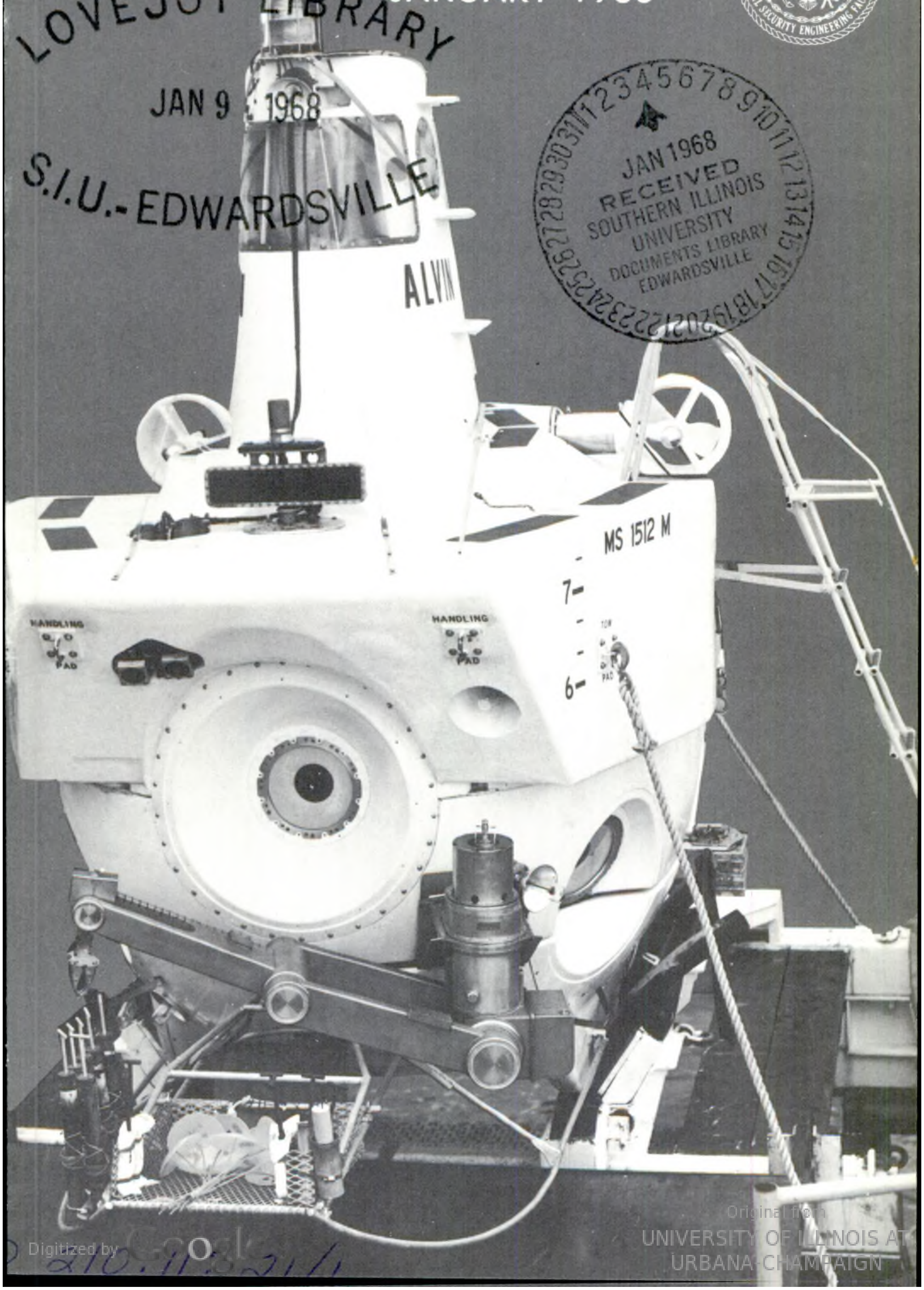
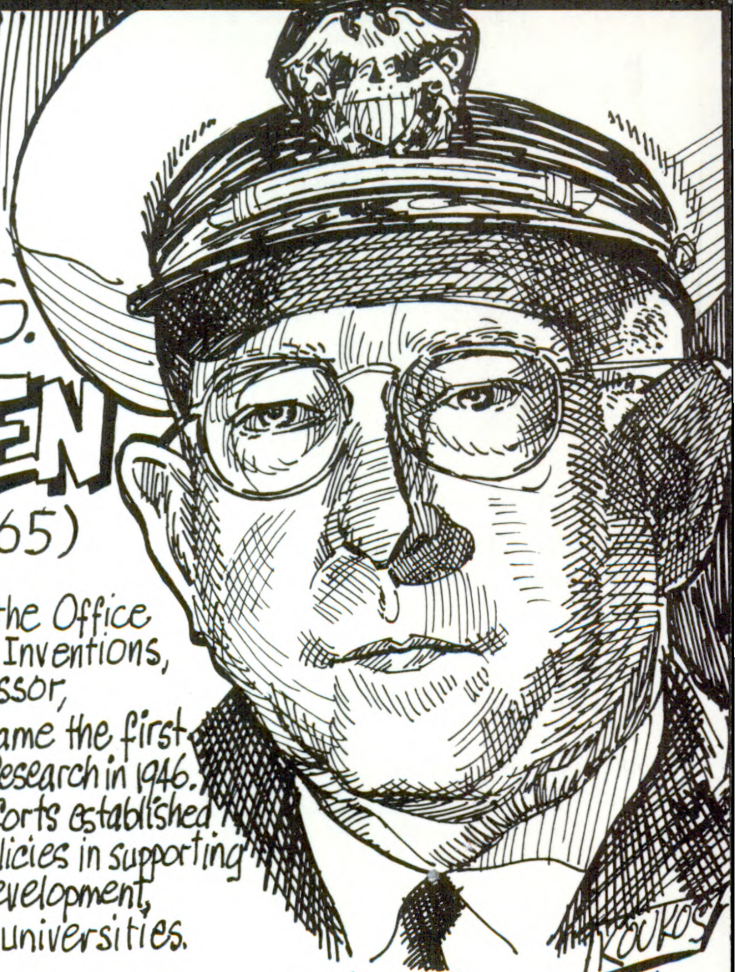
NAVAL RESEARCH REVIEWS

JANUARY 1968



Portraits in Science



VADM.
HAROLD G.
BOWEN
(1883 - 1965)

After heading the Office of Research and Inventions, O.N.R.'s predecessor, VADM Bowen became the first Chief of Naval Research in 1946. His vigorous efforts established O.N.R.'s basic policies in supporting research and development, particularly in universities.

As Chief of the Bureau of Engineering (1935-[illegible]), he developed and installed high pressure, high propulsion machinery on Navy Ships and provided funds for N.R.L. for nuclear research which contributed to the development of the atomic bomb. While Director of N.R.L. he assisted in developing radar.

Admiral Bowen's many awards included the Navy's Distinguished Service Medal and Commendation Ribbon and Franklin Institute's Newcomen Medal.

Basic Research — A Necessary Resource for the Navy*

RADM Thomas B. Owen
Chief of Naval Research

It is no coincidence that Navy Day is celebrated on October 27, the birth date of Theodore Roosevelt. Although it is not widely known, Theodore Roosevelt was one of the staunchest supporters the Navy ever had. One indication of this is that he was the founder of the Navy League.

More than that, Roosevelt had a deep interest in the Navy throughout his life. At the age of 24, when he was beginning his political career in the New York state assembly, he published his *History of Naval War of 1812*, which is still the leading work on the subject. Like his equally famous relative who also went on to be president, Teddy Roosevelt served as Assistant Secretary of the Navy. That was in 1897-98, just prior to the outbreak of war with Spain. He was certain that the war was coming and did much to prepare the Navy for hostilities. His efforts assured the success of the American Navy in that war.

As president he persistently sought to build up the Navy's power and make it as effective as possible. New technology especially fascinated him. He made a dive on the Navy's first operational submarine PLUNGER and insisted on working the controls. His belief in the Navy plus his conviction that it was the most visible and awe-inspiring symbol of power that America could display led him to a startling decision—both to Americans and to the world.

Roosevelt determined in 1907 to send the Navy's mighty battleships around the world on a good-will tour. No country had ever attempted anything like this before. When, a few years earlier, Russia had sent its Baltic fleet halfway around the world to attack the Japanese fleet, the Russian ships had arrived in such bad shape that they were easy prey for the Japanese.

Teddy Roosevelt was one of the few people, in or out of the government, who was sure the Navy could bring it off. The 16 battleships, called the Great White Fleet because immediately afterwards all Navy ships were painted gray, made the cruise a brilliant success. Although they were struck by the worst typhoon in 40 years during the cruise, they recovered to continue in gallant style.

The true significance of this magnificent cruise was this: the Great White Fleet was able to meet the challenge because it represented the

*Based on a paper presented by RADM Owen at a Navy Day Dinner, Cincinnati, Ohio, October 27, 1967.

latest technology. Such a condition cannot be achieved overnight. Preparation must be made long in advance, and preparedness was the message that Teddy Roosevelt kept preaching.

Admittedly, at least until World War II, the Navy's record for preparedness had been spotty, partly due to lack of public support. On the other hand, the Navy has always had one advantage which has enabled it to play a decisive role in wartime. That advantage is the Navy's long tradition of association with science and its offspring, technology.

For example, the American Navy was the first in the world to build a steam warship. This was the DEMOLOGOS launched in 1814. When President John Quincy Adams asked Congress in 1825 to establish a naval academy, he said it was needed "for the formation of scientific and accomplished officers." In 1836 the Navy was authorized to conduct a national expedition led by Lieutenant Wilkes—the first of many naval explorations that have garnered much scientific information. It was a four-year voyage that ranged from the Central Pacific to the Antarctic and benefited a number of fields of science. Some of the charts it produced proved useful to the Navy at Tarawa in 1943.

A naval observatory operation was started informally in 1830 and officially established by Congress in 1841. During the Civil War the Secretary of the Navy set up a "Permanent Commission" to obtain for the Navy information on "questions of science and art." This encouraged the leading scientists of the day to ask Congress for something they had long wanted, a National Academy of Sciences. With the Navy's example of the use of science before it, Congress granted immediate approval.

Even before the United States became involved in World War I, the Secretary of the Navy, Josephus Daniels, appointed a Naval Consulting Board headed by Thomas Alva Edison. In outlining the board's mission to Edison, Secretary Daniels wrote that "one of the imperative needs of the Navy is machinery and facilities for utilizing the natural inventive genius of Americans to meet new conditions of warfare." Aware that the Navy needed a permanent research organization to exploit science, the board, spurred by Edison, proposed a naval laboratory under the command of an officer with a staff of "civilian experimenters, chemists, physicists, *etc.*"

The war and other problems delayed the formal commissioning of the Naval Research Laboratory until July 1923. Here was a completely new concept—a military laboratory staffed by civilian scientists with the mission of performing both basic and applied research in the physical sciences. It succeeded better than anyone had imagined. One of its early research programs was a study of the behavior of radio waves as they travel through the atmosphere. From this study, NRL developed American radar.

When atomic fission was discovered in 1939, NRL immediately initiated a research program aimed at utilizing this new source of power for ship propulsion. As a result, the laboratory developed a process to separate the uranium isotope U-235 from U-28, thereby providing a significant amount of fissionable material for the first atomic bomb. This gave the Navy a base of technology from which to pursue the development of nuclear propulsion.

ONR Established

The experience with NRL, especially in regard to the contribution that its scientists had made to the war effort, led the Navy to realize that much more attention had to be paid to long-range fundamental research. This is the search for fundamental knowledge, from which all new technology flows. Up to that time the university scientist had not been inclined to involve himself with the government. Because the Navy realized that basic research was so vital to its future, it created what was then a unique organization adapted to the requirements of both the basic scientist and the Navy. This was, of course, the Office of Naval Research established by Act of Congress in 1946. ONR's objective was to provide a mechanism for the support of long-range academic research in those fields of knowledge upon which the Navy depended for its future capability.

One might ask why it is so critical for the Navy to have its own source of fundamental knowledge. How does such research specifically contribute to the advancement of the Navy?

Such questions can best be answered by citing examples from the record. Radar has already been mentioned, a development which is well known. Few people, however, are aware of the impact of basic research in high temperature and low temperature physics.

In 1947, ONR began a program of basic research at a few universities in high temperature gas dynamics. Specifically, ONR felt it was important to know how gases in the atmosphere behaved when they were extremely hot. It is known that a body traveling at very high speed through the atmosphere heats the air or gases surrounding it, which in turn heats the body itself. Although gaining this knowledge was not an immediate problem, the Navy realized that future technology in aerodynamics would require it.

Research funds were concentrated on a pioneer program aimed at adapting a device known as the shock tube to produce high temperature gases. The shock tube, which could send a shock wave through a gas and thereby heat it instantly, was able to provide exact details of what happens to gases heated to extremely high temperatures.

In the mid-1950's, the Navy found that it needed a long-range ballistic missile. A critical question that had to be solved was the reentry problem. A missile had to be designed that could survive the heat generated when it reentered the atmosphere at a speed of 20,000 feet per second. A missile at that speed would actually create a shock wave and thus heat the air to incandescence. Knowledge gained from ONR's shock tube research program made it possible to determine the reentry environment with sufficient precision so that a successful missile could be developed.

Low Temperature Physics

ONR got into the field of low temperature physics back in 1946 as part of its basic research program in the physics of solids or solid state physics. Particularly, ONR wanted more information about the phenomenon that certain metals, when cooled down to temperatures of more than 400 degrees below zero Fahrenheit, offer little or no resistance to the flow of electric current. These superconductors, as they are called, provided a potential for developing far more efficient electronics equipment. In the early postwar years ONR provided the major support for basic research in low temperature physics or cryogenics, as it is now called.

Over the years there has been a gradual accumulation of fundamental knowledge. A great deal has been learned not only about the materials most suitable as superconductors, but also about the properties of liquid helium, the refrigerant used to cool the materials to the required low temperatures. This knowledge has produced superconductors able to carry electric current at capacities three times greater than copper and has permitted the development of practical cryogenic equipment. Even though such equipment requires refrigeration, this disadvantage is more than balanced by the considerable advantages of much smaller size, lighter weight, and greater reliability.

