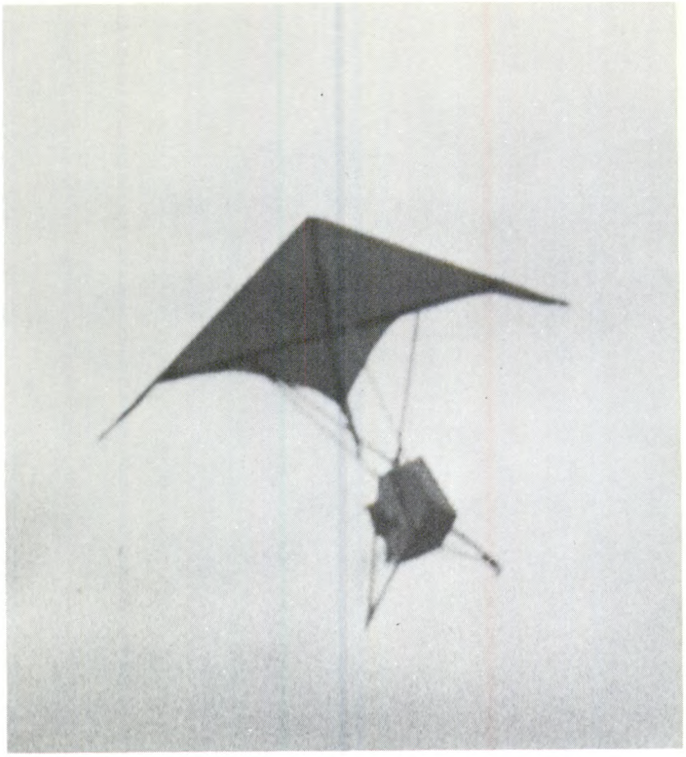
NAVAL RESEARCH

REVIEWS

DECEMBER 1962



Ryan's "Flex-wing."

Republic's "Bikini."

Two radio-controlled drones under consideration by the Marine Corps for reconnaissance use. See story on page 23.

The Continent's Submerged Edge

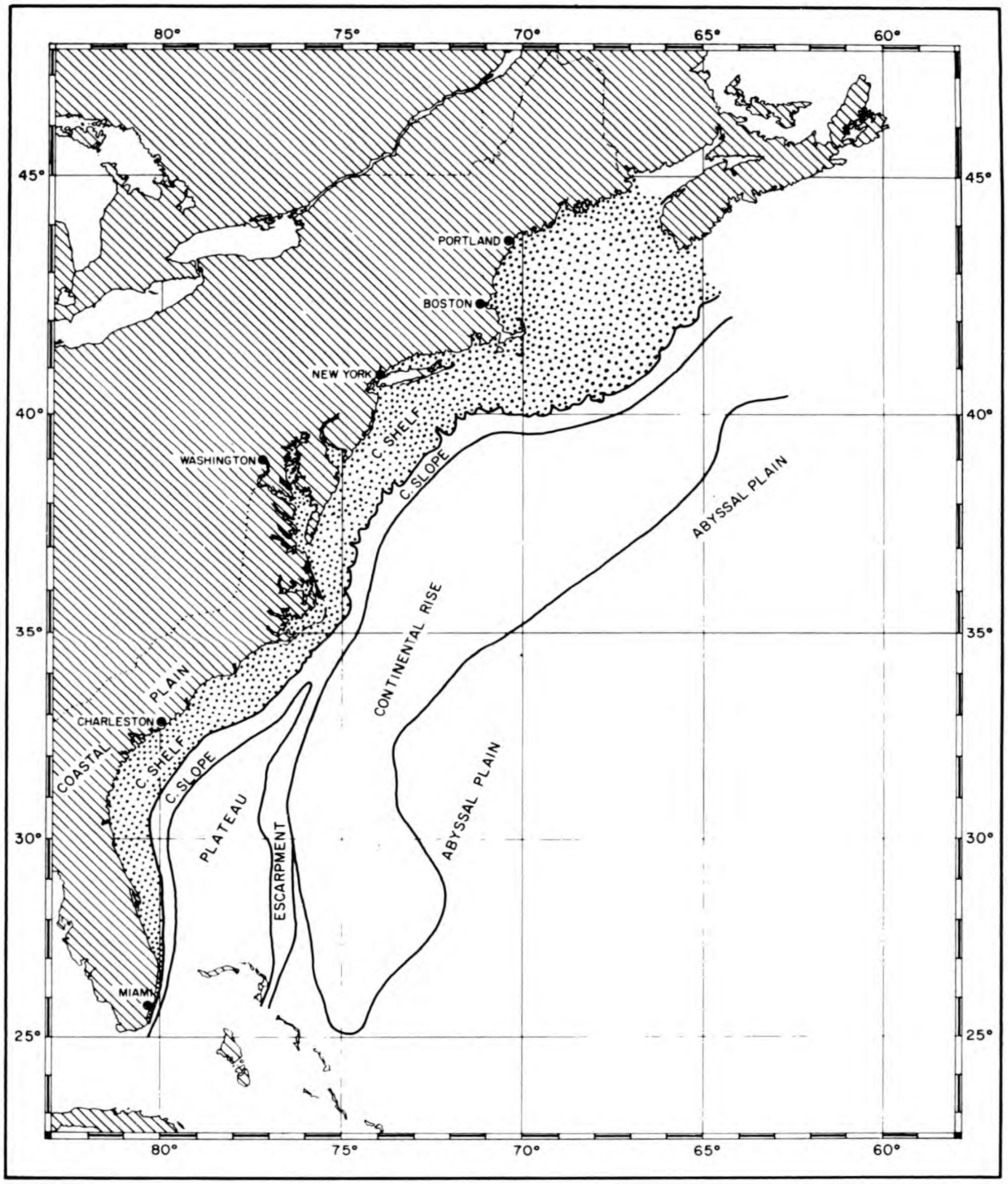
Geologists Explore Sea Floor off Atlantic Coast

An intensive study of the geology of the continental shelf and slope off the Atlantic coast was begun this past summer by the U. S. Geological Survey and the Woods Hole Oceanographic Institution. The ambitious venture, which will continue for several years, will be financed by the Geological Survey and directed by Dr. Kenneth O. Emery of WHOI. Scientists from both organizations will carry out the investigations, utilizing WHOI facilities, which are supported largely by the Office of Naval Research.

The purpose of the study will be to integrate the knowledge and capabilities of land and marine geologists, who hitherto have confined their studies to one side or the other of the water's edge, into a single attack on the marginal zones, about which relatively little is known. A better knowledge of processes and of geological history of the shelf and slope should contribute to a better understanding of sedimentary rocks exposed on the land.

The continental shelf along the U. S. Atlantic coast extends a total distance of about 1,600 nautical miles, northeast to southwest. It slopes outward from the shore to the shelf-break (where the shelf begins to

The research ship GOSNOLD before conversion for geologic studies being made along the Atlantic coast.



Map showing offshore geologic features to be
studied by the Geological Survey and WHOI.

dip toward the much broader, deeper ocean bottom), which lies at a depth of from 450 to 900 feet. The average width of the shelf is about 92 miles, but it ranges from less than 10 miles off southern Florida to 270 miles in the Gulf of Maine. The total area of the shelf is about 150,000 square nautical miles. It is a rather smooth plain, broken only by glacial features, submarine valleys, submerged wave-cut cliffs, and beyond that, the continental rise. The continental slope is a rather steep declivity, averaging about 5 degrees, which descends to depths ranging from 2,700 to 9,000 feet. Its average width is about 30 nautical miles and it covers an area of about 4,500 square miles. Along most of its length it is cut by submarine canyons. The continental rise is a gentle declivity leading from the slope to an abyssal plain which lies at depths of from 16,800 to 18,000 feet. Although, in general, the rise has little local relief, it is cut by some of the same submarine canyons which cut the continental slope. The average width of the slope and rise from the shelf-break to a depth of 16,800 feet is 300 miles, and the total area covered by these features is about 400,000 square miles.

The best surveyed part of the continental shelf lies off New England. Very little is known about it south of Virginia. Far less is known about the continental slope and rise than about the shelf. In the New England area, surveys have been made only to a depth of about 7,200 feet, and only a few sounding lines have been taken between Maine and Florida. Considerably more information is thus needed regarding this vast area. A good start toward obtaining it will be made on the Geological Survey-WHOI investigation by taking numerous additional lines of soundings. According to plan, most of the soundings will be made along lines normal to the coast, spaced 10 miles apart over the continental shelf and 30 to 60 miles apart over the continental slope and the continental rise. Lines parallel to the coast are proposed for the slope area. Altogether, about 35,000 miles will be traveled by ships making the soundings.

