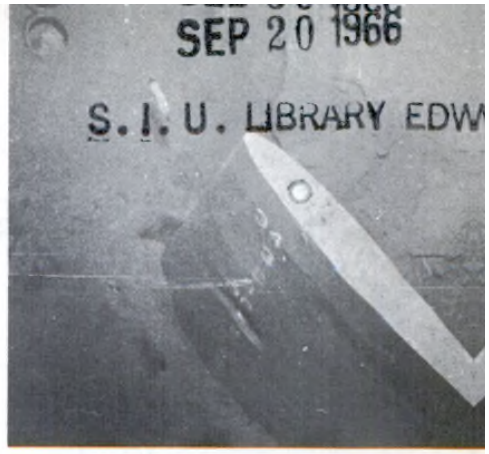
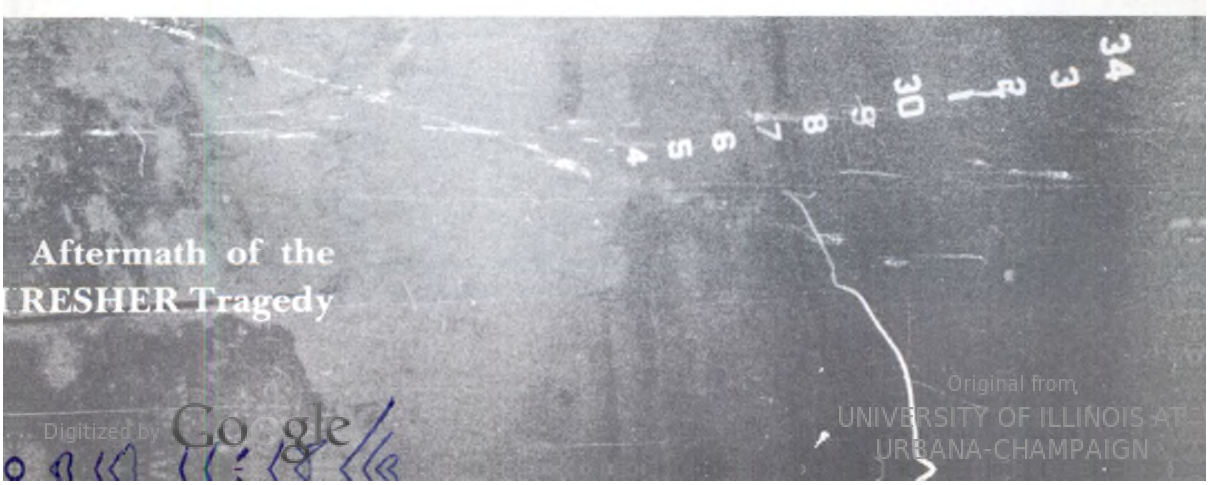
AVAL RESEARCH

REVIEWS

JUNE 1965





Aftermath of the
RESHER Tragedy

For Talent and Influence...

The Defense Department's Highest Civilian Award

Dr. F. Joachim Weyl, Deputy Chief and Chief Scientist, Office of Naval Research, received the highest honor paid by the Defense Department to a civilian employee—the Distinguished Civilian Service Award—during a ceremony held at the Pentagon on May 10. The Deputy Secretary of Defense, Cyrus R. Vance, presented the Award to Dr. Weyl and to five other civilian employees.

Dr. Weyl was selected for the honor "in recognition of 20 years of distinguished service in the Federal Government as a creative scientist and administrator of exceptional talent and far-reaching influence on both national and international sciences.

"His selfless devotion to achieving efficient management of science in Government, and his leadership in establishing high standards of Government scientific administration have typified his invaluable contributions to the scientific effectiveness of the Federal Government. Dr. Weyl's administrative and scientific insight has provided able leadership to many exploratory programs conducted in Naval laboratories and warrants recognition at the highest level in the Department of Defense."

Early in his Government service, the Navy's Bureau of Ordnance awarded to him the Meritorious Civilian Service Award for his work in fundamental explosives research.

Dr. Weyl joined the staff of the Mathematics Branch of the Office of Naval Research in 1947. Two years later he was appointed head of that Branch, and in 1953, he was promoted to Director of the Mathematical Sciences Division. In these positions, he saw and acted on the need for placing emphasis on insuring the kind of environment in which scientists at academic institutions engaged in research under contract to ONR can work effectively and with satisfaction. By his personal interest in stressing this aspect of research administration, which has continued throughout his career, he made a major contribution toward establishing a harmonious and close relationship between the Federal Government and the national civilian scientific community.

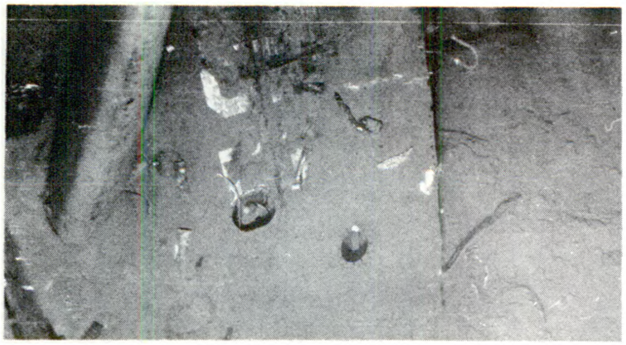
In 1958, Dr. Weyl was promoted to Research Director of ONR, a post that required him to assume responsibility for the scientific supervision of the ONR contract research program. Working with the Assistant Chief for Research (a Naval officer), he promoted, on the one hand, an understanding by the military of the contribution of science to Naval Technology and, on the other hand, an appreciation by the civilian scientist of the Navy's operational goals.

In 1961, he was named Deputy Chief and Chief Scientist of ONR. One of the functions of this post is to assist the Chief of Naval Research in planning and directing all matters affecting the administration and coordination of the Naval research program.

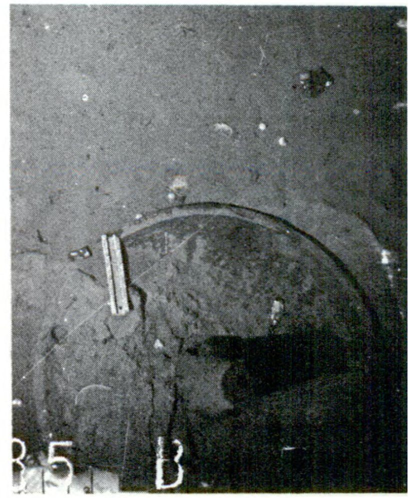
Recognizing Dr. Weyl's unusual talents, the National Civil Service League, in 1964, named him as one of ten outstanding public servants to receive that organization's annual Career Service Awards. Dr. Weyl was cited for "his inspiring direction of ONR and his readiness and effectiveness in providing assistance to other agencies..."

The highest award made by the Navy to a civilian employee—the Navy Distinguished Civilian Service Award—was presented to Dr. Weyl last year.

Other civilian employees who received the Department of Defense Distinguished Civilian Service Award on May 10 are Dr. Elson B. Helwig, Chief, Department of Pathology, Armed Forces Institute of Pathology; Mr. Willard J. Turnbull, Chief, Soils Division, U.S. Army Engineering Waterway Experiment Station; Mr. Victor Lindner, Deputy Director of the Ammunition Engineering Directorate, Picatinny Arsenal; Dr. John W. Evans, Director of the Air Force Sacramento Peak Solar Observatory; and Mr. Jack L. Stempler, Senior Assistant General Counsel, Office of the Secretary of Defense.



An Aftermath of the THRESHER Tragedy



The Development of Deep-Ocean Search and Inspection Techniques by the aval Research Laboratory

C. L. Buchanan

Sonar Systems
Naval Research Laboratory

The loss of the THRESHER in April 1963 created a need for deep-ocean search and inspection techniques that were beyond the capability of Navy equipment operational at that time. To meet this need, the Navy called upon both government and private research organizations to prepare instruments and ships to carry out an intensive search of the 8500-foot-deep waters in which the THRESHER went down. While an interesting story could be told about the work of each of the participating groups, this article is confined to the contributions of scientific teams dispatched to the scene by the Naval Research Laboratory.

By the morning of April 11—the day following the disappearance of the THRESHER—a plan to assist in the search had been prepared by NRL, and activity was underway to outfit the NRL ship USS ROCKVILLE (E-PCER 851), for the assignment. This staunch little vessel carried special research sonar equipment that could be directed at any angle within the downward hemisphere. The ROCKVILLE steamed for the area in which the THRESHER vanished on the afternoon of April 12, only a little more than 48 hours following the tragedy.

Immediately afterward, work commenced on preparing instrumentation for a second research vessel, the USNS GILLIS (AGOR 4). This ship was outfitted to lower and tow magnetometers and television and still cameras near the ocean floor.

During the summer of 1963, the ROCKVILLE made a major contribution to the close-grained bathymetric survey of the 100-square-mile area marked off for the search. During the same period, the GILLIS obtained almost half of the more than 100,000 photographs taken of the ocean floor, and she logged many hours of operations to obtain magnetic and acoustic measurements.