Superconductors can generate an intense magnetic field. Thus, it was possible to develop a powerful magnet, which uses current provided by a few storage batteries. Not too far off is the development of a cryogenic gyroscope so efficient and stable that it will provide virtually error-free long-range navigation. This is important for a submarine's long voyage under water, and even more important for a spacecraft's long journey through space. The development of low noise receivers, stable transmitters and extremely sensitive magnetometers is also now possible.

One application of considerable interest to the Navy is superconducting electrical machinery for shipboard use. Reductions in complexity and structural requirements, including the elimination of complex gears, shafts and bearings, may permit new concepts in vehicle design. Auxiliary power plants can benefit by the use of superconducting devices such as high efficiency, low weight electrical frequency conversion equipment. More efficient and simplified systems for using electricity as the main propulsion for ships can now be considered. Electric propulsion has the great advantage of simple remote control and improved maneuverability, an advantage which, in the past, has been outweighed by the higher cost, weight and volume requirements of electric drive.

The Navy has applied cryogenics to biological research in seeking a long-term preservative for living tissue. One noteworthy result has been the development of procedures for freezing blood so it can be stored aboard ship for years as compared to the present blood bank storage period of 21 days. At the present time the Navy has experimental frozen blood bank systems operating in a Vietnam combat area. When needed for transfusion, it is thawed quickly and is immediately available for use, thus eliminating the search for blood donors.

The Influence of Basic Research

Most people rarely think about the influence of basic research. When a man turns on his transistor radio or his all solid-state portable television set, he is usually unaware of the fact that this achievement stems from basic research in solid state physics started more than 20 years ago, with major support provided by the Navy. He is usually even more unaware that the same research made possible the compact computer system aboard a Polaris submarine that can instantly direct missiles at almost any land target in the world.

This lack of information may be why the president of the California Institute of Technology, Dr. Lee DuBridge, stated in a recent article that "the nation's program of basic research in science is at a critical juncture." Dr. DuBridge goes on to say:

> "Its future progress is by no means assured, and much will depend on the outcome of the debates now . . . [going on] in the public press, in the halls of Congress and in the offices and conference rooms of many government agencies. Pressures for reducing or leveling off research budgets are evident."

This debate is nothing new. Several years ago basic research was castigated for looking into such questions as "Why is the grass green?" Strangely enough, this topic *is* of interest to the Navy. If the detailed mechanism by which a green plant absorbs carbon dioxide and gives off oxygen can be understood, it will be possible to construct large closed environments with a permanent self-contained air supply and probably also gain an important clue in combating air pollution.

The current debate, however, is causing grave concern among those directly involved in basic research. Some people feel the government could save a lot of money by substantially reducing basic research sponsorship. Such a move would be extremely unwise, not only because such effort is an investment in the future but also because it is a hedge in light of the strong efforts of our competition. Every technologically oriented industry in the country invests up to 13 percent of its sales in research in order to be competitive and maintain profits. The Navy, which is similarly technologically oriented, must do likewise to maintain its capability.

Recent discussions are more complicated. Critics of basic research can no longer be met merely by marshalling an impressive array of examples which demonstrate the value of basic science. An even more frustrating problem being faced today is spelled out by Dr. DuBridge, who asks:

> "How does one set forth to government representatives and to the public just how much monetary investment is justified each year, and how it can best be distributed among subject-matter fields?"

This is a good question and one that every research agency wrestles with as it prepares to justify its budget to the Bureau of the Budget as well as to Congress. The National Academy of Sciences has addressed this problem and has not found a clear unequivocal answer. It has, however, attempted to advise the Congress as to the consideration involved in research support and the benefits it has brought to every segment of the economy.

In ONR's case, opportunities are being sought to conduct programs of long-range basic or applied research in those fields of science and technology that will enhance the future capabilities of the Navy. In particular, ONR feels it is important to initiate research programs in scientific areas which have been neglected and where there are serious gaps in the knowledge needed for the Navy of the future.

Sometimes the research support provided is quite modest, but it fulfills one of ONR's major goals, which is to maintain contact with every scientific discipline potentially related to naval operations. Scientific officers or research administrators are required not only to have technical or scientific experience, but also to have general knowledge of broad fields of science and to be able to relate them to Navy needs.

Also, ONR sponsors numerous scientific meetings and seminars which provide a great deal of information on what is going on in science of interest to the Navy. This is one way of finding out where research funds should be invested to achieve the greatest return.

At the same time that these investment opportunities are being exploited, ONR is making certain that it is responding to the special needs of the Navy. In the early years of ONR it was felt that any new scientific knowledge gained through research was bound to be of benefit to the Navy. Today, however, that is not good enough. Now it must be possible to point to any research project supported by Navy funds and demonstrate that it is clearly responsive to the current or future needs of the operating forces.

If the Navy depends heavily on science in peacetime to maintain the strength of the fleet, it follows that an even greater need exists for the scientist in a time of national emergency. A scientist cannot be oriented to Navy needs overnight. He must have built up an understanding of special naval problems from long experience. Only through Navy support of scientific research can such experience be provided.

Basic research generally requires only small amounts of money—a great deal can be accomplished for a small investment with little risk. A number of Navy research contracts are under $20,000. However, without such research to provide basic knowledge about an unknown area, it could happen that the Navy might plunge blindly into an expensive development program, spend millions of dollars, and come to a dead end.

Specific Naval Needs

Although naval research covers just about every scientific discipline, there are certain research areas on which special emphasis is placed. Greater knowledge about the environment, both the atmosphere and the ocean depths, must be gained. If it can be determined how these two environments interact to produce a pattern of world-wide weather, it may be possible to achieve long-range weather forecasting. The study of the ocean has long been a province, and now it is a national program. This has happened because the public has been made aware of the great general benefits to be gained from this research. Vice President Humphrey, chairman of the Council on Maritime Resources, has pointed out: "We stand at the threshold of the most fruitful use of ocean resources in history." The Navy's oceanographic research ships, its deep-diving research submarine Alvin, and its newly developed monster buoy capable of telemetering oceanographic data from 3000 miles away will provide both the Navy and the nation with means of exploiting the ocean for greater national defense and greater national welfare.

The Navy must have new materials to meet the stresses placed on Navy equipment as plans are being made to operate deeper in the ocean, travel faster on the ocean surface and through the atmosphere, and send military forces into the heat of the tropics and the cold of the arctic. New structural materials must be developed that are strong and light or both ductile and able to withstand high heat. Chemical research must produce protective paints and long-lasting lubricants as well as new sources of energy conversion, such as fuel cells.

Finally, better use must be made of people through research in the biological and psychological sciences. Full use has not yet been made of man's ability to think. This may be done by freeing him from routine and monotonous work through the use of automation. In this vein, command and control computer systems are being developed that can solve combat problems aboard ship in seconds instead of hours, still giving man the option of reaching his own decision. Computers are also being built to serve as instructors to train men in technical work.

There is no question that society today is solidly based on technology. Almost every day a new device is developed that gives man a new capability or a new type of convenience that improves his standard of living. Scientific progress is changing the world rapidly. The Navy must also capitalize on the new technology and maintain the pace of progress.

As President Johnson has put it: "We are on the threshold of challenge and of promise for every American. The satisfying assurance that our Navy is in step with the latest scientific and military developments in the world is our constant source of comfort as we meet this challenge."

The Navy can and will keep in step as long as it is permitted to operate a sound program of basic research. The Navy takes pride in the fact that, through the Office of Naval Research, it pioneered in initiating government support for all fields of scientific research. The knowledge that it has produced can never be measured in monetary terms or in the destructive power of new weapons—only in the amount of security it has given and will continue to give to our citizens and those of the free world. A continuing substantial investment in research is required if such security is to be maintained.

ONR Field Offices Established

Two new ONR field offices recently have been established at New Orleans, Louisiana and Gainesville, Florida. These offices will administer Navy research contracts which are awarded to universities in three southern states—Louisiana, Arkansas and the Houston-Galveston-Beaumont area of Texas—and in Florida, respectively. Also, they will service a number of research contracts funded by the Army, Air Force, and the National Aeronautics and Space Administration at these universities.

The ONR Resident Representatives at these offices are Mr. James W. Neal, New Orleans and Mr. Edward Shute, Gainesville. In addition to contract administration functions, their duties will include contacting persons at the various universities who are interested in submitting research proposals to ONR.

The Navy R&D Contract

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Although the term "research and development" is commonly used as a single expression, the term actually connotes a wide range of endeavor. Indeed, the appropriation which provides the Navy with funds for its research and development program is entitled "Research, Development, Test and Evaluation, Navy." The categories of RDT&E contracts include efforts involving research, exploratory development, advanced development, concept formulation, contract definition, engineering development, operational system development, and management and support. Briefly, these terms can be described as follows:

- *Research* includes effort directed toward increased or expanded knowledge in the sciences;
- *Exploratory development* includes effort directed toward expansion of naval capabilities through the application of advances in technology;
- *Advanced development* includes effort directed toward the development of hardware for experimental or operational test purposes;
- *Concept formulation* includes system studies and experimental hardware efforts which precede the decision to carry out engineering and operational system development;
- *Contract definition* is that phase during which preliminary design and engineering are verified and firm contract planning is performed;
- *Engineering development* includes effort directed toward those development programs being engineered for naval use but which have not yet been approved for procurement or operation;
- *Operational system development* includes effort directed toward development and test of systems and weapons that have been approved for production; and
- *Management and support* includes effort directed toward support of installations or operations required for general research and development use.

Procurements which carry the label "research and development" range in size from small basic research contracts wherein the Navy supports fundamental studies to large contracts for the fabrication of the first prototype of an operational missile system. As research moves down the path to operational system development, the requirements become more definitive, the planning more extensive, and the work more costly to perform.

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Obviously the types of contracts, the complexities, and the procedures used in these wide ranges of research and development objectives vary considerably. At one end, there is the cost-plus-fixed-fee contract; and, at the other end, the firm fixed-price type contract. Between these types, a number of other contract types are used, *e.g.*, fixed-price-incentive-fee contracts and cost-plus-incentive-fee contracts. These and other types of contracts will not be discussed in detail in this article. It is sufficient to note that under the cost-plus-fixed-fee contract, the contractor is reimbursed for his allowable costs within the limit of the funds provided and generally receives an agreed upon fixed-fee; and under the firm fixed-price contract, the contractor must perform the work at the negotiated price regardless of his ultimate costs. Under incentive contracts, prices or fees are reset following a period of performance, usually on the basis of prescribed formulas and within pre-established limits and ranges. The type of contract to be used is determined by negotiation between the government and the contractor. The selection is based upon various factors involved, *e.g.*, the type of work to be performed, the risk involved, the degree of definitiveness that can be established in the cost of the work, and the performance of the work.

A principal objective of the Navy research and development program is to assure that the most effective contribution is made to the overall combat readiness of the Navy and the Marine Corps. The Chief of Naval Material and the Chief of Naval Research are responsible for the prosecution of projects in support of requirements established by the Chief of Naval Operations and the Commandant of the Marine Corps. Navy responsibilities are extremely diverse and include operations on the sea, in the sea, in the air, and on the land bordering the sea. This diversity, in turn, necessitates a comprehensive and complex research and development program which involves large expenditures of funds. For example, in fiscal year 1967, Navy R&D contracts awarded to United States contractors totaled $1,589,000,000. From this total, industry received awards which amounted to $1,375,000,000, and educational institutions and other nonprofit organizations received awards which amounted to $214,000,000.

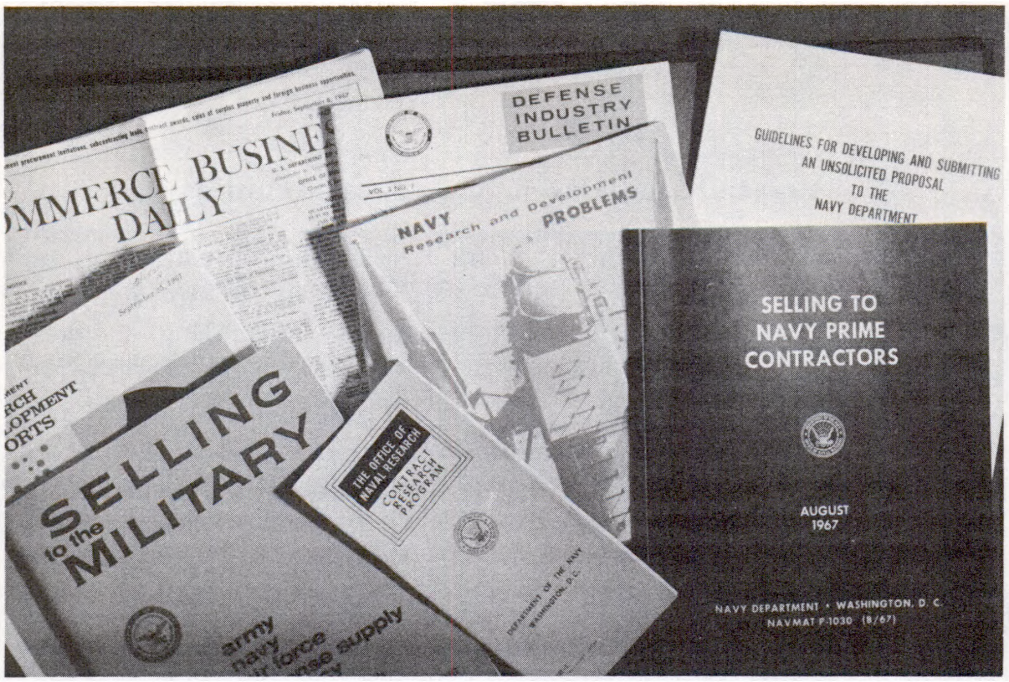
A large percentage of Navy R&D contracts is awarded by headquarters offices located in Washington, D.C. These offices include the Naval Air Systems Command, the Naval Ordnance Systems Command, the Naval Ships Systems Command, the U.S. Marine Corps, and the Office of Naval Research, among others. Field organizations which negotiate R&D contracts include Navy purchasing offices, centers, laboratories, and a variety of other activities. Information concerning the items procured and the location of these purchasing offices is contained in a pamphlet entitled *Selling to the Military*. This publication and other publications designed to assist industry in identifying offices which purchase R&D are available through the Government Printing Office.

