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Divers secure umbilical cord to SeaLab I, which served both as a home and a base of undersea operations for four Navy men for eleven days in July 1964. Some of the hopes and problems of undertakings of this kind are discussed in the article beginning on the facing page.

Military and Civilian Implications of Man's Underwater Operations

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A speech delivered at the Human Performance Capabilities in Undersea Operations Symposium, Panama City, Florida, March 23, 1965.

Man is a contradiction. One minute he is reaching for the stars, and the next minute he is so conservative he refuses to believe truths that are self evident. He is both visionary and reactionary, and so has filled the pages of history with adventure and obstructionism. He is individually brilliant, yet collectively reluctant to change the status quo; nevertheless, his communities have progressed from those of scattered nomadic tribesmen to highly technically oriented nations in a span of a few thousand years. Man has been avid to unravel the mysteries of the universe, yet reluctant to use this knowledge to its best advantage; thus he has advanced by fits and starts, accepting some parts of knowledge and rejecting others. If a perfect formula could have been developed that would have insured that all scientific discoveries and engineering advances automatically became a part of our daily living, it would be fascinating to know what changes in history would have been made.

Curiously, in his search for knowledge, man has ignored to a large extent the major portion of the planet upon which he lives. Certainly, civilization used the oceans in its growth from small scattered communities to large nations. Commerce was borne on its bosom, naval engagements were fought on its waters, folklore and legend grew to thrill the youth with the tales of Ulysses, Atlantis, St. Martin's Isle, Father Neptune, the Flying Dutchman, the Kraken, and the Loch Ness Monster. Oceanography has managed to expose or explode most of these fanciful tales, but all of the efforts that have been made in probing the depths of the oceans have left us with an imperfect understanding of those depths. Interpreting the collected data has given man some clues as to the nature of the underwater world; yet even this imperfect information is resisted by persons wishing to exploit the depths, with the results being that either the equipment leaks when it is first dropped into the medium or it is lost. It is amazing that man, with his knowledge of the terrestrial areas of the earth and the ability to soar into space outside the earth's atmosphere, remains ignorant about the magnificent resources available to him within the oceans.

Only during our lifetimes have scientists and engineers turned to the oceans and massed a full-scale exploration of the marvels held in their depths. As the research continues, a realization is growing that accurate interpretation of the readings of the instruments dangled from a transient hull that skitters from place to place requires a highly trained individual. When the mass of data has been sifted, certain facts seem to emerge: the direction of the current is to the north or to the south as the case may be, the temperature of the water is so much Centigrade, the salinity has a given parts per million, and so it goes. Yet all of us know that in spite of the best efforts of the oceanographers, the factors specified may differ widely from the published data. Several years ago, we were conducting an oceanographic operation off San Clemente Island, California, in an area in which the United States Fleet had operated for years. The charts informed us that the set of the current at a depth of 250 feet was to the south, so we strung our arrays and proceeded in a northerly direction to breast into the current. To our embarrassment, the set of the current was to the north, and our instrumentation ran ahead of us, complicating the interpretation of the data we collected. Here was an area, the conditions of which we should have known more about than those of almost any other area adjacent to the North American continent. All of us who have undertaken oceanographic research can recall similar instances. At times, I think, our data is assembled in the manner of the six blind men describing an elephant; we describe accurately what we observe without being able to relate our portion of the information to the whole.

Placing man beneath the surface of the water is not a difficult problem. Prehistoric man possessed this capability and made breath-holding dives below 100 feet. Fishermen, pearl divers, salvage divers, and sportsmen have penetrated the surface on their sporadic forays. Generations of families, tribes, and communities throughout the world have made diving and swimming a way of life. Yet these capabilities have been limited by the duration of the breath of air the divers could hold within their lungs. Diving bells have been employed for centuries to place man within the ocean but with indifferent success. The bell, which is useful only from a surface support craft, has been dependent upon the whims of the weather; any surface buildup of wind or wave has forced a withdrawal of the equipment from the water. The hard-hat diving suit has been available for more than 140 years, and legendary exploits have resulted from the use of this equipment. Here again, the diver, encapsulated in his suit, was dependent upon surface support, and work could only be accomplished when the weather was favorable. Totally pressurized containers, such as bathyscaphs and submarines, have been employed for more than 100 years. In spite of the tools and facilities available for entering the oceans, man has only just recently become able to live within the ocean independently of surface support.

What this independence will mean for the future will not be known fully until many more years of research and development exploration have passed. We are able to say today, with certain reservations, that man can live comfortably and safely within the ocean for extended periods of time at depths greater than 200 feet. As we obtain, through continued research, greater knowledge of man's reactions within the environment, the reservations will be removed. With properly designed shelter and support facilities for operations conducted below a depth of 60 feet requiring more than four hours' work, it is safer and more economical to allow the divers to remain beneath the surface until the operation is completed. The greater the depth requirement, the more practical this technique becomes. Eventaully, systems will be designed that will permit the personnel that will inhabit the underwater dwelling to leave the surface under their own power, maneuver the structure to the exact location on the bottom where they wish to reside, and anchor it in place. The structure will be mobile for ascent and descent, be fully equipped to support its crew for periods of up to two or three months, be capable of pressurization during the transiting periods, and be capable of operations that are independent of any unit on the surface.

The successful development of this mobile habitat is possible on the basis of present technology, except for the energy package needed to drive the propulsion motors and support the structure and its inhabitants for the duration of the operation after they have landed. To provide power for these dwellings, today, we must depend upon remote power sources on a surface craft or the beach. Batteries are available to give small amounts of energy for short periods of time, but recharging them depends upon air-breathing or nuclear power sources, which require large crews to operate. Until the habitat can be freed from all umbilical ties with the surface or the shore, the full potential of the habitat cannot be realized. The United States Navy has investigated the exotic power sources under development, which include fuel cells, heat cells, solar conversion systems, radio-isotopes, and small automatic nuclear reactors. None of these sources has reached the state of development that will permit its use within the next five years.

Eventually, power technology will advance to the extent that it will permit the development of a package that will provide 50-150 kilowatts and that will be automatic in operation, self contained, and capable of reliable operations for six months or more. When the independence of the habitat from the surface or shore support has been assured, operational systems based on the Man-in-the-Sea projects will become realities and take their places within the military and civilian technology.

Is it possible for us to develop the true picture of the underseas environment? The answer obviously is "yes." As more and more information is collected, the weight of the evidence will gradually permit us to approach the correct answers. The time required to obtain these answers may be expedited by making a more careful analysis of what information is needed, the establishment of more permanent oceanographic stations in key areas, providing better training for oceanographers, and, most important, by increasing the ability to use man as an instrument to observe the environment and interpret the data properly.

Thanks to the wisdom, skills, and energy of the men who have pioneered in these efforts, the question of whether man can enter the hostile oceans and wrest from them their secrets has been answered in the affirmative. No longer must man venture hesitantly into the oceans like a toy encased in a protective coat dangling from the end of a string tethered precariously to a ship on the surface. His ability to live beneath the surface at depths greater than anyone envisioned a few short years ago has been proved. He now possesses the ability to live, work, eat, sleep, and participate within the oceanic environment—remaining not for minutes, but for days, weeks, or months if the need arises. With the facilities now available, man is no longer a spectator looking at the changing subterranean scenery through glass ports: he is a member of the aquatic fraternity. The ability of man to enter the aquatic environment is a fact that has been proved feasible; yet, we have many unknown questions to ask and answers to obtain before this mode of life becomes as routine as going to the store for a loaf of bread or the morning newspaper.