The ocean floor in the search area was found to be made up of a wide variety of materials of two major origins. The largest portion of the materials consists of small particles—clays and silts—and the ultimate remains of all of the life in the sea. A considerable portion, however, consists of rocks of many sizes, which are presumed to have been carried into this area by icebergs. The bottom is the home of scavengers, such as sea urchins, which consume the various organic materials that fall like rain to the bottom. Small pebbles are distributed unevenly over much of the floor, but in some locations, they occur in long rows. Large rocks are not uncommon, and a few boulders as much as 15 feet in diameter were photographed. In places, the rocks occur in clusters and mounds. Many of their surfaces have become the homes of crinoids, which in this area are almost exclusively of the "feather star" variety.

Life near the floor is plentiful. Fishes that range in length from one to two feet were seen frequently swimming in schools. Larger forms of animal life were observed most often swimming alone. Some of the types photographed were squid, skate, and the so-called "frill sharks."

In certain restricted areas, the ocean floor is strewn with a variety of foreign material, such as pieces of paper and metal; many of the objects that were observed have not been identified. Figure 1 is a photograph of a typical scene. Several large, identifiable objects, such as an air flask (Figure 2) and a mushroom anchor (Figure 3), were photographed also.

Some objects of significance were recovered from the ocean floor. For example, a battery plate was brought up by the Woods Hole Oceanographic Institution's research ship ATLANTIS II (see Naval Research Reviews, April 1963). A package of "O" rings was recovered by a rock dredge operated by the Lamont Geophysical Laboratory's research ship USNS CONRAD (AGOR 3) (see Naval Research Reviews, June 1964). A third item—a piece of copper pipe—was recovered by the bathyscaph TRIESTE by means of a mechanical arm.

The bits of "circumstantial" evidence mentioned above constitute, essentially, the body of knowledge concerning the location of the

Figure 1 — Scattered debris

Figure 2 — Air flask

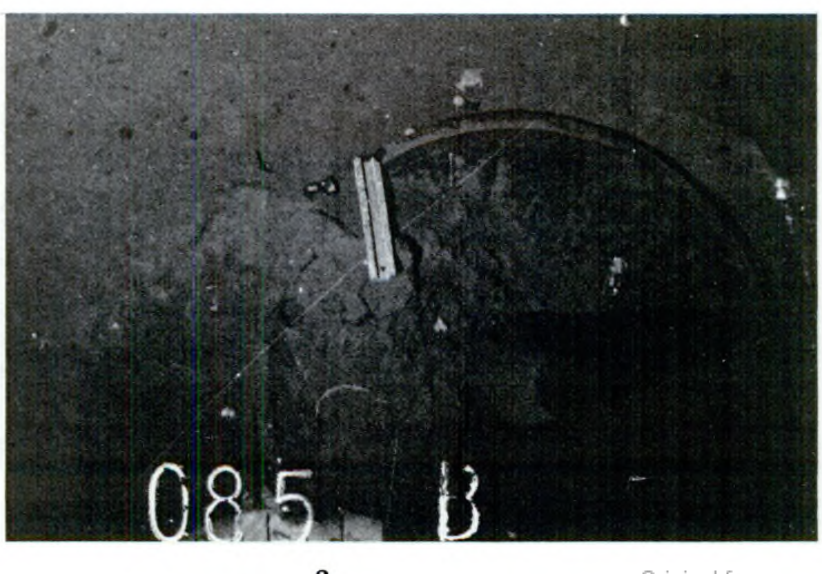


Figure 3 — RESHER's anchor

THRESHER hulk which existed at the end of operations in 1963. In all of the photographs, not one clue as to the whereabouts of the pressure hull was found.

Operations conducted by NRL in the vicinity of the THRESHER in 1964 were undertaken to develop and test equipments and techniques applicable to the search and inspection of deep-ocean floors. Several major improvements in surface-ship capability were made as a result of the longer period of time which was available for preparation that year. One of these advances was the acquisition of the USNS MIZAR (T-AK 272). This ship was obtained because of her broad beam, excellent maneuverability at low speeds, and her relatively large rooms, which provided the spaces needed for laboratories, living quarters, and the stowage of towing equipment. Three 12-inch-diameter wells were built into the ship's structure to receive hydrophones—part of an acoustic tracking system designed to permit accurate determination of the location of the towed vehicles as well as of the location of fixed markers placed on the ocean floor.

Another important improvement that was made was the development of a remote control and telemetry system that permitted virtually all available sensors to be operated simultaneously. (In 1963, most surface ships could perform only one type of search at any one time.) The power, control, and telemetry functions built into the towed instrument vehicle are illustrated in Figure 4. The power system consisted of a 20-ampere-hour 28-volt battery pack that could be charged continuously through the tow cable—a 22,000-foot-long, 3/4-inch-wide line that was insulated by and encased in a 30,000-pound breaking strength armor. The system included six instrument-command channels, by means of which six relays in the towed vehicle could be closed selectively by application of appropriate frequencies at the shipboard end of the cable. After passage of the output signals from each of the sensors over the cable, the information was filtered, amplified, and displayed in a suitable fashion aboard ship.

The primary sensors selected for the towed system in the "search" mode were three "still" cameras, a magnetometer, and two side-looking sonars.

The still-camera system consisted of three standard "Edgerton" cameras that were arranged so as to permit complete photographic coverage of a path almost 100 feet wide. Special "strobe" lights were constructed and mounted at angles that gave the best possible illumination over the wide path. In order to obtain the maximum number of photographs per run, a special thin-base film was obtained that permitted the exposure of 700 frames for each of the three cameras, or the production of more than 2000 photographs per run.

Because of the large angle of view of the cameras and the location of the lights at the center of the path of coverage, the illumination provided was not uniform from the center of the strip to the outer edges. Therefore, a two-part developer system, named "Diafine," was procured for use. In this system, after exposure of the film, the developer is first treated chemically to be inactive, and in this condition is allowed to be absorbed in the emulsion. The film is then transferred to a tank that contains an activator which permits the developing process to proceed. Since no additional developer is added in this stage, the parts of the film which are highly exposed soon use up all of the developer, and the process stops. In those areas which are weakly exposed, the developing process continues. As a result, almost the same density is obtained in the weakly exposed areas as in the heavily exposed portions. This system appears to be well suited for the type of application made of it aboard the MIZAR.

The magnetometer selected for towing was of the proton precession type. The sensor consisted of a toroidal coil filled with kerosene. It was mounted well aft of the main body of the vehicle on a rigid plastic boom. Precession signals were amplified selectively in the towed vehicle and then passed up the cable. On board ship, they were filtered, amplified further, and applied to a counter, where the time required for a selected number of cycles was read out. This output is inversely proportional to the magnetic field.

The sonars, which consisted of one 35 kc unit and one 40 kc unit, were operated on the port and starboard sides, respectively, of the ship. The 4-foot-long transducers were mounted in acoustic reflectors on each side of the towed vehicle. The entire electronic system—two transmitters, two receivers, and two keyers—was mounted in a single pressure housing. After the signals passed up the cable, they were amplified in two separate receivers and displayed on a dual recorder of the helix type. The two helices were reversed in pitch so that the resulting display was roughly geographic in nature. Each sonar was operated via one of the command channels, which permitted time-sequencing of the various events. This procedure proved to be extremely valuable in preventing mutual interference.

Normally, the cameras were operated every 10 seconds, and the magnetometer was operated 3 seconds and 8 seconds after each phtograph was taken. The side-looking sonars were operated once each second.

The mechanical arrangement of the towed vehicle is shown in Figure 5. Because the towing speed was to be about one knot, no fairing was required. The entire structure was made of nonmagnetic materials, although, unfortunately, some of the pressure cases were magnetic. The towed body and its instruments weighed 1100 pounds,