Research and Development Opportunities

An essential, but somewhat difficult task facing industry is determining how to obtain information regarding R&D opportunities. Such information is available from a large number of publications issued by activities both in and out of the Navy. A publication issued by the Navy entitled "Navy Research and Development Problems" reflects some of the Navy's current scientific and engineering needs and enlists the assistance of industrial organizations and educational institutions toward solving these problems. This document, which was recently revised, is published by the Chief of Naval Material. The new edition may be obtained from the Naval Material Command in Washington. Also, some of the technical systems commands, Navy offices, and laboratories publish brochures which describe the R&D programs which a specific command, office, or laboratory sponsors.

Other sources that may prove helpful in obtaining information on government-sponsored research planned or in progress, on means of obtaining R&D reports, and on Navy and other governmental R&D opportunities are summarized below:

- *The Commerce Business Daily* contains such information as notices of proposed procurements, contract awards made, and a section entitled "Research and Development Sources Sought" which provides advance notice of the government's interest in a specific research field and invites firms to submit information on their qualifications to the purchasing office listed.
- *U.S. Government Research and Development Reports,* which are issued semimonthly by the Clearinghouse for Federal Scientific and Technical Information, Department of Commerce, announce the availability of unclassified government-sponsored R&D reports and lists current government-sponsored R&D projects. The Clearinghouse also publishes a consolidated index every month which is entitled "Government-Wide Index to Federal Research and Development Reports."
- *The Science Information Exchange,* Smithsonian Institution, furnishes reports on current research planned or in progress. In response to queries concerning research work in a special field of interest, the *Science Information Exchange* furnishes a "Notice of Research Project," which contains the name of supporting agency, a short title, names of investigators, location of work, summary of work in progress, and level of effort.



• *The National Referral Center for Science and Technology,* which operates in the Library of Congress, provides a single place where anyone with an interest in science and technology may go for advice on where and how to obtain information on specific topics. The Center has published three directories covering a broad range of information resources.

• *The Defense Documentation Center for Scientific and Technical Information (DDC)* indexes and distributes technical documents to qualified contractors and prospective contractors.

• *The Defense Industry Bulletin,* published monthly by the Department of Defense and available to industry, contains a calendar to technical meetings and symposia.

In addition, publications issued by trade journals and professional societies are helpful sources of information. Personal contacts, of course, are desirable: visits with small business specialists, technical personnel, and contracting officers located in Navy and other DOD purchasing and contract administration offices in Washington and throughout the United States are important sources of information regarding R&D contracting procedures and opportunities.

Information obtained from R&D publications, symposia and meetings, and visits with Navy technical personnel may encourage a business concern to submit an unsolicited proposal relating to new ideas or products to a Navy headquarters office or a Navy field activity in the hope of obtaining a contract. Two publications which provide useful information and guidance for submitting unsolicited proposals are the

Navy Material Command's *Guidelines for Developing and Submitting an Unsolicited Proposal to the Navy Department* and ONR's *The Office of Naval Research Contract Research Program.*

In speaking of opportunities, it is important to stress that small business is encouraged to participate in Navy R&D programs. In fact, in fiscal year 1967, small business concerns received Navy R&D awards which amounted to $97,634,000. This, of course, does not represent the true picture of the participation of small business concerns since small business did receive substantial dollars through subcontracts. In this regard, a publication entitled *Selling to Navy Prime Contractors,* published in August 1967, provides information and guidance to business concerns seeking subcontracting opportunities. In addition, this booklet, which may be purchased from the Government Printing Office, contains a directory of prime contractors.

Generally, the prime contracts performed by small business concerns are in the categories of research, exploratory development, and advanced development. Prime contracts for operation system developments normally require the services of organizations with large engineering, technical, and manufacturing staffs and extensive facilities. However, small business concerns can and do provide specialized experience, skills, and components needed for operation system developments. In fact, as a result of inventions, discoveries, and specialized technical capabilities, many small business concerns of yesterday have expanded to become the large business concerns of today.

Special Consideration in R&D Contracting

Although research and development contracts generally are considered a specialized form of contract which are separate and distinct from supply contracts, the differences are not extreme. Actually, many common clauses and procedures are applicable to both forms of contracts.

Those clauses and procedures which are peculiar to R&D contracts are contained in the Armed Services Procurement Regulation (ASPR). For example, clauses for both fixed-price and cost-type R&D contracts are prescribed in Section VII, ASPR. Procurement procedures of special application to research and development contracts, some of which pertain only to educational and other nonprofit institutions, are found in Part 1, Section IV, ASPR. When this latter part of ASPR was drafted, many persons felt that a detailed and lengthy chapter would be required. However, upon closer examination, it was concluded that many of the procurement policies and procedures already contained in ASPR for production and supply contracts also applied to R&D contracts.

In spite of these similarities in procurement procedures, however, there are substantial differences in philosophy, emphasis, techniques, and methodology. For example, almost without exception, R&D contracts are negotiated rather than formally advertised. The reason for this is because the R&D program requires exploratory and creative work. Thus, there are no design specifications that would enable contractors to bid on fixed requirements. The use of negotiation, however, does not rule out competition in R&D contracts. Rather, competition is utilized to the extent practicable by publicizing planned procurements and requesting proposals. Even when contracts for basic research (and sometimes other types of R&D contracts) result from unsolicited proposals, there is competition in a sense because the Navy can support only a portion of the unsolicited proposals received. In other words, support can be given only to those that appear to have the greatest merit.

The Navy feels that it is essential to select responsible contractors who are technically qualified to perform the specialized work. Thus, because the preparation of technical proposals can be costly, an attempt is made to limit requests for proposals to those sources which already have been technically evaluated and found qualified to perform the planned task. In order to stimulate and increase competition, however, a concerted effort is made to expand the number of qualified sources. One way of doing this is to encourage small business concerns to submit their qualifications. Also, proposed procurements are reviewed by small business specialists to determine if proper consideration is being given to participation by small business.

It is important that the contractor understand the R&D work and the contractual obligations and that questions or ambiguities are clarified during negotiation. The Navy's objective is to prepare a contract which clearly and completely outlines the task to be done, and, at the same time, permits flexibility and encourages creativity. During the performance of the R&D contract, close liaison between technical personnel and administrative contracting officers in the government and technical and business personnel in the contractor's organization is necessary to follow the progress being made.

Another distinguishing feature of a R&D contract is that *performance* specifications are used instead of the definitive *design* specifications used in production and supply contracts. In R&D contracts, inspection and acceptance procedures generally involve approval of technical reports, breadboard models, or limited quantities of end items, such as prototypes. In supply contracts, inspection of large quantities of hardware may be necessary to assure that they are being manufactured according to firm design specifications.

Finally, it should be pointed out that considerations regarding patents, data, and copyrights are of vital importance in R&D contracts. In these areas, the Navy's objective is to protect the public interest and, at the same time, protect contractors' proprietary rights and encourage private innovations.

Problem Areas in Performing R&D Contracts

Like most things in life, the acceptance and performance of R&D contracts offer both benefits and pitfalls. These contracts may be financially rewarding, enhance technical capabilities, be helpful in commercial work and thus improve the competitive position of the contractor. On the other hand, R&D contracts may be difficult to perform successfully within the agreed time limit or the fixed price or estimated cost, and thus may result in financial losses to a contractor.

Difficulties which confront the R&D contractor arise from a number of factors. For example, he may be unable to perform the work because, for reasons beyond his control, the scope of work may prove to be beyond the present state-of-the-art. Also, he may have relied, to his misfortune, on informal or oral instructions from a government representative who was not authorized to commit the government and whose instructions were not formalized by contract amendment. Another difficulty that could arise is that the cost to complete a fixed-price contract may substantially exceed the fixed-price, in which case the contractor must bear the loss. On the other hand, in a cost-type contract, the contractor may have incurred costs which are disallowed or he may have exceeded the total estimated cost without proper authorization from the government. In both cases, he may be required to absorb the difference.

Contractors have made appeals to the Armed Services Board of Contract Appeals and Federal courts in cases involving financial and performance problems. Examples of typical appeal cases which illustrate these problems appear below.

In one case, the contractor determined that the performance required by the government for a complex digital data recording and transcribing system could not be achieved in accordance with the design described by the government. Thus, the contractor proposed his own design even though he knew this required performance beyond what was then the existing state-of-the-art. As a result, he failed to comply with the performance specifications contained in the fixed-price contract. The contractor's claim, based on impossibility of performance, was denied on the basis that he had entered into the contract with full knowledge of the perils of performance and thereby assumed the risk of impossibility. He was held in default and could not recover the contract price or his excess costs.

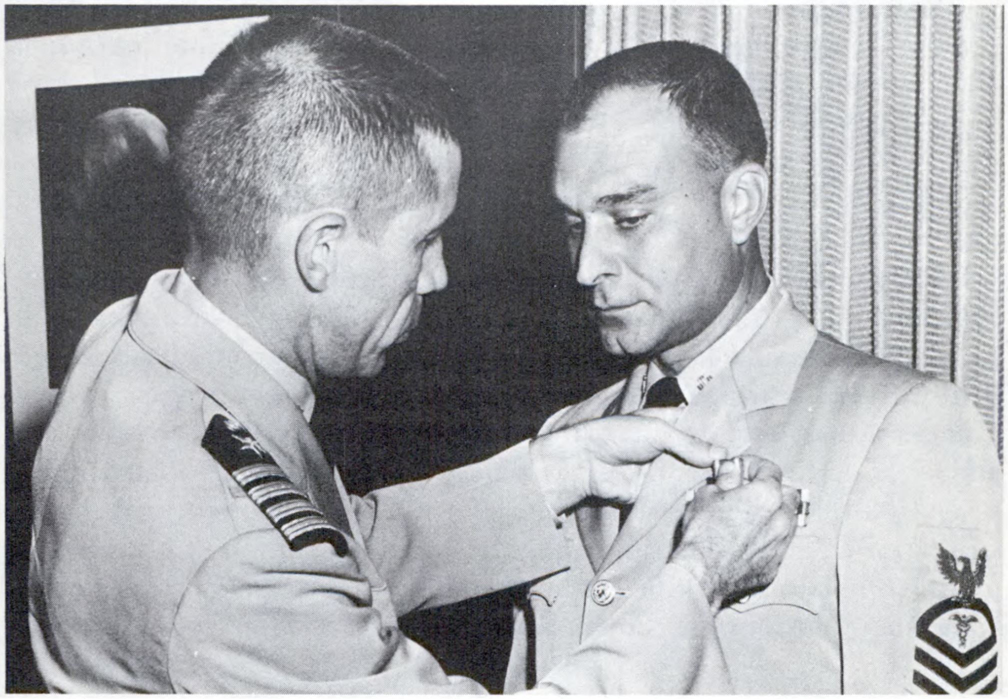
In another case, the contractor exceeded the estimated cost provided in a cost-plus-fixed-fee R&D contract. Reimbursement of the excess cost was denied by the contracting officer. On appeal, the contractor based his case principally on the fact that he acted in good faith in continuing performance. It was held that the "Limitation of Cost" clause in the contract clearly stated that the contractor was not to exceed the estimated cost without authorization from the contracting officer, and that this clause had, in fact, been reinforced by oral advice to the contractor not to exceed the funds allocated. The contractor's claim was denied by the Armed Services Board of Contract Appeals.

Many problems which arise in performance or reimbursement never reach the appeal stage. For example, a recent case involved the question of government acceptance of two experimental antenna systems which had been designed and constructed by a capable and reputable contractor. The work had been performed under a fixed-price R&D contract which had been awarded on the basis of competition and extensive proposal evaluations by the government. However, the contractor apparently did not fully appreciate the complexities of meeting performance specifications, with the result that his costs substantially exceeded the fixed-price. He not only failed to realize a profit but also suffered a substantial loss.

The foregoing remarks are not intended to discourage business concerns from participating in R&D contracts. Rather, they are included to indicate that risks *are* inherent in these contracts because of the difficulties involved in clearly describing the work to be performed, in carrying out the specific obligations of the parties involved, and in accurately estimating the costs required to perform the work. The contracting officer is bound by the contract provisions and a complex system of procurement regulations, decisions, and practices. Although he may often be sympathetic with the problems confronting the contractor, he is precluded from providing any relief not authorized in the contract. Contracts are legal documents and the parties thereto must understand what obligations are required in accomplishing the research and development work statement. The desired goal, of course, is to negotiate contracts which, upon completion, provide the government with successful R&D results for which the contractor receives adequate compensation.

In conclusion, it is important to reiterate the benefits that can be derived by contractors performing R&D programs. As stated before, these benefits include financial awards, enhancement of technical capabilities, improvement in competitive position, growth, *etc.* Some business firms have been able to successfully diversify their markets by entering a new field through R&D contracts. For example, aircraft manufacturers have gone into oceanographic work. Small business concerns have come up with new ideas which have had a substantial influence in the electronics industry, and, as a result, many of them have grown into nationally recognized companies. In this time of continually emerging technology, there is always a need for competent and alert business firms to submit proposals offering fresh ideas and technical merit for advancing Navy R&D programs.

Chief Waldron Receives Navy Commendation Medal



CAPT James C. Matheson, Director of NRL, presents the Navy Commendation Medal to Chief Hospital Corpsman Lester E. Waldron.

Chief Hospital Corpsman Lester E. Waldron has been honored by the Navy and the Republic of Vietnam for meritorious service while serving as a medical advisor to the people of Quang Tin province.

Chief Waldron received the Navy Commendation Medal from CAPT James C. Matheson, Director of the Naval Research Laboratory, during a recent ceremony. Chief Waldron, who is currently assigned as dispensary supervisor at NRL, also received a certificate of appreciation from the Republic of Vietnam's Ministry of Health.

The certificate which accompanied the Navy Commendation Medal cited Chief Waldron for reorganizing and operating the outpatient clinic in the hospital of Quang Tin province between May 1966 and May 1967. Under his guidance, the number of outpatient visits made to the clinic was doubled. Also, the quality of medical care was greatly improved. The certificate was signed by ADM Roy L. Johnson, Commander in Chief of the Pacific Fleet.

Chief Waldron instituted English classes at the hospital to overcome the language barrier. Also, he worked closely with local Vietnamese on the construction of a new hospital building.

The certificate of appreciation from the Republic of Vietnam cites Chief Waldron for his invaluable assistance in the field of health.