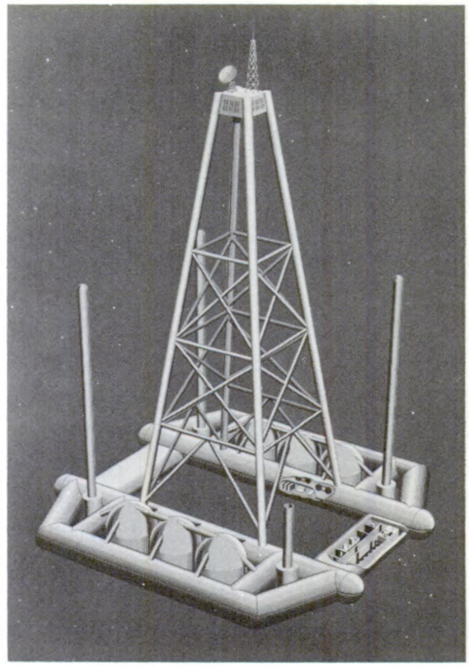
Other studies will be made of ocean-bottom sediments. About 1,500 to 2,000 samples will be taken from the shelf to delineate areas covered by sediments of different origin, such as glacial and organic. In addition, approximately 600 cores, each about 15 feet long, will be taken from the deeper areas, and about 300 dredgings for rock samples will be made along the walls of submarine canyons, the shelf-break, and the steep continental slope.

Seismic investigations will also be made. Although many refraction and reflection lines have already been run across the continental shelf, considerably more seismic data are needed, particularly for the continental rise. Some of the information expected to be obtained from the new studies is the amount of sediment of various ages which covers the shelf, slope, and rise; the localities in which older strata crop out; and the nature of materials which pass through submarine canyons.

Among the other investigations to be made will be a study of water movement in relation to the movement of sediments; and an examination of biological populations on the ocean bottom, particularly to determine the extent to which the activities of these organisms cause a mixing of the sediments. The biological data are also required to interpret properly the distribution of organic matter in the sediments and to understand better the processes of rock formation under the oceans—for example, the way in which thick beds of limestone are built up from accumulations of tiny marine organisms.

FORDS

Floating Ocean Research and Development Station



R. E. Faires
Sound Division
Naval Research Laboratory

There is a burgeoning interest in the properties of the ocean deeps as well as in the behavior of equipment submerged to great depths for long periods of time. The interest has a broad basis which is manifested by requirements for ocean surveillance, deep-running submarines, deep-operating ordnance devices, oil industry and mining industry operations at sea, obtaining food and fresh water from the ocean, and many scientific experiments conducted at sea, to name a few. As a consequence, unusual vehicles and specialized facilities are becoming an increasingly important necessity in deep-ocean operations. Thorough evaluation of acoustic transducers placed very deep in the open ocean where they will eventually operate imposes severe requirements both for vehicles and facility capabilities.

Late in 1957, Naval Research Laboratory personnel conceived the idea of an ocean-going platform designed to meet the requirements of transducer research and development. The resultant structure has a wide variety of potential uses in fields other than acoustic transducer evaluation, with emphasis on the detection and study of long-wavelength ocean phenomena and operations involving the lifting of large weights at sea. For the last three years a vigorous effort has been in progress to establish the fundamental design for the structure which has maximum flexibility of end usages in dealing with the ocean environment.

DESIGN REQUIREMENTS

From the beginning, incorporating certain features into the design has been patently necessary to meet today's needs and to provide a growth potential for unseen future developments. These features include the following:

- Small translational and rotational motions as generated by ocean surface waves, even in moderately severe storms.

- Capability of lifting a load as large as 450 tons (900,000 pounds) at sea and lowering it to a depth of at least 6,000 feet below the water surface.

- Prime power, fuel, machinery, and housekeeping facilities for self-sufficient, manned operational periods of at least four weeks.

- Space and equipment for storing and handling such equipment as long electrical cables, wire ropes, and pipes.

- Large laboratory spaces for transient personnel and equipment as required for remote, deep submergence measurements.

- Low noise radiation from both acoustic and electromagnetic sources.

- High-density ballast which can be separated rapidly and reliably, if necessary, without causing instability.

- Limited self-powered mobility for protection against drifting hazards and for operational orientation functions.

- Capability of survival in extremely severe storms at sea.

The above requirements have led to the conceptual approach outlined below and shown in Figure 1. The structure is called the FORDS, which here is an acronym for Floating Ocean Research and Development Station.

DESIGN PHILOSOPHY

A basic approach, which could yield small heave and roll motions of the FORDS, was adopted early in the present study. A floating object whose structural parts are above and below the water-air interface will have small motion in an ocean surface wave when the buoyancy or displacement forces acting on the structure near the interface are small compared with the inertial forces of the structure. If a major percentage of displacement and mass of the structure is located in a region of small water-particle motion, then the motions of the structure will approximately equal the wave motions of the water at that depth.

Hydrodynamic theory indicates that wave motion is reduced to about 5 percent of the surface value at a depth of 1/2 wavelength. Thus, a floating structure might move about ± 6 inches in a wave whose surface height is 20 feet from crest to trough, provided that most of the structure displacement is at a depth of 1/2 wavelength.

This view makes the floating object similar to a mechanical spring and a mechanical mass connected together; the mechanical spring is analogous to the buoyancy per unit draft at the interface, and the mechanical mass is equivalent to the total displacement of the structure.

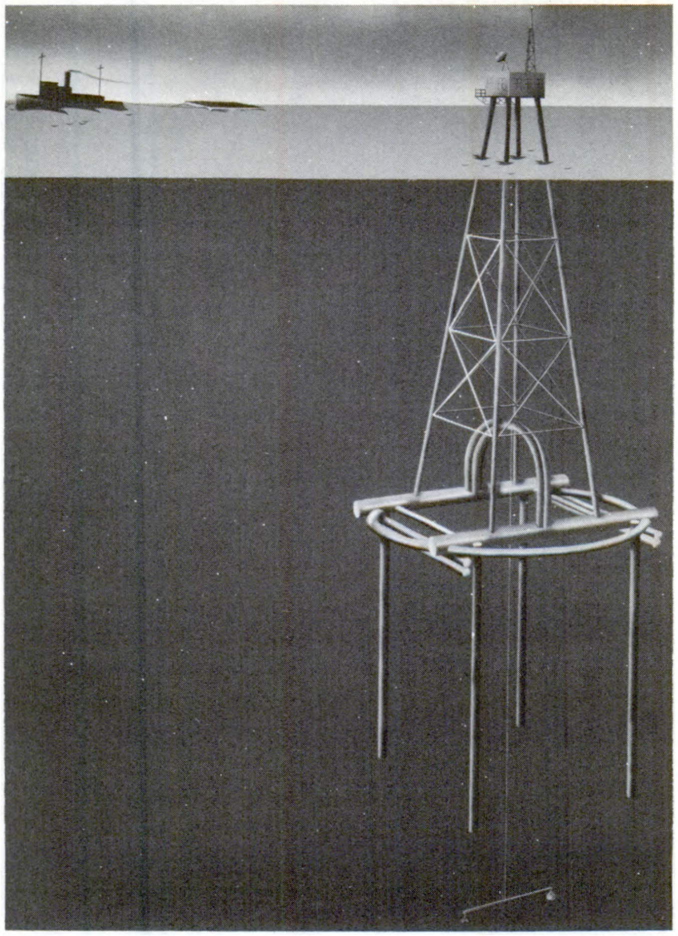


Figure 1--Artist's concept of the initial model of the FORDS.

Resonance, or relatively large motion, might then be expected at some particular frequency, but this frequency can be made exceedingly low by proper design.

With this philosophy, the question becomes: What wavelength should one choose as a limiting design basis? An anticipated operational area for the FORDS would be the semitropical island region of the Atlantic Ocean.

In this geographic area, wavelengths of about 500 feet or less and wave heights up to 20 feet are frequently encountered but are rarely exceeded. These conditions are roughly similar to a Sea State 6 (a rather rough sea) plus a moderate swell. Consequently, when a 500-foot wavelength is the design basis, the major part of the FORDS' displacement is located about 250 feet below the water surface. The part above water should allow about a 50-foot clearance for reasonable assurance of survival in a hurricane, which generates wave heights of 40 to 50 feet. A major vertical dimension of 300 feet is therefore determined. This vertical dimension is generated by setting a 300-foot, hollow-pipe derrick structure atop a set of pressure hulls which provide the major displacement. The maximum vertical dimension is 450 feet, which includes a set of retractable legs whose function is discussed in later paragraphs.

The determination of horizontal structure dimensions is more troublesome. Horizontal dimensions equal to or greater than the design wavelength of 500 feet could contribute vastly reduced motions, both translational and rotational. However, a structure 500 feet in diameter would be extremely expensive, even when accompanied by much smaller vertical dimensions. This alternate philosophy was rejected early because high costs outweigh the benefits.

