AD-A009 048

FIRST ANNUAL REPORT, 15 DECEMBER 1968 TO 14 DECEMBER 1969

Scripps Institution of Oceanography

Prepared for:

Office of Naval Research
Advanced Research Projects Agency

15 January 1970

AD-A009048

i

ANNUAL REPORT

SCRIPPS INSTITUTION OF OCEANOGRAPHY
University of California, San Diego
Dr. William A. Nierenberg, Director

ADVANCED OCEAN ENGINEERING LABORATORY

sponsored by

ADVANCED RESEARCH PROJECTS AGENCY
Advanced Engineering Division
ARPA Order No. 1348

PERIOD: 15 December 1968 to 14 December 1969

Administered by the Office of Naval Research
Contract N00014-69-A-0200-6012
(formerly Contract N00014-67-A-0109-0012)

January 15, 1970

January 15, 1970

ANNUAL REPORT

12/15/68 to 12/14/69

INTRODUCTION

In this first annual report of the Advanced Ocean Engineering Laboratory (AOEL), it seems appropriate to present a brief narration of its founding and touch on a few highlights which occurred during the year. This will be followed by capsule descriptions of the various projects which were started, as well as progress accomplished.

During the summer and fall of 1968, the Director of SIO, Dr. William A. Nierenberg, met several times with the Director of ARPA, Dr. E. Rechtin, and others including Dr. David Mann, Director of ARPA's Strategic Technology Office. The discussions concluded that there was a need for an organization to coordinate and conduct advanced ocean engineering research in several diverse fields. It was agreed that ARPA would finance such projects and AOEL was established in the SIO Director's Office to furnish local administration.

A Steering Committee, chaired by Dr. Nierenberg, was formed and met three times during the year -- January, March, and September. The purpose of the Committee was to consider various proposals presented by SIO scientists; evaluate them and make specific recommendations to ARPA for sponsorship of selected projects. Members of the AOEL Steering Committee are:

Dr. William A. Nierenberg, Chairman
Dr. Henry G. Booker, UCSD-APIS
*Lt. Col. Gordon M. Gray, OSD-ARPA
Mr. Cecil Green
Prof. John D. Isaacs, UCSD-SIO
Dr. A. B. Kinzel
Dr. Walter H. Munk, UCSD-SIO
Mr. Henry A. O'Neal, ONR
Dr. Stanford S. Penner, UCSD-AMES
Dr. Roger Revelle, Harvard
Dr. Fred N. Spiess, UCSD-SIO
Dr. Edward Teller, UC-Berkeley
*Dr. C. J. Wang, ARPA
Dr. Herbert F. York, UCSD

---

* Replaced original representatives, Dr. David Mann and CDR Walton Boyer.

At the January meeting, the Committee approved two projects, namely: Stable Floating Platform (Dr. F. N. Spiess, Principal Investigator) and Mid-Ocean Buoys (Prof. J. D. Isaacs, Principal Investigator). Shortly thereafter work on these two programs was started with funds in the amount of $170,000 furnished under ONR Contract #N00014-67-A-0109-0012. The buoy program was a cooperative venture with the Applied Research Laboratory of Johns Hopkins and the engineering research aspect of the floating platform was carried on solely by SIO personnel. At the March meeting, three new projects as well as additional funding for the platform program were recommended to ARPA. Funds for the latter, in the amount of $250,000 were received in June. A proposal for the three new programs, in the amount of $308,862, was submitted in May but the funds were not received until the last few weeks of the contract year. Hence, little work has been accomplished on these projects which are:

1) Benthic Array (Drs. W. H. Munk and R. D. Moore, Co-principal Investigators).

2) Overpressures Due to Earthquakes (Dr. H. Bradner and Prof. J. D. Isaacs, Co-principal Investigators).

3) Advanced Studies in Nearshore Engineering (Drs. D. L. Inman and W. G. Van Dorn, Co-principal Investigators).