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1967—Alvin's Year of Science

LCDR J. D. Donnelly
Underseas Programs
Office of Naval Research

During 1967, Alvin, the Navy's oceanographic research submarine, has been engaged in a series of scientific dives in areas ranging from the Bahamas to the coasts of New England. The large amounts of data obtained and results achieved, both from this series of dives and those made in 1966, have more than demonstrated the invaluable role that such deep-diving vehicles can be expected to play in future oceanographic research. Alvin can no longer be regarded as an experimental tool.

In 1966, scientists from the Woods Hole Oceanographic Institution, which operates Alvin under contract to the Office of Naval Research, put the unique vehicle through a heavy schedule. As could be expected, this workload, which ranged from inspecting the Navy's Atlantic Undersea Test and Evaluation Center off Andros Island to searching and locating an H-bomb lost in waters off the coast of Spain, took a heavy toll on the little submarine. Cracks were observed in the main structural frame; other signs of wear were noted throughout the ship. Thus, to make Alvin safe for her equally heavy 1967 schedule, it was transported to Otis Air Force Base near Woods Hole for a complete overhaul.

In order to thoroughly inspect and repair the structural framework, Alvin had to be completely disassembled. This meant a major delay before the submarine could begin its 1967 schedule. All reassembly and modification operations had to await the completion of frame repairs, primarily because many of the parts had to be "built in place." Modifications made during this period added greatly to the vessel's effectiveness: aluminum buoyancy spheres were replaced by new titanium spheres to improve corrosion resistance, and syntactic foam sponsons attached to the personnel sphere were extended to provide more buoyancy for greater payload. Also, improvements were made to the ballast systems, propulsion plant, and electrical systems.

The instrument suit on Alvin generally remained the same. However, changes included the following:

- The original 12-second recycle camera was replaced by two Edgerton cameras and Strobe with a four-second recycle time capability. Also, a control panel for camera operation was installed.
- A precision depth gauge, which reads to the nearest 0.1 meter, has been added.

afterbody immediately forward of the starboard window with enough force to drive its 1-1/2 foot sword in to the hilt. Alvin's crew immediately checked out all systems, and, even though there was no apparent damage, decided to terminate the dive. When Alvin reached surface, the swordfish was still trapped, although its sword was almost torn from its body. Crewmen hoisted Alvin, fish and all, on board Lulu. After a thorough inspection and checkout, the little submarine was pronounced fit: there were only a few scratches on its fiberglas skin.

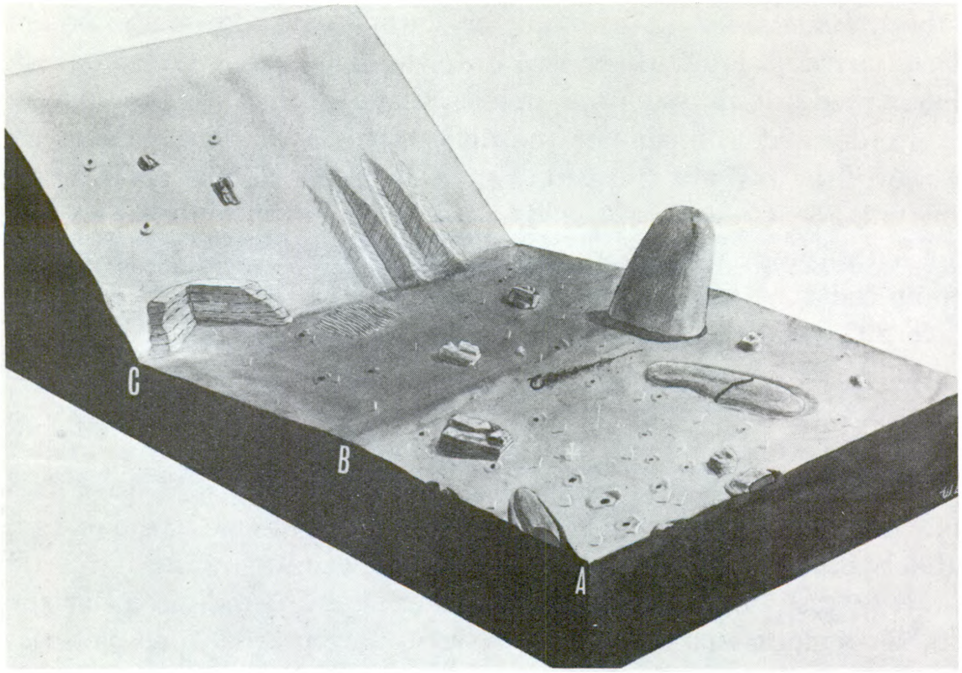
Dive 202 greatly enhanced the dinner table and produced the following scientific information: that the broadbill swordfish (*Xiphias gladius*) ranges to a depth of 2000 feet and tolerates water as cool as 8°C. What precipitates an unprovoked broadbill attack remains a matter of speculation.

The next few dives were made to observe the banks along the margin of the Blake Plateau and to investigate the deep scattering layer off Cape Hatteras. Observations made during Dive 203 indicated that the coral banks along Blake Plateau's western margin are actually a series of elongated ridges and troughs that parallel the continental slope. The regularity of wave length (260-330 ft), height (130-165 ft), and linear and parallel trends suggest that these ridges are regional features rather than coral reef accumulations.

Woods Hole scientists found that the deep scattering layer, investigated during Dive 204 on July 13, had a definite infrastructure, with layers of squid, myctophid-like fish, and euphausids each comprising a reflecting layer. Also, they found that the continental slope off Cape Hatteras is covered with mud, even though slopes average 14° and in some places exceed 70°. Before leaving the area, a number of shallow dives were made east of Cape Charles to investigate the geology and biology of a series of ridges in depths of 150 to 180 feet.

Late July found Alvin back in Woods Hole. The submarine's next assignment was to explore Oceanographer's and Hydrographer's Canyons, both of which are in the proximity of Woods Hole. A brief dive that had been made into Oceanographer's Canyon in October 1966 had established several basic geological facts about the east coast canyons:

- The sediment on the canyon floor has been moving seaward, carrying with it extremely large blocks of sedimentary rock that have fallen from the steep canyon walls;
- Since the canyon was formed, it has been partially filled with sediment, most of which has been eroded away again; and
- Present-day currents on the canyon floor are strong enough to move sediment along the axis, although their maximum velocity remains unmeasured.



Artist's rendition of geological features of the floor of Oceanographer's Canyon at a depth of 4900 feet—compiled from photographs and notes taken on the dive.

Despite this important information that resulted from the 1966 dive, the primary objective—to measure and sample the sedimentary rock strata of Cretaceous and Tertiary age that outcrop in the canyon walls—had not been achieved. Thus, during two dives made in Oceanographer's Canyon in early August, the canyon walls were examined inch by inch over a vertical extent of 2900 feet (4973 to 2073 feet). Seven rock samples were recovered for laboratory analysis and dating. Also, oceanographers made a complete photographic record of all important geological features seen in the canyon.

The mission of Dive 209, made a few miles west of Hydrographer's Canyon at 5214 feet, was to observe and collect samples of the sediment layer on the bottom for a study of the biological life in this area. The scheduled dive, which was made on August 13, was to proceed over a given area extending over the Continental Slope a few feet off the sediment. Alvin was to follow the contour of the bottom, with the oceanographers taking photographs and collecting samples along the way. After about three hours, the crew spotted an object out of the port window which resembled an aircraft. Pilot Marvin McCamis turned the submarine around, focused its headlights on the object, and discovered a World War II Navy F6F Bearcat. The plane, which had been ditched in 1944, was sitting upright with its wheels down, and apparently was in very good condition. Before continuing the dive, Alvin's crew spent some time investigating the plane and recording any markings for possible identification.

Several days later, Alvin returned to the site, and collected a number of samples of sediment from the upper 1-2 cm level of the sea floor surface for laboratory analysis. Microscopic examination of these samples has revealed the presence of living organisms, including resting spores from phytoplankton.

Sunday, September 24, was a bad day for Alvin. The weather was poor, and waves eight feet high pounded against the mother ship. The little submarine had just finished a dive and was attempting to enter the lifting cradle. Suddenly, a wave hit and Alvin surged into Lulu's starboard stern. The impact was so great that both Alvin's mechanical arm and sampling tray jerked free and sank into the ocean. The loss of the arm was very serious, for it reduced the ship's utility as a sampling tool by about two-thirds. Thus, the crew took Alvin down again, hoping to spot the missing manipulator. Although they were not successful, they did plant two submerged navigation aids to mark the area. Then Lulu, with Alvin aboard, returned to Woods Hole.

While members of the Woods Hole Deep Research Vehicle Group were making plans to search for the arm and building a special tray to pick it up, Alvin left for its next expedition. Eight dives were made during the period October 3-6. The special sound-scattering feature known as "Alexander's Acres," a midwater phenomenon peculiar to the Slope Water, was present at the diving site. The Woods Hole Institution has been studying this layer for a number of years, and has learned a good deal about its distribution, behavior, and acoustical characteristics. However, the big question still remained: "What animal was responsible?" Because of its acoustical properties, however, it was felt that some swim-bladdered schooling fish was the culprit.

Mechanical arm ready to take a rock sample from an outcrop in side of Oceanographer's Canyon at depth of 4700 feet.

During the first dive of the series, No. 226, Alvin descended to 2050 feet, which, as observed by surface echo sounder, is near the bottom of the layer. Alvin's sonar was put in operation, a conspicuous target was chosen, and Alvin closed it with lights off. At range "zero," the lights were turned on, and the submarine found itself in the middle of a large school consisting of thousands of lantern fish 50-60 mm long. Pilot McCamis drove Alvin through the school, catching dozens of specimens in the special net that had been rigged on the sampling basket. The whole procedure was repeated at this and other depths, always with the same result. The lantern fish were later identified as *Ceratoscopelus maderensis.*

Subsequent dives were spent in verifying the nature of these fish schools and studying their behavior. Photographs of Alvin's sonarscope were made for studying the spatial distribution of the *Ceratoscopelus* schools as compared to the spatial distribution of the sound scatterers observed with the surface echo sounder. Also, photographs were made of the fish schools themselves.

On October 11, the expedition departed Woods Hole for the purpose of searching for and recovering the lost mechanical arm. During the first two dives at the site, about two square miles of ocean bottom were searched. On the third dive, after a half hour on the bottom at 4300 feet, the arm was sighted—first by sonar and then visually. The special recovery tray developed by the institution's Deep Research Vehicle Group worked well. Both the arm and sample tray, which had been lying on the ocean bottom for three weeks, were recovered and brought to the surface.

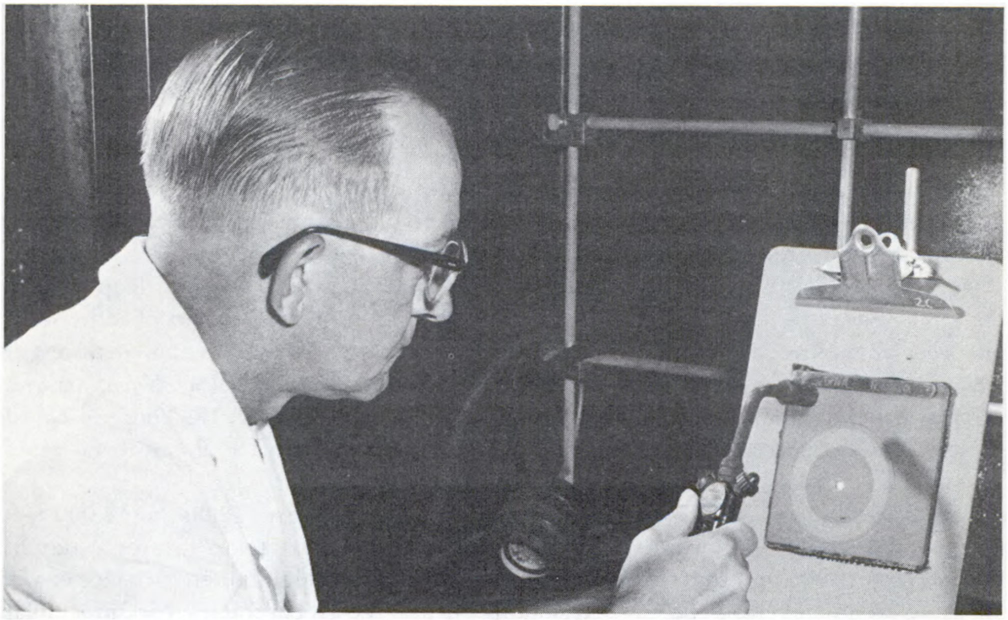
The remainder of the season was spent in making shallow dives in the vicinity of Woods Hole for geophysical and biological observations. As of November 1, a recapitulation revealed a total of 55 dives during the five-month operating cycle, an average dive duration of five hours, an average dive depth of 3265 feet, and a total of 13 dives in excess of 5000 feet.

Next year, Alvin will have help with its workload of oceanographic exploration. A sister ship is currently being built by Electric Boat, Groton, Connecticut under Navy contract, and is scheduled to be ready for operation in August 1968. Alvin and its partner, tentatively dubbed "Huey," will afford the opportunity to work as a team in the deep ocean studying acoustic phenomena, light transmission, and spatial distribution of temperature, salinity, biology, and currents.

The Second International Conference on Photosensitization in Solids will be held at the University of Arizona, Tucson, January 29-31. Additional information on this conference, which is sponsored by the ONR Physics Branch, may be obtained from Professor Gordon Tollin, University of Arizona.

Research Notes

NRL Finds Method to Prolong Life of Teflon Coatings



A. G. Sands applies a Teflon coating to vulcanized rubber with flame sintering technique

Naval Research Laboratory chemists have devised an application technique which substantially prolongs the useful life of Teflon coatings on vulcanized rubber.

In a recent issue of *Rubber Age*, A. G. Sands and E. J. Kohn, both of the NRL Chemistry Division, describe a flame-sintering technique which increases abrasion resistance of polytetrafluoroethylene coatings on vulcanized rubber without affecting the physical properties of the rubber.

Teflon, or polytetrafluoroethylene, is a widely used polymer originated and manufactured by du Pont. Its dry lubricant properties were discovered and put to wide naval use by NRL chemists over 15 years ago. Although a thin coating of Teflon sprayed on a metal surface had wear resistance, it was too limited when subjected to the abrasive action usually encountered in dynamic systems. This deficiency was overcome in 1950 by heating the coated metal item in a 650°F to 750°F oven for 20 seconds to 30 minutes.