Again the question, what criteria should be adopted? An important requirement for an at-sea transducer test facility is the ability to lift, lower, and retrieve all types of devices. These devices include both dense, large-weight (up to 900,000 pounds or more) units and bulky, large-area (linear dimension up to 150 feet or more) units. In addition, the transducer measurement techniques require linear dimensions in the measuring system which approach 150 feet, and the measuring system must be lowered with the transducer being tested.

One solution is a large open-well, spanned by a strong derrick-like structure, which allows unencumbered access to all depths. The presently selected dimensions of the open-well are 75 by 150 feet. The overall horizontal dimensions are then determined by the structure required to surround the open-well, to provide a major part of the displacement, and to provide space for machinery, instrumentation, etc.

The anticipated remote location of the FORDS imposes problems in logistics and transfer operations. One solution to these problems is to assemble the transducer and measurement system on a barge at a coastal port and tow the barge to the FORDS. The transfer operation would then require that the barge be brought into the open-well with the transducer positioned under the lifting points of the overhead derrick of the FORDS. This transfer operation also requires a large, open, center-well and contributes to the need for the 75-foot dimension of the open-well which allows a moderately large barge to be positioned below the derrick. The alternative of an "over-the-side" transfer operation, particularly for loads as large as 450 tons, imposes exceedingly severe handling, crane lift, and static stability difficulties which are avoided when the lifting line passes through the center of gravity of the FORDS.

The presence of a 300-foot derrick rising above the principal displacement region, plus a load-lifting point which may be as much as 100 feet above the "deck" plane, requires that large diameter pipes (6 to 12 feet) about 150 feet long be attached to hang below the principal displacement region. These pipes, or legs, which are filled with high-density ballast at the deep end, insure that the center of gravity of the FORDS is always below the center of buoyancy for all operations required when the major displacement region is below the water surface. These legs can be designed to be retractable, if the connection between each leg and the main body structure is a hydraulic jack or other lifting mechanism. The exceedingly desirable consequences of retractable

A. Model in wave trough.

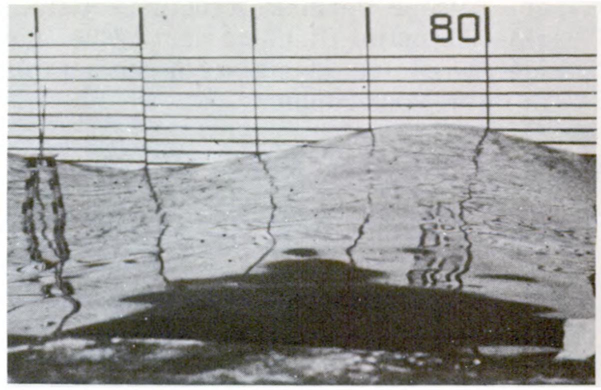
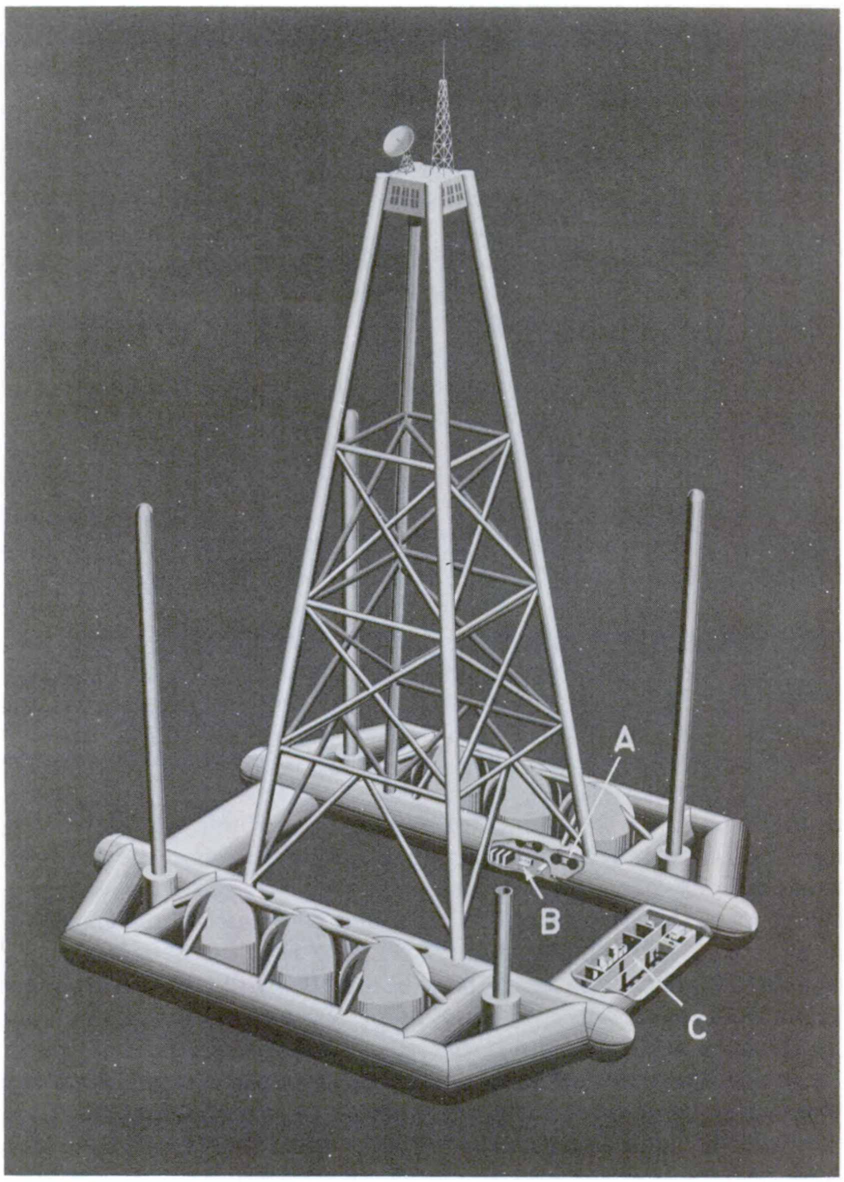


Figure 2--Artist's concept of a recently proposed version of the FORDS showing cutaways of (A) cable-handling equipment, (B) instrumentation area, and (C) living quarters.



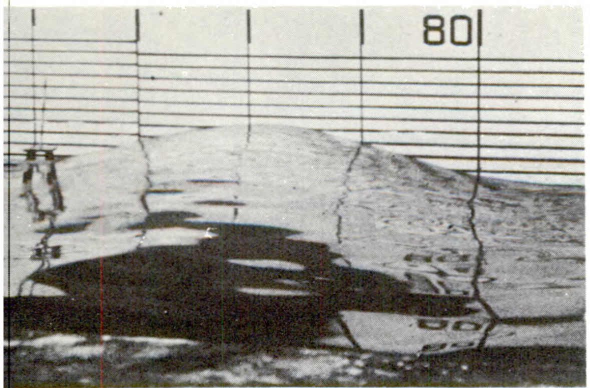
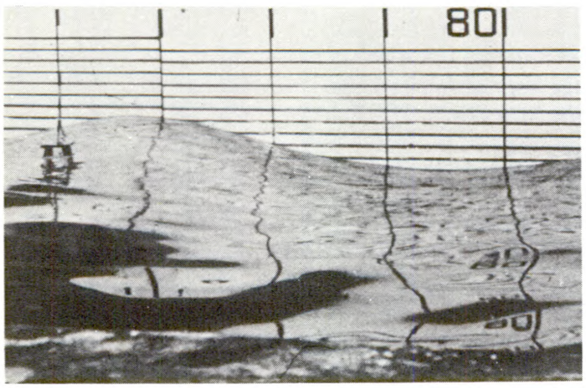


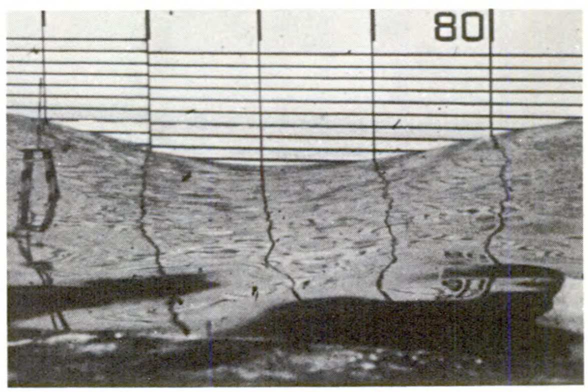
Figure 3(A-D)--Tests of a 1:120 scale model of the FORDS in the wave tank at the David Taylor Model Basin. A wave period of 10 seconds and a wave height of 48 feet are being simulated.