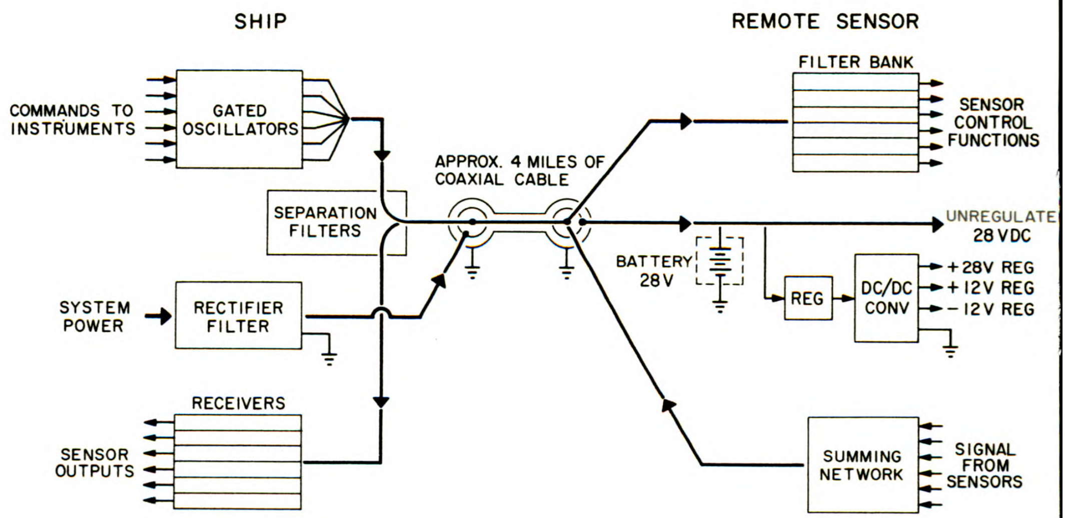
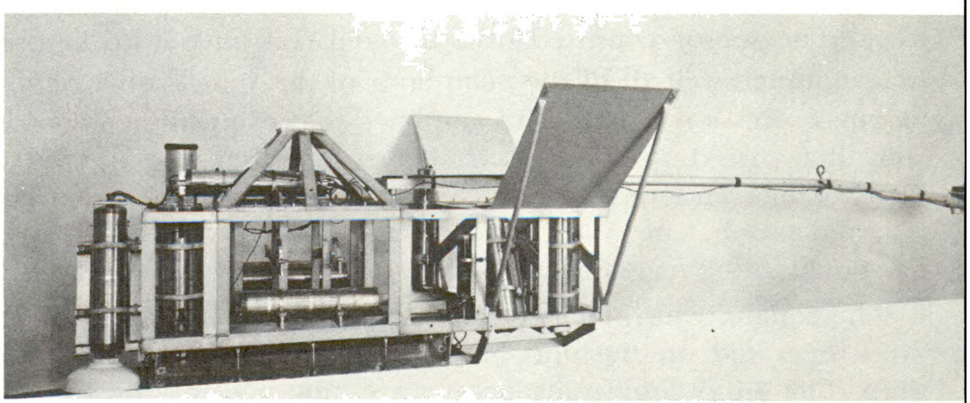
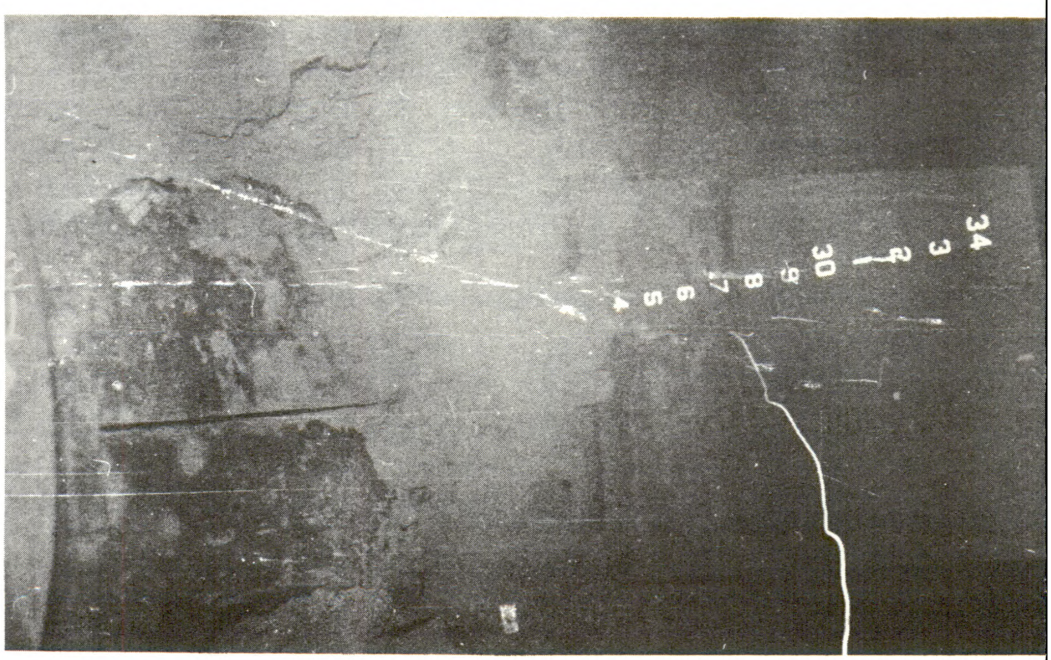


Figure 4 — Block diagram of electronic components of search system





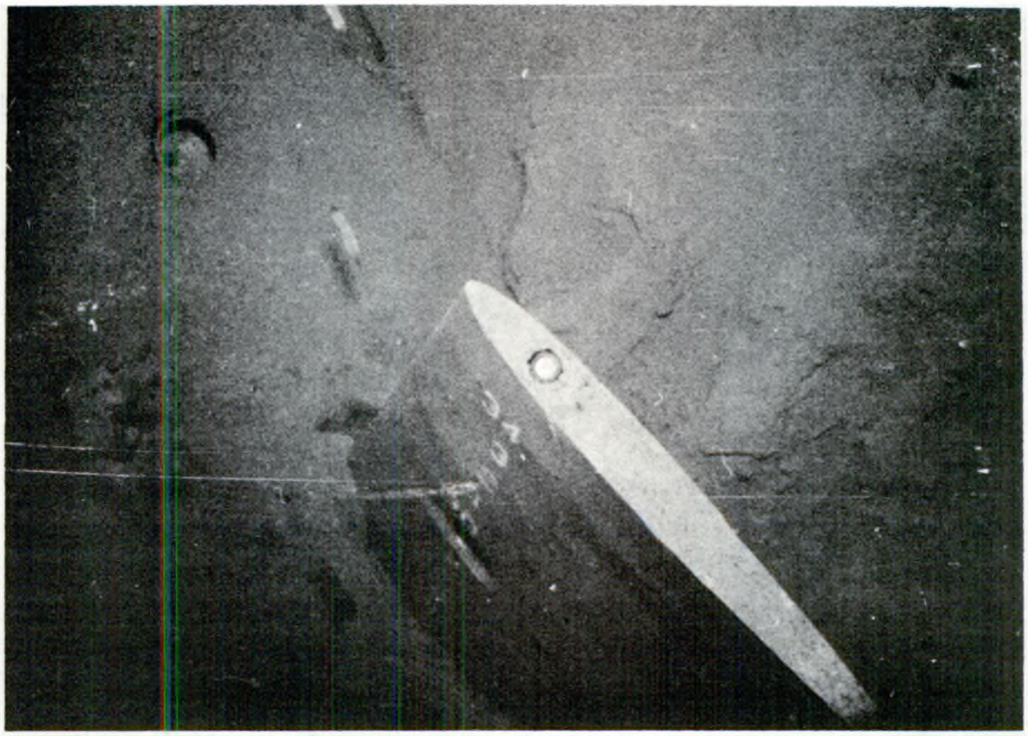


Figure 7 – THRESHER's sail

gure 5 – The towed search vehicle.

gure 6 – THRESHER's stern section from port side

Figure 8 – THRESHER's tail from above

but about one ton of ballast was added for better towing characteristics. The height of the towed equipment was controlled by an operator in the laboratory who viewed the "pinger" display on a graphic recorder and operated the winch through remote controls.

On June 26, the MIZAR sailed from Boston on her first "operational" voyage. After only eight hours "on bottom," the THRESHER'S stern section, including the topside rudder, the portside stern plane, and the after portion of the hull, was located and photographed. A magnetic anomaly was noted at the time, but its meaning was not confirmed until the photographs were developed and viewed the following day. One of these original pictures is shown in Figure 6.

Early in July, the MIZAR steamed for the area again. Between July 9 and 21, more than 20,000 photographs of the hulk and the surrounding terrain were obtained. The majority of these photographs were taken within a 1000-foot-diameter circle, in which lie the five major portions of the hulk. Typical photographs of these remains of the submarine are shown in Figures 7 and 8. During this period, the search team tracked the towed vehicle by means of the acoustic system mentioned previously—without the aid of fixed acoustic markers placed on the ocean bottom (technical difficulties prevented their use). All navigation during this period was performed by means of the Decca system, which was operable only during daytime hours.

In operations conducted later in the summer, acoustic markers were placed on the bottom and employed successfully. These references permitted operations at night, when the Decca system was inoperable, and gave tracks which appeared to be smoother than those obtained by means of Decca navigation. By the end of the summer, a total of 60,000 photographs of the ocean floor in this area had been taken. Early in the summer, confidence in the magnetometer's ability to signal the proximity of the hulk was established, and, from that time on, the cameras were tuned off when the magnetic-field indication was normal. Whenever an anomaly was noted, the cameras were turned on. By the latter part of the summer, this practice had to be modified, because all photographs were being made of the areas close to each of the major portions of the hull, and no photographs were being taken between these areas. By leaving the cameras on for a short period of time after the magnetometer had indicated that the cameras had passed beyond the immediate locality in which a part of the hull was situated, it was possible to extend the areas photographed so that essentially the entire 1000-foot-diameter ocean floor was covered.

These photographs are now being assembled into a large photomontage by the Naval Reconnaissance and Technical Support Center. When this montage is finished, it will be the most complete photographic record of a deep-ocean floor ever obtained.

Some Chemical Aspects of Corrosion Inhibition

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The basis for estimating the importance of corrosion at any given time generally is the seriousness of the problem which faces an individual or an organization in terms of potential loss. The corrosion of metals has not been, in itself, an especially active or interesting field of search for the realities of nature. As a field, it does not particularly belong "scientifically." In other words, it has little standing among the scientists in either of the basic sciences pertinent to it, although it does have reasonable stature among metallurgists. The chemists and physicists are apt to think of investigations of corrosion in terms of a highly pragmatic type of testing; however, the very involved problems of the interface and of the kinetics of the reactions are intriguing and deserve greater long-range interest.