Rubber, however, cannot sustain the time-temperature conditions required for the oven heat treatment without severe loss of physical properties. Sands and Kohn were successful in sintering the coating on rubber by carefully and quickly passing a high temperature (2660°F) flame of a blowpipe torch in a reciprocating motion over a coated surface area. When various signs indicated the coating was sintered, the flame was transferred to an adjacent area where the process was repeated.

Infrared sintering was also shown to be effective if a very thin aluminum heat barrier was first vacuum deposited on the rubber before the Teflon coating was applied. Without such a barrier, the rubber burned and charred.

It was also found that adding colloidal boehmite alumina to the Teflon spray dispersion promoted self-healing of any cracks in the coating when it was subjected to abrasive wear. Where cracks were present, peeling always was initiated at the crack edges in coatings not containing this additive.

Scripps-ONR Ocean-Buoy Pilot Program

A pilot program to investigate the vast central North Pacific and designed to obtain knowledge of ocean-atmosphere interaction and improve long-range oceanographic and meterological forecasting was recently announced by San Diego's Scripps Institution of Oceanography and the Office of Naval Research.

Initial observations and study of physical changes in the upper ocean layers will be made in a 4,000,000-sq-mile region extending some 1,000 miles south of the Aleution Islands. If the results of the pilot study warrant, plans for a long-range study will be made. Beneficiaries of such a study would include Navy vessels and aircraft, U.S. Weather Bureau forecasters, the U.S. Bureau of Commercial Fisheries, commercial fishermen, farmers, ship operators, and UNESCO's World Weather Watch, which is expected to become operational in the early 1970's.

Principal investigator for the study is John D. Isaacs, professor of oceanography at Scripps, and director of Scripps' Marine Life Research Group.

For this initial study, Scripps scientists and engineers, who have had deep-moored instrument stations under development since 1952, will install two clusters of four, deep-moored, unmanned, catamaran-type, floating instrument stations north and northwest of Hawaii. In the center of each cluster will be a 40-foot monster buoy (See *Naval Research Reviews* issue of January 1967, "The Monster Buoy"), developed for the Office of Naval Research by the Convair Division of General Dynamics. This buoy has already been tested extensively off the Florida coast and Bermuda.

The Scripps-developed instrumented stations, moored in water 12,000 to 18,000 feet deep, will record surface wind speeds and directions and water temperatures at depths extending to 1,000 or 1,500 feet below the surface. A separate station in each cluster will measure ocean currents. The moored stations will also record barometric pressures, solar radiation, and relative humidity.

The two Convair-developed stations will record water temperature, surface wind speed and direction, barometric pressure, precipitation, relative humidity, solar radiation, and wave height. They will telemeter data for immediate use by the scientists in various governmental groups. The Convair-ONR monster buoy Alpha, which was anchored off La Jolla, Calif. in early June by Scripps and Convair engineers, is presently undergoing long-range telemetry tests.

Organizations which are cooperating with Scripps and ONR in the study include the Weather Bureau, the Bureau of Commercial Fisheries, the Navy's Fleet Numerical Weather Facility of Monterey, Calif., the U.S. Coast Guard, the National Aeronautics and Space Administration, and other universities.

It is expected that measurements of several portions of the infrared spectrum of the ocean surface will be carried out and color photographs will be taken by NASA's Manned Orbital Laboratory aircraft during their instrument-calibration flights above the area. In this operation, the NASA-MOL would make its calibrations by means of the instrument stations used in the Scripps study. Pictures of the Pacific Ocean cloud pattern from satellites will be extensively used.

Poseidon Vehicle Tested

The first underwater launch of the Poseidon test vehicle was successfully completed at the Navy's Pop-Up Range at San Clemente Island, a test range of the Naval Undersea Warfare Center, Pasadena, California.

The Poseidon, like its predecessor, Polaris, is a Fleet Ballistic Missile designed to be launched from submerged submarines. However, Poseidon is larger, longer, and has twice the accuracy and payload of the Polaris.

The launch was the first in a series of eighteen underwater launch tests to be conducted during the next ten months at NUWC's test range by Westinghouse Electric Company for the Navy Special Projects Office. During these tests, the missile will be ejected by pressure from a generator similar to the one to be used to launch Poseidon from a submarine.

The test was a static shot to establish the compatibility of Poseidon with the launching system. In later tests, the launch vessel will be moving to simulate a submarine under way. The ultimate goal of the tests is to develop a submarine launch system for Poseidon.

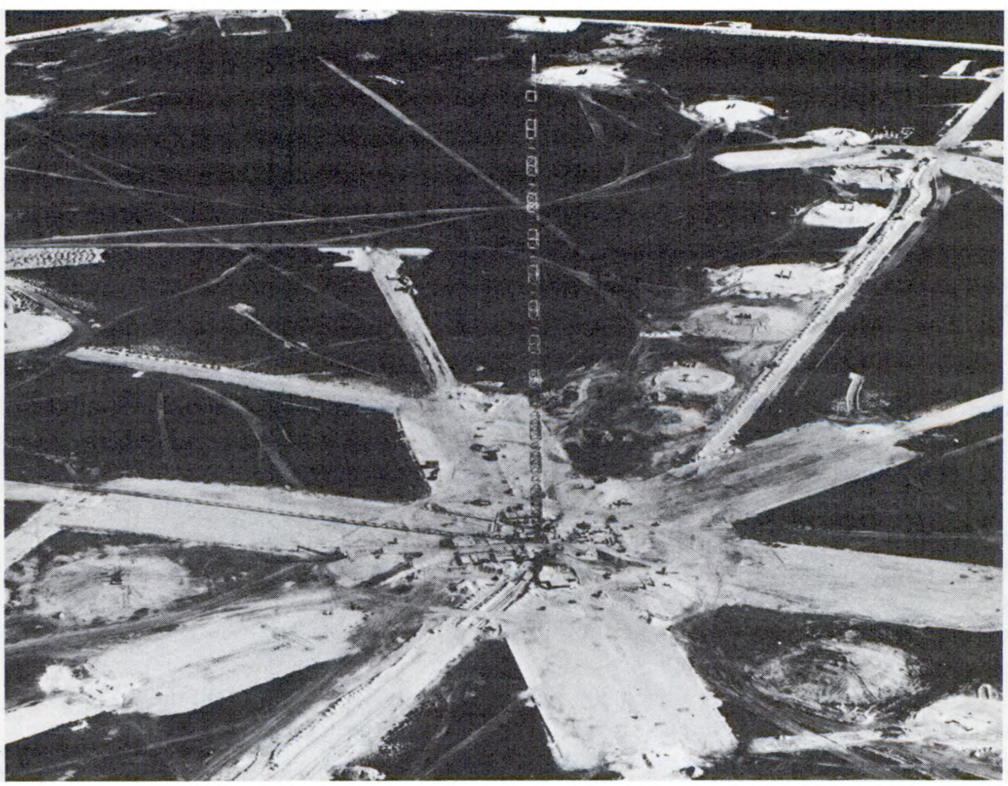
NCS Australia Becomes Operational

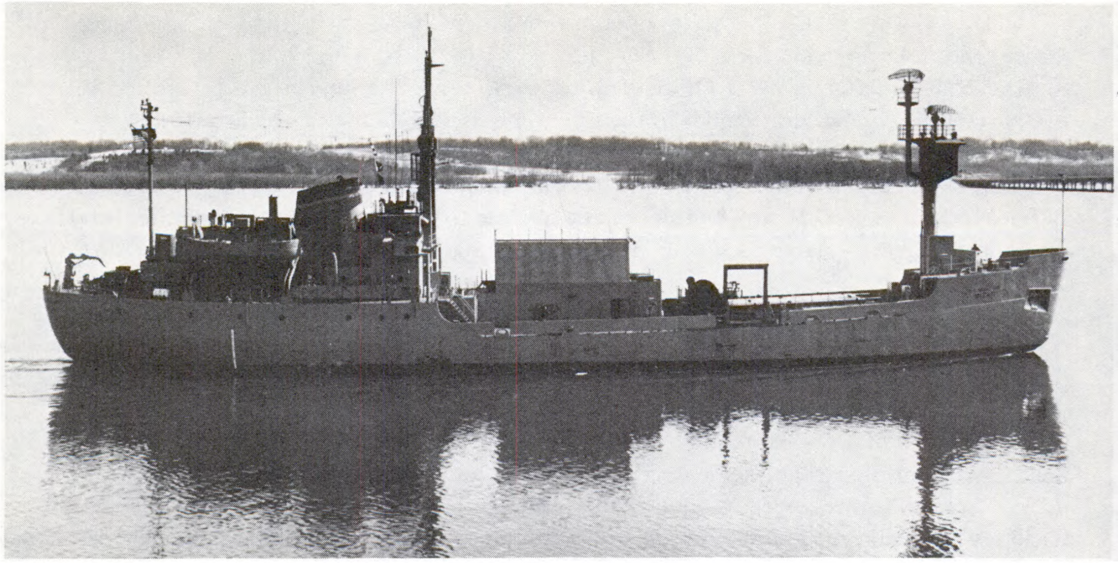
The U.S. Naval Communication Station, North West Cape, Western Australia, which became operational on September 1, 1967, is the highest man-made structure in the Southern Hemisphere. The station is the world's largest facility devoted to Very Low Frequency transmissions and was built under the guidance and direction of the Naval Facilities Engineering Command to improve communications to the Fleet in Far Eastern waters.

The station is located in an extremely remote and desolate area in Australia and is completely self-sufficient. The heart of the complex, Tower Zero, is 1271 feet high. The station is the culmination of ten years of planning, and more than four years of work by Australian and American craftsmen.

CAPT Robert Friedman, USN, Commanding Officer of the station, sent the following message to Australian and American government officials as the first official transmission:

> "AUSSIE AND YANK WORKING TOGETHER HAVE DONE IT AGAIN. ONE MILLION WATTS VLF ON THE LINE FROM NW CAPE AT 01000Z, SEPT 67."





MIZAR Returns to Sea

The USNS MIZAR, NRL's oceanographic research vessel which gained international recognition for locating the THRESHER hull in 1964 and for the major role played in recovering the H-bomb lost off the coast of Spain in 1966, has returned to sea after major modifications.

These modifications, which will provide increased research capability, improved support facilities, and more adequate accommodations, include the following:

- A chemistry-biology laboratory which will provide a new dimension to NRL's programs in chemical and biological ocean science research;
- A new machine shop and work space, complete with lathes, drill press, band saws, and associated equipment which will permit on-site routine maintenance of heavy equipment;
- Modified quarters for scientists which can comfortably accommodate up to 19 people, including office space and a combination lounge-conference room; and
- Minor modifications in the electronics and photographic laboratories.

The MIZAR was originally a small cargo ship designed for Arctic water operation. However, because of her exceptional width—52 feet—and excellent maneuverability at slow speeds, the ship was converted to a research vessel in 1964. Since that time, MIZAR has been used primarily for studying characteristics of the deep ocean, especially the ocean floor.

To accomplish these studies, sensors are mounted aboard an unmanned vehicle, lowered into the ocean, and towed along as the ship moves. Control signals flow down through a shielded coaxial cable in the center of the sensor vehicle's towing cable and sensor information flows up this cable. The sensors provide information for a wide variety of acoustic, optical and other oceanographic studies.

With a tracking system designed at NRL, scientists can determine the exact location of towed equipment at all times. The system consists of a digital computer used in conjunction with an array of hydrophones mounted on the ship's bottom. It can also be used to determine the ship's position in relation to a beacon on the ocean floor or to guide a free submersible.

Sensor vehicles and other towed equipment normally are lowered into the sea through a center well in the ship. An enclosure over the well area protects scientists and equipment from the weather.

On the Naval Research Reserve

NRR Article Inspires Training Duty

In October 1966, an article entitled "The Friction-Reducing Effects of High Polymers," by Dr. J. W. Hoyt of the then NOTS Pasadena, appeared in the *Naval Research Reviews*. LCDR D. M. McEligot, USNR, a member of NRRC 11-7, Tucson, and an associate professor in Aerospace and Mechanical Engineering at the University of Arizona, noted that the observations contained in the article, plus those found in other recent papers on the subject, were comparable to some phenomena he had observed in his investigations of heat transfer to low Reynolds number, turbulent, gas flows. Thus, with a student to assist him, he undertook a side effort to survey some of the data for pipe flow of polymer solutions.

Meanwhile, a quota was requested and granted for active duty for training (ACDUTRA) with Dr. Hoyt's group. LCDR McEligot participated in the program. Because of the preparatory work he had done as a result of the above-named article, LCDR McEligot felt that the training was the most fruitful he had ever received—both from his viewpoint and that of the Navy. Necessary orientation took only a few hours; the remainder of the two weeks was spent in productive labor.

The first week was spent in studying the feasibility of several experiments with polymer solutions and extending the results of an existing analysis for the pressure drop in tubes. The second week was devoted to measurements of drag reduction with the polymer solutions in the laminar-to-turbulent transition range for pipe flow. Although only rough plots of the results obtained were constructed during the experiments, LCDR McEligot is using them to continue his studies in data reduction for the voluminous measurements at the University of Arizona. He is currently writing a computer program to eliminate hand calculations, and reading pressure drop data from the oscillograph records. When completed, the final results of the studies will be forwarded to the Naval Undersea Warfare Center, Pasadena (formerly NOTS).