The questions must include the following: How should personnel be selected and trained? What useful work can they accomplish? What are the modifying effects of water temperature and depth? Is there any degradation of physical dexterity with depth and time? How should the tools and equipment that the aquanaut will use be designed? Are there psychological changes in the divers and are these changes, if any, detrimental to safe operations? Do the aquanauts adapt to the environment, and is this adaptation predictable? How far from the habitat may the diver venture for reconnaissance and work? How often may he venture forth? Will he comply with a work plan sent to him from the surface, or will he ignore it? Which of the many Man-in-the-Sea programs that have been proposed are worthy of adoption?

In reviewing the implications of providing man with a tridimensional ability underwater, we are immediately struck with the fact that whatever we have been able to accomplish in the past indirectly within the sea, we can now do much better. We have opened to man an ability to accomplish those things which he has done previously on land and in the air but which have been denied to him as far as the oceans are concerned. We will give him the abilities to develop new concepts that have not been and cannot be developed above the surfaces of the watery realm. Our fathers were surface-bound and gazed in wonderment at the first attempts of the aviator to free himself from the limitations of the surface. Our children accept aviation as an accomplishment that is no more remarkable than next year's spring clothing styles. Who is to say that our grandchildren should not be brought up to look toward oceanic technology in the same manner.

What are some of the implications of becoming aquanauts? Many of them seem self evident: We will be able to enjoy the beauty of the undersea world, we will be able to learn more about its rules by becoming participants rather than observers, we will locate new resources that have eluded us up to this point in time, we will develop new industries based upon the knowledge obtained from these explorations, and we will give to mankind a technique for further expansion. Before we can present these advantages on a silver platter, we must face the hard fact of reality that little is known about two-thirds of the earth's surface, and many thousands of man-hours must go into the exploration of this portion of the world before our third dimension becomes a way of life.

When I was a boy and my father bundled us into the automobile for a lengthy trip, we had to carry a guidebook so we could drive from town to town without getting lost. This guidebook told us that if we wanted to go from Corning to Chico, California, 5.8 miles south of Corning, we had to turn to our left just before we reached a red barn with a Bull Durham sign on it and cross the railroad track. If we missed this turn, we were off our route. Today, with adequate signs, we think nothing of zipping along at 70 miles per hour and putting many hundreds of miles behind us in a day's travel. In the ocean we have a similar problem to the one I encountered as a boy. Before we can set out on a trip beneath its surface, we must learn the topography so we can move safely from one location to another.

Scientists today are arguing to a certain extent about the surface of the moon in preparation for a landing, yet we know even less about the conditions of the bottom of the seas not more than one mile off our coastlines. Once we learn these waters, why shouldn't they become the suburbs of tomorrow for our metropolitan areas along the coastlines? Once we learn to harness the energies of the seas, why should we remain dependent upon the whims of the atmospheric weather that limit our hydroelectric power? Once we learn how to control aquaculture, why should we roam the oceans searching for fish, when we can process the catch at the scene of the harvest and transport only the processed product? Once we understand the problems of inner space, why should we attempt mining and petroleum extraction from the surface, when underwater ore reduction and petroleum refining will be more economical? The military implications are equally far reaching. Properly exploited, a knowledge of undersea strategy and tactics will add flexibility and power not now adequately possessed by any navy in the world.

Opening the oceanic world to mankind has vast implications. With the increases in population that we will see over the next few decades and the demands for additional resources to support the unborn billions of earth inhabitants of the future, we must learn to look at the world as an entirety, not as small, semi-isolated land masses. Yesterday, the world beneath the sea surface was a frightening one to mankind. Today its hostility remains, but by better understanding the demands of this environment, we will be able to leave to the world of tomorrow a priceless asset whose perils are understood. By playing the game according to its rules, man will become truly ubiquitous and a full partner of nature in all her moods.

Cape VIII

Early this year, a group of scientists from the Navy Electronics Laboratory and the Scripps Institution of Oceanography and a group from the University of Mexico combined their talents in a series of underwater explorations called "Cape VIII." The explorations were made in submarine canyons off the coast of Baja California, Mexico, by means of Captain Jacques-Yves Cousteau's Diving Saucer.

Baja California was chosen as the locality for the study because off its coast the bottom features are typical of those that were formed during the glacial lowering of sea level throughout most of the world. Thus the features provide clues as to the processes by which sediment was deposited on the sea floor during that period of time. In addition, weather conditions there, unlike those off the coast of southern California, are ideal for conducting sea operations during the winter months. The area is also the only one south of Monterey, California, in which hard granite is being cut by submarine processes.

Dives were made to depths of nearly 1000 feet. The bottom of one canyon was found to contain blocks of freshly broken granite as large as ten feet in diameter. The blocks appeared to have been carried into the canyon by flowing sand in a large submarine avalanche. At depths of more than 900 feet, currents of 0.2 knots were measured, whereas in shallow water evidence of strong currents was lacking. This difference in the rate of movement of water at the two levels is similar to that observed in the LaJolla and Scripps canyons off the coast of southern California.

An unusual interest was shown by the investigators in the many beer cans that had been discarded in the ocean by residents of the Baja area. Because flip-top cans were not introduced in the area until about a year ago, it was possible, by measuring the extent to which these objects were buried in the sand, to obtain indications of the rate of sediment deposition. The measurements revealed that at least two inches of sediment had been deposited in the one-year period.

The vehicle for the explorations, the Diving Saucer, weighs about 7000 pounds, is approximately 10 feet in diameter and 6 feet high, and is propelled at a speed of about 1 knot by two water jets mounted on its sides. It holds two crew members—a pilot and an observer—who lie in a prone position.

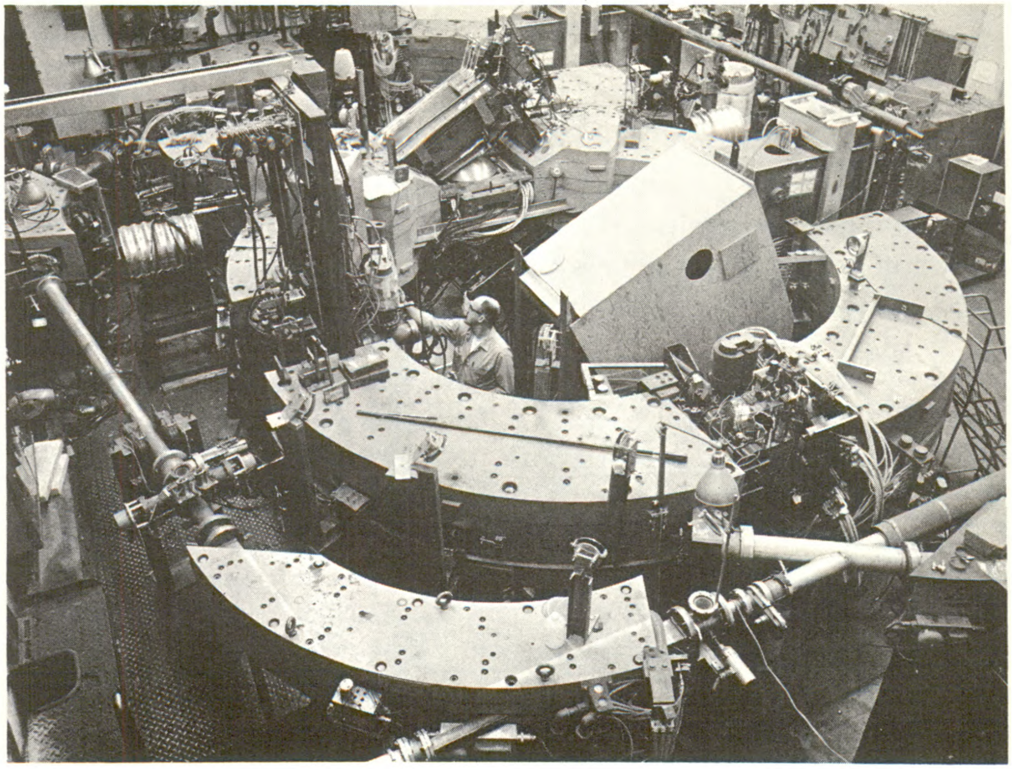
Experiment in Electron Collision

A unique experiment designed to test certain fundamental concepts of matter has been initiated successfully by a team of Stanford and Princeton University physicists working with support from the Office of Naval Research. On February 1, these scientists injected two streams of electrons into a pair of storage rings and caused them to collide, head on, at a relative energy of 360 Bev (billion electron volts). The event, the first one of its kind to have occurred at such an extremely high energy, climaxed six years of intensive work, much of which was beset with problems that threatened to nullify the scientists' efforts.