There are certainly some very complex events which take place during the course of a corrosion reaction. In the case of dry reactions, nucleation, film growth, transport of one or another species through the film, and surface chemistry must play a part in the kinetic sequence. In the case of reactions in condensed media, the same considerations apply, and when the environment is capable of conducting an electric current, all of the complications of electrochemical processes are introduced.

Still other complexities result when chemicals are used to inhibit such reactions, especially in the conductive environment. The principal problems, however, remain those of surface chemistry and electrochemistry. The procedure is to add chemicals to the environment as a means of treating the interface between metal (more exactly, in some cases, the solid scale on the surface) and condensed fluid.

Corrosion inhibitors have been classified in a variety of ways. Some of the most defensible ways are as precipitating, oxidizing, or adsorbing agents. The first two of these inhibitors are made up almost entirely of inorganic chemicals, and the last one is made up of organic chemicals.

The precipitating inhibitor is described clearly by its title. It is usually an alkali metal salt of an anion whose heavy metal salts are insoluble. Thus the anion in solution reacts with the metal ion emerging from the metal lattice to produce a precipitate in place. The solid barrier generally is composed of the heavy metal salt or a hydrolyzed product of the salt. The protective character of the barrier depends on its continuity

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and its inherent permeability, since it functions largely as an impediment to material transport. Clearly, this area of research involves nucleation rates, grain growth, epitaxy (oriented intergrowth between two solid phases), and related subjects, which should be of the greatest consequence to the use of such inhibitors. Very little work is being carried on in this area.

The oxidizing inhibitor, which is perhaps best exemplified by the chromates, appears to have as its primary purpose the ability to produce a so-called passive film in place. These films are oxides or quasi-oxides, and their character may be related to the kinetics of their formation. Without regard to the model or the mechanism, it is clear from the work of quite a few persons that the system is essentially one in which oxidation of the metal takes place electrochemically. That is, it does so by virtue of the action of converting the oxidizing inhibitor to its reduced form. In other words, the redox couple provides the potential and current for passivity.

The adsorbing inhibitor. There still remains some question as to the possibility of inhibition by oxidizing agents by virtue of adsorption. All oxyanions are not equally potent as oxidizing agents. A case in point is that of the pertechnetate ion TcO_4^-. This material has been shown to inhibit steel in aqueous solutions for years without being converted to a lower oxidation form or being used up in any way. Adsorption is the only remaining possible explanation for the effectiveness of TcO_4^-.

Aside from this one example of an inorganic material functioning by adsorption, there are many organic substances which are not normally considered to be precipitants for heavy metal ions and which are not oxidizing in character and yet which do inhibit corrosion reactions. These substances are polar in character and must have, for practical purposes, some solubility in aqueous systems. In principle, a discussion of these materials should be independent of the acidity of the medium and presence or absence of oxygen; but with respect to real systems, it is better to limit the discussion to oxygen-free acid systems. The complications are thereby reduced.

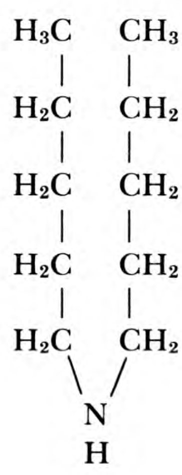
A valid and reasonably acceptable theory envisages the organic molecule as adsorbing on the metal surface and providing a film capable of acting as a material barrier. Often the inhibitor is said to be associated particularly with the region of the so-called cathodic reaction, which is that area of the metal at which the reduction process takes place.

Usually in these systems this association involves the conversion of hydrogen ions to hydrogen gas. This general proposition has appeal, because many of the organic materials used for purposes of inhibition are substances which are capable of forming cations in acid solution.

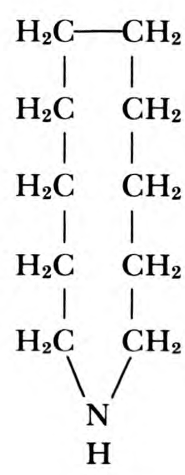
It has seemed reasonable to suppose that these positively charged particles should accumulate around the area in which the positively charged ions are being discharged.

There are, indeed, other attractive aspects of the simple theory of physical association of organic compounds with the metal surface, but careful consideration of the evidence suggests that there is more to the story than that alone. It can be shown that some of the organic materials are highly specific in their effect. For instance, ortho-toluidine is a more effective inhibitor than either para-toluidine or meta-toluidine. All three of these compounds would cover essentially the same area of surfaces once they had been adsorbed, and, therefore, it is difficult to explain the greater effectiveness of one over the other if the molecule acted simply as a blanket.

A more dramatic example of differences in effectiveness arises from a comparision of di-n-amyl amine and cyclodecylimine. These two compounds are composed of the same numbers of carbon and hydrogen atoms. They are arranged in almost the same way, except as shown below (not with spatial significance). The latter consists of a ring, and the former does not. The molecular weights are within two units of one another. The amine is much larger than the imine and, therefore, covers more area, provided the very reasonable assumption is made that each is attached via the nitrogen. They are both of about the same basic strength. Yet the cyclic compound is about three or four times more efficient in inhibiting the corrosion of iron in 6N HCl.



di-n-amyl amine



cyclodecylimine

This difference makes the proposition of simple physical association alone insufficient. In this laboratory we have suggested and have been seeking evidence for and against the proposition that not only is there physical association of the organic material with the metal surface, but that in certain cases there is also chemical association—in other words, chemisorption. This chemically associated material, which can be no more than a monolayer thick, serves to some extent as a material barrier. It must also serve an additional purpose: It may act as an "energy barrier"; it may function in such a way that it inactivates the site to which it becomes attached, or it may serve to alter the thermodynamic character of the metal surfaces.

The examples cited above prove that chemical bonding is involved. This laboratory has produced much of the supporting evidence to this effect and is in the process of acquiring more. Understanding how the chemically bound material inhibits the corrosion rate is a considerably more difficult task, and so far only a few possibilities have been uncovered. If this understanding is achieved, finding solutions to some of the most difficult corrosion problems will become more probable.

In any event, one pragmatic outgrowth is worth noting—that is, if repetitive chemical bonding were possible, enhanced inhibition should be achieved. We have now found, in fact, that low molecular weight polymers, such as ethyl pyridine and ethyl pipridine, show noticeably greater inhibition for steel in oxygen-free acid solutions on an equal weight basis than do the monomeric forms. Thus, simultaneously, an encouraging practical result has been obtained and new avenues of basic research have been found.

Distribution of Scientific and Technical Personnel. Of the 52,000 Federal Government professional scientific and technical personnel working in research and development in October 1962, almost one-half were in the Department of Defense. Within Defense, somewhat less than one-half of these personnel, or 11,300, were in the Department of the Navy. No other department or agency had as many as 10,000 professional R&D personnel. In the Department of the Army, there were 8300 personnel in research and development, and in the Air Force, 4900.

Symposium on System Theory. The fifteenth in a series of international symposia on system theory was presented in late April in New York by the Microwave Research Institute of the Polytechnic Institute of Brooklyn. The symposium, which was sponsored in part by the Office of Naval Research, provided a review of the present status of system theory research and a forum for discussion of the latest outstanding advances of interest to engineers, physicists, and mathematicians.

It was the aim of the symposium to present mathematical developments and engineering interpretations of mathematical theory, which, together, define system theory. In this context, the term "system theory" includes concepts that are fundamental to problems of control, communication, information processing, and economic forecasting, as well as those developments in specialized problem areas that show promise of relating to the general class of problems.

A New Fence in Texas

Navy researchers are working to improve the unique satellite-watching Space Surveillance System by erecting a smaller, second electronic fence across the southern tip of Texas. They are also modifying and expanding the existing fence, which extends across the southern portion of the United States. Transmitters or receivers now are located in California, Arizona, New Mexico, Texas, Mississippi, Alabama, and Georgia. The modifications to the existing system are expected to cost about $10 million. An estimated $2 million more will be spent in the construction of the South Texas line. New construction and modification work should be completed by late summer or early fall.

The Texas line, which is being installed on a research and development basis, will allow for a refinement of orbit parameters on a satellite's initial pass, if the object penetrates both the existing fence and the new fence.

Modifications to the existing system—the Navy portion of the Space Detection and Tracking System (SPADATS)—includes the installation of two new receivers—one at Lewisville, Arkansas, on the Red River, and another near Hawkinsville, Georgia. In addition, the old 108-megacycle receivers are being converted to a frequency of about 216 megacycles. The new receivers will provide additional low-altitude coverage, and the power increase will allow for higher altitude reception. Other receivers are located at Brown Field, California; Elephant Butte, New Mexico; Silver Lake, Mississippi; and Fort Stewart, Georgia.

