and areas of capability. The

Program assessed the status of criteria and methods and determined which areas to pursue. In FY 74 these activities were primarily performed by a consortium of four Navy laboratories, CEL, NUSC, NUC and DTNSRDC. They addressed a total of nineteen areas of technology in accordance with their own capabilities and availability of personnel. These assigned areas of technology (AAT) are shown in Figure 2-3. The studies of the AAT's resulted in criteria and methods areas to be developed into an interim capability and further study in FY 75. In addition to the Phase I study efforts, five contracts were initiated in FY 74. They were:

- Studies of Deep Ocean Moor Dynamics -- Texas A&M
- Management/Planning Support -- Progress Management Service
- Compendium of Ocean Construction Platforms -- Robert Taggart Incorporated
- Management/Planning Support -- Wheeler Industries
- Current Measurement System Design Support -- Woods Hole Oceanographic Institution

The four Navy laboratories developed detailed outlines of their AAT's in the form of Technology Breakdown Structures (TBS) and Technology Interface Requirements (TIR). The TBS's served to translate the generic mission requirements into specific capabilities requirements. This was done by dividing the AAT's into specific work elements and associated systems that could be clearly defined. The majority of TBS's were hardware and equipment oriented; however, in some cases it was necessary to also provide a breakdown of the performance and specification parameters. The TBS's final form was a block diagram and a narrative which elaborated, clarified and defined the elements.

The TIR reflected the input and output dependencies of an AAT with other areas of technology. These were indicated on the TBS block diagrams by ellipses. Figure 3-2 shows a typical TBS summary block diagram. In addition, point papers were written to identify needs for criteria and methods. The TBS's were evaluated by the Project Office (FPO-1) to define the scope for each AAT and identify additional AAT's as necessary for interface with those assigned. Following a review of the evaluation with the four laboratories, assignments were made of C&M areas for continued efforts during FY 75.

In FY 75 the title of the program changed from "Ocean Engineering and Construction Standards and Criteria" to "Ocean Facilities Engineering Criteria and Methods". The scope of the program had become more specifically oriented toward ocean facilities engineering as it was defined

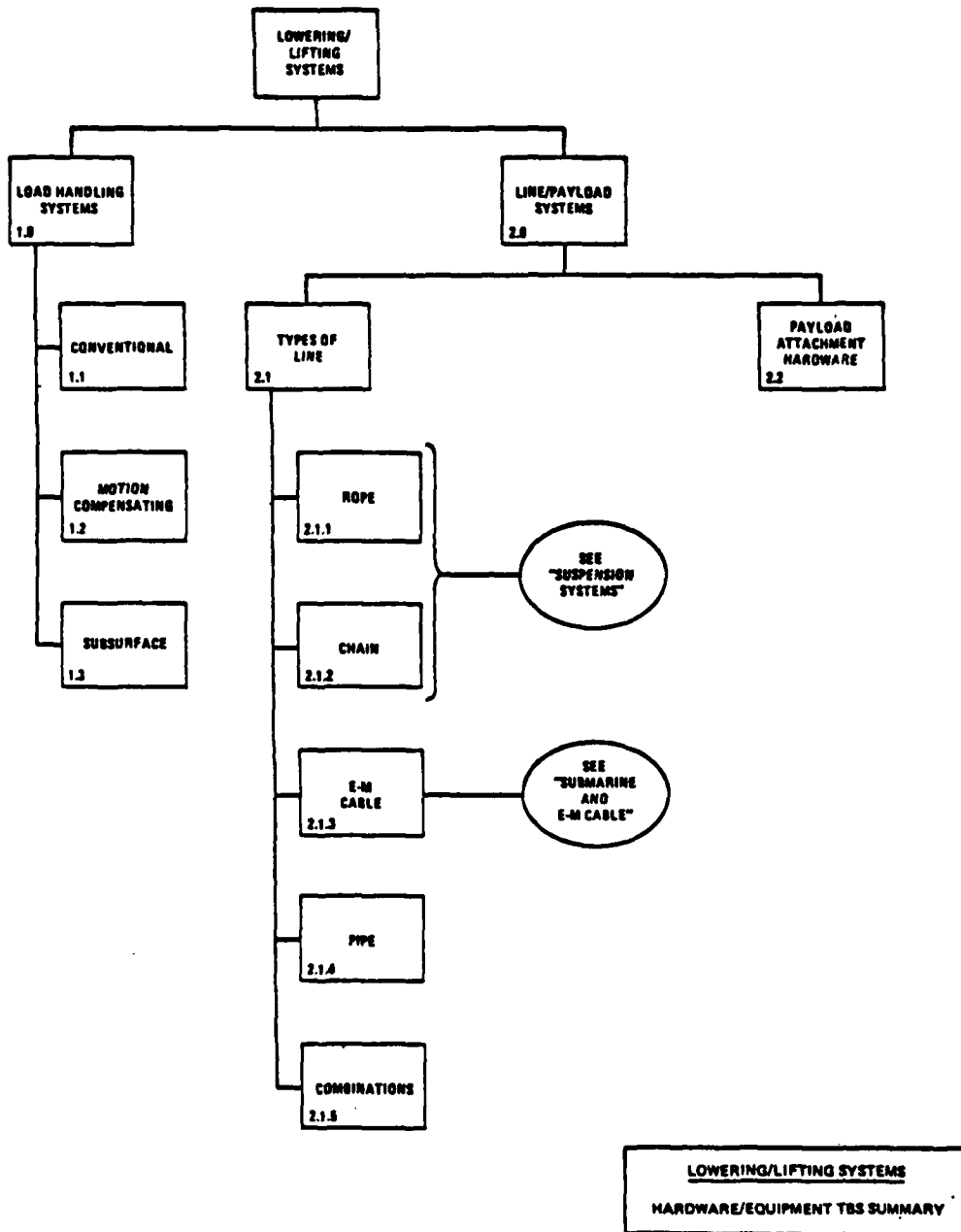


Figure 3-2. Typical TBS Summary

by NAVFAC rather than as defined nationwide by industrial/academic institutions, and the entire life cycle of the facility was included for investigation. The first part of FY 75 was devoted to review of the point papers on the AAT's, further analysis of the NAVFAC ocean facilities engineering mission requirements and the development of a list of C&M's to be pursued. The participating Navy laboratories were then assigned specific C&M areas to begin preparation of technical reports. Two more AAT's were selected for study -- "Dynamics of Floating Structures" assigned to NSRDC and "Nearshore Site Surveying" assigned to CEL. Guidelines for the execution of the remainder of Phase I and the Phase II study were also developed. Three contracts were initiated in FY 75 to support C&M development. They were:

- Cathodic Protection System Study -- Rockwell International;
- Work Breakdown Structures to Identify/Define Ocean Facilities Engineering Capability Requirements -- Lockheed Missile and Space Company;
- Identification/Definition of Criteria and Methods Study Areas; Develop Five-Year Plan; and Define Phase II Studies -- Rockwell International through NELC.

Early in FY 76 the program office was notified that funding would not be provided in FY 77 nor in FY 78. Consequently, the planned systematic development of a C&M capability was terminated in order to use the remaining funds in FY 76 and TQ on priority capability requirements. The title of the program was therefore again changed to "Capability Development Program" to more accurately describe its purpose -- no longer to be limited to standardized criteria and methods. Activities that were subsequently funded to Navy labs in FY 76 were:

- Cable Stabilization Design Guidelines -- CEL;
- Compilation of Hydrodynamic Characteristics of Array Components -- DTNSRDC;
- Study of Cable Equipment Testing -- NUSC;
- Development of Environmental/Bathymetric Scenario of St. Croix -- NORDA.

Five contracts were also initiated in FY 76 in support of the Capability Development Program. These were:

- Develop a Deep Sea Ship Moor Computer Simulation Program -- General Electric Company;

- Develop a Computer Software Library and Composite Subject Index -- Hydrospace Challenger through ONR;
- Develop a Format/Method for Project Structure, Planning and Control -- Undersea Research Corporation through ONR;
- Prepare a Compendium of U/W Electrical Connections and Morrison Seal Design Manual -- University of Washington through NAVSEA;
- Study the Impact of Navy Variations to DOCMS Design -- Woods Hole Oceanographic Institution.

Section 4

ACCOMPLISHMENTS AND FUNDING

4.1 GENERAL

The approach established within the C&M Program to reach the stated goal was logically conceived and had progressed reasonably well toward fruition at Program termination. The data gathered provides an excellent basis for future development should the Program be reinstated. Completed products have been disseminated to Ocean Facilities Engineers within various Navy organizations and have been used successfully on numerous ocean engineering and construction projects.

This section presents the accomplishments of the Program by delineating products received from the various participants and providing a brief description of the product. Additionally, the funding provided by fiscal year to the participants over the duration of the Program is presented.

FUNDING HISTORY FY 74

TITLE	LABORATORY/ CONTRACTOR	COST
1. Phase 1a Studies - Construction	CEL	\$200,000
2. Search for existing design criteria and specifications	NUSC, New London	10,000
3. Development of Stds & Criteria documentation	Wheeler Industries	10,133
4. Guidelines for OE/C Compendiums and Publications	Systems Evaluation	7,425
5. Deep Ocean Moor Dynamics Study	Texas A&M	53,412
6. Phase 1a Studies - Hydrodynamics	DTNSRDC	206,538
7. Experimental Methods in Vortex Shedding	Mar, Inc.	35,462
8. Phase 1a Studies - Work Systems	NUC, San Diego	100,000
9. Phase 1a Studies - Submarine Cables	NUSC, Newport, RI	120,000
10. Phase 1a Studies - Ocean Construction Platforms	Robert Taggart, Inc.	56,324
11. Design of Current Measurement Systems (DOCMS)	Woods Hole Oceanographic Inst.	58,895
12. Phase 1a Studies - Program Support	Progress Mgmt.	<u>46,724</u>
Total FY 74 Budget \$905,000	Total FY 74 Expenditures	\$904,913

FY 74

Topic FY 74-1 - Phase 1a Studies - Construction

Lab/Contractor: CEL

Key Person/Author: See individual topic summaries FY 74-1.1 through 1.9

P.O., W.R., Contract No.: PO4-0002

Start/End: 9/5/73 - 12/74

Cost: \$200,000

Product: Phase 1a Reports - Topic Element Breakdowns and Point Papers for the following Assigned Areas of Technology (AAT):

1. Anchor Systems
2. Bottom Breakout Forces
3. Cable Protection/Immobilization
4. Lowering/Lifting Systems
5. Seafloor Soil Sampling & Testing
6. Site Preparation (Clearing and Excavation)
7. Nearshore Explosive Clearing/Excavation
8. Surface Navigation Systems
9. Nearshore Site Surveying

Description: See individual topic summaries. In addition to the topic element breakdowns each report contained a glossary pertinent to the areas of technology being defined. The supplementary reports for each area presented point papers on those items needing further study. The point papers discussed the importance of the technology area with respect to the NAVFAC mission, priorities involved and the course of action to be pursued to achieve the goals of the program.