B. Model on positive slope of the wave.

C. Model on wave crest.



D. Model on negative slope of the wave.



legs are: the minimum draft of the FORDS becomes about 30 feet instead of 150 feet and allows entrance into shallow water, the entire structure can be raised above the water surface in a harbor for repair and upkeep, and the required towing horsepower is markedly reduced.

The design philosophy yields a tentative structure illustrated by a proposed layout shown in Figure 2. The maximum horizontal dimension is about 240 feet. The total vertical dimension is 450 feet, with the retractable legs extended. The major displacement of about 6,500 tons (at the base of the four-leg derrick) is provided by 20-foot diameter pressure hulls which serve also as major strength members and space for storage, prime power, control and handling machinery, laboratories, and quarters. The reserve buoyancy, for 50 feet of derrick above water, is about 500 tons.

MODEL TESTS

From these general dimensions, a 1:120-scale model of the structure shown in Figure 1 was constructed. The motions of the model were measured in the 140-foot wave basin at the David Taylor Model Basin. Typical results are given in Table 1. Figure 3 shows four positions of the model in a surface wave. The roll and pitch motions are surprisingly small, probably because of the damping effect of the retractable legs.

TABLE I

Motions of 1:120-Scale Model in Wave Basin

Wave-Length (feet)	Heave[1]		Surge[1]		Roll[2]	
	Min. Draft[3]	Max. Draft[4]	Min. Draft[3]	Max. Draft[4]	Min. Draft[3]	Max. Draft[4]
1200	0.60	0.20	0.60	0.30	0.25	0.15
900	--	0.12	--	0.20	--	0.06
600	0.40	0.02-0.10	0.30	0.15	0.15	0.04

1 Feet per foot of wave height.
2 Degrees per foot of wave height.
3 Pressure hulls at surface, retractable legs down.
4 Pressure hulls 250 feet below surface of water.

Static stability tests, which are given to determine the ability of a structure to maintain an upright position, were performed with the 1:120 scale model, after modification, to simulate the mass and displacement distribution of the tentative layout shown in Figure 2. These tests demonstrated that the FORDS is remarkably stable for all static draft conditions required in any operational situation. In addition, they indicate that the free or resonant heaving period of the FORDS is in excess of 125 seconds and the free rolling period is about 35 seconds (for maximum draft condition).

RECENT DEVELOPMENTS

The Bureau of Yards and Docks has written a contract with a commercial organization to carry out more detailed feasibility studies than are possible at NRL. In these studies, particular emphasis is placed on determining structural strength requirements, details of weight-handling systems, operational methods of weight transfer at sea, control systems, fabrication methods, safety features, and the effects of the various operational systems on the overall concept.

When these determinations are completed, an estimate of the cost of the structure and the operating systems of the FORDS will become available to guide subsequent activity.

The Floating Ocean Research and Development Station will be a pioneering vehicle, equipped to accomplish activity at sea which is impossible with any existing vehicle. The new approaches should enable the Navy to increase substantially its knowledge of the ocean environment.

The Sea State Recorder

A buoy designed to measure and record the height, frequency, and shape of sea waves has been developed at the Naval Missile Center, Point Mugu, California. The "sea state recorder," as it is called, is needed to correlate the state of the sea with the strength and distortion of radio pulse signals reflected from the water during radio transmissions between aircraft.

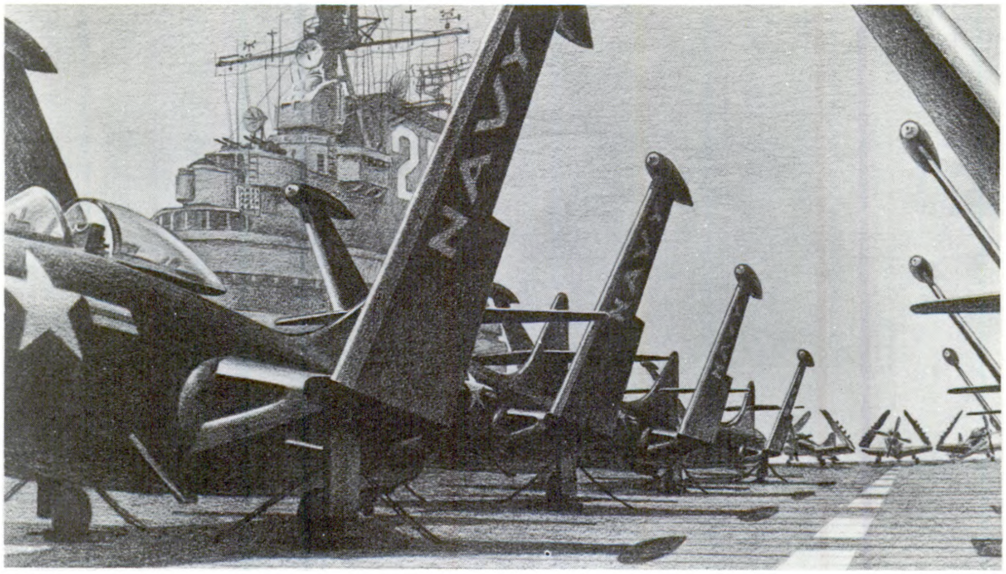
The recorder, which rides upright in the water, is nearly 20 feet long, weighted at the bottom for stability, and fitted with a large flange to minimize vertical motion. A watertight compartment houses the recording equipment and other instrumentation. Mounted vertically on the outside of the buoy is a 10-foot brass tube fitted with 40 electrical resistors embedded in epoxy plastic. This tube, which remains half submerged in calm seas, is kept to windward by a wind vane on the buoy. As the ocean waves rise and fall along the tube, part of the tube's resistance is diverted by the water. These changes in resistance are recorded continuously, indicating the water level on the tube, and thus the height, frequency, and shape of sea waves at any instant.

Naval Missile Center scientists are now interested in using the sea state recorder in conjunction with studies underway as part of the Navy's Project HYDRA--a concept for launching booster rockets directly from the sea. The buoy would be applied to an investigation of the effect of sea conditions on the booster's buoyancy and motion.

Radio Control Designers Receive Awards

Two former Naval Research Laboratory scientists have been awarded the Edward Longstreth Medal by the Franklin Institute for "their design and development of aircraft radio control systems which permitted the first pilotless control flights in this country." These flights enabled the military services to improve greatly the accuracy of antiaircraft weapons and fire control.

The two men are Dr. Matthew H. Schrenk, now research coordinator for the Office of Naval Research; and Carlos B. Mirick, now retired. Dr. Schrenk first reported to NRL in 1926 and was reassigned to ONR in 1955. During this period he was supervisory electronic scientist in the Radio Division. Mr. Mirick began work at NRL in 1923 and retired in 1948. He also was assigned to the Radio Division—as a radio engineer--and served in that capacity for most of his years at NRL.



When Navy artist Herbert Hahn painted this picture of a group of Panther jets lined up on a carrier deck, he could very well have had in mind, in addition to the waiting planes, the thousands of Navy aviators who, throughout the past few decades, have been called suddenly from the ready room to fly off to an uncertain destiny in the sky. Determining the effects of such stress on these men is one object of the study described in the accompanying article.

The "Thousand" Aviators—23 Years Later

CDR R. E. Mitchell, MC, USN
Naval School of Aviation Medicine
Pensacola, Florida

Because cardiovascular disease is a primary cause of death in the United States and certain other countries, a large amount of research is being conducted in an effort to understand it and to develop techniques for treating it effectively. One form of investigation now being applied to this problem is the "longitudinal" study (also called "prospective study" or "study of cohorts")—a method whereby individuals are examined over a number of years to determine processes of aging.

The value of longitudinal investigations has been amply demonstrated by the success of a number of such studies which have and are now being conducted throughout the United States. They are more effective than "cross section" examinations for studies of aging because the pathologic changes involved in aging appear to be influenced by various host or environmental factors which exert themselves throughout much of the lifetime of an individual. Therefore, if one studies a large segment of the life spans of his subjects, he will be better able to chart the courses of many of the changes that occur. If at some point in the study, pathologic conditions begin to manifest themselves, the investigator will be in a favorable position to relate them to specific changes and to the factors responsible for them.

The ultimate goal of this work is to develop methods by which life expectancy can be predicted—with the view to altering the course of events, where possible, to enable people to live longer and more productively. Such studies can also help military and civilian leaders select individuals for assignment to difficult or otherwise unusual tasks, such as those which might involve exceptional stress or boredom.

In 1940, a study of 1,056 Naval cadets and instructors was undertaken at the Naval School of Aviation Medicine at Pensacola, Florida. This investigation, called the Thousand Aviator Study or Pensacola Study was made to solve problems which were expected to occur as a result of the sudden influx of many new cadets to the flight-training program early in World War II. To assure that this burden would not lessen the chances of the best cadet prospects for completing their training, potential weaknesses of the program had to be discovered and eliminated quickly. Therefore, the cadets and instructors were given a wide range of tests, and the scores were related subsequently to their success in completing the flight course.