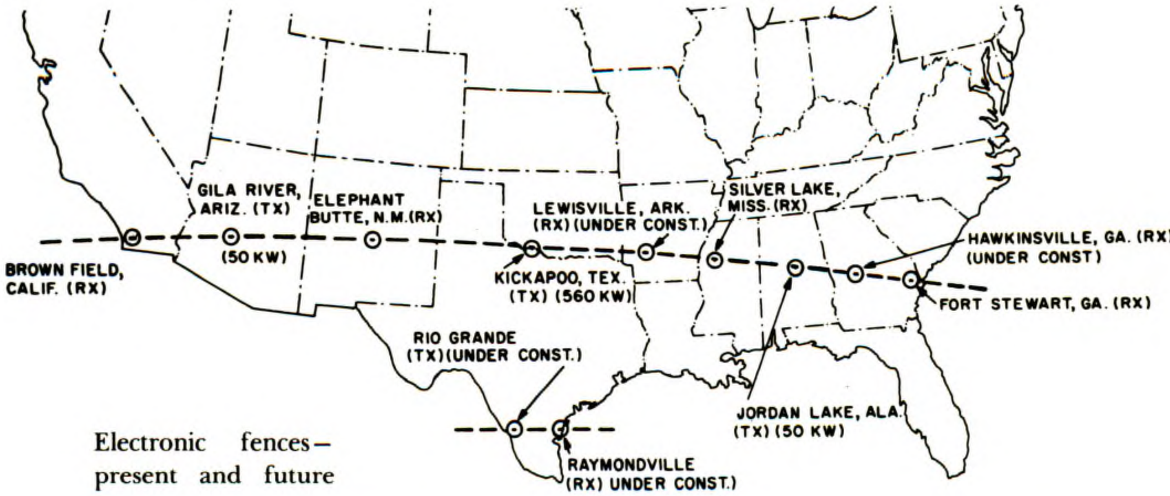
Transmitters now operating include a 560,000-watt installation at Kickapoo, Texas, about 100 miles northwest of Dallas, and 50,000-watt stations at Gila River, Arizona, and Jordan Lake, Alabama.

Transmitting and receiving antennas for the new detection line are expected to be up to a mile in length. They will consist of dipoles above a series of parallel wires strung a few feet above the ground. Existing antennas range from 400 to 5600 feet in length.

The present system, which detected its first orbital object in the summer of 1958, cost in excess of $20 million. It is the only known satellite detection and tracking system of its type in the world.

The southern Texas line, which will be designed in virtually the same manner as the existing line, will include a transmitter on the Rio Grande River near Roma and a receiver near Raymondville.

The Space Surveillance System was installed to detect, identify, and predict the orbits of non-radiating satellites—those which do not send out radio waves at all or which transmit only on command—as they pass



Electronic fences—present and future

over the United States. The system observed its first space object on August 7, 1958, just 48 days after receiving funding approval from the Advanced Research Projects Agency. Today, the system's around-the-clock operation is adding to its list of hundreds of known space travelers.

The data from the detection network are transmitted continuously over a telephone circuit to recorders at NRL and at the Navy Space Surveillance System headquarters, located in the Naval Weapons Laboratory at Dahlgren, Virginia. There the information is fed to high-speed digital computers that track and predict orbits and maintain a display of the current status of satellites.

The system works by transmitting a screen of electromagnetic energy upward in a narrow fan shape from the stations located in Kickapoo, Gila River, and Jordan Lake. As an orbiting object passes through this fence, a part of the radiated electromagnetic energy is reflected back to one of the receivers, which gives a sensor the arrival angle of the signal. At the same time, another reflected wave is returning to a second receiver, which gives another sensor a second angle. The position of the orbiting object can then be determined by simple triangulation. With the addition of the south Texas fence to the system, not only will the angle of arrival be obtained more quickly and with greater accuracy, but—when a satellite passes through both the new and the old fences—the speed and future positions of the object will be determinable.

The over-all SPADATS program includes also Army, Air Force, and Royal Canadian Air Force sensors and the contributions of many civilian scientific groups. The entire program including the Navy's Space Surveillance System, is under the operational control of the North American Defense Command (NORAD), the headquarters of which are in Colorado Springs, Colorado.

Technical Appliance Corporation, Radio Corporation of America, and Page Communications Engineers, Inc., are under contract for the south Texas Project. Bendix Corporation will provide operational manpower for the completed system. Contracts for expansion and modification of the existing system are held by RCA, Technical Appliance Corp., and Litton Industries, Inc. The Bureau of Naval Weapons, the management bureau for the space surveillance program, is funding the NRL research and modification work.

Information on orbiting satellites is relayed to this display room at NRL and to a control center at Dahlgren, Virginia. Here, Roger Easton, head of the NRL Space Surveillance System Branch, looks over the readout from receiver sites along the southern portion of the Nation. The computer information enables monitors to detect new satellites and predict the arrival of old ones.

The Recovery of STU 1-1

Construction Materials Hauled Aboard Tug After 3 Years of Exposure at One-Mile Depth

One of the largest and heaviest objects yet retrieved from a great ocean depth was hauled aboard a Navy tug off the coast of southern California on February 25 by the Naval Civil Engineering Laboratory, Port Hueneme, California. It is Submersible Test Unit (STU) 1-1—a tower-like structure that stands 14 feet high and weighs 7000 pounds in air when loaded with its 1318 specimens of 301 different construction materials.

STU 1-1 was emplaced at a depth of 5,300 feet on the edge of the continental shelf at a point 27 miles southwest of Santa Rosa Island on March 29, 1962. Since that time, two other units have been emplaced and recovered at Pacific Ocean depths of 2350 and 6000 feet (see Naval Research Reviews, March 1965). Emplacements at depths of about 12,000 feet are planned for fiscal year 1965-66. The experiments are being conducted as part of NCEL's Deep Ocean Program, the overall aim of which is to determine the effects of various deep-ocean parameters on construction materials.

According to plans at the time STU 1-1 was lowered, the unit was to be left on the bottom for a period of six months, after which the effects of the physical, chemical, and biological environment on the specimens were to be investigated. To facilitate installation and recovery of the unit, NCEL engineers designed a completely submerged rigging complex untilizing buoyant polypropylene rope, fluid-filled subsurface buoys, and an acoustic-actuated anchor-release device. Unfortunately, storms and mechanical difficulties that arose during and after the emplacement operation thwarted all attempts to recover the unit until last February.

Included in the specimen load of the STU were samples of 191 metals, 56 nonmetallic materials, 11 electrical conductors, and 14 wire ropes and cables. Eight of the wire ropes were stressed to 20 percent of their ultimate tensile strength.

While the STU was being installed, the bottom waters and sediments were sampled to determine their physical properties and chemical and biological composition. Also, a deep-sea camera was lowered to obtain photographs of the ocean floor at the chosen location. During the STU's period of exposure, studies of the ocean-bottom environment were conducted: a current meter was placed with the unit to record water movements, and periodic visits to the site were made to monitor the chemical and physical properties of the bottom waters.

The recovery operation conducted last February had its dramatic moments. A team from NCEL left Port Hueneme on February 19 aboard the USS CHICKASAW, a 1500-ton ocean-going tug outfitted with salvage equipment, for the STU emplacement site, which was approximately 80 miles to the southwest. Upon arriving at the site, the surface position of the vessel relative to the most probable location of the STU was fixed as nearly as possible by the use of Lorac. Grapneling and bottom-drag methods then were employed in an attempt to attach a line to the unit. Because of the rough treatment which this equipment received on the rocky bottom, three flukes of a six-fluke sliding-prong grapnel were lost. Operations for the day were discontinued when a storm drove the vessel to Johnson's Lee, Santa Rosa Island.

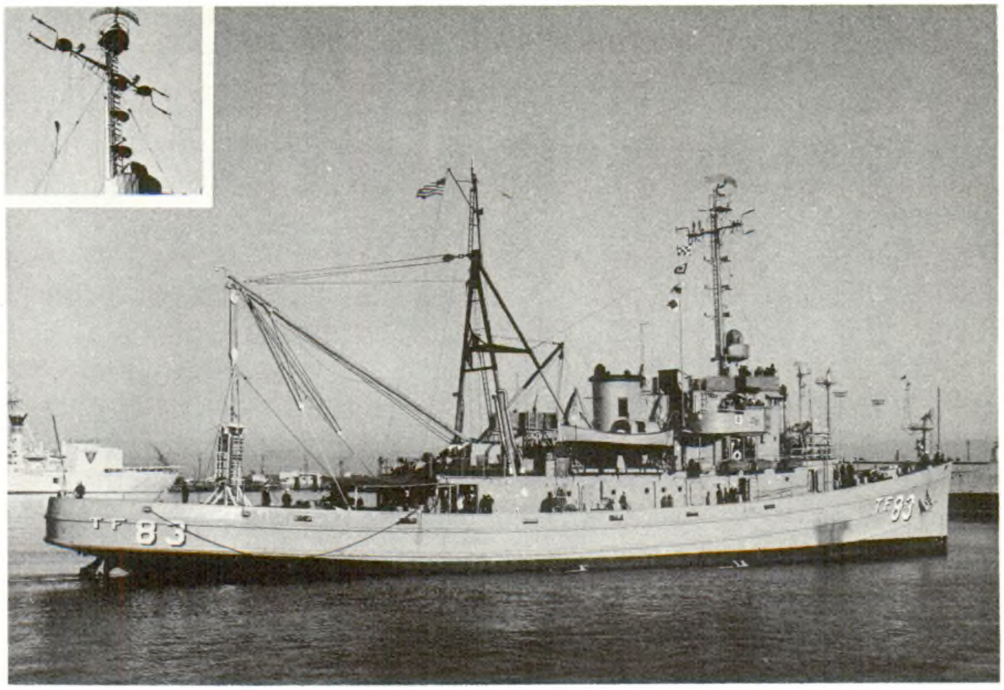
Upon relocating the STU early Tuesday morning, the 23rd, the crew aboard the CHICKASAW began operations with a British-made Rennie chain grapnel, which consisted of four interlocking loops of steel chain and eight flukes that protruded at intervals. Shortly after noon, a "bite" was made. Because the dynamometer showed that a heavy load was on the line, the recovery team decided to try pulling with the ship. But there was no "give." After a few minutes, the dynamometer showed that 10,000 pounds had been held momentarily, then lost. Only 1000 pounds was still attached. It was hauled in: 1600 feet of polypropylene line, which had been part of the inverted catenary line in the STU mooring complex.