During the early part of the year, a great deal of effort was expended by SIO personnel on the Stable Floating Platform which resulted in the production of an Engineering Feasibility Study. SIO was greatly assisted in this study by marine architectural consultants, L. R. Glosten, Seattle; and Alan C. McClure and H. Beckmann, both of Houston. During this same period, the cognizant division of ARPA was the Strategic Technology Office (Dr. David Mann and CDR Walton Boyer) who, concurrently with SIO efforts, had engaged several concerns to form a Systems Analysis Group to study and recommend operational concepts and applications for several variations of a deep-ocean, stable, mobile, floating platform. This group consisted of representatives from RAND, IDA, RRI, Battelle, GRC, CNA, CAL, SURI, and SRI, as well as from ONR, ARPA, NSRDC, and NSSC.

During the middle of the year, cognizance of the AOEL contract was changed from the STO of ARPA to the Advanced Engineering Division, Dr. C. J. Wang, Director, and Lt. Col. G. M. Gray, Liaison Officer. After this change and after the September Committee meeting, the SIO platform program changed direction toward model testing, evaluation and analysis which would result, in 1970, in specific recommendations for an oceanographic research platform, with construction plans firmed up by the end of the year. A proposal in the amount of $823,165 for this work for the period 12/15/69 to 12/14/70 was submitted in October. The scope of the work outlined in the proposal was accepted by ARPA. However, due to limited funds, the total was scaled downward to $434,070 with the assurance that the balance of $389,095 would be provided in FY 71. Accordingly, a budget revision was forwarded in November but funds, in the form of a contract amendment, were not received until after the end of the contract year.

At the September meeting of the Steering Committee (the first attended by representatives from the Advanced Engineering Division of ARPA), reports were given by Dr. Nierenberg and others on progress during the first nine months of AOEL as well as proposed work to be accomplished during the ensuing contract year. The Committee did not recommend any new programs to be submitted to ARPA, however, three programs (Radar Studies, Munk/Nierenberg; Pelagic Aircraft, Isaacs; and Magnetometer Survey, Spiess) were discussed at some length. It was decided that they merited consideration but further theoretical studies should be made with the intent to submit formal requests to ARPA for funding -- sometime during calendar year 1970. Minutes of all Committee meetings were distributed to all members.

At the end of the first year, the positions listed on the next page were supported (100%, unless otherwise noted) by contract funds. Other SIO staff members were involved, to varying degrees, without charge to the contract.

AOEL ADMINI- STRATION	STABLE FLOATING PLATFORM	MID-OCEAN BUOYS	BENTHIC ARRAY	ADVANCED NEARSHORE ENGINEERING	EARTH- QUAKE OVER- PRESSURES
Project Mgr.	Prin. Invest.(25%)	Assoc. Dev. Eng. (50%)	Asst. Research Physicist	Res. Asst.(50%)	-0-
Sr. Dev. Eng.	Sr. Dev. Eng.(50%)	Des. Drftsmn(50%)	Prin. Elec. Tech.		
Admin. Asst.	Assoc. Dev. Eng.(50%)				
Asst. Res. Oc.	Sr. Eng. Aid				
	Lab. Mechanician				
	Prin. Elec. Tech.				
	Programmer				
	5 Student Assts. (Hourly)				
	"Work Study" Students				

STABLE FLOATING PLATFORM

The Stable Floating Platform program during the past year can be divided into three major parts. These are: Studies of platform applications, Studies of platform configurations, and the development of supporting facilities.