Topic FY 74-1.1 -- Anchor Systems

Author: R.J. Taylor, D.G. True and H.J. Lee

Description: Anchor systems for fixed ocean facilities were described. A comprehensive breakdown of anchor technology was given in terms of all possible classes and subclasses of equipment and parameters, each class and subclass being described by relatively terse verbal statements, sometimes including numerical information.

The report included a discussion of the impact of anchor technology on other areas of technology within the field of ocean facilities engineering, and, also, the impact of other technologies on anchor systems.

A glossary pertinent to anchor systems was provided.

Supplementary report FY 74-1.1S was a collection of 14 Point Papers as listed below which discussed anchor-system technology areas which were deficient in established criteria and methods for optimal execution of projects in ocean engineering and construction. Recommendations were made in each Point Paper which specified the actions to be pursued in establishing the needed criteria and methods. The recommended actions included compilation of existing data on all types of anchors used in ocean construction and the development of standard analytical methods for predicting the performance of anchors.

The Point Paper topics were as follows:

- Anchor Characteristics
- Acoustic Energy Emission
- Abrasion of Anchor System Ground Tackle
- Installation Time of Anchor Systems
- Hydrodynamics of Anchors During Installation
- Multiple Anchor Properties
- Automatic Mooring Systems
- Deadweight Penetration
- Drag Penetration
- Ballistic Penetration Into Seafloor Materials
- Powered and Aided Penetration
- Anchor Pullout Force and Direction
- Anchor Load-Displacement Behavior
- Soil Properties for Holding Capacity Prediction

Topic FY 74-1.2 -- Bottom Breakout Forces

Author: H.J. Lee

Description: This report described the processes for extracting an object from a state of embedment in the seafloor. A comprehensive breakdown of breakout-force parameters was given in terms of all possible classes and subclasses of importance in ocean facilities engineering. Each class and subclass was described by relatively terse non-quantitative verbal statements.

The report included a discussion of the impact of breakout-force technology on other areas of technology within the field of ocean facilities engineering, and, also, the impact of other technologies on breakout technology.

A glossary pertinent to Breakout Forces was provided.

Supplementary report FY 74-1.2S presented one Point Paper,

- Bottom Breakout Forces

which discussed criteria and methods needed for optimal execution of ocean construction projects which involve bottom breakout forces. The Point Paper recommended that standard analytical procedures be developed for predicting object embedment and the forces required for object breakout. The procedures would be based on data and information supplied by field personnel.

Topic FY 74-1.3 -- Cable Protection/Immobilization

Author: P.J. Valent, M.C. Hironaka, W.W. Perkins, R.L. Watts,
H.C. Wheeler and R.D. Hall

Description: Protection and immobilization systems were described for submarine cable systems - both bottom laid and suspended - used as power and data links to and from fixed ocean facilities and as components of such facilities. A breakdown of cable protection/immobilization technology was given in terms of classes and subclasses of equipment and parameters, each class and subclass being described by short verbal statements, including pertinent numerical and mathematical information. The report was not an engineering manual, but rather a tutorial exposition for managers and program planners in ocean facilities engineering and construction. A specific objective of this report was presentation of minimal background information to be used in establishment of criteria and methods for the Navy's ocean facilities engineering efforts.

Topic FY 74-1.3 (Cont'd)

The report included a discussion of the impact of cable protection and immobilization technology on other areas of technology within the field of ocean facilities engineering, and also the impact of other technologies on cable protection and immobilization. This effort was performed jointly by CEL and NUC. See Topic FY 74-8.5.

Topic FY 74-1.4 -- Lowering/Lifting Systems

Author: D.A. Davis, L.W. Hallanger and R.D. Hitchcock

Description: Lowering and lifting systems for fixed ocean facilities were described. A comprehensive breakdown of lifting-system technology was given in terms of all possible classes and subclasses of equipment and parameters, each class and subclass being described by relatively terse verbal statements, including pertinent numerical and mathematical information.

The report included a discussion of the impact of lifting-system technology on other areas of technology within the field of ocean facilities engineering, and, also, the impact of other technologies on lifting systems.

A glossary and list of nomenclature related to lowering and lifting system technology was provided.

Supplementary report FY 74-1.4S presented three Point Papers,

- Pipe Properties
- Load Handling System Properties
- Motion Compensation

which discussed lifting-system technology areas which were deficient in established criteria and methods for optimal execution of projects in ocean engineering and construction. Recommendations were made in each Point Paper which specify the actions to be pursued in establishing the needed criteria and methods. The recommended actions included compilation of existing data on the properties of pipe and other types of lift lines and the development of standard analytical methods for predicting the performance of lift lines.

Topic FY 74-1.5 -- Seafloor Soil Sampling and Testing

Author: M.C. Hironaka and H.J. Lee

Description: This report described the techniques and equipment for in-situ and laboratory testing of seafloor soil. A comprehensive breakdown of soil-testing technology was given in terms of all possible classes and subclasses of equipment and parameters of importance in ocean facilities engineering. Each class and subclass of the breakdown was described by relatively terse non-quantitative statements.

The report included a discussion of the impact of seafloor soil-testing technology on other areas of technology within the field of ocean facilities engineering, and, also, the impact of other technologies on seafloor soil testing.

A glossary pertinent to Seafloor Soil analysis was provided.

Supplementary report FY 74-1.5S presented four Point Papers,

- Seafloor Soil Sample Testing
- Seafloor Soil Sampling
- In-Situ Seafloor Soil Testing
- Synthesis of Data on Engineering Properties of Seafloor Soils

which discussed criteria and methods needed in sampling and testing soils for properties useful to ocean construction engineers. Recommended actions included establishment of data banks on laboratory and in-situ test results.

Topic FY 74-1.6 -- Site Preparation (Clearing and Excavation)

Author: R.D. Hitchcock and E.J. Beck

Description: This report described the equipment and systems for excavation of the seafloor. A comprehensive breakdown of excavation technology, excluding explosives, was given in terms of classes and subclasses of equipment and parameters important to ocean facilities engineering. Each class and subclass was described by relatively terse verbal statements, including a limited amount of numerical information.

The report included a discussion of the impact of seafloor-excavation technology on other areas of technology within the field of ocean facilities engineering, and, also, the impact of other technologies on seafloor-excavation systems.

Topic FY 74-1.6 (Cont'd)

A glossary with nomenclature listed as applied to Site Preparation techniques was included.

Supplementary report FY 74-1.6S contained three Point Papers,

- Diver-Controlled Excavator Systems
- Submerged Remotely Controlled Excavator System
- Surface Dredges

which discussed criteria and methods needed in the planning and execution of construction engineering projects involving the clearing and excavation of seafloor sites (excluding explosive methods). Recommended actions included compilation of data on the environmental impact of excavation of the seafloor by means of diver-controlled and remotely-operated machines, identification and cataloging of standard components for floating dredges, and compilation of laws regulating seafloor excavation operations and the installation of seafloor pipelines and cables.

Topic FY 74-1.7 -- Nearshore Explosive Clearing/Excavation

Author: L.W. Hallanger

Description: This report described the techniques and systems for seafloor clearing and excavation by means of explosives; as used in ocean facilities engineering. A comprehensive breakdown of explosive-excavation technology was given in terms of all possible classes and subclasses of equipment and parameters, each class and subclass being described by relatively terse verbal statements, including a limited amount of numerical information.

The report included a discussion of the impact of explosive-excavation technology on other areas of technology within the field of ocean facilities engineering, and, also, the impact of other technologies on explosive-excavation technology.

A glossary was provided which relates to the technology of seafloor clearing and excavation.

Supplementary report FY 74-1.7S presented one Point Paper,

- Nearshore Explosive Clearing and Excavation

Topic FY 74-1.7 (Cont'd)

which discussed criteria and methods needed in the planning and execution of construction engineering projects involving explosive clearing and excavation of nearshore seafloor sites. The Point Paper recommended that field work be conducted for the purpose of collecting data on existing methods of nearshore explosive excavation. It was further recommended that new excavation techniques be developed which place reduced emphasis on trenching and increased emphasis on other kinds of excavation.

Topic FY 74-1.8 -- Surface Navigation Systems

Author: R.D. Hitchcock

Description: This report described surface navigation systems used in operations involving fixed ocean facilities. A comprehensive breakdown of surface-navigation methods was given in terms of classes and subclasses of equipment and parameters, each class and subclass being described by relatively terse verbal statements, including pertinent numerical or mathematical information.

The report included a discussion of the impact of surface-navigation technology on other areas of technology within the field of ocean facilities engineering, and, also, the impact of other technologies on surface navigation systems.

A glossary with nomenclature pertinent to Surface Navigation Systems was included.

Supplementary report FY 74-1.8S contained three Point Papers,

- Geodimeter
- Radio
- Gyrocompass

which discussed criteria and methods needed in the planning and utilization of surface navigation systems for ocean construction projects. The Point Papers recommended development of standard analytical methods for nearshore positioning with distance-measuring geodimeters. Other recommendations were standardized software for integrated radio-satellite systems and miniaturized in-line gyro sensors for cable structures.

Topic FY 74-1.9 -- Nearshore Site Surveying

Author: J.B. Ciani

Description: This report described the techniques and equipment for nearshore site surveying as applied in ocean facilities engineering. A comprehensive breakdown of nearshore survey technology was given in terms of all possible classes and subclasses of equipment and parameters, each class and subclass being described by relatively terse verbal statements, including a limited amount of numerical information.

The report included a discussion of the impact of nearshore site-survey technology on other areas of technology within the field of ocean facilities engineering, and, also, the impact of other technologies on nearshore site surveying.