All instruments had been placed on a common time base, so it was possible to relocate the surface position from which the original bottom contact had been made. When grapneling was resumed, it took place against the colorful background of an ocean "circus"—the passage of thousands of porpoises, seals, and whales on their annual migration northward.

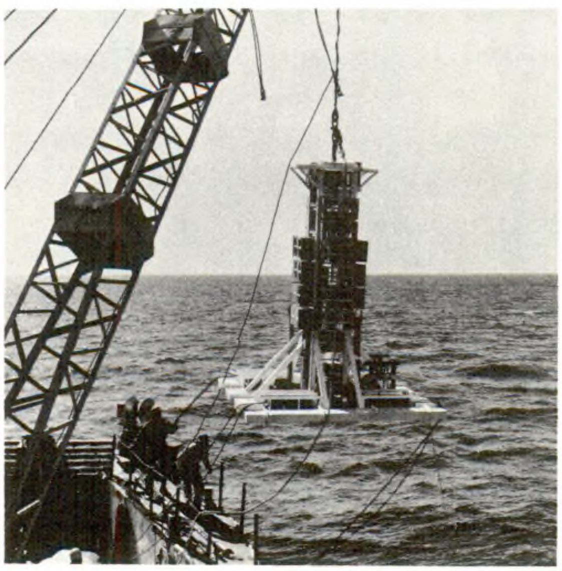
All day Wednesday was spent attempting to hook onto the submerged unit. But the "fish" would not be caught. Not until just after midnight on Thursday was another "bite" made. The winch hauled 200 feet of 7/8-inch steel wire over the stern of the CHICKASAW. It turned out to be wire that had been lost during the STU emplacement operations three years previously.

Early on Thursday, a new tactic was tried: the CHICKASAW was steered around and around in tight circles. The action, it was hoped, would cause the Rennie grapnel at the end of the mile of line to twist upon itself, much as the end of a short length of rope, lying on the ground, will twist upon itself if one makes a circular motion with the end held in this hand. By this means, perhaps, the grapnel would snag the 500 feet of nylon rope that was known to be attached to the STU.

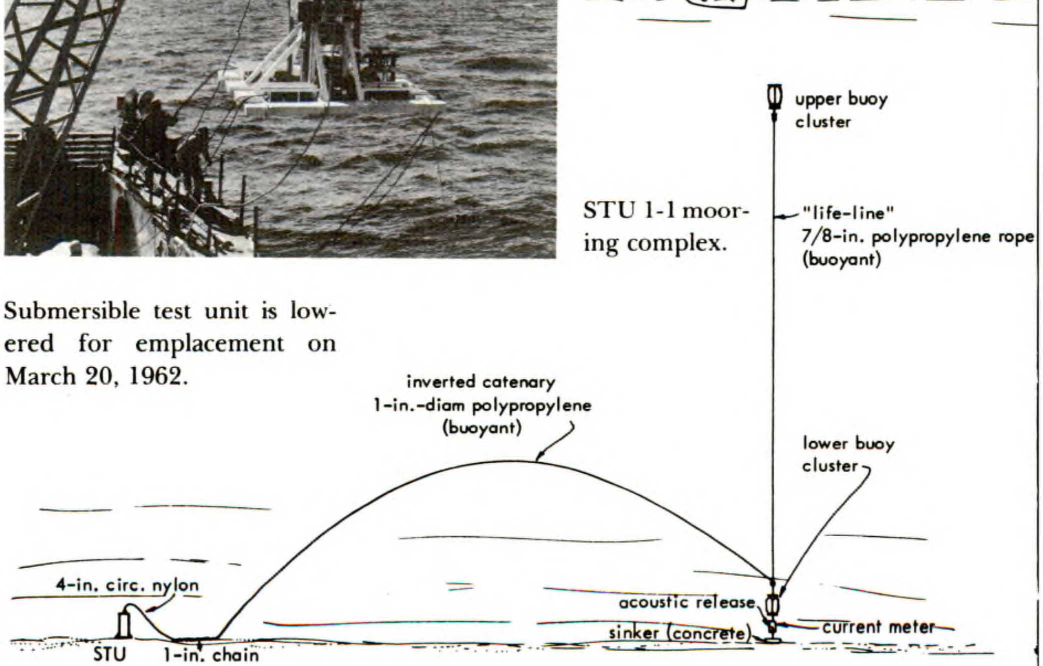
One complete turn was made, then another, after which the vessel headed on a straight, northwesterly course. There was a firm "bite."



Recovery ship USS CHICKASAW arrives at Port Hueneme carrying test unit on rear deck. The upended broom on mast signals "clean sweep."

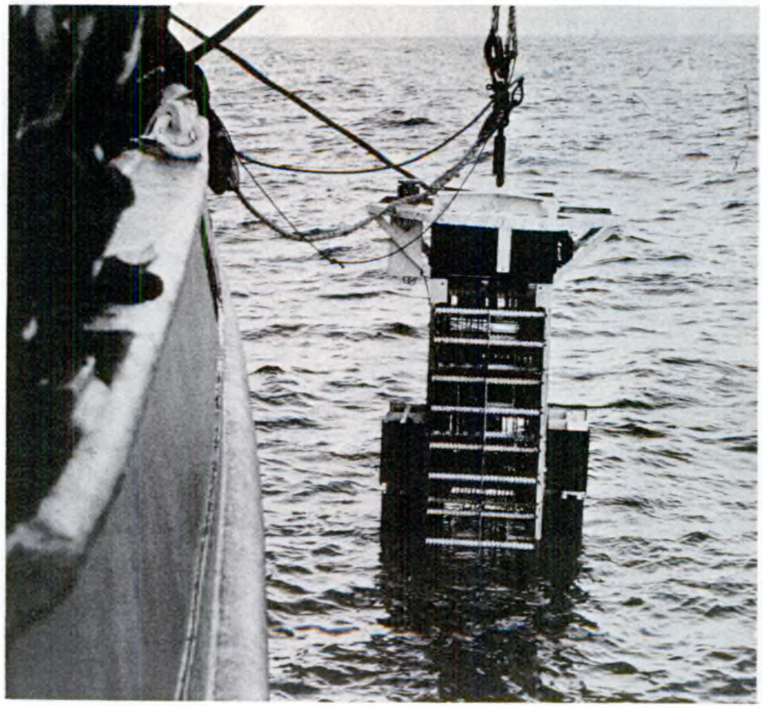


Submersible test unit is lowered for emplacement on March 20, 1962.

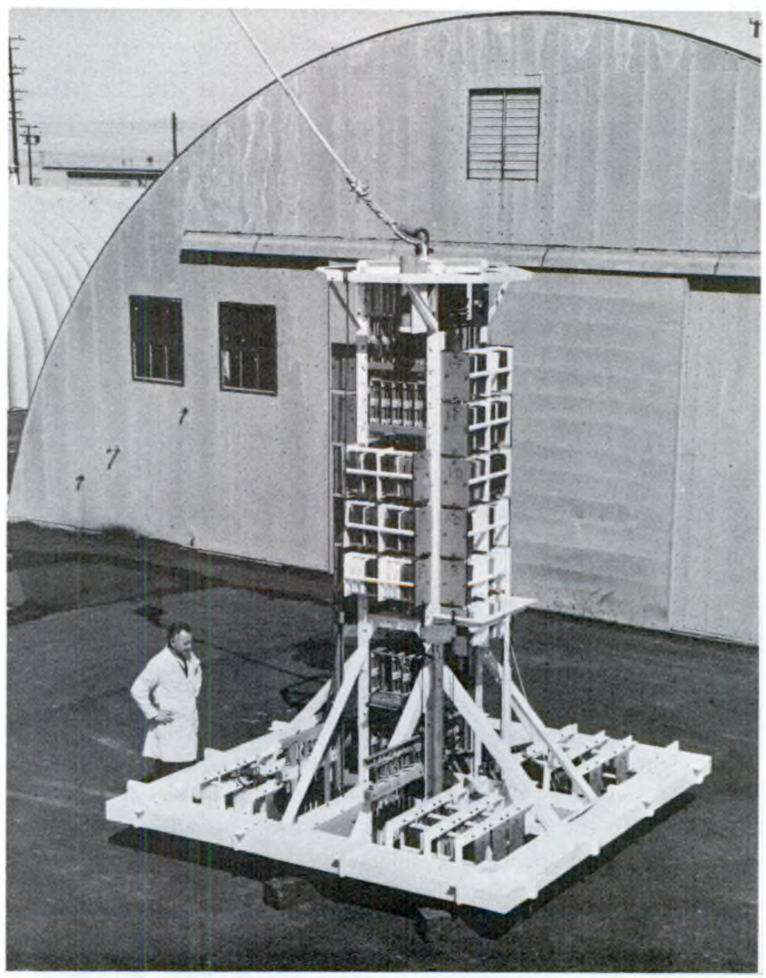


STU 1-1 mooring complex.

unit emerges from
fic after three-year
on the bottom.



very-team members
rles K. Paul, leader
ter), R. A. Krutenat
w), and H. J. Loper
ve) relax on STU
after returning the
to shore.