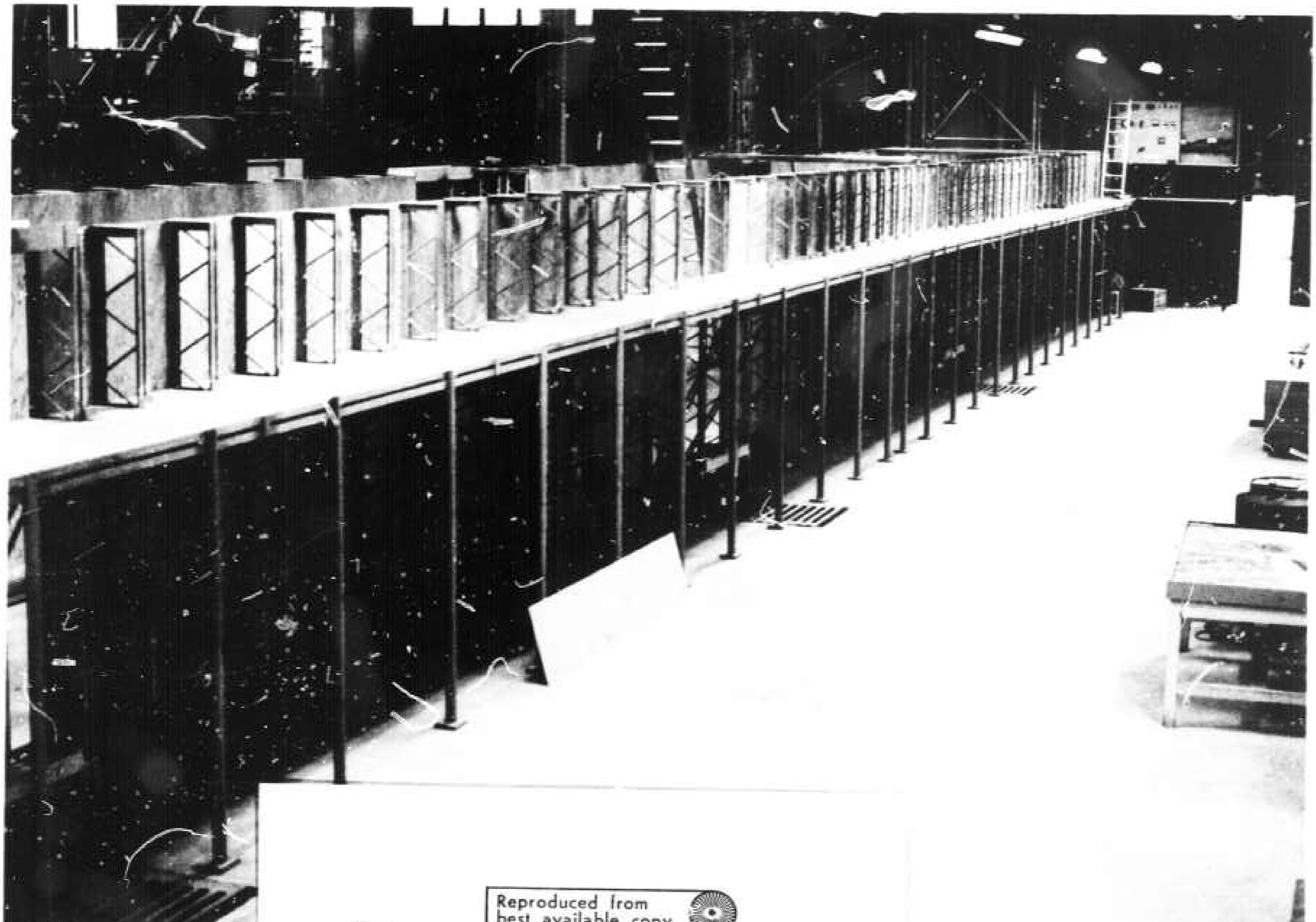
Facilities development occupied a major portion of the time and funding. The purpose is to provide a model testing tank and related data processing capability to support studies of platform structural and operational problems. After discussions early in the year, a decision was made (based on budget and space considerations) to concentrate effort on the construction of a long, narrow tank suitable for work with about 1/100 linear scale models. Professors Charles Cox and Douglas Inman collaborated in establishing the basic design.

The resulting structure (Fig. I and II) is of wood supported by extensive external steel framing and coated on the inside to provide watertight integrity. The tank is 146 feet long, 8 feet wide, and 8 feet high. This allows for a maximum of 6½ feet of water. Plexiglass viewing windows 8 feet high by 4 feet wide are provided at three locations and a fourth window measures 8 feet by 8 feet.