After the war the investigation was resumed, with a different purpose—to obtain a "longitudinal" view of these men, particularly to evaluate the cardiovascular system and establish a range of standards of normal electrocardiograms. Other valuable information can be gathered through the examinations in the following ways:

- If an individual is found to have a significant disease, the data from previous examinations may provide clues for possible prediction of the disease.
- Comparisons between flying and non-flying personnel show whether those exposed to the stresses and hazards of flight are more susceptible to certain diseases.
- Changes which occur in an individual as he ages are revealed by differences in the tests, and these differences give information about aging processes.

The Thousand Aviator Study is one of the first longitudinal investigations to have been undertaken. It has now been underway for 22 years, with interim examinations having been made in 1952 and 1957 (*Naval Research Reviews*, August 1957). The fact that the project has been continued for such a long time is becoming increasingly significant, because the individuals involved are at the age at which cardiovsacular diseases generally become manifest. Thus, another look at the group at this time should prove highly rewarding.

In past years, teams of doctors were sent out to examine the former cadets and instructors in the areas in which they lived. For the 1963 examinations, however, attempts will be made to bring as many of the group as possible to Pensacola. This procedure is preferred because more comprehensive testing can be done at the Naval School of Aviation

Medicine. During the 1957-58 re-survey, 785 men were examined. How many of this group will be available for study in 1963 is not known, but the number is expected to be large enough to permit fruitful analyses of the data obtained.

The coming re-survey will be a joint Navy-U. S. Public Health Service project, and it will be under the direction of CAPT Ashton Graybiel, MC, USN. His principal associates will be CDR R. E. Mitchell, MC, USN, and LCDR A. Oberman, USPHS. Approximately 18 months will be required to complete the examinations. Basically, the methods utilized will be the same as those used previously, except that techniques are being standardized to conform with those being used in other longitudinal surveys. The examinations will include the following in addition to routine physical check-ups.

- Blood studies, including fat levels, a test of thyroid function, cholesterol levels, blood sugar levels, and a test for gout.
- Special X-rays of the heart and lungs.
- A battery of routine and exercise electrocardiograms.
- Tests to measure the ballistic forces of the heart.
- Tests to measure the force and direction of the electrical activity of the heart.
- Lung function studies.
- Hearing tests.
- Special body measurements of fat deposition and other conditions.
- Brain-wave studies.
- Tests to determine the general condition of the eyes.
- Psychologic testing.

Data taken in the current examinations will be added to those taken in past tests, which have been coded for analysis by means of data processing equipment. When the new data have been studied in the light of the old, all of the information will become more meaningful. The largest dividend yet to be derived from the Pensacola Study should then be realized.

The Woods Hole Oceanographic Institution has received a grant from the National Science Foundation for converting an R5-D Navy aircraft for use in the Indian Ocean region during the international survey. The plane will be used to follow monsoon winds and to study other meteorological conditions.

Electronics Research . . . .

In the Oceans, on Land, in the Air

Periodically over the years, *Naval Research Reviews* has reported on individual facilities and activities of the important West Coast research establishment of the Bureau of Ships—the Navy Electronics Laboratory. For example, articles have appeared on the bathyscaphe TRIESTE, which descended to the deepest floor of the oceans; on NEL's oceanographic research tower, located a few miles off the southern California coast; and on its new anechoic tank, in which important acoustic investigations will be made.

To cover all of NEL's activities in a single article would be an impossible task—unless done in a very general way—because they are so numerous. Therefore, following in the pattern of the past, a few more reports on the Laboratory's facilities are presented here in random fashion. Obviously, these selections are not intended to indicate either the scope or the importance of the overall work at the Laboratory.

ARCTIC POOL

To solve many important research problems, NEL has found it imperative to establish facilities for controlled-environment studies. Among these is an artificial arctic pool used for sea-ice physics research. In this unique enclosure, which is 30 by 75 by 16 feet in size, sea water can be frozen to thicknesses of 7 feet or more under simulated blizzard conditions. A circular chamber 45 feet deep lies beneath the pool, permitting the handling of under-ice submarine equipment and instruments for measurements of breaking strength and acoustical properties of sea ice.

The pool was built into a former Army gun battery enclosure on Point Loma. A portion of the original concrete revetment was utilized by the engineers for one wall. An access passage leads to the bottom of the pool and the submarine test chamber.

COMMUNICATING VIA METEOR TRAILS

NEL has for several years devoted considerable effort to the development of a communication system which utilizes meteor trails as a means of reflecting radio signals to specific stations in short bursts. A successful experimental one-way digital system has been developed in preliminary steps toward this objective. It consists of a headquarters shore station and a ship station, each of which normally can transmit and receive data simultaneously.

The essential difference between conventional communication systems and one that makes use of meteor-trail reflections is the short-period, intermittent nature of communications made by the latter. The transmissions must be made in bursts so as to be completed in the brief time (usually less than one second) that the electron density in the trail remains sufficiently high to reflect the signals. To do this effectively, the system must be capable of sensing the presence of properly oriented meteor trails. The chief advantage of communicating via meteor trails is that reception is limited both in area and time, which means that the messages transmitted cannot be intercepted easily by enemy stations.

The frequent, though random, occurrence of suitable trails permits a vhf communication circuit to be established between two points on the earth's surface that are separated by distances as great as 1,200 miles. Factors determining how satisfactory any specific burst may be in establishing a communication path include the orientation of the trail and its geometric relationship to the ends of the path; the height (usually between 50 and 75 miles), length, and intensity of the meteor's ionized trail; and the frequency employed. In addition, the incidence of the bursts is subject to diurnal and annual variations, the effect of each being somewhat dependent upon the latitude and direction of the communication path.

To send messages at the high speeds required for meteor-trail reflection, special message preparation and equipment is needed. Assuming that the message to be transmitted is carried originally at a standard message speed, and that it is to be received ultimately at a similar speed, some readily accessible storage devices are needed at both ends of the link. Types of storage devices that can be used include magnetic cores, drums, tape, and delay lines. NEL's system uses dynamic data storage, employing magnetostrictive delay lines, operating in conjunction with digital logic modules.

When a message is to be sent, teletype data are read from punched tape at standard speed and inserted in the digital store. High-speed read-out is controlled by digital logic and signal sensing circuits. When the presence of a suitable meteor trail allows transmissions of a burst of information, the receiving station, by means of a control signal, tells the other station to send its high-speed data.

Reception of the data and operation of the store input and output are controlled, as before, by means of a signal sensing and logic circuitry. Stored data, when available, are read out of the digital device and fed to a teletype page printer at standard speed. The RF equipment consists of commercial phase-modulated transmitters and fm receivers designed for speech use.

SPECIAL RESEARCH SHIPS

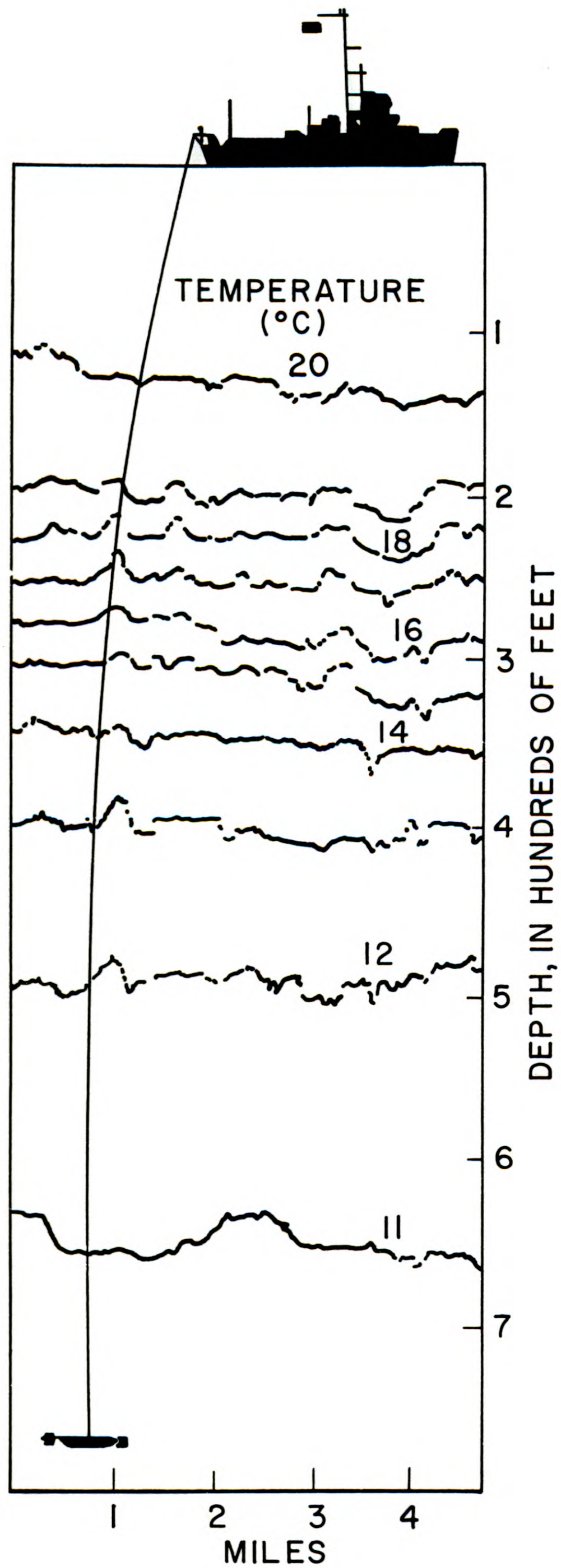
NEL operates several research ships for studies afloat. One of these is the 85-foot sailing vessel SALUDA, which provides a quiet platform for sonar and oceanographic studies. The SALUDA is one of the few sailing ships still on active duty with the Navy. (See cover.)