A glossary related to nearshore Site Surveying was provided.

Supplementary report FY 74-1.9S contained two Point Papers,

- Seafloor Surveying
- Ocean Environment Surveying

which discussed criteria and methods needed in the planning and utilization of nearshore site-survey methods for ocean construction projects. The Point Papers recommended that procedures which have been investigated experimentally by the Civil Engineering Laboratory be adopted as interim standards for nearshore cable installations and other ocean construction work.

Topic FY 74-2 - Search for Existing Ocean Engineering Design Criteria and Specifications

Lab/Contractor: NUSC, New London, Ct.

Key Person/Author: Brister Gray

P.O., W.R., Contract No.: WR4-2007

Start/End: 9/5/73 - 10/15/74

Cost: \$10,000

Product: Data Item Descriptions

Description: Program support was provided by developing Data Item Descriptions (DIDS) as an approach to data gathering and by relating the DIDS to engineering design criteria and specifications.

Topic FY 74-3 - Development of Standards and Criteria Documentation

Lab/Contractor: Wheeler Industries

Key Person/Author: Scott Terrill, Ben Witt

P.O., W.R., Contract No.: 73-C-0443

Start/End: 7/1/73 - 1/22/74

Cost: \$10,133

Product: Technical Report "Development of Ocean Engineering and Construction Standards and Criteria Program Documentation"

Description: A detailed Topic Breakdown of ocean engineering and construction elements applicable to the NAVFAC mission was presented. The NAVFAC mission was divided into three major areas

- Engineering and Design
- Construction and Installation
- Maintenance and Repair

The Topic Breakdown was based on the concept of generic derivation in which relevant areas of technologies were recognized and topics selected.

A glossary of terms pertinent to ocean engineering was included.

Bibliographies of existing and pertinent documentation on standardization of symbols, terminology, abbreviations and units of measure applicable to ocean engineering and construction was also included.

Topic FY 74-4 - Guidelines for Ocean Engineering and Construction Compendiums and Publications

Lab/Contractor: Systems Evaluation Co.

Key Person/Author: Lester Barrer

P.O., W.R., Contract No.: N00025-74-0724

Start/End: 7/31/73 - 12/73

Cost: \$7,425

Topic FY 74-4 (Cont'd)

Product: Documents of Guidelines for Compendiums, Publications, Data Items, and Testing/Technical Studies

Description: Provided technical assistance in the preparation of first draft of Guidelines of an OE/C Compendium; NAVFAC OE/C Publications; Data Items; and Detailed Proposals for Validation Testing and/or Technical Studies. Also provided assistance in obtaining DDC listings of OE/C documentation and current RDT&E efforts. Documentation of Procedures for establishing OE/C Standards and Criteria was also provided.

Topic FY 74-5 - Deep Ocean Moor Dynamics Study

Lab/Contractor: Texas A&M University

Key Person/Author: R.F. Dominguez, M.R. Monterroso, C.E. Nuckolls

P.O., W.R., Contract No.: N62477-74-C-0042

Start/End: 10/15/73 - 9/76

Cost: \$53,412

Product: Technical Reports: "Three Dimensional Dynamic Modes and Frequencies of Slack Cables" by R.F. Dominguez, M.R. Monterroso and C.E. Nuckolls, June 1974, (Dynamics of Deep-Sea Moors - Vol. I, Ref. COE-177); "Comparison of Steady-State and Dynamic Analysis of a Trapezoidal Moor Under Large Current Induced Displacements" by C.E. Nuckolls and R.F. Dominguez, July 1976, (Dynamics of Deep-Sea Moors - Vol. II, Ref. COE-178).

Description: The three dimensional natural frequencies, periods of vibration and modal configurations of elastic cables of arbitrary configurations were obtained and tables were presented which permit the determination of the natural periods for the first 48 modes of vibration of cables of any size and uniform mass distribution. The effect of altering the cable's extensibility modulus was considered and the tables were developed for two conditions of cable support; rigidly supported at each end, and free to move at the upper end in heave. The solution was based on three dimensional extension of the numerical method presented by Dominguez and Smith (1972) for evaluating the dynamic response characteristics of arbitrary elastic cable structures. Also, comparison was made with the classical taut string analogy showing that significant error can result from using this method for estimating the natural frequencies of slack cables.

Topic FY 74-6 - Phase 1a Studies - Hydrodynamics

Lab/Contractor: DTNSRDC

Key Person/Author: John Pattison; also see individual topic summaries
FY 74-6.1 through 6.7

P.O., W.R., Contract No.: PO4-0004

Start/End: 11/73 - 8/74

Cost: \$206,538

Product: Phase 1a Reports - Technology Breakdown Structures and Point
Paper Supplements for the following Assigned Areas of Tech-
nology (AAT):

1. Suspension System Elements
2. Hydrodynamics of Suspension Systems
3. Hydrodynamics of Subsurface Structures
4. Dynamics of Subsurface Structures
5. Motions of Floating Structures

Description: See individual topic summaries. In addition to the topic
element breakdowns each report contained a glossary pertinent to the
areas of technology being defined. The supplementary reports for each
area presented point papers on those items needing further study. The
point papers discussed the importance of the technology area with respect
to the NAVFAC mission, priorities involved and the course of action to
be pursued to achieve the goals of the program.

Topic FY 74-6.1 -- Suspension System Elements

Author: L.W. Bonde, Hydrospace-Challenger, Inc.
W. Dalton, Mar, Inc.

Description: The report provided graphic displays and narratives of
the Technology Breakdown Structure.

Supplementary report FY 74-6.1S defined requirements in six areas
(strength, fatigue, physical properties, elasticity, creep and shock
loading) with respect to suspension system elements.

Topic FY 74-6.2 -- Hydrodynamics of Suspension Systems

Author: D.B. Dillon, Hydrospace-Challenger, Inc.
W. Dalton, Mar, Inc.

Description: The report provided both a graphic display and narrative of the Technology Breakdown Structure. Technology Interface Requirements were listed.

Supplementary report FY 74-6.2S identified needs for standards and criteria in the following areas: Hydrodynamic Drag of Suspension Systems and Elements, Suspension System Reponse to Environmental Forces and Vortex Shedding.

Topic FY 74-6.3 -- Hydrodynamics of Subsurface Structures

Author: D.W. Coder, M.F. Jeffers, Jr. of NSRDC

Description: Technology breakdown structure presented graphically and with narrative. Technology interface requirements were listed.

Supplementary report FY 74-6.3S provided recommendations for standards and criteria of this topic under Ocean Hydrodynamics, Sediment Hydrodynamics, Physical Characteristics, Fluid Dynamic Interactions, Hydroelastic Effects and Induced Flow Hydrodynamics.

Topic FY 74-6.4 -- Dynamics of Subsurface Structures

Author: D.W. Coder, M.F. Jeffers, Jr. of DTNSRDC

Description: Technology breakdown structure presented graphically and with narrative. Technology interface requirements were listed.

Supplementary report FY 74-6.4S stated the following needs for standards and criteria. Acceptable Levels of Motion needed to be defined as a function of missions to be performed by the subsurface structures. Methods for predicting the motion of the subsurface structures were required. Configuration design guidelines were needed to aid the ocean engineer in determining shapes and internal arrangements which yield the minimum undesirable motion.

Topic FY 74-6.5 -- Motions of Floating Structures

Author: N.K. Bales of DTNSRDC

Description: Technology breakdown structure presented graphically and with narrative. Technology interface requirements were identified.

Supplementary report FY 74-6.5S contained five Point Papers,

- Properties of Floating Structures
- Hydrodynamic Loadings Acting on Floating Structures
- Frequency Domain Characteristics of Floating Structure Oscillatory Motions
- Time History Characteristics of Floating Motions
- Extreme Value Statistics of Floating Structure Oscillatory Motions

which discussed criteria and methods needed in the analysis of the forces on floating structures. Recommended actions included the stated need for development of mathematical models to assess underwater sectional shape and the need for additional experimental data to be gathered to assist in developing standard predictive techniques.

Topic FY 74-6.6 -- Wind Loads on Ocean Facility Structures - A Survey

Author: N.T. Tsai of DTNSRDC

Description: A survey of wind loads data was conducted to compile and annotate the existing wind loads data applicable to ocean facilities structure, including ships, moored systems and offshore structures. After a literature survey of the data source at Naval Ship Research and Development Center (DTNSRDC), a bibliography on wind loads data was prepared. Data item summary sheets were given for some of the representative wind loads data, such as a typical analytical method or a representative test method. It was found that there was a lack of wind loads data on offshore structure and a systematic approach was needed to develop a handbook on wind loads on ocean facilities structures. A technical memorandum No. TM15-75-14 was published. In this technical memorandum data item summary sheets were presented for fourteen publications representative of the wind loads data on ships.

Topic FY 74-6.7 -- Design Procedures for Deep Ocean Ship Moorings

Author: D.F. Brown of Lorelei, Inc.

Description: This report presented the design procedures, formulas, and data used in the design and evaluation of deep ocean ship mooring structures. The scope of the investigation was restricted to fleet type moorings whose basic components consist of anchors, cables and buoys. A buoyed, three degree mooring design furnished by the U.S. Navy was evaluated in detail. This served as an example problem to clarify the various design procedures and the use of design information.

Topic FY 74-7 - Experimental Methods in Vortex Shedding

Lab/Contractor: Mar, Inc.

Key Person/Author: J.J. Nelligan

P.O., W.R., Contract No.: Via NSRDC PO4-0004

Start/End: 4/74 - 12/74

Cost: \$35,462

Product: Technical Report: "A Survey of the Experimental Methods in Vortex Shedding from Cables and Cylinders"

Description: A quick survey was performed of the experimental techniques employed in vortex shedding measurements from cables and cylinders. Measurement techniques were reviewed in frequency and amplitude of vibration, vortex shedding frequency, oscillatory lift and draft (cylinders) and oscillatory tension (cables) as well as wake measurements.