The experiment opens up a large new area of research into some of the most profound questions in physics. For example, high-energy electron collisions consititute the severest test yet devised for one of modern physics' most reliable theories—the theory of quantum electrodynamics. Even more intriguing, perhaps, is the possibility of determining the size of the electron, which is so small that no one has ever been able to measure it.

The storage rings utilized to produce the collisions were first envisioned nine years ago by a Princeton University physicist, Professor Gerard K. O'Neill. Because Stanford's Mark III billion-volt linear electron accelerator was an ideal source of electrons, Professor O'Neill enlisted the aid of Professor W. Carlisle Barber, head of Stanford's High Energy Physics Laboratory, which houses the accelerator. Professors Burton Richter of Stanford and Bernard Gittelman of Princeton also joined the effort. Work on the rings began in 1959 under the joint sponsorship of the Office of Naval Research and the Atomic Energy Commission.

The storage rings are made of stainless steel. Each is 12 feet in diameter, rectangular in cross section, and hollow, so as to support a high vacuum. When joined together, the two rings form a figure "8." At one point on each ring is an opening through which electrons produced by the Mark III linear accelerator are injected into the interior channels so that they move in a clockwise direction. Steered by large electromagnets, placed on the walls of the channels, and pushed along by low-power radio waves, the electrons circulate at a speed of about 186,000 miles per second. In tests conducted within the past few months, the electrons have been kept in circulation at the speed of light for as long as 35 hours. As each beam is made to move clockwise, and as the rings are joined at one point, the beams can be so directed in the area of juncture of the two rings that the electrons will collide head-on.



By smashing electrons together in this pair of high-vacuum "storage rings," a Stanford-Princeton team has produced unprecedented relative energies of 360 billion volts. Surrounding engineer Clarence Noyer is one of the rings in which electrons race at about the speed of light, guided by massive electromagnets. The second ring is in the upper left background. The electrons collide in the shiny dome-shaped section (part of which can be seen at upper center) where the rings meet to form a figure "8." The collision zone is surrounded by two spark chambers and other instruments which detect and measure the results. Pipes at left and lower right guide electrons into the rings from a one-billion-volt linear accelerator.

Each electron beam has an energy of 300 Mev (million electron volts) relative to the laboratory, but an energy of 360 Bev relative to the other beam. Thus, when a collision occurs, the relative energy of 360 Bev is produced, an amount far greater than that produced by the world's most powerful accelerators. To create this amount of energy in an accelerator of the Mark III type without arranging for the collision of beams, the accelerator would have to be 20 miles long. In that case, one group of electrons would remain "at rest" while another group would have to be accelerated to 360 Bev to bring about a collision of equivalent energy.

When the Stanford-Princeton team builds up to 500 Mev beams in their storage rings, as they plan to do, the electron collisions will produce a relative energy of 1000 Bev. Such ultra high-energy collisions are necessary to bring the mutually repellent electrons close enough to each other to permit new determinations to be made of their size and behavior. In the past, the electrons have been brought only as close to each other as one fermi's length (one ten-trillionths of a centimeter). At this distance, the behavior of the particles can be explained nicely by means of quantum electrodynamics. But will these explanations still hold when the electrons are brought into closer proximity of each other? If not, scientists will have to change some of their ideas about the structure and behavior of sub-atomic particles.

Although the initial results of the colliding-beams experiment have not yet been analyzed fully, the investigators have determined that the quality of the data is very good. This determination has been particularly gratifying because of the multitude of problems that had to be solved before the storage rings could be made to function properly—problems that made it appear questionable whether or not any data would be forthcoming from the work. "Beam blowups" were especially disturbing. One beam would always explode and dissipate in a way that was not predictable by theory. Only after making exhaustive measurements, by means of which the investigators were able to improve the theories, were the beams brought under control.

The beam current (number of electrons) in each ring is now running at about .03 amperes. As more collisions will occur if the current is higher, the investigators are working to improve various features of the system which will enable them to raise the current.

Many nuclear physicists in high-energy physics laboratories both in the United States and abroad have been watching the Princeton-Stanford experiment with great interest. The Russians already have built a similar apparatus at their "science city" near Novosibirsk in Siberia, although they have not yet succeeded in creating high-energy electron collisions. At Orsay, France, an Italian-built single ring is being used with a linear accelerator, but not to produce collisions of two high-energy streams of electrons. Additional colliding-beams systems probably will be built in the future, including one that is planned for use in conjunction with a two-mile linear accelerator now under construction at Stanford.

For the past two years the colliding-beams project at Stanford has been supported by ONR alone.

National Academy President Re-Elected. Dr. Frederick Seitz, president of the National Academy of Sciences since 1962, has been re-elected for a six-year term beginning July 1. His re-election took place under new bylaws that provide, henceforth, for a full-time, salaried president. Previous presidents customarily have maintained a primary affiliation elsewhere. Dr. Seitz is presently a member of numerous advisory and liaison groups, including the Naval Research Advisory Committee, Office of Naval Research. He was chairman of that Committee in 1960-62).

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Mr. Richards, inventor of the UDC, demonstrates his ultrasonic transmitter and receiver. The device can monitor many kinds of movement, including respiratory activity of a goldfish, as shown in the photograph, the heartbeat of an unborn child, and the pulsations of blood in veins.

Ultrasonic Heartbeat Monitor

An electronic device capable of monitoring the heartbeat of human embryos as early as 10 weeks after conception is being used by physicians at the National Naval Medical Center in Bethesda, Maryland. The device, called the Ultrasonic Doppler Cardioscope (UDC), emits a narrow beam of high-frequency sound, the echo of which provides a means of detecting the tiny motion of the unborn baby's heart. The UDC also can keep an accurate check on the unborn infant's heart during delivery, which no other device available currently can do. Although the UDC is still in the developmental stage, physicians believe that it may prove to be valuable, in addition, in the study of cardiovascular diseases in adults.

Two of the small units have been in use for about a year under the direction of Dr. Dwight A. Callagan, Chief of Obstetrics and Gynecology at NMC. A third unit is undergoing further development by its inventor, James R. Richards, an electronics engineer at the Naval Research Laboratory who has spent 25 years studying sound techniques for the Navy. He worked out the technical aspects of the UDC at his home during off-duty hours.

The UDC emits a beam of sound 400 times higher than that of the audible range—a beam that travels through semi-solids and liquids, such as the abdominal wall and amniotic fluid surrounding an unborn child. When the narrow beam strikes a moving object, such as the heart, its echo is bounced back to a receiver built into the hand-held transmitter. Electronic equipment translates the returned ultrasonic signal to audible frequencies, which are fed into a tape recorder. The signal then can be viewed on an oscilloscope, photographed for future study, or even played over a loudspeaker for any doubting mother-to-be.