1-1, fully loaded,
ts emplacement in
h 1962.

The dynamometer indicator showed that the line supported a load of 8000 pounds, then 10,000 pounds, then 12,000 pounds. Two hours and three minutes passed as the load was hauled upward. Finally, the grapnel broke the surface, and the STU's white nylon bottom line appeared. The STU itself and its 1300 valuable specimens were only a few feet below.

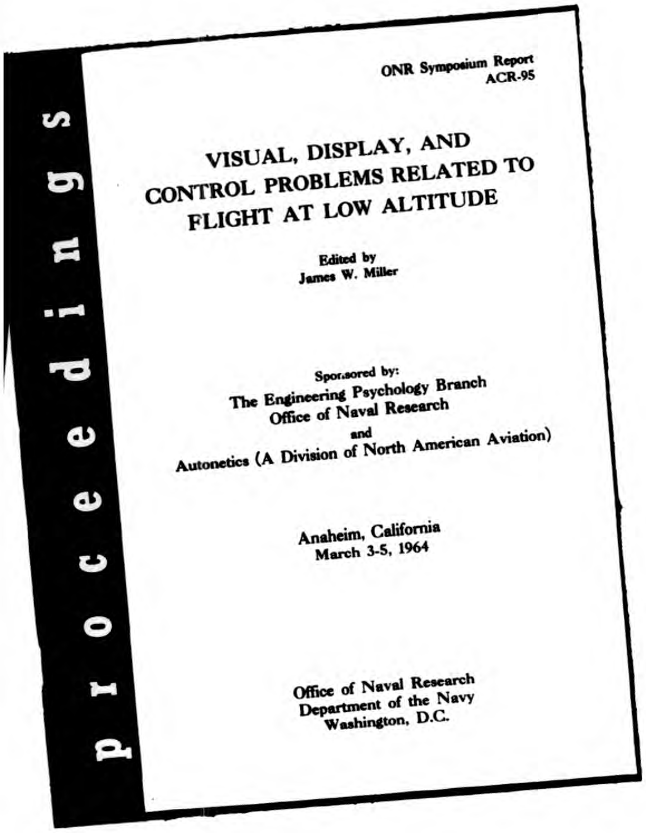
Suddenly, one of the two strands of line supporting the unit snapped. The 7000-pound "catch" dangled by a single strand. Speedily, deftly, a crewman spliced the broken line. The load was raised higher. At last, the test unit, itself, broke the surface. Two divers attached an auxiliary line, and the STU was guided around to the CHICKASAW's side. During one of the final hours of the final day that had been allotted for the search, the unit was hoisted aboard ship.

A patch of fresh mud on the top of STU 1-1 revealed that the test vehicle had been knocked over by the grapneling operation. But until that moment, she had sat firmly upright on the rocky bottom. Many of her specimens had deteriorated badly, but her structural steel framework was in excellent condition, having been protected by a coat of vinyl paint. There was a heavy hydroid-like growth on the STU and on all of the specimens, and a tiny white lobster-like creature, 2 inches long, crawled from between two plates of aluminum alloy. After washing, the framework shone white in the moonlight.

With the information obtained through the Deep Ocean Program, engineers will be able to design and emplace or construct a variety of facilities beneath the sea, such as fuel caches, supply depots, refueling stations, submarine repair facilities, nuclear weapon shelters, utility systems, and power generators. The retrieval of STU 1-1 constitutes an important step forward toward this goal.

Physics of Quantum Electronics Conference. A conference on the physics of quantum electronics, which will be sponsored by the Office of Naval Research, will be held in San Juan, Puerto Rico, June 28-30, 1965. The intent of this conference is to select from the broad area of quantum electronics some aspects of physics which are of a fundamental nature, as contrasted to applications and technology, and to gather together a small group of 150-200 active scientists to discuss recent accomplishments in theory and experiment and new possibilities in this field of research.

Among the areas of discussion will be nonlinear phenomena, including harmonic generation, mixing, Raman and Brillouin effects, multiphoton absorption, breakdown in gases, spectroscopy with lasers, and fundamental experiments with lasers. Also to be discussed are the theory of laser oscillators and amplifiers, problems of coherence and noise, excitation processes, relaxation mechanisms, spectroscopy of laser materials, semiconductor lasers, including methods of population inversion, recombination, and stimulated emission, the effects of electric and magnetic fields, and the stimulated emission of phonons.



proceedings

ONR Symposium Report
ACR-95

VISUAL, DISPLAY, AND
CONTROL PROBLEMS RELATED TO
FLIGHT AT LOW ALTITUDE

Edited by
James W. Miller

Sponsored by:
The Engineering Psychology Branch
Office of Naval Research
and
Autonetics (A Division of North American Aviation)

Anaheim, California
March 3-5, 1964

Office of Naval Research
Department of the Navy
Washington, D.C.

ONR and ACR Reports

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Deputy
Executive Assistant for
Scientific Information
Office of Naval Research

A basic philosophy of the contract research program of the Office of Naval Research has been and continues to be that the results of such research represent the investigator's findings. To be useful, those findings must be communicated. Accordingly, the investigator is encouraged to communicate his findings to his scientific colleagues. A primary means for such communication is, of course, the recognized scientific journals.

A second means for the communication of ONR research results—one that usually permits the presentation of results in greater detail than is practicable in the professional journal—is the scientific or technical report. Such reports are available to Government agencies and their contractors through the Defense Documentation Center (DDC). Those reports which are unclassified are released to the general public in this country and abroad through the Clearinghouse for Federal Scientific and Technical Information of the U.S. Department of Commerce.

Two important series of scientific and technical reports prepared by or for ONR are designated "ACR" (for Assistant Chief for Research) and "ONR" (for Office of Naval Research). Each publication of the two series is numbered. The two series differ from each other, essentially, in that the ACR series arises from the contract research program, which is administered by the Assistant Chief for Research, whereas the ONR series is concerned with Navy-wide (both intra- and extra-mural) findings in research; the ONR series, which implies official approval of the Chief of Naval Research, is thus more comprehensive.

ACR Reports

One example of an ACR report is the state-of-the-art monograph on an over-all facet of the contract research program, such as research in metallurgy. This report, ACR-61, "Perspectives in Materials Research," dated February 1963, was edited by L. Himmel and J. J. Harwood, both formerly with ONR, and by W. J. Harris, Jr. (see *Naval Research Reviews,* July 1963, page 19). That publication is also Number 10 in a series of "Surveys of Naval Science;" it was reprinted recently by the Government Printing Office and is offered for sale by the Superintendent of Documents.

Another category of reports in the ACR series comprises collections of papers presented at scientific meetings sponsored or cosponsored by the Office of Naval Research. An example is "ONR Symposium Report, ACR-85, Inter-Service Conference on Techniques for Determining the Military Career Force Structure." This publication contains the proceedings of the sixth of a series of conferences, held in May 1963, on job analysis in the military services. It is available from DDC to certified users as AD 600 052; it is also on sale by the Clearinghouse at $2.00 a copy. (Where practicable, of course, ONR authors also utilize the scientific and technical journals; ACR-85 is an 80-page report, and thus is too long to be published in a single issue of a journal.)

The ACR series of reports serves the further purpose of summarizing current significant research in various aspects of the contract research program. Thus, ACR-97, "Information Systems Summaries," dated July 1964, presents highlights of the research sponsored by the Information Systems Branch of ONR. This report can be obtained from DDC as AD 606 772; it is sold by the Clearinghouse for $3.00 (in hard copy) or $0.75 (in microfiche).

ONR Reports

One major category of reports in the ONR series is the proceedings of the Navy Science Symposia, at which Navy scientists discuss their in-house research and development activities which are of common Navy interest; one such interest is automation, which provided an overall theme for the 8th Navy Science Symposium, which was held in 1964 at the U.S. Navy Postgraduate School in Monterey. Understandably, many of those reports are classified for security reasons.

A long-time "best seller" in the ONR series is the first report of that series to be published, ONR-1, "Contract Research Program," the most recent edition of which was issued in February 1965. Potential ONR investigators have found this report of particular value as a guide to the scope of the contract research program. (It has served also as a guide to the establishment of contract research programs by other agencies.

Lists of unclassified ONR and ACR Reports are presented below and on following pages. In the future, *Naval Research Reviews* will announce the publication of such reports and will provide information as to the availability of the reports, including "AD" numbers for certified users of DDC services.