Topic FY 74-8 - Phase Ia Studies - Work Systems

Lab/Contractor: NUC, San Diego

Key Person/Author: See individual topic summaries FY 74-8.1 through 8.5

P.O., W.R., Contract No.: PO4-0003

Start/End: 8/73 - 2/75

Cost: \$100,000

Product: Phase Ia reports - Technology Breakdown Structures and Point Paper Supplements for the following Assigned Areas of Technology (AAT):

1. Bottom Navigation Systems
2. Recovery Systems
3. Remote Work Systems
4. Search/Relocation Systems

Description: See individual topic summaries. In addition to the topic element breakdowns each report contained a glossary pertinent to the areas of technology being defined. The supplementary reports for each area presented point papers on those items needing further study. The point papers discussed the importance of the technology area with respect to the NAVFAC mission, priorities involved and the course of action to be pursued to achieve the goals of the program.

The technology breakdown structures and technology interface requirements for all four areas were published in Volume I of NUC TN 1486. A bibliography of publications used in defining the areas of technology was also included in Volume I.

The second volume documented the need for standards and criteria to serve as accurate, reliable guidelines in using the techniques and equipment described in Volume 1. Volume 2 contained 19 point papers describing the individual requirements. An additional area of technology, Cable Protection/Immobilization, responsibility for which was shared with CEL was also presented in Volume 2.

Topic FY 74-8.1 -- Bottom Navigation Systems

Author: J.N. Price

Description: Bottom navigation systems as applied to underwater navigation of work systems, divers and/or Fixed Ocean Facilities (FOF) for the purpose of installation, maintenance or repair of FOFs were described.

A comprehensive breakdown of bottom navigation technology was given in terms of all possible classes and subclasses of equipment and parameters, each class and subclass being described by relatively terse verbal statements, sometimes including numerical information.

The report included a discussion of the impact of bottom navigation technology on other areas of technology within the field of ocean facilities engineering, and, also, the impact of other technologies on bottom navigation systems.

Supplementary report FY 74-8.1S was a collection of Point Papers as listed below which discussed bottom navigation technology areas which were deficient in ocean engineering and construction. Recommendations were made in each Point Paper which specified the actions to be pursued in establishing the needed criteria and methods. The recommended actions included compilation of existing data on all types of bottom navigation capabilities for ocean construction and the identification of needed R&D efforts to meet positioning requirements.

The Point Paper topics were as follows:

- Acoustic Locators and Targets
- Vehicle Navigation Sensor Suit

Topic FY 74-8.2 -- Recovery Systems

Author: R.L. Watts

Description: Recovery systems used in the recovery of bottom-mounted or bottom-tethered FOFs or FOF components were described. Specifically excluded were the recovery of surfaced or floating FOFs or FOF components and diver recovery methods.

A comprehensive breakdown of recovery system technology was given in terms of all possible classes and subclasses of equipment and parameters, each class and subclass being described by relatively terse verbal statements, sometimes including numerical information.

Topic FY 74-8.2 (Cont'd)

The report included a discussion of the impact of recovery system technology on other areas of technology within the field of ocean facilities engineering, and, also, the impact of other technologies on anchor systems.

Supplementary report FY 74-8.2S was a collection of Point Papers as listed below which discussed recovery system technology areas which were deficient in established criteria and methods for optimal execution of projects in ocean engineering and construction. Recommendations were made in each Point Paper which specified the actions to be pursued in establishing the needed criteria and methods. The recommended actions included compilation of existing data on all types of recovery systems used in ocean construction and the development of operational standards for selecting proper tools for use by personnel involved in work with recovery systems.

The Point Paper topics were as follows:

- Prepared Lift Points
- Attachment Device Utilization
- Recovery Technique Utilization
- Release Device Utilization

Topic FY 74-8.3 -- Remote Work Systems

Author: H.C. Wheeler

Description: Remote work systems including method and equipment were described. A comprehensive breakdown of remote work systems technology was given in terms of all possible classes and subclasses of equipment and parameters, each class and subclass being described by relatively terse verbal statements, sometimes including numerical information.

The report included a discussion of the impact of remote work system technology on other areas of technology within the field of ocean facilities engineering, and, also, the impact of other technologies on remote work.

Supplementary report FY 74-8.3S was a collection of Point Papers as listed below which discussed remote work system technology areas which were deficient in established criteria and methods for optimal execution of projects in ocean engineering and construction. Recommendations were made in each Point Paper which specified the actions to be pursued in establishing the needed criteria and methods. The recommended actions included compilation of existing data on all types of remote work systems used in ocean

Topic FY 74-8.3 (Cont'd)

construction and the development of an operational matrix to aid in the selection of proper tools for performing an underwater mission.

The Point Paper topics were as follows:

- Unmanned Tethered Vehicle Utilization
- Manipulator Utilization
- Tool Capabilities

Topic FY 74-8.4 -- Search/Relocation Systems

Author: J.N. Price

Description: Search/relocation systems used for the localization and location of objects on the sea floor in a circle of less than ten miles in radius were described.

A comprehensive breakdown of search technology was given in terms of all possible classes and subclasses of equipment and parameters, each class and subclass being described by relatively terse verbal statements, sometimes including numerical information.

The report included a discussion of the impact of search technology on other areas of technology within the field of ocean facilities engineering, and, also, the impact of other technologies on search systems.

Supplementary report FY 74-8.4S was a collection of Point Papers as listed below which discussed search/relocation system technology areas which were deficient in established criteria and methods for optimal execution of projects in ocean engineering and construction. Recommendations were made in each Point Paper which specified the actions to be pursued in establishing the needed criteria and methods. The recommended actions included compilation of existing data on all types of search/relocation systems used in ocean construction.

The Point Paper topics were as follows:

- Visual Markers
- Acoustic Markers
- RF Markers
- Search Technique Utilization
- Optical Search System Utilization
- Acoustic Search System Utilization
- Magnetometer Search Utilization

Topic FY 74-8.5 -- Cable Protection and Immobilization

Author: W.W. Perkins

Description: NUC shared responsibility with CEL in the investigation of cable protection/immobilization. CEL dealt with near-shore operations extending from on-shore through the surf zone to working depths of 130 feet. NUC covered deep-sea operations and methods that could not be implemented by divers. See Topic FY 74-1.3.

Supplementary report FY 74-8.5S was a collection of Point Papers as listed below which discussed cable protection/immobilization system technology areas which were deficient in established criteria and methods for optimal execution of projects in ocean engineering and construction. Recommendations were made in each Point Paper which specified the actions to be pursued in establishing the needed criteria and methods. The recommended actions included compilation of existing data on all types of cable protection/immobilization systems used in ocean construction and the close coordination between NUC and CEL in their anchor systems and cable protection/immobilization efforts.

The Point Paper topics were as follows:

- Burial of Submarine Cables
- Sheaths for Submarine Cables
- Anchors for Submarine Cables

Topic FY 74-9 - Phase Ia Studies -- Submarine Cables

Lab/Contractor: NUSC, Newport, RI

Key Person/Author: B. Gray, E. Retherford, R. O'Connor, R. Fromer, J. Clark, J. DePrimo

P.O., W.R., Contract No.: PO4-0006 and Amendment #1

Start/End: 12/73 - 6/74

Cost: \$120,000

Product: Phase Ia reports - Technology Breakdown Structures and Point Paper Supplements for the following Assigned Areas of Technology (AAT):

1. Electrical Penetrators
2. E-M Terminations
3. Submarine and E-M Cable

Topic FY 74-9 (Cont'd)

Description: See individual topic summaries. In addition to the topic element breakdowns each report contained a glossary pertinent to the areas of technology being defined. The supplementary reports for each area presented point papers on those items needing further study. The point papers discussed the importance of the technology area with respect to the NAVFAC mission, priorities involved and the course of action to be pursued to achieve the goals of the program.

Topic FY 74-9.1 -- Electrical Penetrators

Author: R. Gerlipp

Description: Electrical penetrators used to transfer electricity through a water barrier were described. Particular emphasis was placed on through pressure-hull penetrators discussing types, components and materials utilized.

A comprehensive breakdown of penetrators was given in terms of all possible classes and subclasses of equipment and parameters, each class and subclass being described by relatively terse verbal statements, sometimes including numerical information.

The report included a discussion of the impact of electrical penetrators on other areas of technology within the field of ocean facilities engineering, and, also, the impact of other technologies on penetrating systems.

A glossary pertinent to electrical penetrators was provided.

Supplementary report FY 74-9.1S was a collection of 5 Point Papers as listed below which discussed electrical penetrators technology areas which were deficient in established criteria and methods for optimal execution of projects in ocean engineering and construction. Recommendations were made in each Point Paper which specified the actions to be pursued in establishing the needed criteria and methods. The recommended actions included compilation of existing data on all types of electrical penetrators used in ocean construction and the development of standard analytical methods for predicting the performance of electrical penetrators.

The Point Paper topics were as follows:

- Electrical Properties
- Pressure Induced Forces
- Load Induced Forces
- Environmental Deterioration
- Time Induced Properties

Topic FY 74-9.2 -- E/M Terminations

Author: J. A. Rhoades

Description: Electromechanical (E/M) terminations used either for the completion of an electrical circuit or for the transmission of mechanical forces between cables and structures were discussed. The discussion was logically divided into electrical connectors and mechanical terminations with a detailed physical description and typical usage of each.

A comprehensive breakdown of electromechanical termination was given in terms of all possible classes and subclasses of equipment and parameters, each class and subclass being described by relatively terse verbal statements, sometimes including numerical information.

The report included a discussion of the impact of E/M termination technology on other areas of technology within the field of ocean facilities engineering, and, also the impact of other technologies on E/M termination systems.

A glossary pertinent to E/M termination systems was provided.

Supplementary report FY 74-9.2S was a collection of 10 Point Papers as listed below which discussed E/M termination system technology areas which were deficient in established criteria and methods for optimal execution of projects in ocean engineering and construction. Recommendations were made in each Point Paper which specified the actions to be pursued in establishing the needed criteria and methods. The recommended actions included compilation of existing data on all types of E/M terminators used in ocean construction and the development of standard analytical methods for predicting the performance of E/M terminators.

The Point Paper topics were as follows:

- Physical Properties of Strength Members
- Physical Properties of Electrical Connectors
- Contact Scoring Resistance
- Conductor Strength
- Contact Corrosion Resistance
- Breakdown Voltage
- Electromagnetic Susceptibility
- Contact Resistance
- Termination Strength
- Contact Pressure and Wipe

Topic FY 74-9.3 -- Submarine and E/M Cable

Author: E. Retherford

Description: Submarine and electromechanical (E/M) cables are discussed under two major headings - electrical core components and mechanical components.