Other ships in regular use at NEL are the USS MARYSVILLE (EPCER 857); USS REXBURG (EPCER 855); and USS BAYA, a former Fleet submarine reconstructed for important sonar experiments. A number of small craft are also available. All NEL vessels, and some belonging to tenant activities, dock at the waterfront.

THE NAVAL TACTICAL DATA SYSTEM

For several years the Laboratory has been working in cooperation with several major industrial firms on a new Naval Tactical Data System (NTDS), with which an entire Naval task force can be coordinated almost to the point of operating as one ship. The system will thus expand the effective scope of instant command decision to global dimensions.

NTDS works at fantastic speeds. Uncorrelated information coming from a variety of sensors and radio communications goes into data processing equipment located on board major combatant ships. Here such functions as detection, location, tracking, speed, identity, and size of friendly or enemy vehicles are worked out in transistorized computers that form the "brain" of the system. The "answers" are displayed automatically on scopes installed in the Combat Information Centers where command and operating personnel monitor the tactical situation and issue required commands. The display of such information makes it readily possible for key personnel to comprehend quickly the immediate situation, permitting a concentration of judgement upon the job of effective weapon assignment to threats against the ships. Moreover, computer installations within the task force, interconnected by means of radio equipment employing advanced communication techniques, will exchange tactical information at high speeds. As a result, the task force commander as well as individual unit commanders will be provided with a complete over-all tactical picture of the task force situation.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DEPTH, IN HUNDREDS OF FEET
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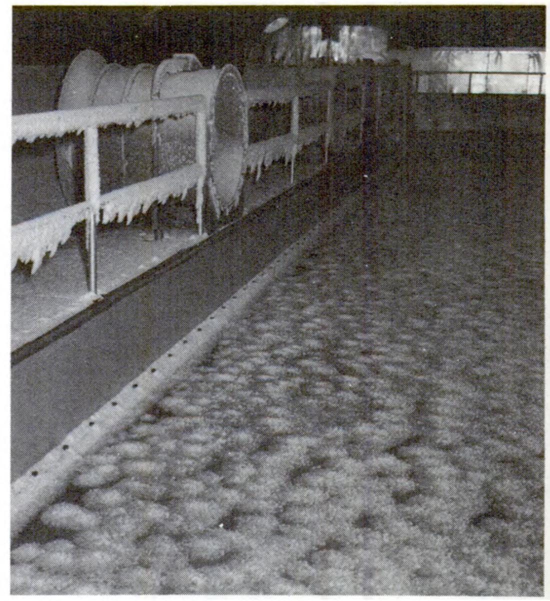
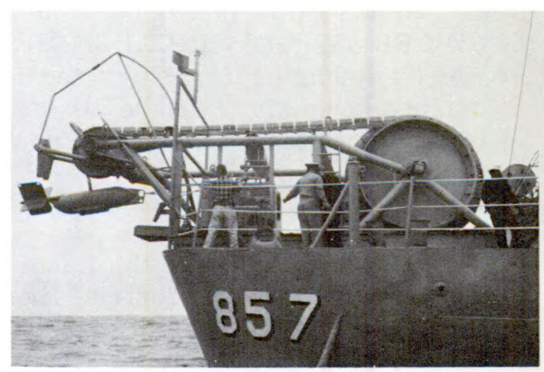
MILES

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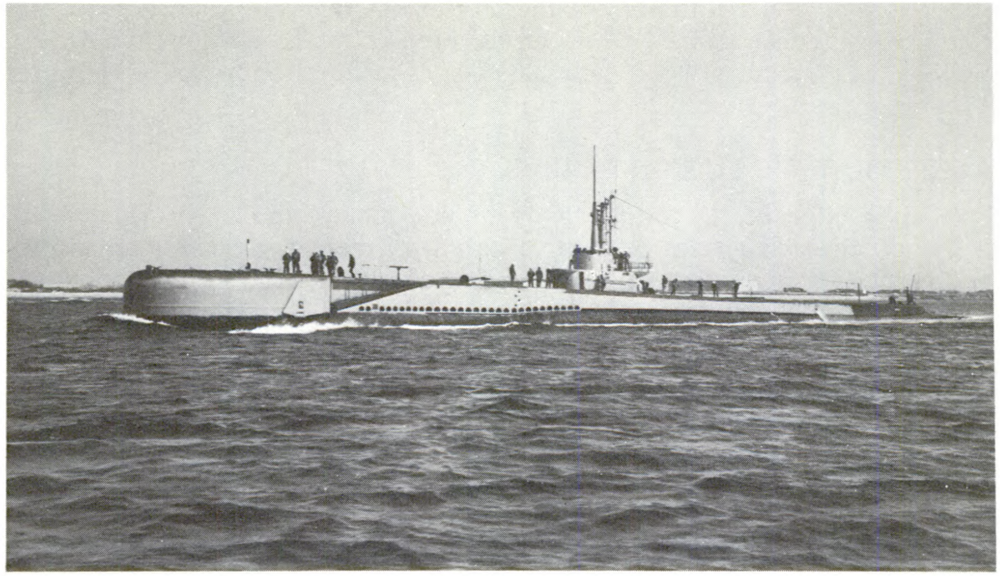
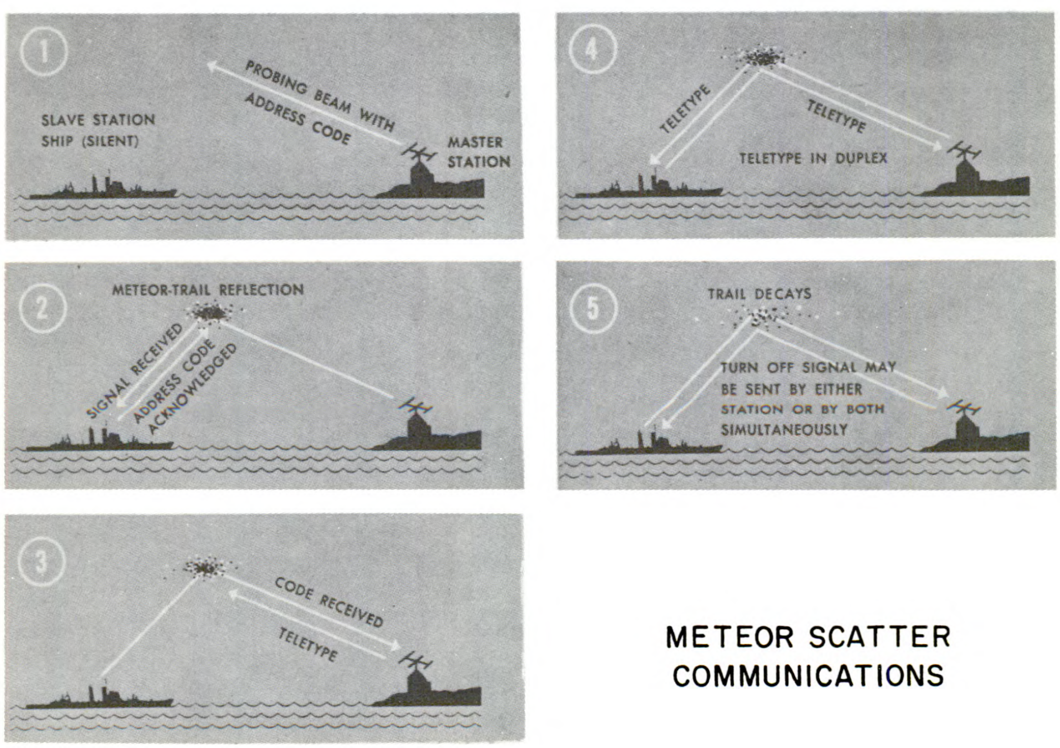


The research submarine USS BAYA.