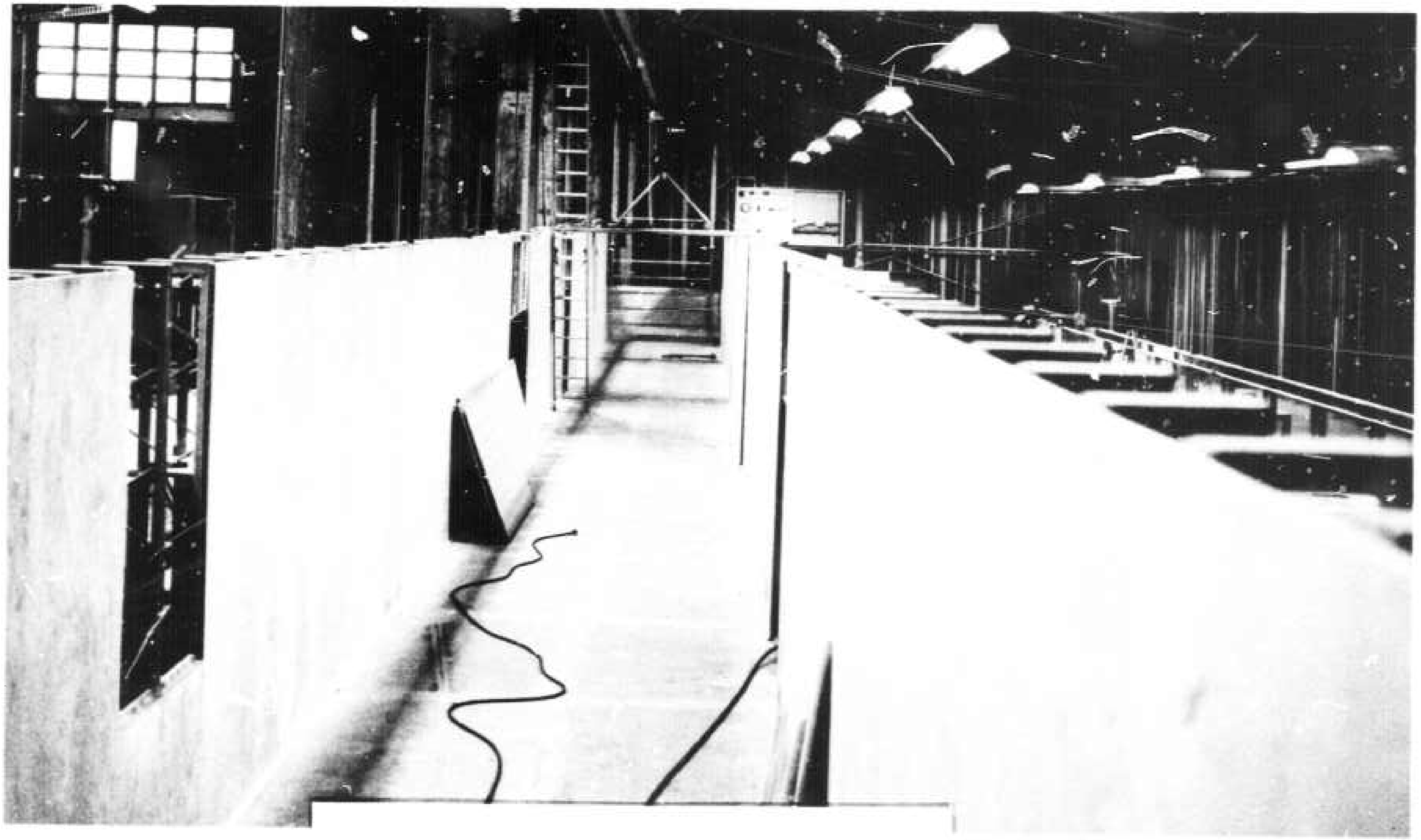
The wave generator consists of a flat paddle driven by a servo-actuated 30 horsepower hydraulic system. The paddle is suspended from overhead by linkages that are adjustable to give simple rotation, simple translation, and combinations of these motions. The generator is designed to provide simple and complex wave systems.

The wave absorber will consist of a flat asbestos-concrete beach having a 1 to 8 slope. A 78 inch diameter fan will provide air flow at quantities of up to 12,000 cfm for studies involving the combination of wind and waves. It is expected that the wave channel will be completed for initial calibrations by the end of January, 1970.

To provide for data analysis and in the future for on-line control of the wave generator, an IBM 1130 computer was obtained. The computer has an eight thousand word core and a one-half million word disk memory. Incorporated with the computer are: a nine-track digital magnetic tape transport system for reading or writing data on magnetic tapes; a ten channel



5-a



5-1?

program-controlled analog-to-digital converter to permit analog signals to be read by the digital computer; and two eight-bit digital-to-analog converters to allow the computer to control analog devices such as hydraulic wave generators, remote oscilloscope displays, and sensor positioning equipment.