A comprehensive breakdown of submarine and E/M cable technology was given in terms of all possible classes and subclasses of equipment and parameters, each class and subclass being described by relatively terse verbal statements, sometimes including numerical information.

The report included a discussion of the impact of submarine and E/M cable technology on other areas of technology within the field of ocean facilities engineering, and, also the impact of other technologies on cable systems.

A glossary pertinent to submarine and E/M cable systems was provided.

Supplementary report FY 74-9.3S was a collection of 6 Point Papers as listed below which discussed submarine and E/M cable technology areas which were deficient in established criteria and methods for optimal execution of projects in ocean engineering and construction. Recommendations were made in each Point Paper which specified the actions to be pursued in establishing the needed criteria and methods. The recommended actions included compilation of existing data on all types of cables used in ocean construction and the development of standard analytical methods for predicting the performance of cable systems.

The Point Paper topics were as follows:

- Environmental Performance of Jacket Materials
- Characteristic Impedance
- Attenuation
- Crosstalk
- Electrical Damage from Mechanical Stress
- Maximum Frequency

Topic FY 74-10 - Phase 1a Studies -- Ocean Construction Platforms

Lab/Contractor: Robert Taggart Incorporated

Key Person/Author: R. Taggart

P.O., W.R., Contract No.: N62477-74-C-0194

Start/End: 5/23/74 - 2/1/76

Cost: \$56,324

Product: Technical Reports: "Search for Literature and Sources of Information on Ocean Construction Platforms"; "Technology Breakdown Structure (TBS) of the Physical and Performance Characteristics of Ocean Construction Platforms"; "Survey of Platform Availability"; "Establishment of Criteria for Selection of Ocean Construction Platforms"; "Compendium of Ocean Construction Platforms"

Description: The purpose of this contract was to provide the Government engineering assistance for the publication of a compendium of ocean construction platforms suitable for NAVFAC special projects.

Topic FY 74-10.1 -- Search for Literature and Sources of Information on Ocean Construction Platforms - Report No. RT-35601

Author: R. Taggart

Description: A search to identify existing manuals, handbooks, textbooks, compendiums and other documentation considered applicable to ocean construction platforms was conducted and pertinent data from each was presented. The data was provided as an annotated bibliography which identified specific literature and sources of information and provided a content summary/analysis and discussion of applicability to ocean construction, together with locator and access information.

Topic FY 74-10.2 -- Technology Breakdown Structure (TBS) of the Physical and Performance Characteristics of Ocean Construction Platforms - Report No. RT-35602

Author: R. Taggart

Description: This report contained a technology breakdown structure (TBS) of the physical and performance characteristics of ocean construction platforms displayed as a block diagram. A narrative which defines each TBS element in terms of standard/accepted definitions, symbols and units of measures was also included. Finally a list of references of the source material used in developing the report was presented.

Topic FY 74-10.3 -- Survey of Platform Availability - Report No. 35603

Author: R. Taggart

Description: A survey of platforms suitable for ocean construction was conducted. Due to the abundance of "platforms" the survey was restricted to three major categories:

- Ocean Construction Survey Platforms
- Ocean Construction Logistics Platforms
- Ocean Construction Work Platforms

These categories were further subdivided into seagoing platforms and inshore platforms. This report provided data on numerous platforms in the foregoing categories. Data included physical description, electrical, navigation and communication equipment and laboratory/accommodation facilities.

Topic FY 74-10.4 -- Establishment of Criteria for Selection of Ocean Construction Platforms - Report No. RT-35604

Author: R. Taggart

Description: This report outlined criteria to be used in selecting ocean construction platforms to be included in a compendium, discussed the data that should be presented in a compendium and provided recommendations relative to the format of a compendium.

Topic FY 74-10.5 -- Compendium of Ocean Construction Platforms

Author: R. Taggart

Description: This report provided information on the physical and performance characteristics of available ocean construction platforms. Platforms were classified into six categories:

- Seagoing Survey Platforms
- Inshore Survey Platforms
- Seagoing Logistics Platforms
- Inshore Logistics Platforms
- Seagoing Work Platforms
- Inshore Work Platforms

For each platform there was a narrative description providing an overview of its physical and performance characteristics. Additionally, for the more complicated platforms, drawings, curves and tabular data were provided.

Topic FY 74-11 - Design of Current Measurement Systems (DOCMS)

Lab/Contractor: Woods Hole Oceanographic Institution

Key Person/Author: Robert G. Walden

P.O., W.R., Contract No.: N62477-74-C-0080

Start/End: 5/20/74 - 12/75

Cost: \$58,895

Product: Technical Report: "Current Measurement System Design Support (Phase 1)"

Description: This report, in two volumes, provided a description of an environmental model, a survey of available current measuring instruments, analyses, tradeoffs, system design and procurement specifications for the system. This study was based on the requirement that current velocity measurements were required from the deep ocean basins of the world between the depths of 300 and 6000 meters below the surface. The measurements were in Eulerian and in the form of time series. Instrument endurance was set between 6-12 months and the recording data was in digital format.

Topic FY 74-12 - Phase 1a Studies -- Program Support

Lab/Contractor: Progress Management Services

Key Person/Author: Robert J. Massey, David M. Hume

P.O., W.R., Contract No.: N62477-74-C-0284

Start/End: 10/3/74 - 11/27/74

Cost: \$46,724

Product: Technical reports: "Events in Development, Approval and Apportionment of the FY + 2 Program; Life Cycle of the Individual Exploratory Development Project; FPO-1 Entry Points in the Research and Development Process; A Master Plan for the OEP Criteria and Methods Program; Interface Relationships Between the Criteria and Methods Program and the RDT&E Community; The Ocean Facilities Engineer; and Introduction to the Criteria and Methods Program of the Ocean Facilities Engineering and Construction Program of the Naval Facilities Engineering Command"

Description: The purpose of this contract was to provide the Government with engineering and technical services to develop a baseline for a Criteria and Methods (C&M) Program Plan. Interface recommendations were provided as well as guides for scheduling and control management tasks.

Topic FY 74-12.1 -- Events in Development, Approval and Apportionment of the FY+2 Program

Author: David M. Hume

Description: This report contained a process flow chart depicting the cyclic development and approval of the Navy budget and apportionment process. The salient feature of the chart was the visualization of the timing of input elements necessary to influence downstream results in some specific time.

Topic FY 74-12.2 -- Life Cycle of the Individual Exploratory Development Project

Author: Robert J. Massey

Description: This report presented a functional model diagram of the evolution of an Exploratory Development project from its conception to final output resulting from its execution.

Topic FY 74-12.3 -- FPO-1 Entry Points in the Research and Development Process

Author: Robert J. Massey

Description: This report presented a diagram of functional and product entry points which could be used by FPO-1 to guide them as to when to become involved in the R&D process.

Topic FY 74-12.4 -- A Master Plan for the OEP Criteria and Methods Program - A Counter Proposal

Author: Robert J. Massey

Description: This report set forth the outline of an alternative approach for accomplishing the purposes of the Ocean Engineering and Construction Criteria and Methods Program. A detailed description of activities required for each phase of the plan was presented.

Topic FY 74-12.5 -- Interface Relationships Between the Criteria and Methods Program and the RDT&E Community

Author: Robert J. Massey

Description: This report addressed relationships between the Criteria and Methods Program and the RDT&E Community. A discussion of the roles of each was presented and recommendations were made that would ensure maximum benefit to the C/M Program from the RDT&E Program.

Topic FY 74-12.6 -- The Ocean Facilities Engineer

Author: Robert J. Massey

Description: This report defined Ocean Facilities, the role of the Ocean Facilities Engineer and discussed the Criteria and Methods Program in terms of users and products.

Topic FY 74-12.7 -- Introduction to the Criteria and Methods Program
of the Ocean Facilities Engineering and Construction
Program of the Naval Facilities Engineering Command

Author: Robert J. Massey

Description: This report discussed the NAVFAC mission in Ocean Engineering and Construction and provided a detailed description of the Criteria and Methods Program as it was originally envisioned.

FY 75

FUNDING HISTORY FY 75

TITLE	LABORATORY/ CONTRACTOR	COST
1. Underwater Nearshore Explosive Clearing and Excavation	CEL	\$ 65,000
2. Hydrodynamics Study - Wind Loads	DTNSRDC	30,000
3. Reliability Studies	Technical Engineering Services	40,000
4. Submarine Cable Test Equipment Study	NUSC, New London	15,000
5. Inspection of Objects Retrieved from the Deep Ocean	CEL	20,000
6. WBS for Fixed Ocean Facilities	Lockheed	93,363
7. Program Management Technical Support	Rockwell Int.	83,288
8. Deep Ocean Mooring Equipment Study	Rockwell Int.	19,340
9. Uplift Resisting Anchor Study	CEL	14,000
10. Capability Development Requirements Analysis	NELC	115,000
11. Design Guidelines for Nearshore Cable Stabilization	CEL	35,000
12. Methods of Characterizing and Predicting the Performance of Engineering Materials in the Ocean Environment - Metals	CEL	20,000
13. Snoopy Sonar Modification Analysis	NUC, San Diego	10,000
14. Kevlar Design Guide	NUSC/NRL	25,000
15. Correlation and Ship Motion Computer Study	DTNSRDC	10,000
16. DSSM Computer Simulation Support	DTNSRDC	40,000
	Subtotal	\$634,991
Other Capability Development		
UCT Training	COMCBPAC	9,500
OCP Modification	J.J. Henry	154,734
OCP Outfitting	SUPSHIP	50,000
OCP Support	NAV ORD STAT	5,000
	Subtotal	\$219,234
Total FY 75 Budget \$855,000	Total FY 75 Expenditures	\$854,225

Topic FY 75-1 - Underwater Nearshore Explosive Clearing and Excavation

Lab/Contractor: CEL

Key Person/Author: L. W. Hallanger

P.O., W.R., Contract No.: PO5-0002

Start/End: 11/4/74 - 6/30/76

Cost: \$65,000

Product: Technical Note N-1409 "Underwater Explosive Excavation Testing at San Nicolas Island, California, 1972-1973"

Technical Report R-843 "Interim Field Guide to Nearshore Underwater Explosive Excavation"

Description: Data from a series of tests designed to provide preliminary information on a variety of topics relating to nearshore underwater explosive excavation was presented.