At left, diagram showing thermistor chain in operation; right top, the unique salt-water Arctic Pool; right center, thermistor chain ready for lowering off stern of USS MARYSVILLE; right bottom, Naval Tactical Data System equipment undergoing tests.

Method utilized for effecting meteor scatter communications.



METEOR SCATTER COMMUNICATIONS

Some aspects of the operating philosophy of NTDS originated at the Naval Research Laboratory, which developed the Electronic Data System (EDS)—the "granddad" of data handling systems for air defense of the Fleet.

ACOUSTIC REFLECTION EQUIPMENT

Knowledge of the thicknesses of sediments and of the shape and depth of any rocky platform (or other prominent reflector) beneath the sediments is important in underwater acoustic studies, and in basic research of the geology of the sea floor. At NEL such a device (the Sonic Profiler or Marine Sonoprobe) is being used in the shallower waters of the continental shelf. It is essentially a "souped-up" echo sounder operated with high power and a short pulse length. The sound beam reflects from the water-sediment interface, penetrates the sediment, and is reflected from the rock-sediment interface—and in many cases reflects from the bedding within the rock. The depth of penetration into the sediment or rock is dependent on their acoustic properties; ordinarily penetration of 100 to 200 feet is made in soft muds; up to 100 feet in sands and rocks.

THERMISTOR CHAIN

An important instrument in the study of thermal structure of the oceans is the NEL 900-foot thermistor chain, installed on the Laboratory's oceanographic research vessel, USS MARYSVILLE (EPCER 857). With the new chain, it is possible to make vertical sections of temperature structure from the surface to a depth of about 800 feet, as the ship steams anywhere in the oceans. This is virtually two-dimensional oceanography.

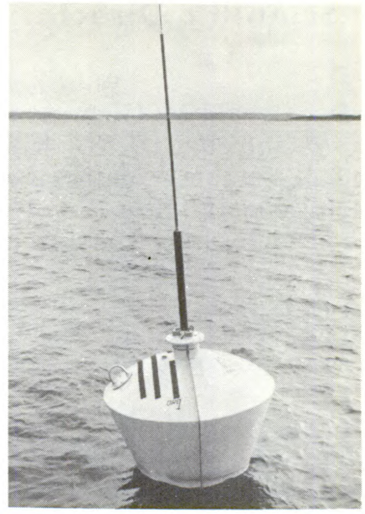
The thermistor chain has been towed along the West Coast of the United States and to the Hawaiian Islands in the Laboratory's study of internal waves, oceanic thermal fronts, domes, upwelling, sea mount effect, and other features of the thermal structure of the upper 800 feet of the sea.

The chain, together with the drum on which it is wound, is large and rugged, weighing 37,500 pounds. It is composed of large flat links about 1 foot long, 10 inches wide, and 1 inch thick, with a 2,300-pound streamlined "fish" at the end to hold it down. The "fish" and connected chain are lowered from the stern as the ship proceeds through the water. About 100 pairs of insulated wires fit through grooves inside the flat links. Every 27 feet along the underwater portion of the chain, the wires connect with temperature sensors—thermistor beads.

The upper end of these electrical leads connects with a recorder located in the ship's laboratory. Signals from the beads are scanned electronically every 10 seconds, and lines showing the depths of constant temperatures are printed on 19-inch wide tape. This rapid scanning of the temperature structure of the sea is equivalent to taking bathythermograph readings every 100 feet, if the ship proceeds at 6 knots. Also printed on the same tape is the depth of the "fish" (or maximum depth of observation), at the end of the chain, and the temperature of the sea surface.

Research Notes

Method of Tracking Drift Buoys is Refined



WHOI's new drift buoy.

A new method of locating drift buoys used in the study of ocean currents was put in service this past fall by the Woods Hole Oceanographic Institution, which developed it. The method relies on navigation radio stations in Florida and Massachusetts, utilizing a variation of the console navigation system, which is in operation in several areas in Europe. In the Bermuda area, where the current buoys are now being used primarily, signals put out by these stations intersect at approximately right angles. All that is required to determine a buoy's position is to equip the buoy with a small receiver for picking up the signals and a transmitter to send them to the searcher. Upon command from shore, plane, or ship, the buoy's transmitter is activated and the signals relayed. The signals give true azimuth from the buoy to the Florida and Massachusetts navigation stations, but not range. However, buoy positions can be determined from azimuth alone, simply by drawing the two azimuth lines on a chart. The method is accurate to within about five miles.

The drift buoy consists of an aluminum case 8 inches in diameter and 14 feet long containing the position-determining radio equipment and other devices required for the particular investigation undertaken. It is partly enclosed by a truncated cone flotation device made of fiberglass and styrofoam which is about 5 feet in diameter at its widest point and about 7 feet high (see photograph).

A further modification of the radio equipment has been planned, but not as yet adapted to the buoy. It will enable WHOI to keep track of a buoy at all times, without having constantly to interrogate it. An endless-tape recorder is being developed which, when coupled with a radio receiver, will receive signals at predetermined intervals from the stations in Florida and Massachusetts and store them for relay at a later time. Upon command, when communication conditions are favorable, the stored signals will be transmitted from the buoy to the Institution's radio installation at Waquoit on Cape Cod. They will reveal the various positions of the buoy during a specific period of time prior to the interrogation.

—Max C. McLean, ONR Scientific Liaison Officer, WHOI

Scientific Director Leaves Naval Observatory

Dr. Gerald M. Clemence, scientific director of the Naval Observatory, Washington, D. C., has been named chairman of the Division of Physical Sciences of the National Academy of Sciences—National Research Council. He will hold the position vacated earlier this year by Dr. Frederick Seitz on his election to the presidency of the Academy.

Appointed by Dr. Seitz as vice chairman of the Division was Professor Edwin L. Goldwasser, a member of the University of Illinois' Department of Physics.

In their new positions, Dr. Clemence and Professor Goldwasser will be responsible for a wide range of activities, including the U. S. national committees of international scientific unions in physics, astronomy, radio, and crystallography, as well as study committees concerned with problems in basic and applied research. They will also oversee the Division's advisory services to many agencies and executive departments of the Federal Government.

Geologic Structures Studied off Carolinas

A large-scale seismic study conducted off the coast of the Carolinas last July by the Woods Hole Oceanographic Institution's research ships CRAWFORD and BEAR has revealed a broad area of extremely complicated geologic structures under the continental shelf and the Atlantic coastal plain. The seismic "picture" was obtained by means of a series of fairly strong charges set off in a line running normal to the coast near the border of the two states. The explosives were detonated by a Navy ordnance team on temporary duty aboard a Coast Guard cutter that assisted in the study.

Scientists aboard the BEAR and CRAWFORD set up "listening" stations offshore to record the seismic waves created by these charges after they had been transmitted through the water and refracted by the various layers of sediments beneath the ocean floor. Also "listening" was a group from the University of Wisconsin and the Carnegie Institution which manned a series of receiving stations in a line running up the coast and into the coastal mountains of North Carolina. The seismic line established by the study is believed to be the first one to extend both over the edge of the continental shelf and over the coast line and into adjacent land areas. Data obtained in the investigation are now being analysed to obtain better definition of the complex formation along the dividing line between these continental and ocean bottom areas.

Chief scientist on the BEAR was Miss Elizabeth T. Bunce, a geophysicist with WHOI, and the leader of the scientific party aboard the CRAWFORD was Mr. John Ewing from Columbia University's Lamont Geophysical Observatory. —Max C. McLean, ONR Scientific Liaison Officer, WHOI

Heart "Failure" of the Shark

Dr. Warren J. Wisby, an Office of Naval Research contractor who is studying animal behavior at the University of Miami's Marine Science Laboratory, has made an interesting discovery concerning shark behavior. By means of implanted electrodes he has been able to record the electrocardiogram of sharks, and thus to determine the effect of fright and other stimuli on the fish. His instruments reveal that the heart of at least one fish—the lemon shark—stops beating on reception of an electric shock or on the reception of any other of several "fright stimuli" tried, and that it recommences spontaneously a few minutes later. The lemon shark's heart stops beating, also, when chasing prey. This curious behavior—the cessation of heart action at precisely the time when tissue demands for oxygen and nutrients are greatest, is as yet not understood. Dr. Wisby expects to investigate it further.

—John E. Flynn, ONR, New York

Reconnaissance Drones for the Marines

Small, radio-controlled drones—of the type used for many years for target practice—are notoriously hard to knock out of the sky. Furthermore, they are inexpensive enough to be expendable and they can be flown over enemy lines without risking a pilot. These characteristics have made the little planes attractive as possible agents for battlefield reconnaissance.