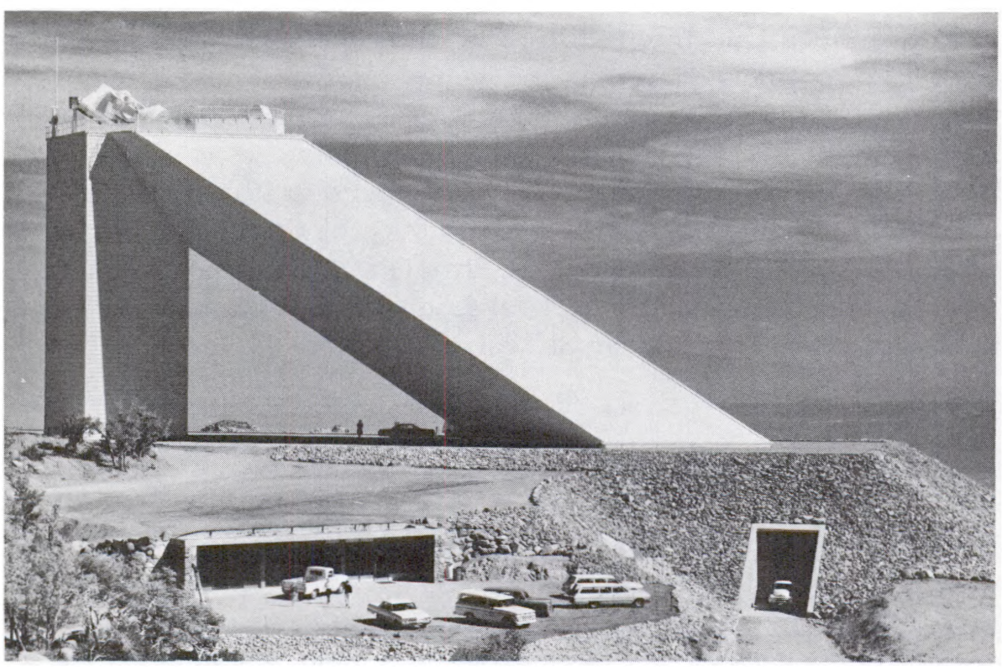
American Nuclear Society President Addresses NRRC 11-7

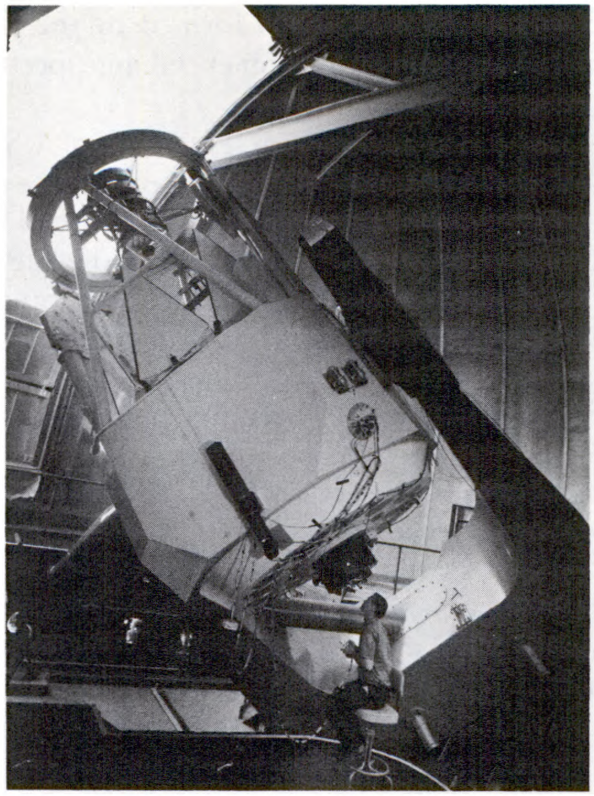
Norman Hilberry, the National President of the American Nuclear Society, was the featured speaker at the annual dinner meeting of NRRC 11-7, Tucson, Arizona. After describing the mobilization of scientific manpower for the Manhattan Project at the beginning of World War II, Mr. Hilberry discussed the progress made through the years that has led to great technical achievements. His presentation included many humorous anecdotes which illustrated the ever-present human element. Of particular interest to Company members was the analogy to the mission of the Research Reserve and the manner in which it was accomplished twenty-five years ago: the earlier versions of mobilization orders were simply telegrams from one scientist to another asking the latter to obtain a leave of absence from his job to work on an important secret government project.

The toastmaster for the evening was Philip H. Krutzsch, former CO of NRRC 11-7 and Assistant Dean of the new Medical College at the University of Arizona. The audience included a wide spectrum of members, past members, prospective members and their wives. The pleasant and informative meeting was held at the Commissioned Officers Mess, Davis-Monthen Air Force Base, Tucson.

NRRC 11-7 Visits Kitt Peak National Observatory

The Kitt Peak National Observatory has been the focal point of several recent meetings of NRRC 11-7, which normally meets at the University of Arizona, Tucson. Mr. James M. Miller, Associate Director of the national facility, arranged for members of NRRC 11-7 to tour KPNO offices, laboratories and shops in Tucson during their September meeting, and to take a trip to the observatory at Kitt Peak for their





Members of NRRC 11-7 inspected the 84-inch stellar telescope at Kitt Peak Observatory

next meeting. Also, at later sessions, KPNO personnel discussed "Latest Developments in the Technology of Large Optics" and "Labor Negotiations in a Research Facility." Mr. Miller, a LCDR in the Naval Reserve, is a member and former CO of NRRC 11-7.

At KPNO's Tucson headquarters, the unit toured instrument, electronics and machine shops; engineering departments; mirror finishing and testing facilities; the library; and the computer facility which includes a CDC 3200 high-speed digital computer. Following the tour, the group met in the conference room to discuss the 150-inch telescope being constructed for the mountain site and the possibility of constructing a much larger telescope in the future. Films and recent photographs of KPNO's southern hemisphere observing site at Cerro Tololo, Chile, completed the presentation.

At the Kitt Peak National Observatory, 53 miles southwest of Tucson, NRRC 11-7 members and several prospective members first viewed a 36-inch remote controlled (from Tucson) telescope. This telescope has served as part of a feasibility study in connection with orbiting astronomical telescopes and for remote operation and data processing operations for the Cerro Tololo site. Next, the unit examined operating stellar telescopes, ranging in size from 16 inches to 84 inches, and inspected the progress of the construction of an additional 36-inch stellar telescope. A trip through the 500-foot McMath solar telescope highlighted the visit: the unit visited the 80-inch heliostat on top, traveled down the diagonal path formed by the water-cooled windshield, and interviewed an astronomer taking spectrographic measurements in the observing room.

The National Science Foundation, which has supported the Kitt Peak Observatory from its inception, executed a contract with the Association of Universities for Research in Astronomy, Inc. in December 1957 during the final days of the site survey. AURA, a non-profit corporation formed in 1957, is made up of the following universities: University of California, University of Chicago, University of Texas, Harvard University, Indiana University, University of Michigan, Ohio State University, Princeton University, University of Wisconsin, and Yale University. When Kitt Peak was selected as the site for a national astronomical observatory, AURA located its headquarters in Tucson and commenced construction.

Kitt Peak was selected after a survey and testing program that lasted three years and included studies of over 150 mountain ranges, mostly in the southwestern part of the United States. The survey employed all available means, ranging from rocket photographs to foot and horseback travel. Kitt Peak's combination of unusually clear weather, minimum air turbulence, remoteness, vegetation cover, and suitable summit area resulted in its selection in 1958. Also, the fact that it was located near a university that could provide support contributed to its selection.

The mountain observing station is a self-contained community. The basic utilities include water collection and storage systems, electrical power, and a fire control system. Other support facilities include a maintenance garage, shops, warehouse, offices, dining-recreation building, sewage disposal system, and weather station. Also, roads had to be incorporated in the site plan to support the telescope operations.

Sixty percent of the observatory's telescope time is allotted to qualified visiting astronomers and advanced graduate students; 40 percent is utilized by the observatory's own staff. Although the resident astronomers maintain homes in Tucson, they, along with the visiting astronomers, occupy dormitory rooms during observation periods on Kitt Peak. Only the necessary maintenance staff lives in houses on the mountain.

The current program is perhaps the most concentrated dosage NRRC 11-7 has received in astronomical topics. However, astronomy has been popular in the unit for the last several years, primarily because of the large number of telescopes that have been located in the state of Arizona. Previous speakers on this topic include Professor R. H. Noble, of the Stewart Observatory, who discussed "Optical Aspects of Astronomy," and KPNO's "Red" Ludden (formerly at Lick Observatory), who discussed "Optical Materials and Metallurgy in the Design of Modern Astronomical Telescopes."

Computer Programming Course Conducted

One of the objectives of the Research Reserve training program is to increase the reservist's readiness by enabling him to prepare for his probable mobilization assignment. Since the use of high-speed digital computers is becoming ever more important in the technology-oriented Navy, NRRC 11-7 recently conducted a concentrated course in computer programming.

In the initial session, a rough history of computer development during the last decade was presented from the user's point of view. By tracing the evolution of computers from machine language programming on the IBM 650 to the almost human language programming of the current CDC 6600 system, along with a description of the equipment, it was possible to give a rapid initial orientation. This overview was completed by the presentation of a simple data reduction program in FORTRAN and a description of the sequence in which it would be processed by the SCOPE monitor system.

The second and third meetings were devoted to detailed instruction in the BASIC FORTRAN language. This was deemed proferable to the newer, more versatile FORTRAN IV since some of the computers available for practice would not accept the latter language. The last two sessions were devoted to practical work: the first programming assignment was a simple navigation problem and the second was a treatment of statistical uncertainties in data reduction from biological experiments. A field trip is being planned which will permit members to process the programs on a local computer.

Instructors were Dr. D. E. Bryan, Arizona Field Station, USDA; Dr. R. L. Voigt, University of Arizona; and Dr. D. M. McEligot, University of Arizona. All are members of NRRC 11-7.

NRRC 13-6 Arranges Navy Day Activities

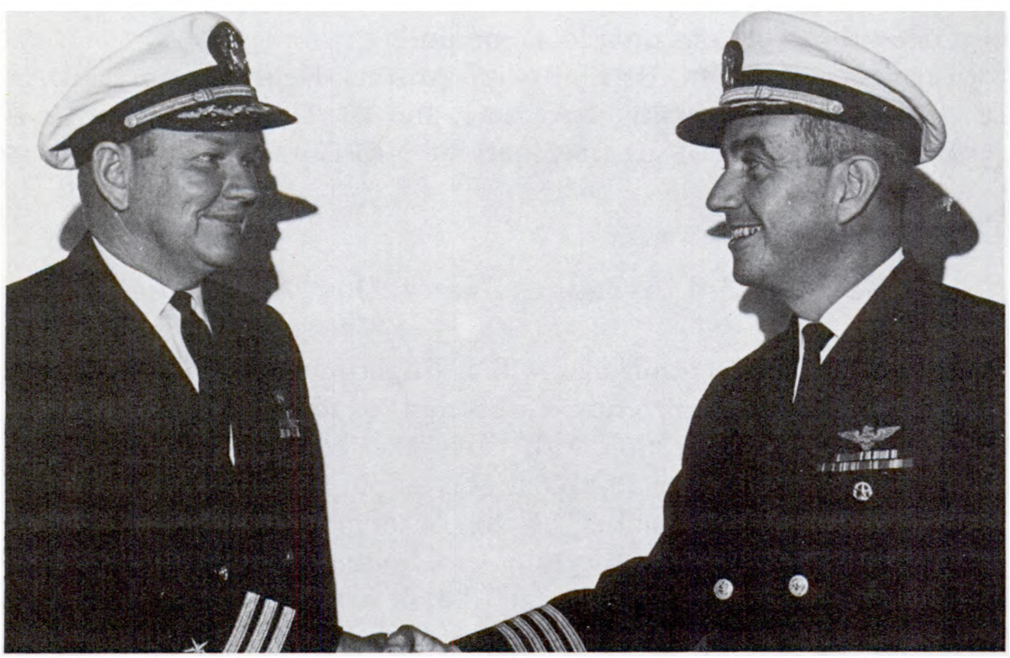
RADM Draper L. Kauffman, USN, Superintendent of the Naval Academy, Maryland, recently completed a tour of northwestern United States in connection with Navy Day ceremonies being held during the week October 23-27. He was accompanied by Midshipman Jeffrey A. Cook, Commander of the Academy's 4000-man brigade.

One city visited during the tour was Boise, Idaho, where RADM Kauffman was the chief speaker at Idaho's first annual Navy League Convention, which opened on October 23. CAPT Thomas J. Wadsworth, USNR-R, Commanding Officer of NRRC 13-6, participated in and represented the Research Reserve at the Convention. All Navy Day activities in southeast Idaho were arranged by NRRC 13-6.

Members of NRRC 13-6 greet Superintendent of Naval Academy. Left to right: CAPT B. Colwell, USNR; Midshipman Jeffrey A. Cook; RADM D. L. Kauffman, USN, Academy Superintendent; and CAPT T. J. Wadsworth, USNR.

RADM Kauffman noted the tremendous improvements that have taken place at the Academy over the last several years. Also, he mentioned that ONR research funds (in connection with the Trident Scholar Program) have had a very healthy effect on the Academy's scientific staff and curriculum.

CDR Johnson Research Reserve Assistant



CDR John P. Johnson, USNR (left) is welcomed aboard ONR Branch Office, Pasadena by CAPT J. D. Kuser, USNR, Director. CDR Johnson has assumed the duties of Research Reserve Assistant for the 11th, 12th, and 13th Naval Districts.

Selected Contract Research Reports

The contract research reports listed below have been extracted from the U.S. Government Research & Development Reports 67, No. 18 and 19 of 25 September and 10 October 1967. Government agencies and their contractors who are registered with the Defense Documentation Center of the Defense Supply Agency may obtain *free* copies from the Center at Cameron Station, Alexandria, Virginia 22314. Abstracts of the reports are found in USGRDRs 67, No. 18 and 19.

For non-DDC users, most reports may be purchased from the Clearinghouse for Federal Scientific and Technical Information, Department of Commerce, Springfield, Virginia 21151.