Data from these tests were included in a field guide designed to provide the Ocean Facilities Engineering personnel of the Naval Construction Forces with the information necessary to successfully conduct underwater explosive excavation projects in rock and coral with primary emphasis placed on techniques suitable for cable and pipeline route preparation.

Topic FY 75-1.1 -- Underwater Explosive Excavation Testing at San Nicholas Island, California 1972-1973, Technical Note - TN-1409

Author: L. W. Hallanger

Description: A series of tests designed to provide preliminary information on a variety of topics relating to nearshore underwater explosive excavation was conducted at San Nicolas Island, California, during 1972-1973. Topics investigated included: (1) suitability of standard Navy demolition materials for use in underwater excavation projects; (2) potential for modifying certain standard Navy demolition charges to allow their use or to improve their performance in underwater applications; (3) suitability of certain commercially available conventional explosives in underwater applications; (4) suitability of commercial field-mixable, two-component explosives for underwater

Topic FY 75-1.1 (Cont'd)

applications; (5) identification of operational restraints for near-shore explosives work; (6) validation of techniques that appear to be suitable for nearshore explosive excavation work; and (7) determination of the limitations inherent in the techniques that could be applied. Data obtained from a total of 55 test shots consisting of 198 separate charges were presented.

Topic FY 75-1.2 -- Interim Field Guide to Nearshore Underwater Explosive Excavation - TR-R-843

Author: L. W. Hallanger

Description: This field guide provided information concerning explosives, equipment and techniques suitable for use in underwater explosive excavation projects. Primary emphasis was placed on techniques suitable for cable and pipeline route preparation in rock and coral. A glossary of terms used was included.

Topic FY 75-2 - Hydrodynamics Study -- Wind Loads

Lab/Contractor: DTNSRDC

Key Person/Author: J. Pattison, R. Singleton

P.O., W.R., Contract No.: WR5-2020

Start/End: 11/15/74 - 2/75

Cost: \$30,000

Product: Report: "A Measurement Technique for Determining the Hydrodynamic Characteristics of a Towed Sea-Going Barge"

Description: NAVFAC towed the converted YFNB-33 barge from New Orleans, Louisiana to Norfolk, Virginia during the early part of September, 1974. The Naval Ship Research and Development Center (DTNSRDC) developed a Project Execution Plan (PEP) that addressed the measurement and analysis of hydrodynamic resistance data on the YFNB-33 during the aforementioned exercise.

Topic FY 75-3 - Reliability Studies

Lab/Contractor: Technical Engineering Services

Key Person/Author: R.O. Kidd, W.E. Harrison, D. Wheeler

P.O., W.R., Contract No.: WR5-2021 and PO5-0018 to NUC, San Diego

Start/End: 11/15/74 - 6/5/75

Cost: \$40,000

Product: Technical Reports: "An Analysis of the Utility of Statistical Reliability Assurance Techniques in Fixed Ocean Facility Design"; "Utilization of the General Effectiveness Model (GEM) Program for Reliability Assurance in Fixed Ocean Facilities"

Description: The purpose of this effort was to evaluate the feasibility of applying reliability engineering techniques, currently used in aerospace, strategic weapons, and electronics to the design and development of fixed ocean facilities.

The reports described significant characteristics of reliability models, the reliability characteristics of fixed ocean facilities, and existing models with model selection criteria. An example was provided utilizing the reliability model in the design of the Tethered Float Breakwater (developed jointly by the Navy and the State of California). The General Effectiveness Methodology (GEM) model was used.

Topic FY 75-3.1 -- An Analysis of the Utility of Statistical Reliability Assurance Techniques in Fixed Ocean Facility Design

Author: R. O. Kidd, W. E. Harrison and D. Wheeler

Description: This report discussed the feasibility of applying reliability engineering techniques currently used in aerospace, strategic weapons and electronics to the design and development of fixed ocean facilities. The report also described an approach that could be utilized in a test case; the Tethered Float Breakwater developed jointly by the United States Navy and the State of California.

Topic FY 75-3.2 -- Utilization of the General Effectiveness Model (GEM)
Program for Reliability Assurance in Fixed Ocean
Facilities

Author: R. Kidd and W. Webb

Description: This document described how to use the Generalized Effectiveness Methodology (GEM) computer program. The description was from the pragmatic point of view of the engineer who would be responsible for the programming, coding, key-punching and running the GEM. The GEM program was a sophisticated computer program that calculated various reliability figures of merit for complex man-machine systems using a simple user-oriented language.

Topic FY 75-4 - Submarine Cable Test Equipment Study

Lab/Contractor: NUSC, New London

Key Person/Author: D.A. Cain, R.B. Gay, C.D. Johnson, B. Gray,
M.S. Leff, E.G. Marsh

P.O., W.R., Contract No.: WR5-2022

Start/End: 11/15/74 - 2/21/75

Cost: \$15,000

Product: Technical Report: "Evaluation of Methods and Criteria for
Cable Testing and Test Equipment" TM EA31-9-75

Description: This report dealt with recommended tests, test procedures, and test equipment which could be used on submarine type cable up to twenty miles in length. The cables considered were those that had left the manufacturer and were in storage or in the process of installation. The intended use was of great importance when considering which tests should be performed. Therefore, included were design guidelines which would serve as an aid to designing cables and also as an aid for re-qualifying old cables for new and different intended uses.

A survey of test equipment for recommended tests was accomplished and was included together with test procedures. A broad survey of different manufacturers and types of equipment was also included.

Discussion of the mechanical integrity of submarine cables was also included.

Topic FY 75-5 - Inspection of Objects Retrieved from the Deep Ocean

Lab/Contractor: CEL

Key Person/Author: J.F. Jenkins

P.O., W.R., Contract No.: WR5-2019

Start/End: 11/15/74 - 2/76

Cost: \$20,000

Product: Technical Report: "Inspection of Objects Retrieved from the Deep Ocean - AUTECH Acoustic Array" Technical Note N-1424
February 1976

Description: This project was to develop and apply techniques to maximize the amount, quality, and applicability of data obtained from the inspection of objects retrieved from the ocean. Guidelines for the inspection of structures recovered from the sea were prepared, exercised, and, as appropriate, revised. These guides set forth procedures for inspection of objects recovered from the sea which could be uniformly applied by field personnel with limited expertise in the field of marine corrosion and which would result in the accumulation of data which could be compared with data obtained by other field personnel. To validate these guidelines, portions of the AUTECH acoustic array were retrieved from the Tongue-of-the-Ocean, Bahama Islands, in March 1974 for repair and refurbishment. The field inspection of the retrieved portion of the array assisted in the determination of the extent to which undamaged or unrecovered portions could be utilized in the refurbished array.

Topic FY 75-6 - Work Breakdown Structures for Fixed Ocean Facilities

Lab/Contractor: Lockheed Missile & Space Company, Inc.

Key Person/Author: See individual topic summaries FY 75-6.1 through 6.6

P.O., W.R., Contract No.: N62477-73-C-0359 Modification P0007

Start/End: 12/9/74 - 12/75

Cost: \$93,363

Product: Technical reports: "Ocean Facilities Engineering"; "Ocean Facilities Engineering Capability Requirements"; "Topics, Organization and Study Areas for Proposed Criteria and Methods Design Handbooks"; "Naval Fixed Ocean Facilities-Bottom Mounted Surface Structures" "Naval Fixed Ocean Facilities-Suspended Cable Structures"; "Environmental Aspects of Ocean Facilities Engineering"

Description: Detailed breakdown structures were generated for the following:

- Functions OFE must address during the life cycle of a facility
- Suspended Cable Structures - components and subsystems
- Bottom Mounted Surface Structures - components and subsystems
- Environmental aspects OFE must address during the life cycle of a facility
- Identification and definition of all topics to be addressed in the proposed OFE publications series

Four charts were generated that identified OFE capability requirements.

Topic FY 75-6.1 -- Ocean Facilities Engineering

Author: A.S. Dunbar, D.P. Germeraad, and W.F. Hill

Description: This report presented a definition of Ocean Facilities Engineering (OFE) as related to the mission of the Naval Facilities Engineering Command (NAVFAC). A description of the functions to be performed for and under the cognizance of NAVFAC during the life cycle of a Fixed Ocean Facility (FOF) project was provided as well as the interrelationship of those functions as applied to all Naval fixed ocean facilities.

A detailed breakdown structure was included that addressed the significant functions to be considered in planning, designing and constructing fixed ocean facilities and the maintenance, repair and services required during the life of that facility.

A glossary of pertinent terms was also included.

Topic FY 75-6.2 -- Ocean Facilities Engineering Capability Requirements

Author: T. J. Anderson and W. F. Hill

Description: This report described, defined, and interrelated a series of Capability Requirements for the design of bottom mounted surface structures and suspended cable structure of Fixed Ocean Facilities. The Capability Requirements were categorized and their interrelationships defined by a generic breakdown structure.

Topic FY 75-6.3 -- Naval Fixed Ocean Facilities - Bottom Mounted Surface Structures

Author: T.J. Anderson, E.H. Nickell, and W.F. Hill

Description: This report documented a detailed breakdown structure of Fixed Ocean Facility components related to Bottom Mounted Surface Structures. The data presented herein described, defined, and interrelated the elements of bottom mounted (BM) surface structure types of Fixed Ocean Facilities.

The data presented herein were restricted to facilities that were unmanned or that might be temporarily manned during inspection or maintenance - in effect, defining the type of BM hardware that was available and might be employed to construct a facility of the types addressed in this report.

Topic FY 75-6.4 -- Naval Fixed Ocean Facilities - Suspended Cable Structure

Author: T.J. Anderson, R. Norton and W.F. Hill

Description: This report documented a detailed breakdown structure of Fixed Ocean Facility (FOF) components related to Suspended Cable (SC) Structures. The data presented described, defined and interrelated the elements of suspended cable structure types of FOF. The data were restricted to suspended cable structures for application to sensor arrays, submarine cables, cable landings and unmanned deep sea ship moorings, thus defining the type of SC hardware that was available and could be employed to construct a facility broadly defined by one of the four types of structures addressed in the report.