Two surveillance drone systems are currently under consideration: Republic Aviation's "Bikini" and Ryan's "Flex-wing" (see photos, inside front cover). Limited research and development work on both systems, including the use of aerial cameras as sensors, has been completed through flight trials. The most recent test was that of the ONR-sponsored Bikini* at Twentynine Palms Marine Corps Base last September.

Both drones are small and are man-portable. The Ryan drone is called Flex-wing because its configuration embodies the Rogallo wing. Bikini on the other hand uses the standard fixed-wing configuration. Both drones are designed to carry payloads of around 20 pounds at speeds of 50 to 60 knots. Both can be launched from short, light-weight launchers and are controlled by radio-command link. The Bikini is recovered by parachute and Flex-wing is "flared" for landing.

Marine Corps tentatively plans to continue a research and development program to determine which configuration will be most desirable. This program may culminate in comparative testing in the summer of 1963. Testing will include the two airframes mentioned above, launch systems, and radio command links.

*Republic's experimental drone, incidently, was given the name "Bikini" because of the analogy between the aircraft and the swimming suit of the same name. As they put it, "Both are small, lightweight, highly functional, and provide coverage of those areas of maximum interest."

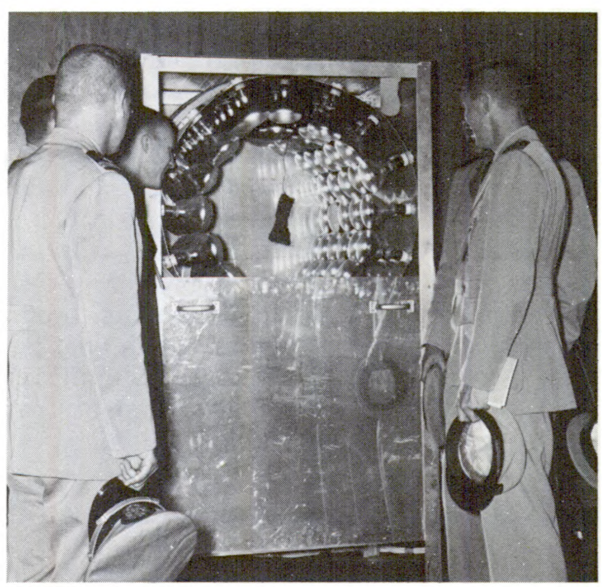
On The Naval Research Reserve

Operation of the centrifuge at the Environmental Simulation Facility, Pacific Missile Range, is explained to members of NRRC 9-21 and 9-17.

Colorado Reservists Visit California Activities

On August 23 and 24, 1962, nine members of Naval Reserve Research Company 9-21, Denver, Colorado, and three members of NRRC 9-17, Boulder, Colorado, visited military activities in California under group training orders. The tour, which was arranged through the efforts of LCDR Gus Francis, USNR, Commanding Officer, NRRC 9-21, included stops at the Pacific Missile Range, Point Mugu; Naval Missile Facility, Point Arguello; and Vandenberg Air Force Base, Lompoc.

Colorado reservists view the infra-red heat chamber in the Environmental Simulation Facility at the Pacific Missile Range.



Reservists participating in the group training are engaged in activities which involve research in aviation, computer programming, aerology, chemistry, and education, to mention a few. Familiarization with the programs of the activities visited is in accord with the mission of the Research Reserve program, which is "to provide qualified individuals in the conduct and administration of scientific research."

Members of the two companies were provided transportation for the weekend trip by aircraft assigned to Lowry Air Force Base, Denver, Colorado.

Electronic Computers Seminar

The Second Research Reserve Seminar on Electronic Computers and Their Military Applications was held at Stewart Air Force Base, Newburgh, New York, from October 14-27, 1962. The seminar was conducted by Naval Reserve Research Company 3-14, Poughkeepsie, New York, under the sponsorship of the Office of Naval Research. Substantial technical and logistic support and assistance was provided by Air Force personnel of the Boston Air Defense Sector and Stewart Air Force Base.

The seminar was attended by 60 officers of the Navy, Army, and Air Force Reserves. Forty-four attendees were Naval reservists, eleven were Army reservists and five were Air Force reservists. Seventeen States and the District of Columbia were represented.

The program was opened by CDR N. J. Smith, USNR, Commanding Officer of NRRC 3-14, who also served as chairman for the training course. The keynote address was made by RADM L. D. Coates, USN, Chief of Naval Research. Admiral Coates pointed out that the importance of computers to the Navy is illustrated by the fact that every shipboard and aircraft weapons system requires a computer-controlled "nervous system." The Admiral noted further that the increasing dependence on computers necessitates seminars such as this one to familiarize Reserve officers with their use in military operations.

An impressive group of authoritative speakers provided material for the remainder of the course. Beginning with the history of computers, the presentations dealt with functions and machine organization, programming, design and devices, uses, and future trends. Leading organizations in the computer field sent representatives to acquaint the reservists with the various phases of their operations. Among these were IBM, Remington Rand, Burroughs, Electronic Associates, Systems Development, C-E-I-R, and Control Data. Also, cognizant divisions of other companies provided speakers—Ford Motor Company, Philco, MITRE, National Cash Register, and IEC. Mr. C. L. Bradshaw from Marshall Space Flight Center, National Aeronautics and Space Administration, outlined uses of computers in the U. S. space program. Informative tours were made to plants at IBM, IEC Corporation, and ATT Long Lines Division.

A summary and critique was held on the last day. Following this panel discussion CAPT J. W. Jockusch, Jr., USNR, Special Assistant to the Chief of Naval Research for Research Reserve, discussed the Navy's Reserve program in general and the Research Reserve program in particular. A general discussion of Reserve policies was held after this presentation.

Attesting to the success of the seminar was the recommendation from the majority of the reservists attending to the effect that it should be scheduled annually.

Seminar on ASW

The Tenth Annual West Coast Research Reserve Seminar was conducted at Pasadena, California, during the two-week period commencing October 21, 1962, on the timely subject of anti-submarine warfare, RADM L. D. Coates, USN, Chief of Naval Research, emphasized the challenge of ASW when he stated in his message to the conferees, "The recent rendezvous maneuver of two of our nuclear submarines at the North Pole is only one indication of the increasing capabilities of the submarine in naval warfare. This, in turn, requires us to exert ever greater efforts in ASW research to meet this challenge."

Fifty-four reservists participated in the seminar, 43 from the Naval Reserve and 11 from the Army Reserve. The seminar was under the general direction of CAPT R. J. Trauger, USN, Commanding Officer, ONR Branch Office, Pasadena. The program was organized and arranged by LCDR W. C. Walston, USN, with the assistance of LCDR N. L. Fish, USN, both of the ONR Branch Office.

The seminar was opened by CDR Burt Jones, USNR, who served as chairman. CAPT Trauger welcomed the group and introduced RADM L. D. Coates, USN. For the next two days the reservists were given firsthand knowledge of the organization, mission, and activities of the Commander, Antisubmarine Warfare Force, Pacific, by a member of his staff, CDR Roger Allen, USN. His effective presentations formed a sound basis for the remainder of the material presented at the seminar. He was followed by two members of the staff of Commander, Operational Test and Evaluation Force—CDR B. E. Glendinning, USN, and CDR H. P. Prather, USN. Notable presentations were made by representatives from the Naval Ordnance Test Stations, Pasadena and China Lake; Varian Associates; and Northrup Corporation.

The reservists were on tour for most of the second week of the seminar. The first two days of that week were spent at the Navy Electronics Laboratory, Point Loma, where the group was addressed by distinguished speakers from the Scripps Institution of Oceanography as well as staff members of NEL. The tour was completed by a visit to the Antisubmarine Warfare School at San Diego. On the remaining two days of the seminar, informative presentations were made by members of RCA, Lookheed Aircraft Corporation, Hughes Aircraft Corporation and Aerojet General Corporation. The seminar was concluded by a presentation by CAPT J. W. Jockusch, Jr., USNR, Special Assistant to the Chief of Naval Research for Research Reserve.

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*Articles are arranged under the ONR division or laboratory having Cognizance of the research described.

†Written by the editorial staff of Naval Research Reviews or adapted from anonymous sources.

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IN THIS ISSUE

NAVAL RESEARCH reports highlights of technical progress in research by Navy laboratories and contractors and the development of important naval research facilities. The magazine is listed for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. Subscription price: $1.50 per year in U. S. and Canada; $2.00 per year, foreign; $0.15 per individual copy. Changes of address should be sent to Code 740, Office of Naval Research, Washington, D. C. The issuance of this publication approved by the Secretary of The Navy on 1 March 1961.

NEL's graceful SALUDA, a yawl operated for oceanographic research. See page 15.

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