AERONAUTICS

Three-Component Measurements on Rectangular Wings With Cavitation, Final Report; Max-planck-institut Fur Stromungsforschung, Gottingen (West Germany); Reichardt and Sattler; AD-652 393

Helicopter Rotor Blade Radar Antenna; Bell Helicopter Co., Forth Worth, Texas; Upton and Young; AD-656 439

ASTRONOMY AND ASTROPHYSICS

An Experimental Study of Taylor Columns'; Woods Hole; Hide and Ibbetson; AD-656 027

Astrophysical Problems; CalTech; Tombrello; AD-656 150

Spectral Studies of Materials Possibly Present on the Martian Surface; Texas Technological Coll., Lubbock; Draper and Adamcik; AD-655 257

Instabilities in Highly Evolved Stellar Models; CalTech; Rakavy and Shaviv; AD-655 493

On Some Coincidences Between Wavelengths of Absorption Features in HZ 29 and in Quasi-Stellar Objects; Calif. U., San Diego; Burbidge *et al;* AD-655 494

On the Inversion of the Density Gradient at the Fringe of the Convection Zone; CalTech; Chitre and Shaviv; AD-655 495

On the Necessity of Schwarzschild's Criterion for Stability; CalTech; Lebovitz; AD-655 497

Predicted Emission Spectra of Quasi-Stellar Sources in the Far Ultraviolet; CalTech; Bahcall and Sargent; AD-655 498

Primordial Element Formation, Primordial Magnetic Fields, and the Isotropy of the Universe; CalTech; Thorne; AD-655 524

Model Stellar Atmospheres; Texas U., Austin; Edmonds, Jr.; AD-655 663

On the Cosmological Distortion Effect; Washburn Observatory, Madison, Wis.; Kristian; AD-655 718

ATMOSPHERIC SCIENCES

The Energy Dependence of the Fragmentation Parameters and Mean Free Paths of Cosmic Ray Nuclei With Z Greater Than or Equal to 10 (+); Minnesota U.; Cleghorn *et al;* AD-656 046

The Absorption of X-Rays by Interstellar Gas; Queen's U., Belfast (Northern Ireland); Bell and Kingston; AD-656 352

The Energy Spectrum of the Z> or −20 Component of the Cosmic Radiation; Minnesota U.; Freier and Waddington; AD-656 432

The Charge Distribution of the Energetic Very Heavy Nuclei in the Primary Cosmic Radiation; Minnesota U.; Mathiesen *et al;* AD-656 433

On the Energy Fluxes of Low-Energy Protons and Positive Ions in the Earth's Inner Radiation Zone; Iowa U.; Frank and Swisher; AD-656 627

Solar Radiation and Atmospheric Absorption in the MM Wave Region; Calif. U., Berkeley; Silver; AD-656 754

Ionospheric Perturbations and Schumann Resonance Data; M.I.T.; Nelson; AD-656 761

Research on the Dynamics of Air-Sea Interaction; M.I.T.; Mollo-Christensen; AD-655 471

BEHAVIORAL AND SOCIAL SCIENCES

Some Advantages and Disadvantages of Small Scale Industry in a Highly Industrialized Economy; Kalamazoo Coll., Mich.; Bradfield and Del Aguila; AD-655 296

Optimal Investment Policy: An Example of a Control Problem in Economic Theory; Harvard U.; Dobell and Ho; AD-655 563

Welfare, Static and Dynamic Solution Concepts; Yale U.; Shubik; AD-655 824

Measuring the Quantities of Fixed Factors; Stanford U.; Gorman; AD-655 826

Crosslanguage Study of Perceptual Confusion of Plosive Phonemes in Two Conditions of Distortion; Ohio State U.; Singh and Black; AD-655 319

Relationship of Goal Level to Performance Level; American Institutes for Research, Silver Spring; Locke; AD-655 197

Pitch Judgments of Octave Pure Tones; Ohio State U.; Swigart and Black; AD-655 321

Optimal Maintenance Policy and Sale Date of a Machine; Carnegie; Thompson; AD-656 029

Performance in an Auditory Vigilance Task While Simultaneously Tracking a Visual Target; Douglas Aircraft Co., Inc., Long Beach, Calif.; Baker and Harabedian; AD-656 437

Computer-Assisted Explanation: A Guide to Explaining: and Some Ways of Using a Computer to Assist in Clear Explanation; Information International Inc., Cambridge, Mass.; Berkeley; AD-655 915

Administrative Training and Research Using Small Group Exercises. Combining Management Training and Research; Pittsburgh U.; Bass; AD-655 992

The Socialization of Academic Motivation in Minority Group Children; Mich. U.; Katz; AD-656 724

Configural Analysis; Wash. U.; Fox; AD-655 921

Techniques for Investigation of the Structure of Individual Differences in Psychological Phenomena; Ill. U.; Tucker; AD-655 930

Components of Decisions in a Simulated Environment; Rutgers; Castore and Streufert; AD-656 367

Leadership in Negotiations and the Complexity of Conceptual Structure; Rutgers; Streufert *et al;* AD-656 368

Studies of Memory Transfer in Rats; Cornell U.; Rosenblatt; AD-656 488

Social Structure and Shifting Agriculture of the White Meo; Wildlife Management Inst., Wash., D.C.; Binney; AD-655 931

Impact of Modernization in the Philippines; Pa. St. U.; Guthrie and Lynch; AD-656 122

BIOLOGICAL AND MEDICAL SCIENCES

Non-Thermal Effects of Alternating Electrical Fields on Biological Structures; Pa. U.; Schwan and Sher; AD-656 736

The Role of Putrescine in Microbial Metabolism; N. Hampshire U.; Durham; Herbst; AD-656 737

Corticoid Therapy for Pretibial Myxedema. Observations on the Long-Acting Thyroid Stimulator; Clinical Investigation Center, Oakland, Calif.; Benoit and Greenspan; AD-656 554

Controlling a Lethal Growth Process; Purdue U.; Neuts; AD-656 484

A Bibliographical Sourcebook of Compressed Air, Diving and Submarine Medicine; Medical Coll. of Va., Richmond; Hoff and Greenbaum, Jr.; AD-656 674

Actinomycin D Inhibition of Amino Acid Transport in Streptococcus Faecalis; City of Hope Medical Center, Duarte, Calif.; Holden and Utech; AD-655 560

Isolation and Properties of Polyribosomes From Cerebral Cortex; Indiana U.; Campagnoni and Mahler; AD-655 676

The Physical Basis of Coding and Reliability in Biological Evolution; Stanford U.; Pattee; AD-655 232

Effects of Redox and Sulfhydryl Reagents on the Bioelectric Properties of the Giant Axon of the Squid; M.I.T.; Huneeus-Cox *et al;* AD-655 708

Electrochemically Active, Fieldtrainable Pattern Recognition Systems; Space-General Corp., Los Angeles; Stewart *et al;* AD-655 650

Parasites in School Children of I-Lan and Peng-Hu Hsiens: and Adults in I-Lan and Chang-Hua Hsiens, Taiwan; Southwest Foundation for Research and Education, San Antonio, Texas; Kuntz and Wells; AD-655 670

Survey of Intestinal Parasites of School Children in Kee-Lung Shih: Hua-Lien, Tao-Yuan, Nan-Tou, Chang-Hua and Ping-Tung Hsiens, Taiwan; Southwest Foundation, San Antonio; Kuntz; AD-655 671

Contractility of Ventricular Strips as Related to Hibernation and Temperature; Colorado State U., Ft. Collins; South; AD-655 587

Hibernation and Preferentially Chosen Environmental Temperatures; Colorado State U.; Gumma *et al;* AD-655 588

CHEMISTRY

Optimal Control of Distributed Parameter Chemical Reactions; Northwestern U.; Chang; AD-655 468

Preparation and Properties of Some Fluoroalanes; Dow Chemical Co., Midland, Mich.; Flagg and Schmidt; AD-655 830

Mass Spectrometric Study of Homogeneous Nucleation in Free Jets; Midwest Research Inst., Kansas City, Mo.; Milne and Greene; AD-655 292

The Mass Spectrometric Detection of Dimers of Nitric Oxide and Other Polyatomic Molecules; Midwest Research Inst.; Milne and Greene; AD-655 454

Electronic Spectra of Aza-Aromatics in Polymer Matrices; Calif. U., Santa Barbara; Park *et al;* AD-655 464

B6H10 Preparation; Space General, Los Angeles; Gerhart and Williams; AD-656 593

Electrochemical Studies in the Synthesis of N-F Compounds; Tracor, Inc., Austin, Texas; Spears *et al;* AD-442 627

The Oxidation and Pyrolysis of Ethylene in Shock Waves; Harvard; Homer and Kistiakowsky; AD-656 040

Correction for Double Layer Charging During Stripping of Adsorbed Layers; Tyco Labs, Inc., Waltham, Mass.; Brummer; AD-656 044

The Correction for Electrode Oxidation During the Anodic Estimation of Adsorbate Coverage on Smooth Pt Electrodes; Tyco Labs; Brummer and Cahill; AD-656 048

Test of the Direct Interaction Model for Atomic Reactions: Correlation of the Outgoing Electrons in Electronic Ionization; N.Y. Univ.; Glassgold; AD-656 052

The Energetics of Ion Transport in the Presence of Polymeric Compounds Which Alter the Rheological Properties of Water; Little (Arthur D.) Inc., Cambridge, Mass; Horne *et al;* AD-656 058

Bound States of an Electron in a Dipole Field; Queen's U.; Crawford and Dalgarno; AD-656 353

Specific Volumes of Water at High Pressures Obtained From Ultrasonic-Propagation Measurements; Harvard U.; Vedam and Holton; AD-656 440

Optical Potential for a Chemically Reactive System; Va. U.; Eu and Ross; AD-656 638

Research in Atomic and Molecular Properties by the Molecular Beam Method; Columbia Radiation Lab, New York; Kusch; AD-656 734

EARTH SCIENCES AND OCEANOGRAPHY

The Influence of Natural Light on the Vertical Migrations of an Animal Community in the Sea; Scripps; Boden and Kampa; AD-656 004

Marine Borer and Fouling Studies; Clapp (William F.) Labs, Inc.; Duxbury, Mass.; AD-656 090

Israel South Red Sea Expedition Reports, Bulletin No. 43, 1962; Tel-Aviv U.; AD-656 727

Israel South Red Sea Expedition Reports, Bulletin No. 46, 1962; Tel-Aviv U.; AD-656 728

A Submerged Holocene Shoreline Near Block Island, Rhode Island; R.I. Univ., Kingston; McMaster and Garrison; AD-656 143

Temporal Precision in Beach Profiling; La. St. Univ.; Ferm and Dolan; AD-656 145

Potential Applications of Magnetic Gradients to Marine Geophysics; M.I.T.; Byrd, Jr.; AD-655 892

Porphyrins of High Molecular Weight in a Triassic Oil Shale: Evidence by Gel Permeation Chromatography; Woods Hole; Blumer and Snyder; AD-656 223

Measurement and Interpretation of Motional Electric Fields in the Sea; M.I.T.; Sanford; AD-655 891

Track Charts and Bathymetry, USNS Josiah Willard Gibbs (T-AGOR 1) Operation 240, North Atlantic Ocean, 21 September 1966-3 October 1966; Columbia U.; Fleming and Cherkis; AD-656 718

Internal Behavior in Fish Schools; Cornell U.; McFarland and Moss; AD-655 694

The Structure of Polynomial and Fourier Coefficient Matrices; Northwestern U.; Krumbein; AD-655 445

The General Linear Model in Map Preparation and Analysis; Northwestern U.; Krumbein; AD-655 446

The Directional Swell Spectrum off Block Island; Stevens Inst. of Tech., Hoboken, N.J.; Rank *et al;* AD-655 465

Dynamic Characteristics of West Florida Gulf Coast Beaches; Univ. of S. California, Los Angeles; Gorsline; AD-655 562

Development of an Ocean Data Station Telemetering Buoy; General Dynamics/Convair, San Diego, Calif.; AD-655 618

The Normally-Incident Reflectivity of the Sea Floor at 12kc and its Correlation With Physical and Geological Properties of Naturally-Occurring Sediments; Woods Hole; Breslau; AD-655 245

Fortran IV Computer Programs for Markov Chain Experiments in Geology; Northwestern U.; Krumbein; AD-655 447

Sedimentologic Studies of the Colorado Delta; U. of S. Calif., Los Angeles; Gorsline; AD-655 631

San Andreas Fault North of Point Arena, California; Scripps; Curray and Nason; AD-655 709

Cenozoic Orosphaerid Radiolarians From Tropical Pacific Sediments; Scripps; Riedel and Friend; AD-655 714

Structure of the Western Somali Basin; Woods Hole; Bunce *et al;* AD-655 742

Track Charts, Bathymetry, and Location of Observations, North Atlantic Ocean and Caribbean Sea; Woods Hole; Bumpus and Dunkle; AD-655 427

Contrasts in Coastal Bay Sediments on the Gulf and Pacific Coasts; U. of S. Calif., Los Angeles; Gorsline; AD-655 561

Deep Water Internal Waves Study; Lockheed-Calif., Burbank; Carsola; AD-655 630

Late Tertiary Biostratigraphy (Planktonic Foraminifera) of Tropical Indo-Pacific Deep-Sea Cores; Scripps; Parker; AD-655 715

Quasi-Synoptic Monthly Hydrography of the Transition Region Between Coastal and Slope Water South of Cape Cod, Massachusetts; Woods Hole; Cresswell; AD-655 639

Further Observations on the Secondary Nitrite Maximum in the Northern Equatorial Pacific; Scripps; Wooster; AD-655 712

ELECTRONICS AND ELECTRICAL ENGINEERING

A General Purpose Video Input Device for a Digital Computer; Bold, Beranek and Newman Inc., Cambridge, Mass.; Strollo and Teitelman; AD-655 642

Response Characteristics of a Savonius Rotor Current Meter; Woods Hole; Fofonoff and Ercan; AD-655 641

Some Aspects of Pattern Recognition by Computer; M.I.T.; Guzman-Arenas; AD-656 041

Optimum Quantization of Random Sequences; Harvard; Gish; AD-656 042

Information Theory, Learning Systems, and Self-Organizing Control Systems; Scope Inc., Falls Church, Va.; Uffelman; AD-656 082

MATERIALS

Physical and Mechanical Properties of Poly-m-Carboranylene-siloxane Copolymers; Princeton; Sperling *et al;* AD-656 049

MATHEMATICAL SCIENCES

Asymptotic Normality of the Maximum Likelihood Estimate in Markov Processes; Wisconsin U.; Roussas; AD-656 032

An Asymptotic Expansion for Posterior Distributions; Wisconsin U.; Johnson; AD-656 033

The Separate Computation of Arcs for Optimal Flight Paths With State Variable Inequality Constraints; Harvard; Speyer *et al;* AD-656 394

Estimation Using Sampled-Data Containing Sequentially Correlated Noise; Harvard; Bryson, Jr. and Henrikson; AD-656 396

Two Queues in Series With a Finite Intermediate Waiting-room; Purdue U.; Neuts; AD-656 483

Some Results on Almost Sure and Complete Convergence in the Independent and Martingale Cases; Purdue U.; Stout; AD-656 485

The Delivery Problem; Carnegie Tech.; Hayes; AD-656 030

L-Shaped Linear Programs With Applications to Optimal Control and Stochastic Programming; Calif. U., Berkeley; Van Slyke and Wets; AD-656 045