Topic FY 75-6.5 -- Environmental Aspects of Ocean Facilities Engineering

Author: M. Briggs, W.R. Butler, E.P. Kiefer and P.T. Waterman

Description: This report presented a generic breakdown structure, with supporting narrative, of the most significant environmental factors (EV) that Ocean Facilities Engineering (OFE) personnel must address during the lifetime of a Fixed Ocean Facility (FOF). Environmental aspects were categorized into three main classes:

- Atmospheric
- Ocean
- Seafloor

Those environmental aspects that might have a significant influence on the site selection, environmental loads for design purposes and potential detrimental impact on the desired performance of the FOF were listed.

A glossary of pertinent terms was also included.

Topic FY 75-7 - Program Management/Technical Support

Lab/Contractor: Rockwell International

Key Person/Author: See individual topic summaries FY 75-7.1 through 7.5

P.O., W.R., Contract No.: N62477-75-C-0183

Start/End: 1/15/75 - 8/16/75

Cost: \$83,288

Product: Report on Definition of Ocean Facilities Engineering
Report on Prototype for Future C&M Studies
Phase II Guidelines Report
Style and Format for C&M Study Reports
Guidelines for the Preparation of Ocean Facilities
Engineering Technical Reports [Subsequently FPO-1-77(1)]

Description: The purpose of this contract was to provide the Government with engineering and technical services for documentation related to performing a variety of management support and technical review functions. This work included the definition of requirements for and assistance in generating the documentation for decentralized program execution.

This work included the development of charts and other displays showing the time phasing and status of program activities, coordinating the flow and filtering of information obtained by the program and general technical reviews/assessment of on-going program activities including consolidation of Navy evaluation of C&M development efforts.

Topic FY 75-7.1 -- Definition of Ocean Facilities Engineering

Author: W. D. Knox and J. M. Herrington

Description: This document presented a definition of Ocean Facilities Engineering in terms of engineering functions and interacting technology areas encompassed during the design, construction and maintenance of a facility.

Topic FY 75-7.2 -- Prototype for Future C&M Studies

Author: R. Schwarz

Description: This document presented a 5 year plan for the development of criteria and methods. A discussion of the evaluation criteria used to establish priorities of the individual study area was also included. The procedure used in identifying the C&M capability requirements, C&M study areas were fully explained.

Topic FY 75-7.3 -- Phase II Guidelines

Author: R. A. Schwarz

Description: This document contained four study prototype:

- Methods of Characterizing and Predicting the Engineering Properties of Suspension Elements--Synthetic Fiber.
- Methods of Characterizing and Predicting the Performance of Engineering Materials in the Ocean Environment--Metals
- Underwater Nearshore Explosive Clearing and Excavation.
- Deep Sea Ship--Mooring Computer Simulation

Each prototype was a technical examination of an individual C&M area and contained illustration of the methodology and approach that was to have been used in conducting the Phase II studies.

Topic FY 75-7.4 -- Style and Format for C&M Study Reports

Author: H. Murphey

Description: This document presented guidelines for the preparation of Ocean Engineering Capability Development Program reports. The document presented sample reports and formats to be used by responsible engineers assigned to monitor the individual capability development topics.

Topic FY 75-8 - Deep Ocean Mooring Equipment Study

Lab/Contractor: Rockwell International

Key Person/Author: T.T. Craig and J.M. DesLierres

P.O., W.R., Contract No.: N62477-75-C-0072 - P0002

Start/End: 9/27/74 - 8/75

Cost: \$19,340

Product: Technical report: "Cathodic Protection System Study," August 1975

Description: An analysis was conducted of the Cathodic Protection Systems to determine their application to deep ocean mooring cables. The analysis identified areas of design parameters of system stress, current generating ability and area of influence, cathodic material and operational life.

Topic FY 75-9 -- Uplift Resisting Anchor Study

Lab/Contractor: CEL

Key Person/Author: D.A. Davis, D.B. Jones

P.O., W.R., Contract No.: PO5-0008

Start/End: 4/3/75 - 12/75

Cost: \$14,000

Product: Handbook for Uplift Resisting Anchors

Description: Anchors having the capability to resist uplift forces were identified and data on the properties and performance of these anchors were provided. A reference manual was prepared that incorporated the data and new developmental efforts.

Topic FY 75-10 - Capability Development Requirements Analysis

Lab/Contractor: NEIC

Key Person/Author: Richard Gamble

P.O., W.R., Contract No.: PO5-0005

Start/End: 4/24/75 - 10/75

Cost: \$115,000

Product: C&M Capability Development Activities Flow Diagram
Program Management Plan Outline
Tasking Documentation
Cost Savings Report
Five Year C&M Program Plan
PERT Document
Guidelines for the Preparation of Capability Development
Program Management Reports

Description: An analysis of Navy planned programs was conducted to identify and define projected OFE capability requirements. An analysis of the requirements for quarterly progress reports and fiscal year summary reports was made to determine their application to FPO-1. A flow diagram of capability development activities was developed as it applies to C&M.

Topic FY 75-11 - Design Guidelines for Nearshore Cable Stabilization

Lab/Contractor: CEL

Key Person/Author: R.L. Brackett, P.J. Valent

P.O., W.R., Contract No.: PO5-0002 Amendment #1

Start/End: 6/2/75 - 12/77

Cost: \$35,000

Product: Handbook of Design Guidelines

Description: The guidelines were presented in handbook form using available technical data representative of the state-of-the-art knowledge of nearshore cable stabilization methods such as split pipe, rock bolts, trenching, slant drilling, and others. The guidelines applied to armored and unarmored electrical cables with design lives of 1 to 20 years when placed in the nearshore zone to ocean depths of 150 feet. The guidelines included consideration of seafloor types and conditions, surf, waves, and currents as well as labor, equipment and work platform requirements.

Topic FY 75-12 - Methods of Characterizing and Predicting the Performance of Engineering Materials in the Ocean Environment-Metals

Lab/Contractor: CEL

Key Person/Author: J.F. Jenkins

P.O., W.R., Contract No.: PO5-0012

Start/End: 6/2/75 - 2/76

Cost: \$20,000

Product: Technical report: "Methods of Characterizing and Predicting the Performance of Engineering Materials in the Ocean Environment-Task 1", CEL Technical Memorandum M-52-76-03, Feb 1976

Description: A classification system was developed which uniquely defined and identified 133 metal alloys used in construction of ocean structures and equipment. The alloys were organized into 7 groups: Aluminum, Steels, Stainless Steels, Nickel, Copper, Titanium and Miscellaneous. The "universal" ocean environment was separated into

Topic FY 75-12 (Cont'd)

two basic categories, Seawater properties and Structural Application-related parameters. A breakdown structure of the ocean environment into zones was established as follows: Zone I - Shallow; Zone II - Deep, Highly Aerobic; Zone III - Deep Slightly Aerobic; Zone IV - Deep, Anaerobic; Zone V - Bottom Waters; Zone VI - Bottom Sediments.

This program was terminated prematurely at the completion of Task I.

Topic FY 75-13 - Snoopy Sonar Modification Analysis

Lab/Contractor: NUC

Key Person/Author: I. Lemaire, M.J. Kolar

P.O., W.R., Contract No.: PO5-0013

Start/End: 5/30/75 - 3/25/76

Cost: \$10,000

Product: Test Report

Description: The objective of the NAVFAC Snoopy self noise test was to determine the acoustic compatibility of the NAVFAC Snoopy vehicle with the NUC developed Minisonar system. Specifically, the test attempted to determine if the radiated noise level from the vehicle's hydraulic system fell into the listening range of the sonar.

Topic FY 75-14 - Kevlar Design Guide

Lab/Contractor: NUSC started topic;
NRL finished topic

Key Person/Author: K.M. Ferer, R.C. Swenson

P.O., W.R., Contract No.: PO5-0021 to NUSC

Start/End: 6/6/75 - 7/76

Cost: \$25,000

Product: Technical report: "Design Guide for Selection and Specification of Kevlar Rope for Ocean Engineering and Construction"

Description: The objective of this design guide was to present information for use in selecting and specifying "Kevlar" aramid ropes for ocean engineering and construction applications.

This guide was based on available technical data which was representative of state-of-the-art knowledge of the material, rope design, manufacturing processes, test procedures and application engineering.

The various constructions available were compared with similar constructions of other rope materials including wire rope and comments were made on the relative merits of each for different ocean engineering applications. This comparative data between aramid fiber rope and rope made from other materials was an aid to help support objective decisions by an engineer in selecting rope materials. Since cost factors were important considerations in the selection process, the relative cost of comparable ropes of various materials was established.

In addition, this guide provided information on splices and terminations for aramid rope so that the engineer could understand joint efficiencies, reliability factors and load constraints involved in selecting and specifying splices and terminations. It discussed service considerations such as sheave sizing, abrasion, fake-down requirements, sharkbite protection, environmental exposure and related application information which was needed to specify handling and protective requirements.

Topic FY 75-15 - Correlation and Ship Motion Computer Study

Lab/Contractor: DTNSRDC

Key Person/Author: A.E. Baitis, T.R. Applebee

P.O., W.R., Contract No.: POS-0020

Start/End: 6/6/75 - 6/76

Cost: \$10,000

Product: Technical report: "Comparisons Between Measured and Predicted Surge, Sway, and Yaw for LCU 1610 and FF 1006" by A.E. Baitis and T.R. Applebee, June 1976, DTNSRDC, Ship Performance Dept. Report SPD-694-01

Description: The purpose of this effort was to provide comparative data on ship motions for use in verification of the DSSM computer program.

Topic FY 75-16 - Deep Sea Ship Mooring Computer Simulation Support

Lab/Contractor: DTNSRDC

Key Person/Author: C.R. McCreight

P.O., W.R., Contract No.: POS-0019

Start/End: 6/6/75 - 12/76

Cost: \$40,000

Product: Computer time, DSSM demonstration and acceptance runs

Description: Under a CHESNAVFACENGCOM contract, the Electronics Systems Division of General Electric Company developed an analytical model necessary for the computer simulation of the dynamic response of a deep sea ship mooring system to the motions of a moored ship under arbitrary wave and drift forces. The major aspects of this effort was to integrate the DTNSRDC six-degree freedom ship-motion computer program and the GE cable dynamics analysis computer program in order to provide DSSM computer analysis program as state-of-the-art design tools for NAVFACENGCOM. NSRDC provided technical support in developing the interface between the two programs and verified the final integrated program on the DTNSRDC CDC computer.