Computer programs have been written to derive a power spectrum from a data input channel and to graph the spectrum on an x/y plotter. A separate program accepts the outputs from up to sixteen wave height sensors for computer analysis. The construction of logic packages for this type of sensor is in progress. Programming is being considered which will obtain a cross-correlation of a pair of data channels and provide power spectra, coherence, and a plot of the phase differences for each spectral frequency increment.

The study portions of the work started with a heavy emphasis on general purpose platforms which could be approached on a modular basis. Since this was being done in parallel with initial studies of platform utilization, the design requirements were not clearly established. In fact, it became clear that the interaction with application was so strong that the concept of a general purpose unit did not appear to be as useful as had originally been hoped. The change in ARPA administration of AOEL, moreover, resulted (late in the summer) in a change of orientation of the work under this heading.

The first eight months, spent in looking at the basic aspects of multi-legged, modular platforms, resulted in two different design concepts: one by L. R. Glosten and Associates, Naval Architects, of Seattle; and one by Alan C. McClure and Herbert Beckmann, Naval Architects, of Houston.

The LRG&A concept for a modular platform consists basically of square platform superstructure modules in the order of 225 feet on a side, and with a depth of about 20 feet. These modules are supported at their corners with approximately 50 feet of clearance from the still water line on tubular hulls in the order of 30 feet in diameter which extend downward to a draft of about 220 feet.

This concept is an extension to large platforms of the proven principles embodied in the successful ocean platform FLIP, which is operated by Scripps Institution and in the design of which the LRG&A organization participated.

In the thinking which has gone into this concept, two fundamental objectives have been kept in mind. First, in order to keep motion response to ocean waves to a very low order, the natural periods of motion (heave, pitch, and roll) should be large as compared to the periods of waves containing substantial energy which will be encountered. Second, by reaching down into deep water for buoyant support to an area in which the surface wave amplitude has decayed to a fraction of its value, the magnitude of the vertical components of pressure variations will be sharply reduced.

This is a truly modular concept in the sense that viable stable ocean platforms can be constructed from the components at any multiple of platform size. As a minimum, a single module -- approximately 225 feet square -- will make a platform. Modules can be strung together in a single line to form a very long platform; or they can be assembled in both directions to form a platform having greater breadth.

The Glosten studies included analyses of deck structure, leg structure, deck coupling, resilient leg mounting, and optimum leg spacing. Also, planning was completed for 1/100 scale model experiments to substantiate the results from the analytical work. The McClure-Beckmann concept for a modular platform employs semi-submersible sections which are similar in general to the design for the Mohole platform. Each module is 300 feet square and has a total height of 130 feet. The module displaces 22,400 tons floating at a draft of 75 feet. It consists of an upper watertight box-shaped hull, 14 feet in total depth, supported by columns which rest on three parallel cylindrical lower hulls each 30 feet in diameter and 300 feet long.

The triple lower hull arrangement was selected to distribute the buoyant forces supporting the deck thereby reducing the stresses in the cross bracing. The ends of the lower hulls are conical to reduce propulsion or towing resistance. Four 35-foot diameter corner columns spaced 200 feet center-to-center provide stability at deep draft and give the platform its principal structural rigidity in the longitudinal plane.

When platform modules are assembled into a long, floating island, for example 1,500 feet long, the columns on adjacent modules are 100 feet apart center-to-center by virtue of the overhang of the deck and extension of the lower hull beyond the columns. This is sufficient to render the columns hydrodynamically independent of one another so that the assembled platform maintains the wave transparency of the individual module.

The platform modules are to be assembled with rigid connections. To enable the assembly to be done at sea, means are provided for step by step engagement. Alignment is assured by four (or more) tapered pins. Each module has pins on one end and receptacles on the other end, so that modules can be added one after another at will. The pins provide, in addition to alignment, the principal shear connections in the vertical and horizontal directions. Tensile forces between modules may be taken by large bolts or by welded plates. In addition to these engineering studies by McClure and Beckmann, they have also completed the planning for 1/100 scale model experiments.

Late in the year, the decision was made that our program would concentrate on producing substantial gains in ability to foresee utilization of floating platforms and giving greater breadth to our ability to conceive, design, build and operate such platforms. Our proposed involvement in this would take three forms:

1. Assistance to ARPA in connection with studies of a wide range of possible applications for such platforms.

2. Investigations of platforms having configurations quite different from simple spar or semi-submersible types. These would look toward ease of deployment and provision of harbors in the open sea for conventional surface craft, surface effect vehicles, and submarines.