Basic to the technique is the Doppler effect—the differences in the pitch of sound reflected from a moving object. For example, the whistle on a locomotive as it moves toward a listener is shriller than the same whistle when the locomotive moves away from him. The same effect holds true for ultrasonic sound waves. The motion of the heart along the axis of the ultrasonic beam produces a change in the frequency of the reflected sound which can be measured by the UDC.

At any tissue interface where there are two tissues having a different sound impedance, an echo is returned. There is no change in pitch, however. The heart of an unborn baby provides, as it pulsates, the retreating and advancing interfaces from which the UDC signals bounce. With proper handling, the UDC can monitor different parts of the heart, even the opening and closing of some heart valves.

In the development of the UDC, a special effort was made to keep the device simple. As the UDC is now constructed, practically anybody—a nurse, an intern, or even an aide—can use it.

Mr. Richards believes that the device is superior to the more familiar electrocardiograph (EKG), not only because of its simplicity of operation, but from the standpoint of the amount and quality of the information output as well. For example, the EKG yields considerable extraneous information, which clutters the graph. The UDC does not. Because of the extraneous "noise" produced by the EKG, a pregnant woman who is shown the graph may refuse to believe the doctor's report on her condition. But when the same woman hears the tiny heartbeat on the UDC loudspeaker, there is no question in her mind as to its meaning. Another advantage of the UDC over the EKG is its anticipated cost—about $1000 as compared with about $7000 for the EKG machine—which places it within reach of any doctor who may have need for it.

Research in adult cardiovascular disease, conducted with the UDC, will begin soon on a volunteer group of NRL employees who have a record of such a condition. The information obtained on this group will be compared with that obtained on a group which is believed to be free of heart troubles.

Mechanical checks are made of the 28-foot parabolic reflector as the instrument is readied for shipment to Hawaii.

Gemini to Aid in Navy Study of Ionosphere

A 28-foot parabolic reflector is being equipped at the Naval Research Laboratory for an experiment to be conducted on Kauai Island, Hawaii, in conjunction with a forthcoming Gemini space flight. The experiment, which is called "VHF-UHF Polarization Measurements," will be carried out in the spring of 1966 during the eighth and ninth Gemini flights. The purpose of the undertaking is to determine the electron content of the ionosphere below the spacecraft. This determination will be made by measuring the Faraday rotation of polarized radio waves as they pass through the ionized layer.

Transmitters and an antenna, developed by the Radar Division of NRL, will be mounted in the Gemini spacecraft. As the orbiting vehicle comes within view of the island of Kauai, the astronaut will orient the spacecraft-mounted antenna toward the earth. Signals of two frequencies will be radiated by the antenna and picked up by the 28-foot antenna at the ground station. From the measured polarization of these received signals, valuable information will be obtained about the structure of the lower ionosphere.

The reflector, which was obtained as surplus property from Fort Monmouth, New Jersey, has been equipped with a special pedestal and control system that were designed and built by the Lear-Siegler Company of Deep River, Connecticut. The Radar Division of NRL is now providing the antenna with a dual-frequency feed and is putting the system through a series of electrical and mechanical tests. When this work is completed, the system will be disassembled and shipped to Kauai Island, where a ground station is being established for the NRL-Gemini experiment.

Solar Eclipse - 1965

By the time this issue of *Naval Research Reviews* is distributed, scientists from the United States and many other parts of the world will have viewed, on May 30, the 38th total eclipse of the sun during this century. From land and air bases in a narrow, 8000-mile-long corridor of the South Pacific, they will have made a variety of observations that are expected to contribute substantially to the objectives of the current world-wide study of the sun and its effects on earth. This study, which began January 1, 1964, and will continue through 1965, is designated the International Years of the Quiet Sun (IQSY), because it takes place during a low point in the 11-year cycle of sunspot and solar-flare activity. Scientists of 70 nations are participating in the IQSY to disentangle some of the complexities of the sun-earth interaction demonstrated in 1957-58, during the International Geophysical Year. The IGY was timed to coincide with the most recent period of maximum solar activity—the most active period ever recorded.

Through the IQSY studies, attempts are being made to establish the quiet-day conditions upon which the sun's explosive processes are superimposed. By studying in detail solar events which are relatively isolated in time, it is hoped that progress can be made in understanding the conditions of equilibrium between the turbulent solar atmosphere and the terrestrial environment and in learning more about the disturbances originating near the sun's surface which upset that equilibrium.

Objectives

The eclipse, a product of the celestial coincidence that the moon is of just the right size and at just the right distance to cover the sun's disk but not its atmosphere, was expected to contribute to the objectives of the IQSY by providing a glimpse of solar events otherwise masked by the bright sky and the intense light from the sun itself. The observations that were planned include the following:

- Direct photography of the extended outer atmosphere, or corona, of the sun. During periods of solar quiet, the corona shows a streamer-like structure that is thought to be a visible manifestation of the sun's magnetic field.

- Spectroscopic and polarimetric observations of the light emitted by the corona. The purpose of making these observations is to gain information about coronal composition, temperature, magnetic fields, and motions.

Near the Centerline at 100,000 Feet

An Experiment Supported by the Office of Naval Research

The technique of launching a high altitude balloon and a scientific payload from the deck of a sailing vessel was successfully tested in late January in preparation for the IQSY eclipse expedition. On May 30, the day of the 38th total eclipse of the sun in this century, which could be seen only in the South Pacific, two balloons were to be launched in succession from the 160-foot schooner Goodwill to obtain photographs and other data on the outer corona during the period of totality.

The experiment was planned by Dr. Edward Ney of the University of Minnesota and sponsored jointly by the Office of Naval Research and the National Aeronautics and Space Administration. The 100,000 cubic-foot balloons were to be launched while the schooner was within 30 miles of Manuae, one of the islands that were selected as bases for the ground observations of the eclipse.

Dr. Ney participated in the observations of the 1959 total eclipse, which was viewed from French West Africa, and the 1963 eclipse, which was seen from Maine. His collection of eclipse data is part of a long-range basic research program in atmospheric and solar physics conducted by the University of Minnesota under a contract with ONR. The 1959 eclipse measurements were made during a period of maximum solar activity, whereas the 1965 eclipse observations were to be made during a period when solar activity was at a minimum. Compari-

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Solar Eclipse—1965. Continued.

- Layer-by-layer analysis of the structure of the solar chromosphere, or lower atmosphere—the puzzling transition zone between the 10,000-degree solar surface and the 3,000,000-degree corona.

- Studies of the response high in our own atmosphere to an interruption of sunlight. Normally, during the day, the sun's rays keep these layers in a highly ionized state. An eclipse speeds up the changes that take place in the normal day-night cycle.

The solar eclipse of May 30 stimulated much scientific interest not only because of its timeliness with respect to the objectives of the IQSY, but because of its unusual length. Near the midpoint of the eclipse path across the Pacific, the moon was to have covered the solar disk for more than five minutes. The maximum possible duration of the total phase of an eclipse is seven and one-half minutes. By comparison, the sun was hidden for only 100 seconds during the 1963 eclipse over Canada and the northern United States.

The bases of operations selected for the eclipse studies were four small islands of the Central South Pacific and several jet transport aircraft fitted out as flying observatories. The planes were to intercept the moon's shadow near the midpoint of its course across the Pacific and race briefly within it. Two of the islands lie at the center of the sons of the two sets of data are expected to throw new light on how energy is transported from the sun through the corona on its way to the earth.