Topic FY 75-17 - Other Capability Development

Title	Agency	P.O., W.R., or Contract No.	Date	Cost	Key Person
UCT Training	COMCBPAC	WR4-4018	5/16/75	\$ 9,500	Spencer
OCP Modification	J.J. Henry	75-C-0157	5/20/75	154,734	Hilsabeck
OCP Outfitting	SUPSHIP	WR5-4020	5/16/75	50,000	Hilsabeck
OCP Support	NAV ORD STAT	WR5-4009	5/16/75	5,000	Hilsabeck

FUNDING HISTORY FY 76

TITLE	LABORATORY/ CONTRACTOR	COST
1. Deep Sea Ship Moor Computer Simulation Program	General Electric Co.	\$114,386
2. Deep Ocean Current Measurement System Design Support	Woods Hole Oceanographic Institution	35,481
3. Project Management Planning & Control System	ONR - Undersea Research Corp.	50,000
4. Reference Manual on U/W Connectors and Seals	NAVSEA - University of Washington	25,000
5. Computer Software Library and Composite Index	ONR - Hydrospace Challenger	98,131
6. Handbook for Hydrodynamic Characteristics of Moored Array Components	DTNSRDC	50,000
7. Compendium of Ocean Construction Platforms	Robert Taggart, Inc.	18,645
8. St. Croix Environmental Scenario	Naval Ocean Research & Development Activity	52,300
9. Cable Stabilization Design Guidelines	CEL	15,000
10. Historical Program Records	ONR - Doty Associates, Inc.	21,570
		<hr/>
SUBTOTAL		\$480,513
11. Other Capability Development		
- OCP Integrated Logistics Support Plan	Rosenblatt & Sons	157,498
- UCT Training	COMCBPAC	60,000
- OCP Outfitting	SUPSHIPS	154,000
- OCP Modification	NUSC, New London	12,000
- GMC Engine Repairs	Hogan Diesel Service, Inc.	2,500
- OCP Support	Tracor	31,176
- OCP Support	SUPSHIP	2,313
		<hr/>
		\$419,487

Total FY 76 Budget \$900,000

Total FY 76 Expenditures \$900,000

Topic FY 76-1 - Deep Sea Ship Moor (DSSM) Computer Simulation

Lab/Contractor: General Electric

Key Person/Author: R.L. Webster, Y.H. Chey

P.O., W.R., Contract No.: N62477-76-C-0002

Start/End: 8/28/75 - 12/76

Cost: \$114,386

Product:

- 1 - User's Manual for SEADYN/DSSM
- 2 - SEADYN/DSSM Program maintenance Manual
- 3 - Final Engineering Report Deep Sea Ship Moor
Computer Simulation Program
- 4 - SEADYN/DSSM Program Acceptance Report

Description: A computer simulation capability for verifying the design and performance of Deep Sea Ship Moors (DSSM) under specified environmental conditions and functional requirements was developed. Also a computerized procedure to solve the transient cable dynamic problems associated with deep ocean cable structure installation and utilization was acquired.

Topic FY 76-2 - Deep Ocean Current Measurement System (DOCMS) Design Support

Lab/Contractor: Woods Hole Oceanographic Institution

Key Person/Author: Clayton W. Collins, Jr., Robert G. Walden, Peter Clay, and Patrick O'Malley

P.O., W.R., Contract No.: N62477-76-C-0046

Start/End: 1/15/76 - 6/1/77

Cost: \$35,481

Product: Report on impact of Navy variations of DOCMS design
Vol. I & II Compendium of NAVOCEANO acceptance test
procedures Implementation Report
Report of validation of tests

Topic FY 76-2 (Cont'd)

Description: A program that assessed the impact of Navy variations to the original DOCMS design. The assessment included analytical modeling to determine performance of system with variations in components. The program provided details of shipboard operational equipment and procedures to implement DOCMS aboard NAVOCEANO vessels. NAVOCEANO acceptance test procedures of DOCMS components was reviewed and documented. The validation testing phase of DOCMS was monitored and documented by the contractor.

Topic FY 76-3 - Project Management Planning and Control System

Lab/Contractor: Undersea Research Corporation

Key Person/Author: John Hess, John Harkness

P.O., W.R., Contract No.: RCP2038-76-00020 to ONR

Start/End: 11/14/75 - 12/76

Cost: \$50,000

Product: Project Management Manual

Description: A manual was developed for use by CHESNAVFACENCOM Code FPO-1 for planning, scheduling, costing and managing Ocean Engineering and Construction Projects. A separate section includes a guide to Navy acquisition procedures.

Topic FY 76-4 - Reference Manual on Underwater Connectors and Seals

Lab/Contractor: Applied Physics Laboratory, University of Washington

Key Person/Author: J. Paradis, C. Sandwith and J. Morrison

P.O., W.R., Contract No.: RCP2038-76-00021 to NAVSEA

Start/End: 11/18/75 - 9/76

Cost: \$25,000

Product: Reference Manual on Interference Seals and Connectors for Undersea Electrical Applications

Description: The manual uses engineering drawings, photographs, and detailed product specifications, as necessary to provide ocean engineers with all necessary information for selecting or designing connectors and seals. Primarily the manual deals with electrical connectors intended for long-term underwater use. Information on connectors and seals recently used for underwater applications was included.

Topic FY 76-5 - Computer Software Library and Composite Index

Lab/Contractor: EG&G Washington Analytical Services Center, Inc.

Key Person/Author: Leslie Bonde, David B. Dillon

P.O., W.R., Contract No.: RCP2038-76-00022 to ONR

Start/End: 11/19/75 - 1/77

Cost: \$98,131

Product: "A Directory to Collections of Engineering Computer Programs"
"An Index of Laws and Regulations Affecting Fixed Ocean Facilities"
"Annotated Bibliography Relative to Fixed Ocean Facilities"

Description: A bibliographic search to locate compendiums of computer programs and official government documents applicable to fixed ocean facility design and construction was performed. Copies of the computer

Topic FY 76-5 (Cont'd)

software compendiums were acquired. Programs, sections of compendiums and entire compendiums identified were indexed in a separate volume and from this a selection was made of those programs which were potential candidates for implementation at FPO-1. (FACSO-IBM370 computer, via TSO terminal). From these potential candidates up to ten programs could be implemented on the FACSO computer, operational from a TSO terminal in a conversational mode.

Topic FY 76-6 - Moored Array Components

Lab/Contractor: DTNSRDC

Key Person/Author: John Pattison, Dr. Tsai, Paul Rispin

P.O., W.R., Contract No.: PO6-0001

Start/End: 11/19/75 - 2/1/77

Cost: \$50,000

Product: Handbook for Hydrodynamic Characteristics of Moored Array Components

Description: A compilation of hydrodynamic data on oceanographic sensors and mooring components as a basis for design of suspended array mooring system. The handbook uses available technical data. It presents such hydrodynamic characteristics as the drag, inertial and damping coefficients and the strumming characteristics of the various sensors and array components other than bare array cable such as buoys, typical connections, and chain assemblies.

Topic FY 76-7 - Compendium of Ocean Construction Platforms

Lab/Contractor: Robert Taggart, Inc.

Key Person/Author: Robert Taggart

P.O., W.R., Contract No.: N62477-74-C-0194 - P00005

Start/End: 11/28/75 - 9/76

Cost: \$18,645

Product: Add-on to Compendium - see Topic FY 74-10.5

Description: An additional five ocean construction platforms were added to the compendium.

Topic FY 76-8 - St. Croix Environmental Scenario

Lab/Contractor: Naval Ocean Research and Development Activity (NORDA)

Key Person/Author: E.L. Ridley, T. Holcombe, A. Einwich, D. Burns,
F.A. Bowles, and J. Egloff, Jr.

P.O., W.R., Contract No.: PO6-0002

Start/End: 12/75 - 7/77

Cost: \$52,300

Product: Technical reports: "The Geological Environment West of St. Croix"; "The Oceanographic/Meteorological Environment West of St. Croix"

Description: The bibliographic and data search brings together meteorological, oceanographic and geophysical data which were collected on a variety of expeditions. This information was evaluated for accuracy and reliability and voids in data coverage. The detailed report prepared addressed the meteorology, oceanography and geology/geophysics of the region bounded by latitude 17°38'N to 17°48'N and longitude 64°53'W to 65°00'W. Subject areas included were weather and climate, sea state, water column physical/chemical properties (salinity, temperature, etc.), currents, bathymetry, sea floor geomorphology, sediment character, magnetic signature, and gravity.

Topic FY 76-9 - Cable Stabilization Design Guidelines

Lab/Contractor: CEL

Key Person/Author: R.L. Brackett

P.O., W.R., Contract No.: PO6-0003

Start/End: 12/75 - 12/77

Cost: \$15,000

Product: Design Guideline Handbook

Description: The object of this effort was the development of a set of design guidelines for use by ocean engineers for selection of nearshore cable stabilization techniques. The guidelines were presented in handbook form using all available technical data which was representative of state-of-the-art knowledge in terms of nearshore cable stabilization methods.

See Topic FY 75-11.

Topic FY 76-10 - Historical Program Records

Lab/Contractor: Doty Associates, Inc.

Key Person/Author: Norman Dunbar

P.O., W.R., Contract No.: via ONR RCP76-RC00029, N00014-74-C-0435

Start/End: 1/76 - 9/77

Cost: \$21,570

Product: Program Summary Report, Volumes I and II

Description: The purpose of this effort was to record and index the results of the Criteria and Methods Program for fiscal years 74, 75 and 76.

Topic FY 76-11 - Other Capability Development

Title	Agency	P.O., W.R., or Contract No.	Date	Cost	Key Person
OCP Integrated Logistics Support	Rosenblatt and Sons	N62477-75-C-0363	8/28/75	\$157,498	Hilsabeck
UCT Training	COMCBPAC	WR00113	9/12/75	60,000	Spencer
OCP Outfitting	SUPSHIPS	WR6-0165	11/19/75	154,000	Hilsabeck
OCP Modification	NUSC, New London, CT	WR76-00258	4/30/76	12,000	Hilsabeck
GMC Engine Repairs	Hogan Diesel	7303	5/7/76	2,500	Hilsabeck
OCP Support	Tracor	N62477-76F-3247	6/14/76	31,176	Hilsabeck
OCP Support	SUPSHIP	WR00254 #1	6/22/76	2,313	Hilsabeck

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