A Class of Models for Adaptive Experimentation and Control; M.I.T.; Hurst; AD-656 470

General Solution for the Economic Design of X-Charts Based on Duncan's Model; Wisconsin U.; Wu and Groel; AD-656 596

The Role of Plausible Reasoning Within Military Intelligence: An Application of Bayes Theorem as a Model for Problem Solving; HRB-Singer Inc., State College, Pa.; Blunt *et al;* AD-656 597

Flows in Arborescences; Carnegie Tech.; Glover; AD-656 626

Price Strategy Oligopoly With Product Variation; Yale U.; Shapley and Shubik; AD-656 721

On Adaptive Nets; Bell Aerosystems Co., Buffalo; Powell; AD-656 764

Likelihood Ratio Tests for Restricted Families; Boeing Scientific Research Labs, Seattle, Wash.; Barlow; AD-655 200

An Algorithm for an Automatic General Polynomial Solver; Stanford U.; Jenkins and Traub; AD-655 230

Recursive Algorithms for Pattern Classification; Harvard U.; Blaydon; AD-655 239

Partial Regularity Results for Nonlinear Elliptic Systems; Calif. U., Berkeley; Morrey, Jr.; AD-655 293

Rate of Convergence in Singular Perturbations; Kansas U., Lawrence; Greenlee; AD-655 448

The Existence of Indempotents in Certain Operator Algebras; Cornell U.; Farrell; AD-655 556

On the Lack of a Uniformly Consistent Sequence of Estimators of a Density Function in Certain Cases; Cornell U.; Farrell; AD-655 557

The Nonsymmetric Game: The Generalized Beat-the-Average Solution; Yale U.; Levitan and Shubik; AD-655 626

Multivariate Optimality Results; Cornell U.; Kiefer; AD-655 711

Analysis and Synthesis of Linear Models for Time Series; Stanford U.; Parzen; AD-655 827

The Estimation of Coherence; Stanford U.; Nettheim; AD-655 828

Time Series Analysis for Models of Signal Plus White Noise; Stanford; Parzen; AD-655 829

Implicit Enumeration Using an Imbedded Linear Program; Calif. U., Los Angeles; Geoffrion; AD-655 444

Inventory Control of a Multiproduct System With a Limited Production Resource; Calif. U., Los Angeles; Evans; AD-655 612

Maximizing Stationary Utility in a Constant Technology; Yale U.; Beals and Koopmans; AD-655 627

MECHANICAL, INDUSTRIAL, CIVIL, AND MARINE ENGINEERING

Design of the Adaptive Feedback Loop in Parameter-Perturbation Adaptive Controls; Harvard; Kronauer and Drew; AD-655 555

Linearized Theory of a Partially Cavitating Plano-Convex Hydrofoil Including the Effects of Camber and Thickness; CalTech; Wade; AD-655 318

Finite Width Effects on the Self-Acting Foil Bearing; Columbia U.; Eshel and Elrod; AD-802 009

Shake Table Tests of a Spiral Grooved Journal Bearing; Mechanical Technology, Inc., Latham, N.Y.; Malanoski; AD-656 398

Investigation of the Time Dependent Wake Measured on a Submarine Body; Littleton Research and Engineering Corp., Mass.; Reed *et al;* AD-656 055

Buckling of Vessels Composed of Combinations of Cylindrical and Spherical Shells; Weidlinger, New York; Harari and Baron; AD-656 639

METHODS AND EQUIPMENT

A Cosmic Ray Program for the Study of Strong Interaction Physics in the Range of 100-1000 GeV; Mich. U.; Jones; AD-655 908

Transducer Calibration Facility at San Vicente Lake; Scripps; Gibson and Lewis; AD-656 467

Simple Circuit for Obtaining Rastered Oscilloscope Displays on Tektronix Oscilloscopes; Cornell U.; Marsters and Wachsler; AD-655 193

ANIP Flight Path Generator Final Report and Maintenance Instructions; Douglas Aircraft Co., Inc., El Segundo, Calif.; AD-655 298

PHYSICS

Light Diffraction by Ultrasonic Surface Waves; Georgetown U., Wash., D.C.; Mayer and Lamers; AD-655 466

Effects of Multiple Paths on Acoustical Signals; Tufts U.; Batteau; AD-655 637

Ultrasonic-Velocity Measurements in Water at Pressures to 10,000 kg/sq cm; Harvard U.; Holton; AD-655 659

On the Propagation of Longitudinal Stress Waves in Finite Solid Elastic Horns; Texas U., Austin; Martin; AD-655 683

Axisymmetric Stress-Wave Propagation Across the Plane Interface Between Two Cylindrically-Bounded Media; Texas U., Austin; Miller; AD-655 689

Calculation of B/A for Water From Measurements of Ultrasonic Velocity vs. Temperature and Pressure to 10,000 kg/sq cm; Harvard U.; Hagelberg *et al;* AD-655 693

Rebinder Effects in MgO; Martin Co., Baltimore, Md.; Westwood *et al;* AD-655 455

Orientation Relations in Simple Thin Film-Substrate Combinations; Georgia Tech.; Gerdes and Young; AD-655 652

A Fortran Program for the Calculation of Compressible Laminar Boundary Layers; N.Y. Univ.; Anton; AD-655 237

Lagally's Theorem for Multipoles; Iowa U.; Landweber; AD-655 199

On Computation of Flow Patterns of Compressible Fluids in the Transonic Region; Stanford; Bergman *et al;* AD-655 472

Condensation of Supersaturated Organic Vapors in a Supersonic Nozzle; M.I.T.; Dawson; AD-655 473

Boundary Layer Over a Thin Needle; Minnesota U.; Lee; AD-655 558

The Uniqueness of Certain Flows in a Channel With Arbitrary Cross Section; N.Y. Univ.; Peters; AD-655 643

A Numerical Solution of the Boltzmann Equation for a Two-Dimensional Gas; Calif. U.; Berkeley; Robben; AD-655 647

Space-Time Correlations of Velocity and Pressure and the Role of Convection for Homogeneous Turbulence in the Universal Range; Trg., Inc., Melville, N.Y.; Chase; AD-655 841

Variable Energy Extraction From a Negative Ion Cyclotron and Related Measurements; Calif. U., Los Angeles; Paul; AD-655 840

Elastic Electron Scattering From 13C; Stanford; Crannell *et al;* AD-655 453

*Structure of 7Be (II). The 6Li (p,p")6Li** and 4He(3He,p") 6Li** Reactions;* CalTech; Harrison; AD-655 500

Structure of 7Be (I). The 6Li (p,p')6Li Reaction;* CalTech; Harrison; AD-655 501

Stimulated Emission From the Upper Hybrid Resonance in a Magnetoplasma; Lockheed Missiles and Space Co., Palo Alto, Calif.; Hill *et al;* AD-655 450

Kinetic Equations for Plasmas; Polytechnic Inst. of Brooklyn; Koga; AD-655 615

A Connection Between SU (3) and O (4); Ill. U.; Ravenhall *et al;* AD-655 653

Ultrasonic Equation of State of Tantalum; Case Inst. of Tech.; Chechile; AD-655 640

Underwater Acoustic Imaging; Lockheed Missiles and Space Co., Palo Alto, Calif.; Green; AD-656 091

Scattering From Time-Varying Rough Surfaces; Bell Telephone Labs, Inc., Whippany, N.J.; Parkins; AD-656 549

Underwater Sound Propagation in the Straits of Florida: The MIMI Experiment of 3 and 4 February 1965; Mich. U.; Unger and Veenkant; AD-656 636

The Study of the Growth Mechanisms of Alloy Filamentary Crystals (Whiskers) Grown From Solids; Calif. U., Los Angeles; Sines; AD-655 917

Two-Dimensional High Speed Flow of Radiating Gas; Polytechnic Inst. of Brooklyn; Khosla; AD-481 002

Investigation of a Theory for the Structure of the Viscous Sublayer in Wall Turbulence; Pa. St. U.; Elswick, Jr.; AD-656 089

Similarity and the Turbulent Energy Spectrum; Pa. St. U.; Lumley; AD-656 147

A Method of Calculating Quasi Two-Dimensional Flows Through Cascades; CalTech; Mani; AD-656 428

Transient Free-Surface Flow; Stanford Research Inst.; Ablow and Lieskovsky; AD-656 489

Burnett Equations and Shock Structure; Polytechnic Inst. of Brooklyn; Khosla; AD-656 575

A Study of the Mean and Turbulent Structure of a Free Jet and Jet Impingement Heat Transfer; Aeronautical Research Associates of Princeton, Inc., N.J.; Donaldson *et al;* AD-656 592

Nonequilibrium Radiation and Ionization in Shock Waves; Purdue; Chapin; AD-656 767

Tunable Spontaneous Parametric Generation of Visible Light in ADP; Cornell U.; Magde and Mahr; AD-656 093

Study of Cross Relaxation and Glass Laser Amplifiers; Electro-Optical Systems, Inc., Pasadena, Calif.; Clark; AD-656 763

Electroluminescence: An Appraisal for Avionic Display Applications; Litton Systems, Inc., Woodland Hills, Calif.; Pizzicara; AD-656 733

Satellite Observations of Particle Fluxes and Atmospheric Emissions; Rice Univ.; O'Brien; AD-656 250

Comparison of the K(+) and K(−) Decay Rates into the Tau and K-mu2modes; Princeton U.; Ford; AD-656 490

An Experimental Study of the (He3,dp) Reaction; Ill. U.; Hoffswell *et al;* AD-656 735

X-Ray Scattering Bibliography; Kaman Nuclear, Colorado Springs; Veigele; AD-656 759

Excited Atoms in Decaying Optically Thick Plasmas; Queen's U.; Bates *et al;* AD-656 354

Cyclotron Echoes in Plasmas; Lockheed Missiles and Space Co., Palo Alto, Calif.; Herrmann *et al;* AD-656 555

Solid-State and Molecular Theory Group; M.I.T.; Slater *et al;* AD-655 966

Ionic Thermocurrents in Alkali Halide Crystals Containing Substitutional Beryllium Ions; Pa. U.; Bucci; AD-656 087

Heat Capacity of Mn (HCOO)2.2H2O Between 1.4 and 20K; Carnegie; Pierce and Friedberg; AD-656 400

The Effect of Pressure on Optical Absorption, Recombination Radiation, and Resistivity of GaSb; Harvard; Kosicki; AD-656 590

The Optical Absorption Edge in the Lead Salts and its Variation with Temperature and Pressure; Harvard; Prakash; AD-656 591

On the Solution of Equation of Transfer for a Grey Gas Enclosed Between Two Plane Surfaces; Polytechnic Inst. of Brooklyn; Khosla; AD-656 576

Mayer's Theory of Condensation and Homogeneous Nucleation; Yale; Parlange; AD-656 640

High Velocity Radiating Flows; General Electric, Phila.; Scala *et al;* AD-656 766

Investigation of the Mechanisms Associated With Gas Breakdown Under Intense Optical Illumination; United Aircraft Corp., East Hartford, Conn.; Smith and Haught; AD-656 084

The Heat Capacity of Cu (NO3)2.25H2O at Low Temperatures; Carnegie Tech.; Friedberg and Raquet; AD-656 224

PROPULSION AND FUELS

The Combustion of Porous Aluminum Plugs With Oxygen Throughout; Stevens Inst. of Tech., Hoboken, N.J.; McAlevy *et al;* AD-656 762

SPACE TECHNOLOGY

Orbits in the Copenhagen Problem Asymptotic at L4, and Their Genealogy; Yale U.; Danby; AD-655 963

A Neighboring Optimum Feedback Control Scheme Based on Estimated Time-To-Go With Application to Re-Entry Flight Paths; Harvard U.; Speyer and Bryston, Jr.; AD-656 395

Satellite Communications Achieved

A landmark in allied naval communications was achieved recently when contact was made between a United States Navy satellite terminal located at the Naval Electronics Laboratory Center, San Diego, and a Royal Navy satellite terminal located at Portsmouth, England.

The shipborne-type terminals, mounted ashore, operated through the Initial Defense Communications Satellite Program satellites. The U.S. Navy's AN/SSC-3 satellite terminal was installed on the roof of NELC's administrative building last August. The Royal Navy's terminal is located at the Admiralty Surface Weapons Establishment at Portsmouth.

The purpose of the tests was to demonstrate the compatible features of the Royal Navy/U.S. Navy terminals. Results indicate that the tests were highly successful. No problems were encountered; both voice and teletype communications were achieved.

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National Fire Prevention Week Open House

Stuart Willent, a seventh grade student at Calvert County (Md.) Junior High School, handles a fire extinguisher under the supervision of NRL firemen

The Naval Research Laboratory's Chesapeake Bay Division hosted several hundred Calvert County, Maryland school children during a recent National Fire Prevention Week open house.

Volunteer firemen from North Beach, Calvert County, Deale, and Benedict joined the NRL firemen to demonstrate latest firefighting and rescue techniques. The children also viewed a number of displays which illustrated good fire prevention practices, the role carelessness plays in causing fires, and proper techniques for combating them.

Random Noise

Dr. James R. Heirtzler, formerly a member of Lamont Geological Observatory research staff, has been designated as the Director of Hudson Laboratories. He succeeds Dr. A. Berman who left Hudson Labs in June 1967 to become Director of Research at the Naval Research Laboratory.

Dr. Robert E. Smith, of the ONR Ocean Science and Technology Group, has recently been appointed as the Director of the Florida Institute of Oceanography. His office will be located at the University of South Florida, St. Petersburg, Florida.

Mr. Carlyle V. Parker, Head of the Solid State Electronics Branch, Electronics Division, NRL, recently received the M. Barry Award for his paper entitled "Artificial Beam Sharpening Technique for Radar Beacon Systems." The award was presented by the Aerospace and Electronic Systems Group of the Institute of Electrical and Electronic Engineers.

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Alvin as configured for geological diving in east coast submarine canyons in August 1967. On the submersible, from top to bottom, are visible a current meter Savonius rotor, a high light source to illuminate canyon walls, the Straza CTFM sonar transducer head, two Edgerton 35-mm cameras and one TV camera (upper left from central view port), strobotron light source for Edgerton camera (beneath handling pad, right), the mechanical arm, several incandescent light bulbs, and the tool rack-sample tray loaded with geological tools. See article beginning on page 18.