Dr. Ney first used high altitude balloons for eclipse studies during the 1963 eclipse. The purpose of doing so was to overcome the problem of sky brightness, which exists in the lower atmosphere during totality and which makes it extremely difficult to observe the dim outer corona from the ground. Distortion caused by the earth's atmosphere is also eliminated by making the observations from balloons. During the 1963 eclipse, Dr. Ney successfully flew two balloons, which were launched from a ground site in Maine. Each vehicle carried eight cameras. The balloons reached an altitude of 110,000 feet and a point within five miles of the centerline of the eclipse. (The centerline is the course of the sun from sunrise to sunset while it is in total eclipse. The period of time during which observations can be made is longest if the observing instruments are located on the centerline.)

ONR began pioneering in the launching of large balloons for scientific purposes in 1946 (see *Naval Research Reviews,* February 1965). Navy ships have been used as launching platforms for some time, but flights from sailing vessels had not been attempted previously.

During trials conducted aboard the Goodwill off the coast of Baja California in late January, different launching procedures were tested to take into account the various wind and sea conditions that might exist at the time of the May operation. One method was a conventional vertical

100-mile-wide path of totality, and the other two lie at its edge. Except for the passage of the moon's shadow over these islands, the shaded area was to have moved almost entirely over water, sweeping from the northern tip of New Zealand at sunrise to the Peruvian coast at sunset.

Observations from the Ground

About a dozen U.S. scientific teams prepared to make observations from the four island sites—Aitutaki, Manuae, and Rarotonga in the Cook Island group, and Bellingshausen in the Society Islands, slightly to the east. At the island locations, the eclipse was to have occurred at about 10:00 A.M. local time on May 30. Clear weather was the primary concern of the ground-based observers planning to make observations by direct photography or other optical means. Meterological records indicated that the probability of having less than three-eighths cloud over at this time of year was about 20 percent, and the chance of one-fourth or less, about 10 percent. It was noted, however, that the averages reflected the usual build-up of clouds during the day, and, therefore, favored the early morning viewing of the eclipse.

Weather was of less concern to three other ground-based programs that were planned. One, which involved Nike rocket firings from the island of Rarotonga into the path of totality, had the purpose, as in

Near the Centerline Continued.

launch, which required that the balloon and the payload beneath it rise 100 feet straight up into the air just before release. Another technique involved placing the payload in a 30-foot boat towed by the schooner and allowing the balloon to rise above the boat prior to its release. In three successful test launches, the balloons lifted off within a minute or two of the scheduled time. The balloons, which reached 100,000 feet, carried scientific instruments that gathered data on zodiacal light.

During the May eclipse, each of the two balloons were to carry four cameras and a special telemetering telescope, designed by Dr. Ney, which can measure the polarization of coronal light. In addition, Dr. Ney planned to set up two electronic telescopes, one on Manuae and another on Bellingshausen. These instruments were to measure the polarization of the corona in different wavelengths, thus providing data which would supplement that obtained from the balloon telescope.

Flying in the Path of Totality

Observations Planned by the Naval Ordnance Test Station

During the solar eclipse of May 30, two scientists attached to the Naval Ordnance Test Station, China Lake, California—William C. White and James G. Moore of the Planetary Physics Division—were to make observations of solar phenomena from an aircraft flying at high altitude.

Solar Eclipse—1965. Continued.

1958, of measuring the intensity of coronal X rays. Another, which also was designed to obtain measurements from rockets, concerned some of the effects of the darkening of the upper atmosphere. The third program that was not expected to be affected greatly by the weather was the launching of balloons from a 160-foot private schooner, the Goodwill, which was based off Manuae.

Observations from the Air

Plans called for a Convair 990 and three Boeing KC 135s, each of which was equipped with 10 or more special viewing ports, to race along the eclipse path at 600 miles per hour, staying within the eastwardly moving shadow for nine minutes or more, which is about five minutes longer than the time that was available to ground observers. The observations made from the air, like those made from the ground, were to be directed at the turbulent processes of the solar atmosphere, localized effects on the solar disk visible just before and just after totality, and the response of the atmosphere high above the earth to an abrupt interruption of sunlight.

The air observations were to be made at an altitude of 40,000 feet, where, because of the lower density of the atmosphere, light scattering

Mr. White's objective was to obtain polarization and photometric data on the outer corona at large solar radii. From these measurements, electron densities and temperatures in the corona can be derived. To obtain the measurements, Mr. White planned to use a K-24 aerial camera back-fitted with a mounting for four lenses, each having a narrow-band interference filter in front of it. The lens mount is rotatable, which allows exposures to be made at three polarization angles; the fourth exposure was to be made to determine coronal brightness.

Mr. Moore's objectives during the flight were to study the existence, spectral composition, intensities, and heights of day air glow. Data on these subjects are needed to explain the interactions between incident solar light and the earth's atmosphere.

At the time of a solar eclipse, the day air glow can be detected, since the scattering sunlight—which is a detriment to normal observations—is reduced greatly. Light scattering is reduced even further when observations are made in the stratosphere instead of on the ground. Mr. Moore planned to measure sky brightness by means of an all-sky scanning, multicolor photometer installed in one of the 15-inch hemispheric domes of the aircraft. This instrument is capable of measuring—in terms of solar-surface brightness or other absolute units—the brightness of the sky in from four to eight discrete wavelength intervals. In addition, Mr. Moore expected to measure the relative contributions of primary and higher order scattering (of sunlight) to the illumination of the daytime sky.

and reflection from the earth are reduced substantially. Such a diminution in sky brightness enhances the contrast necessary for photographing the corona, especially at its faint far reaches.

The aircraft were to be flown by the Air Force Cambridge Research Laboratories, National Aeronautics and Space Administration, Los Alamos Scientific Laboratory, and the Sandia Corporation, the latter two under contract to the Atomic Energy Commission.

Federal agencies that cooperated in various aspects of the eclipse expedition—in addition to those already mentioned—are the Air Force Aerospace Research Laboratories, Defense Atomic Support Agency, National Bureau of Standards, National Science Foundation, Naval Ordnance Test Station, the Office of Naval Research, and the Naval Research Laboratory.

The U.S. Committee for the IQSY, whose Chairman is Dr. Martin A. Pomerantz, Director of the Bartol Research Foundation of the Franklin Institute, Philadelphia, brought together many of the U.S. groups that participated in the expedition. The U.S. Committee for the IQSY operates under the Geophysics Research Board of the National Academy of Sciences—National Research Council.

Two of the experiments that were planned by or for the Navy are outlined in the accompanying articles.

Inventions

Automatic Control of Landings Aboard Aircraft Carriers

U.S. Patent No. 3,131,018, entitled "Automatic Carrier-Controlled Approach System," an invention conceived to bring Navy planes down from the sky to safe landings aboard aircraft carriers, has been issued to Albert Brodzinsky, of the Naval Research Laboratory, and Joseph B. Reynolds, Jr., and Irving M. Saffitz, formerly of NRL. The system was designed to enable instruments aboard the carrier to determine an approaching aircraft's ideal flight path to the ship and to transmit that information to instruments aboard the aircraft, which then control the descent.

Data relating to the approaching aircraft's position and heading are obtained by radar aboard the carrier. The landing system relates this data to similar information that is fed to it on the ship's position and speed, then calculates the required approach and landing pattern. This comparison is translated into turn-axis and elevation control signals, which are telemetered to the approaching aircraft. The control signals are applied directly to the plane's automatic pilot, thereby affecting the corrections of heading and altitude required to place the aircraft on the appropriate approach pattern. This procedure is repeated continuously until the plane is over the deck of the ship, when the pilot takes over the controls to effect the final touchdown of the aircraft.