3. Creation of a capability to solve general problems in this field by attacking two specific ones: Design of a platform to support oceanographic research including model test programs at 1/100 and 1/10 scales, and realization of an approach to the equipment and personnel transfer problem for simple stable platforms.

The first of these items would involve the least cost, being primarily provision of funds for travel and limited engineering or environment studies.

The second item would be largely exploratory in nature and would include investigation of concepts, for example, of stable platforms involving water-inflatable and cable-connected sub-surface portions as well as structures which reflect or absorb wave energy in order to produce nearly quiet water at the sea surface close to the platform.

The third item will attack two very specific problems with the idea of actually carrying them through to completion and would constitute the remainder of the work. In looking forward to use of stable platforms, there has been a tendency to be vague in setting specific performance requirements and, in most cases, even when these requirements were set and studied, nothing was built. It has been our experience (e.g. with FLIP construction) that the real engineering problems and costs did not emerge until the idea of carrying out actual construction was taken seriously -- that is, until there existed a high probability in the minds of the designers that the structure would indeed be built.

It is in this context that we propose a three-step action to build a platform whose mission would be support of oceanographic research. This mission is taken as one which will be of broad significance and yet provides us a frame of reference which closely matches our competence and which can lead to specific performance requirements for the platform. These performance requirements can then be translated into design choices. The choices will, however, be constrained by an assumption that the platform must be significantly different from FLIP (i.e., it will not utilize a single column spar buoy approach) and, in addition, low cost will be a major design consideration. The three steps toward realization will be first, the necessary mission and performance analysis, related choice of configuration, and model testing. Second, the preparation of contract plans and specifications in form and detail suitable for actual construction contract bidding. Third, the construction of the vehicle itself. Only the first two steps (which together can surely be executed within one year) are to be completed in calendar year 1970.