A Continuing Naval Problem

The protection of wood from the destructive action of marine boring animals is a continuing Naval problem of great importance. Illustrative of improvements in the methods of meeting this problem are the inventions of personnel at the Naval Civil Engineering Laboratory and investigators working under contract to the Biological Sciences Division of the Office of Naval Research. These inventions are disclosed in U.S. Patent Nos. 3,111,456 and 3,158,496. Both inventions are a consequence of the recognition by the inventors of the shortcomings of creosote and creosote coal tar combinations used widely to protect wood.

Creosote-Free Preservatives

In the invention covered in the first of the two patents identified above, Harry Hochman, Thorndyke Roe, Jr., and Harold P. Vind systematically screened and tested many creosote-free preservatives.

As a first step in the process, laboratory methods were used to determine what substances were toxic to the principal marine borer organisms. Next, small samples of the wood were treated with one or the other of the toxic substances and then exposed to the action of the live organisms, permitting evaluations to be made of the substances from such viewpoints as volatility, solubility in sea water, and ease of penetration of the substance into the wood. The third step involved the preparation of small panels of the various woods impregnated with the compounds and their exposure in a number of marine environments. The final step was the treatment of wooden members of full-size marine structures.

The most effective substances identified through this empirical approach are the following:

EXAMPLE I

	Parts
Copper naphthenate (6 percent Cu)	16
Crystal violet or malachite green oxalate or tributyltin oxide or tributyltin coconut fatty acid salt	1
Cellosolve	84

EXAMPLE II

	Parts
Chlordan or Dieldrin or Toxaphene	1 to 5
Crystal violet or malachite green oxalate or tributyltin oxide or tributyltin coconut fatty acid salt	1 to 5
Cellosolve	100

EXAMPLE III

	Parts
Copper acetate or copper sulfate	2 to 5
Crystal violet or malachite green oxalate	2
Water	100

Preserving Wood by Silver Chloride Precipitation

The method of treating wood proposed by the second group of inventors—Dixy L. Ray and Cornelius B. Van Niel—relies upon the reaction of the natural chlorides of sea water with the impregnating compound, which causes silver chloride to be precipitated throughout the wood.

To effect this action, the natural chlorides are first removed from the wood. One convenient method of removal is to autoclave the wood with distilled water until the water no longer gives a chloride reaction upon the addition of silver nitrate. The wood is then impregnated with a solution of a silver compound—for example, by autoclaving in a strong solution of silver nitrate until the wood is thoroughly saturated. Exposure to the sea water containing chloride then will permit the chlorides to react with silver nitrate, causing silver chloride to be precipitated throughout the wood.

Tests have established that no marine wood-boring animals will enter wood impregnated with silver chloride over a period of a number of years after treatment.

Salvaging Electrical and Electronic Equipment

Another unrelated but equally damaging effect of sea water is overcome by the invention of Hayward R. Baker and Curtis R. Singleterry of the Naval Research Laboratory. This invention deals with the problem of salvaging electrical and electronic equipment that has been flooded or otherwise wetted by water.

The invention covered in Patent No. 3,138,558 represents a culmination of many years of work by NRL personnel on this problem and others that relate to the surface density of materials. Essentially, the invention relies on the water displacing ability of certain aliphatic ketones. The composition also includes isopropyl alcohol, a polar rust inhibitor, and water in proportions varying, respectively, from 25 to 50 percent, 1 to 3 percent, and 40 to 60 percent. The presence of water reduces the flammability of the composition and makes possible the use of isopropyl alcohol. After the displacement of the water, a thin film of the rust inhibitor is spread over the surface.

The use of this invention has been disclosed in a variety of publications. An unexpected occasion for its employment was in the recovery of the radio, radar, and fire-control equipment removed from the USS CONSTELLATION when that ship was damaged by fire (See *Naval Research Reviews,* February 1961).

Ocean Surveys. Texas Instrument, Inc., Dallas, Texas, is being awarded a $5,604,937 contract for a marine geophysical and oceanographic survey of the eastern and central north Atlantic Ocean and the Norwegian and Mediterranean Seas. Alpine Geophysical Associates, Inc., Norwood, New Jersey, is being awarded a $5,811,477 contract for a similar survey of the western north Atlantic Ocean and the eastern and central north Pacific Ocean. The U.S. Naval Oceanographic Office is issuing the negotiated cost-plus-award-fee contracts.

On the Naval Research Reserve

FIFTH NAVAL DISTRICT REPORTS

Reservist Receives Washington Academy of Sciences Annual Award for Scientific Achievement

LCDR James W. Butler, USNR, a member of Naval Reserve Research Company 5-9, Washington, D.C., since 1951, was the recipient of the 1964 Annual Award for Scientific Achievement in Physical Sciences of the Washington Academy of Sciences. The award was presented at the annual meeting of the Academy on January 19, 1965, at the Cosmos Club in Washington, D.C.

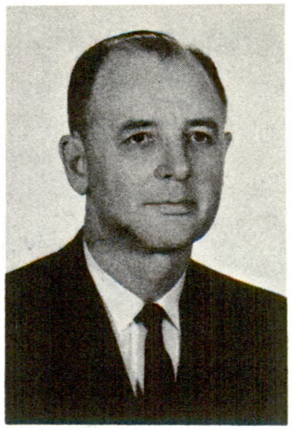
The award was made in recognition of Dr. Butler's extensive and significant contributions to our knowledge of nuclear energy levels, his high research productivity, and his important contributions to the field of nuclear physics. Most noteworthy among these achievements was the discovery that when narrow proton-gamma ray nuclear resonance-curve shapes are measured with high precision, a number of anomalies are observed. The successful explanation of these anomalies has shown that previous interpretations of resonance-curve shapes were incorrect.

LCDR Butler received his B.S. in chemical engineering from the Georgia Institute of Technology and his M.A. and Ph.D. in physics from Rice Institute. He has been a member of the Naval Reserve since 1944 and is an active member of NRRC 5-9 at the U.S. Naval Research Laboratory.

Reservist to Head National Scientific Organization

Dr. Riley D. Housewright, (Captain, USNR), Scientific Director, U.S. Army Biological Laboratories, Fort Detrick, Frederick, Maryland, and member of NRRC 5-3, has been elected president of the American Society for Microbiology (ASM). Concerning this election, President Lyndon B. Johnson wrote, in part, to Dr. Housewright as follows: "This singular honor accorded to a career civil servant by one of our major scientific societies is testimony not only to your individual competence and dedication, but to the Civil Service as well." Dr. Housewright is currently serving as vice-president of the national organization, which has a membership of more than 8000 professionals in the microbiological field. He will assume the presidency on July 1, 1965.

The ASM has as its objectives the promotion of scientific knowledge of bacteriology and related subjects through discussions, reports, and



CAPT Housewright.

publications; the stimulation of scientific investigations and their applications; the planning, organizing, and administration of projects for the advancement of knowledge in the field; and the improvement of professional qualifications.

CAPT Housewright, a Texan, was awarded the M.S. degree in bacteriology by the University of Texas and the Ph.D. by the University of Chicago. In 1943, after six years of teaching experience, he was commissioned in the Naval Reserve and assigned to active duty at Fort Detrick, and in 1946 he accepted a civil service position at that installation.

Recently CAPT Housewright was decorated for the second time with the Meritorious Civilian Service Award, the Army's second highest civilian recognition. He is a former commanding officer of NRRC 5-3, and he has contributed much to the success of the two Research Reserve Seminars on Biological Defense sponsored jointly by the Office of Naval Research and the U.S. Army Biological Laboratories (see *Naval Research Reviews,* September 1963).