MID-OCEAN BUOYS

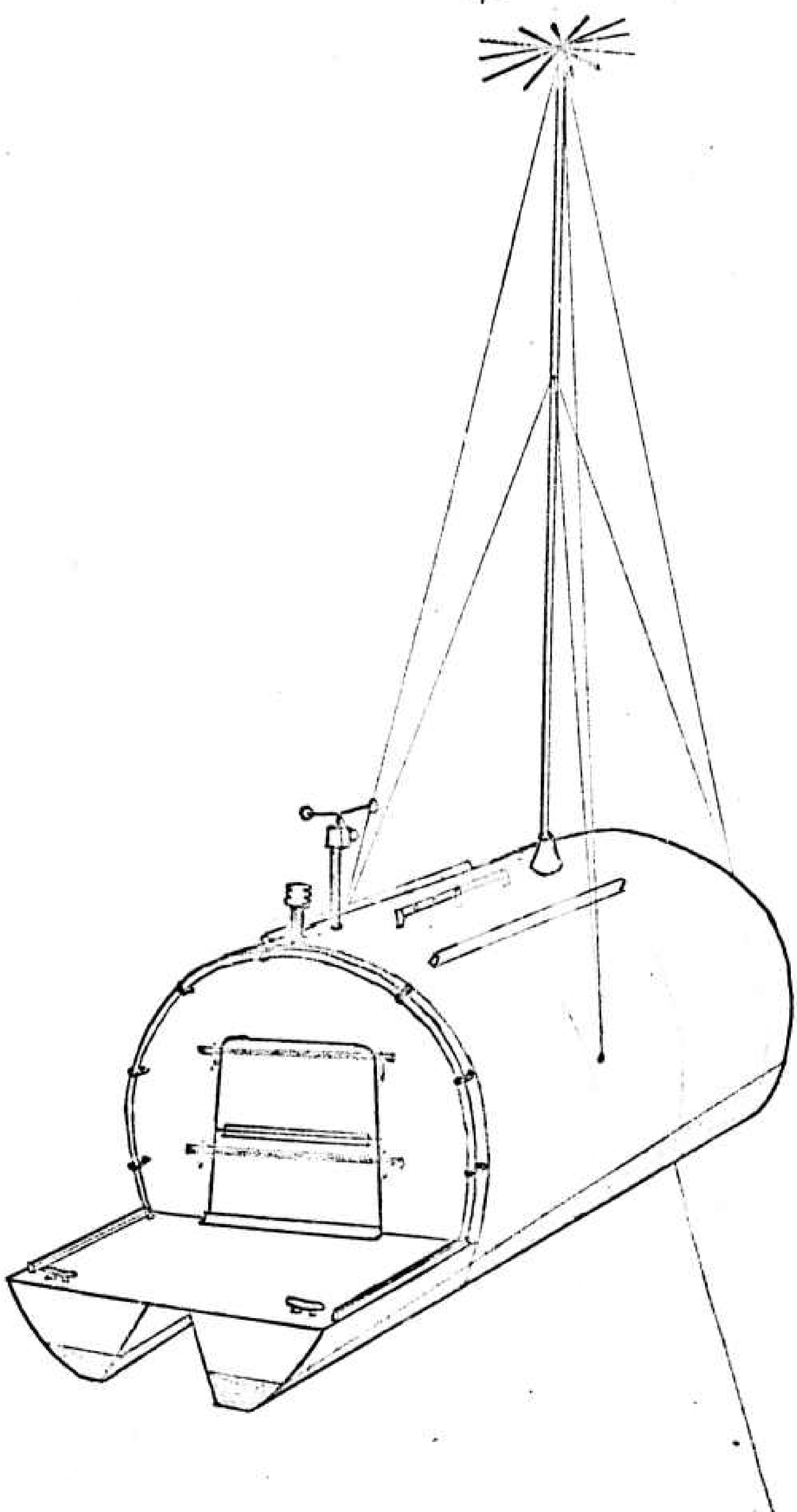
A program using radar at sea being undertaken by the Applied Physics Laboratory (APL) of the Johns Hopkins University required an unmanned platform to house the electronics and support an antenna. The Bumble Bee buoy, developed at the Scripps Institution of Oceanography, having demonstrated its excellent sea-keeping capabilities and survivability in the deep waters of the Pacific, was selected for this purpose. The program initially called for several of these buoys to be outfitted and installed off the California Coast in deep water. Scripps engineers modified the original plans of the buoy by increasing the length 4 feet, making it 20 feet overall in order to accommodate the heavier payload anticipated. (Fig. III)

Four buoys were constructed at a local boatyard under SIO supervision and were shipped to APL for the installation of the electronics and system check out. The first buoy was shipped on the 20th of May and the last left San Diego on July 1st. At about this point in the program, it was decided to plan for further testing in the Atlantic and not re-ship the buoys back to SIO for implantation in deep water.

Upon completion of initial testing in the Chesapeake Bay during the fall of 1969, the first buoy was implanted under APL supervision in December off the Florida coast near the axis of the Gulf Stream in about 450 fathoms of water. SIO had an engineer present as an observer and adviser. This first mooring point was dictated by the orientation of an existing antenna array which is being used in the test and evaluation program. The other buoys will be placed at varying distances along the same azimuth from the antenna as this program continues. It should be mentioned that previous successes with the SIO buoy have been in the deep ocean using a taut moor (0.9 scope) whereas the present installation is in a strong current in relatively shallow water with the scope of the mooring line being about 2.5.

BENTHIC ARRAY

The various problems involved in operating the existing IGPP quartz accelerometer underwater have been considered. With the exception of the details of the data recording system, the various approaches have been decided upon. Work is beginning on the necessary hardware.



(Fig. III) 20ft. Mid-Ocean Buoy (Bumble Bee)

OVERPRESSURES DUE TO EARTHQUAKES

Experimental: We have examined and tested various low power pressure transducers; and we have made preliminary lay-out plans of the inexpensive and the sophisticated package designs. Theoretical: Professor James Brune has developed the first theory of tectonic stress vs the spectrum of seismic shear waves, which may be applicable to our problem. The theory will be studied as soon as a draft of Brune's paper is completed.

ADVANCED STUDIES IN NEARSHORE ENGINEERING

A research assistant has been working one-half time on this project. Plans have been formulated for measuring the effects of wave motion on the water-sediment interface in the laboratory and in the field. Preliminary field measurements have been completed and are now being analyzed.