NRRC 5-10 Celebrates Fifteenth Anniversary

On March 9, 1965, members of NRRC 5-10, Bethesda, Maryland, met in uniform for a dinner-drill at the Naval Medical Center Officers Club to celebrate the fifteenth anniversary of the establishment of the company. Guests participating in the ceremonies were CAPT D. J. Mooney, Jr., USNR, Special Assistant for Research Reserve, representing RADM J. K. Leydon; CDR F. H. Langdon, USNR, Fifth and Sixth Naval District Research Reserve Liaison Officer; and LCDR R. Beskind, USNR, Commanding Officer, Naval Training Center, White Oak, Maryland. Also participating were CAPT B. G. King, USNR, first commanding officer of the company; LCDR D. W. Elliott, USNR, present commanding officer of NRRC 5-10; and CDR E. A. Rubinstein,

Shown at the speaker's table during NRRC 5-10's anniversary meeting, from left to right, are CDR Holloway, LCDR Elliott, CAPT Mooney, CDR Langdon, and LCDR Beskind.

USNR, executive officer of the company. CDR J. T. Holloway, USNR, introduced the speaker, Mr. Willis B. Foster, of NASA, who spoke on the Apollo lunar mission profile.

CAPT Barry G. King Honored

The drill of December 8, 1964, was "Barry King Night" for NRRC 5-10, Bethesda, Maryland. At this drill, a scroll was presented to commemorate his many years of association with the company and also his

CAPT George Z. Williams, right, a former commanding officer of NRRC 5-10 and long-time acquaintance of CAPT King, congratulates the latter upon his receipt of the scroll that expressed the company's appreciation for his services.

impending retirement. CAPT King played a major role in the establishment of the company, and he served as its first commanding officer. The scroll was signed by several original members and former commanding officers of the company.

* * * *

CDR Hawthorne Serves on Extended Active Duty

CDR Mary E. Hawthorne, MSC, USNR, of Naval Reserve Research Company 1-1, Boston, a cytologist and professor of biology at Boston University, was assigned to active duty for training at the Naval Medical School in Bethesda, Maryland, in July 1964. Here, Dr. Hawthorne worked on the development of a new program for the training of laboratory technicians in exfoliative cytology. At the end of her two weeks of active duty, she submitted her recommendations.

As one of the results of the ACDUTRA, CDR Hawthorne was called to temporary active duty in the Pathology Department of the Naval Medical School, while on leave from Boston University, to work on the preparation of teaching materials for the new course, including a "Manual for Gynecological Exfoliative Cytology." CDR Hawthorne will observe the effectiveness of the Manual when the first class of students is assembled.

CDR Mary Hawthorne receives her permanent rank of lieutenant commander, USNR, from CAPT J. H. Stover, Jr., MC, USN, Commanding Officer, Naval Medical School. CDR Hawthorne was on temporary active duty at the time.

Staff Corps Promotion Selections

On the selection list for Staff Corps officers prepared by the Fiscal Year 1965 Reserve Selection Board were 6 Research Reservists for captain and 18 for commander. Congratulations are extended to these officers, whose names and companies appear below:

CAPTAIN, MEDICAL SERVICE CORPS

	NRRC		*NRRC*
Alford, John A.	5-10	Trumbull, Richard	5-10
Baker, Rollin H.	9-16	Youngken, Heber W., Jr.	1-2
Harrison, Robert W.	1-2		

CAPTAIN, MEDICAL CORPS

McFarland, William	5-10

COMMANDER, MEDICAL SERVICE CORPS

Bryan, Douglas E.	8-13	Van Ness, Glenn B.	5-10
Tolhurst, Gilbert C.	5-8	Wagenknecht, Austin C.	9-6

COMMANDER, MEDICAL CORPS

Inhorn, Stanley L.	9-14	Sorrow, John M., Jr.	6-6
Rizack, Martin A.	3-1	Walsh, John J., Jr.	1-2

COMMANDER, SUPPLY CORPS

Agnew, Theodore L.	8-13	Hall, James C.	5-5

COMMANDER, CHAPLAIN CORPS

Cansler, James O.	6-6

COMMANDER, CIVIL ENGINEER CORPS

Hamilton, Gordon W.	12-5

Twenty-Four Research Reserve lieutenants were among the 1194 officers of the Naval Reserve selected for promotion to the grade of lieutenant commander. The board which made these selections convened on March 9, 1965, and its report was signed by the President on April 13. Congratulations to all.

	NRRC		*NRRC*
Albin, F. I.	5-4	Greene, D. L.	4-5
Almgren, F. J., Jr.	4-1	Holway, J. M.	5-4
Boardman, J. R.	6-5	Jones, W. P.	12-3
Brough, J. W.	1-1	Kenney, R. W.	1-7
Chapman, R. L.	12-2	Koch, U. H.	12-5
Clegg, A. A., Jr.	1-3	Levin, H.	9-10
Devaney, J. J., Jr.	1-1	McEligot, D. M.	11-7
Dundes, A.	12-5	Mickelberry, W. C. (CO)	6-11
Fleming, H. D.	5-9	Paillette, D. D.	11-10
Fulcher, C. W. G.	8-4	Pietkiewicz, K. J.	3-14
Gentile, V. J.	3-8	Ryder, R. A. (CO)	9-12
Graves, D. L.	1-1	Savage, P. (WAVE)	1-8

Statistics based on the records of the Research Reservists selected for promotion are as follows:

Date of Rank		*Designator*	
Latest	6-1-60	1105:15	1405: 4
Earliest	5-1-52	1315: 3	1515: 1
Median	7-1-59	1355: 1	

Admiral Leydon Presents General Excellence Award to NRRC 3-9

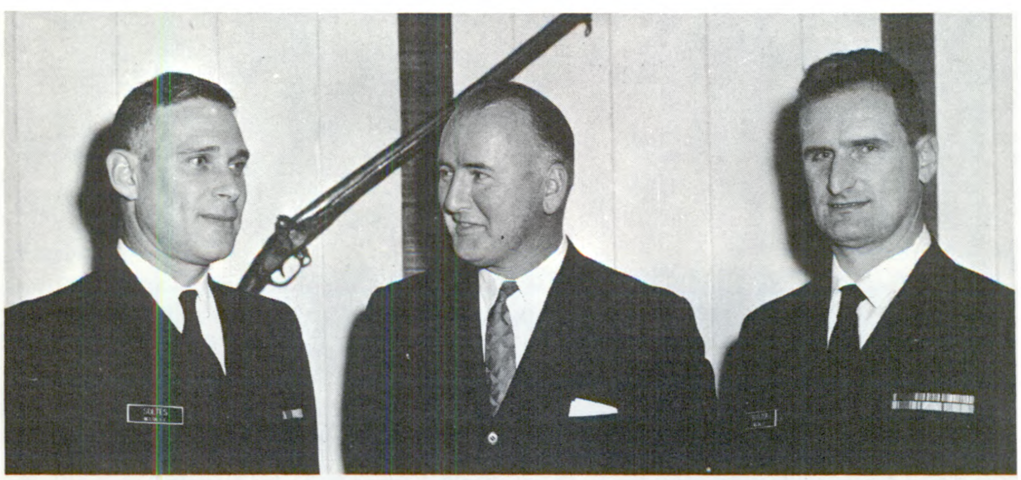
On February 18, 1965, RADM J. K. Leydon, USN, Chief of Naval Research, presented the Award for General Excellence for fiscal year 1964 to Naval Reserve Research Company 3-9, Brookhaven National Laboratory, Upton, Long Island, New York. (Notification of the winner was made in *Naval Research Reviews,* January 1965.) In presenting the award, Admiral Leydon congratulated the company on its outstanding performance, which merited the top award that is given to a Research Reserve company.

The presentation was made at a dinner meeting held at Brookhaven National Laboratory. In addition to company members, their guests, and Admiral Leydon, the ceremony was attended by CAPT D. J. Mooney, Jr., USNR, Special Assistant to the Chief of Naval Research

Admiral Leydon presents Award for General Excellence to LCDR Tassinari.

for Research Reserve, and representatives of the Third Naval District and Brookhaven National Laboratory.

An analysis of NRRC 3-9 reveals that the company has performed well over the years. In 1961, it won the A. Hoyt Taylor Award for the best scientific study submitted in the fiscal year ending June 30, 1961. In 1962, NRRC 3-9 was designated the winner of the second national competition for general excellence. In 1963, NRRC 3-9 was entered as the ComThree competitor, but it was not the national finalist.

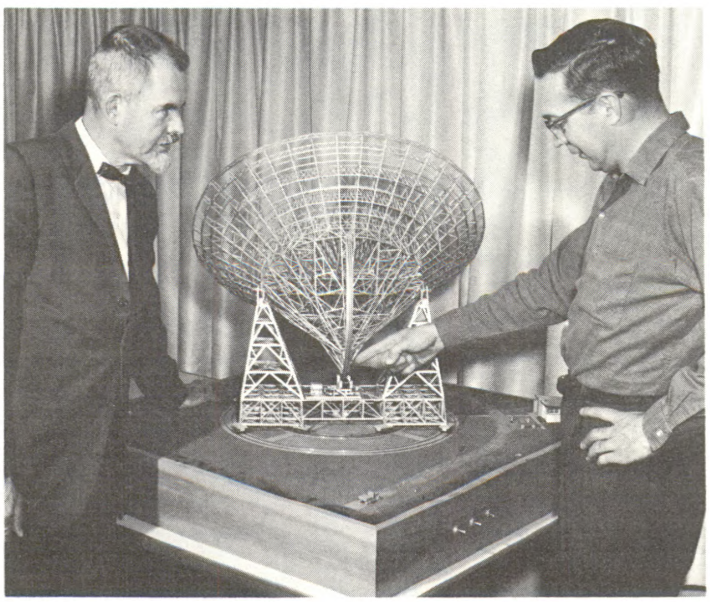


Congressman William H. Bates of the Sixth Massachusetts District described some of the military and peaceful applications of atomic energy at a dinner meeting of Naval Reserve Research Company 1-1, which was held recently at the Boston Navy Building. Shown in this picture, from left to right, are CDR Aaron S. Soltes, USNR, Commanding Officer; Congressman Bates; and LCDR Edward A. Boulter, a member of NRRC 1-1.

When questioned as to how this fine record was achieved, the present commanding officer, LCDR S. T. Tassinari, USNR, replied that high standards of performance are required from each member and that the *esprit de corps* of the company is such that everyone produces the desired results.

The composition of this company is interesting in that there are seven medical officers, five officers having doctor's degrees, and several officers having master's degrees. Fifteen officers are employees of the Brookhaven National Laboratory, and six work for Grumman Aircraft Engineering Corporation at Beth Page, L.I. The remainder are employed in other fields.

Congratulations, NRRC 3-9!



Mr. Austin B. Youmans, right, scienti in-charge of NRL's activities at Sug Grove, discusses a model of the 150-f antenna with Mr. James H. Trexler, he of the Laboratory's Radio Physics Bran Mr. Youmans is pointing to the ch drive.

Large Antenna for West Virginia Mountains

A fully steerable radio antenna as large as any now in operation in the United States is under construction for the Naval Research Laboratory near Sugar Grove, West Virginia. The antenna, a mesh dish 150 feet in diameter, has been designed in such a way as to permit it to be pointed to any spot in the visible sky. The facility will be used for research in radio-wave propagation over terrestrial and space paths. When construction is completed, in mid-1966, the antenna will be used in NRL's program of basic research and to improve military communications techniques.

An $822,000 contract for construction of the antenna and its supporting superstructure has been awarded to Bristol Steel and Iron Works,. Inc., Bristol, Virginia. Previously, a $158,700 contract was let to B. F. Parrott and Co., Inc., Roanoke, Virginia, for clearing and surfacing the site, preparation of concrete foundations, and installation of utilities. This work is nearing completion.

NRL is a tenant on the Sugar Grove site, the major portion of which is controlled by the Naval Communications System Headquarters. The Laboratory currently operates a 60-foot radio antenna there. This antenna and its supporting laboratories, machine shop, offices, and other facilities have been under development for about five years.

Communication Among Researchers

An interesting study concerning communication among scientists was made recently by the American Psychological Association under a grant from the National Science Foundation. The report, entitled "The Discovery and Dissemination of Scientific Information Among Psychologists in Two Research Environments," concerns preliminary studies of scientists' behavior in academic and governmental settings. The information on which the study was based was obtained by means of tape-recorded interviews and questionnaires.

A few of the conclusions of the study are outlined below:

- Apparent in both settings (the academic institution and the government laboratory) was the fact that persons working in the same general research area could have entirely diverse and divergent interests and that a researcher having one interest would communicate with a researcher having a divergent interest as often, if not more often, than with colleagues whose interests were similar to his own.

- Persons involved in the direction or administration of research were found to have special information problems and needs. These persons acquired vast amounts of information, they furnished this information to their staff members and associates whenever it was needed, and they were responsible for disseminating much of the information produced under their direction. Their contribution to the current pattern of information exchange and communication is thus a substantial one and deserves further study.

- Individual research efforts originated in many ways, most of which involved some type of interaction with colleagues. Even when the research idea was conceived by an investigator who chose to maintain some degree of isolation from his colleagues, communication usually played some part in converting the idea into action.

- The most highly valued type of communication was found to be direct interaction with colleagues who are equally interested and involved in similar work. Such communication would relate primarily to the interpretation of findings and the possible applications and extensions of the work.

- Many media were being utilized for the presentation of findings. The choice of media was being made on the basis of the feedback evoked, the types of information provided, and the potential audience commanded.

- The views of the psychologists working in both the governmental and academic environments were elicited on the functions, merits, and shortcomings of the following communication media: Conventions, conferences, specialized group meetings, seminars and colloquia of various sizes and types, forms of correspondence generally encountered, technical reports, and journal publications. Both groups of psychologists agreed, in general, that in spite of the many and various shortcomings of all of these media of communication, each was being used, and used relatively effectively, by substantial numbers of researchers.

Some of these attitudes toward communication held by psychologists might well represent a change which has been taking place over the past few decades throughout science—namely, the fractionization of what formerly were broad areas of research into the many narrower fields which are now being studied intensively. In other words, a scientist now rarely deals with a broad area of research, but is likely to be concerned with one of many aspects of that area, such as biophysics. Therefore, he has a need to communicate frequently with workers in other fields of science to which his specialty relates. In that sense, the findings of the survey may well apply to all scientists rather than to psychologists alone.

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IN THIS ISSUE

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EDITOR: Richard D. Olson

NAVSO P-510

Mr. James R. Richards of the Naval Research Laboratory monitors the respiratory activity of a goldfish to demonstrate the technique he invented of detecting, ultrasonically, many kinds of movement of both living and nonliving systems. A description of the device and brief accounts of its anticipated applications are given in the article beginning on page 10.