Unclassified ONR Reports

The Numbers preceding report titles refer to series number designations, such as ONR-1.

1. Contract Research Program. 20 p. Revised, Feb. 1965.
2. A Decade of Basic and Applied Science in the Navy. Mar. 19-20, 1957.
4. Lecture Series: Problems of Satellites and Space Operations. Apr. to July 1958. 105 p.
5. Vol. 1. Materials Research in the Navy. Symposium, Mar. 17-19, 1959. 386 p.
5. Vol. 2. Materials Research in the Navy. Symposium, Mar. 17-19, 1959. 377 p.
7. Final Report of ONR Study Group on Microelectronics. June 1960. 15 p.
8. AIME-Navy Day Forum: Metallurgy in the Navy. Feb. 15, 1960. 105 p.
9. Vol. 1. The Fifth Navy Science Symposium: Naval Research Proceedings. Apr. 18-20, 1961. 367 p.
9. Vol. 2. The Fifth Navy Science Symposium: Naval Research Proceedings. Apr. 18-20, 1961. 406 p.
9. Vol. 3. The Fifth Navy Science Symposium: Naval Research Proceedings. Apr. 18-20, 1961. 402 p.
11. Conference on Navy Laboratory Microelectronics Program Held at Howard County Laboratory, A. P. L., The Johns Hopkins University. June 12 and 13, 1961. 66 p.
12. Vol. 1. The Sixth Navy Science Symposium: Weapons and Weapons Effects. May 2 and 3, 1962.
13. Vol. 1. Seventh Joint Army-Navy-Air Force Conference on Elastomer Research and Development. Oct. 22-24, 1962. 276 p.
13. Vol. 2. Seventh Joint Army-Navy-Air Force Conference on Elastomer Research and Development. Oct. 22-24, 1962. 221 p.
14. Second Conference on the Navy Microelectronics Program. Sept. 24-26, 1962. 364 p.
16. Vol. 1. Seventh Navy Science Symposium: Solution to Navy Problems Through Advanced Technology. May 14-16, 1963. 294 p.
21. Vol. 1. The Eighth Navy Science Symposium: Automation and the Navy. May 1964.

Unclassified ACR Reports

The numbers preceding report titles refer to series number designations, such as ACR-1.

1. Symposium on Physiological Psychology. Mar. 10 and 11, 1955. 302 p.
2. Conference on Effects of Radiation on Dielectric Materials. Dec. 14 and 15, 1954. 169 p.
3. Joint Services Committee for the Study of Motion Sickness, Report No. 2: Bibliography on Motion Sickness. Jan. 1956. 29 p.

4. Vol. 1. Elastomer Research and Development. Symposium, Jan. 11 and 12, 1956. 126 p.
4. Vol. 2. Joint Army-Navy-Air Force Conference on Elastomer Research and Development. Jan. 11 and 12, 1956. 309 p.
5. A Report on Job Analysis. 1955. 62 p.
6. Progress Report Abstracts (Microbiology Branch). Jan. 1956. 159 p.
8. Suggestions and Procedures for Technical Conferences. Mar. 1956. 24 p.
12. Technology of Molybdenum and its Alloys. Symposium, Sept. 18 and 19, 1956. 16 p.
13. Conference on Photosynthetic Gas Exchangers. June 11 and 12, 1956. 95 p.
15. Symposium on Advanced Programming Methods for Digital Computers. June 28 and 29, 1956. 83 p.
17. Properties of Titanium Compounds and Related Substances. Oct. 1956. 448 p.
18. Progress Report Abstracts (Biology Branch). Jan. 1957. 143 p.
19. Some Aspects of Government-Sponsored Research in Metallurgy. May 1957. 18 p.
21. Surveys of Naval Science, No. 6: The Dental Research Program of the Department of the Navy. July 1957. 54 p.
22. Bibiliography of Unclassified Research Reports in Group Psychology. Sept. 1957. 41 p.
24. Human Engineering Bibliography, 1955-56. Oct. 1957. 306 p.
25. Molybdenum, Its Alloys and Its Protection. Jan. 1958. 18 p.
26. An Annotated Bibliography and Critical Review of Voice Communications. Jan. 1958. 117 p.
27. Progress Report Abstracts (Microbiology Branch). Jan. 1958. 123 p.
29. An Annotated Bibliography and Critical Review of Drugs and Performance. Aug. 1958. 84 p.
30. Second Symposium on Physiological Psychology. March 19-21, 1958. 253 p.
31. Conference on Radio and Microwave Spectroscopy. Nov. 4-6, 1957. 95 p.
32. Human Engineering Bibliography, 1956-57.
33. Arrangements of Groups of Men and Machines (Chapter VIII of Human Engineering Guide to Equipment Design). Dec. 1958. 127 p.
35. Progress Report Abstracts (Microbiology Branch). Jan. 1959. 137 p.
37. Data Processing Seminar on Status of Digital Computer and Data Processing Developments in the Soviet Union. Nov. 12, 1958. 179 p.
38. Second Symposium on Naval Hydrodynamics: Hydrodynamic Noise and Cavity Flow. Aug. 25-29, 1958. 538 p.
41. Proceedings of Tri-Service Conference on Job Qualifications Analysis. May 27 and 28, 1959. 67 p.
43. Human Engineering Bibliography, 1957-58. Oct. 1959.
45. Progress Report Abstracts (Physiology Branch). Jan. 1960. 145 p.
46. Human Engineering in the Navy, 1959. Mar. 1960. 10 p.
47. Progress Report Abstracts (Microbiology Branch). Jan. 1960. 139 p.
48. Bibliography on Saliva. Mar. 1960. 447 p.
49. First International Symposium on Gas Lubricated Bearings. Oct. 26-28, 1959. Distributed in 1961.
50. Symposium on Superconductive Techniques for Computing Systems. May 17-19, 1960.
51. Tri-Service Conference on Staffing Standards. April 19-20, 1960. 98 p.
52. Vol. 1. Third Symposium on Detonation. Sept. 26-28, 1960. 325 p.
53. Photographic Interpretation of Ice. Aug. 1960. 39 p.
55. Human Engineering Bibliography, 1958-59. Oct. 1960.
56. Progress Report Abstracts (Microbiology Branch). Jan. 1961. 139 p.
57. Progress Report Abstracts (Physiology Branch). Apr. 1961. 128 p.
60. Tri-Service Conference on Selection Research. May 25-27, 1960. 273 p.

61. Surveys of Naval Sciences, No. 10. Perspective in Materials Research. Feb. 1963. 771 p.
62. Vol. 1. Symposium Proceedings: Structural Dynamics of High Speed Flight. Apr. 24-26, 1961. 746 p.
63. Introduction to Acoustical Space-Time Information Processing. Jan. 1963. 193 p.
64. Animals and Man in Space: A Chronology and Annotated Bibliography Through the Year 1960. 1960. 97 p.
65. Third Symposium on Hydrodynamics of High-Performance Ships. Sept. 19-22, 1960. 613 p.
66. Progress Report Abstracts (Microbiology Branch). Jan. 1962. 135 p.
68. Progress Report Abstracts (Physiology Branch). Jan. 1962. 219 p.
69. Human Engineering Bibliography, 1959-60. Oct. 1961.

70. Research Highlights (Medicine and Dentistry Branch). Jan. 1962. 97 p.
71. Tri-Service Conference on the Role of Job Evaluation Techniques in the Structuring of Military Occupations. Apr. 25-26, 1961. 53 p.
72. An Evaluation of the Need for Filtration Systems to Protect Sheltered Personnel from Radioactive Fallout. May 1962. 19 p.
73. Vol. 1. Fourth Symposium on Naval Hydrodynamics: Ship Propulsion and Hydroelasticity. Aug. 27-31, 1962. 324 p.
73. Vol. 2. Fourth Symposium on Naval Hydrodynamics: Ship Propulsion and Hydroelasticity. Aug. 27-31, 1962. 326 p.
73. Vol. 3. Fourth Symposium on Naval Hydrodynamics: Ship Propulsion and Hydroelasticity. Aug. 27-31, 1962. 314 p.
74. Marine Borers: An Annotated Bibliography. 1963. 1136 p.
75. Human Engineering Bibliography, 1960-61. Oct. 1962. 343 p.
76. Tri-Service Conference on New Approaches to Personnel Systems Research. May 23-24, 1962. 80 p.
77. Progress Report Abstracts (Physiology Branch). Jan. 1963. 111 p.
78. Research Highlights (Medicine and Dentistry Branch). Jan. 1963. 100 p.
79. Progress Report Abstracts (Microbiology Branch). Jan. 1963. 144 p.

80. Progress Report Abstracts (Biochemistry Branch). Jan. 1963. 130 p.
81. Information Systems Summaries. July 1963. 70 p.
84. Navy-Wide Workshop in Biological Sciences Research. Oct. 14-18, 1963. 30 p.
85. Inter-Service Conference on Techniques for Determining the Military Career Force Structure. May 28-29, 1963. 78 p.
86. Human Engineering Bibliography, 1961-62. Oct. 1963.
88. Progress Report Abstracts (Physiology Branch). Jan. 1964. 98 p.
89. Research Highlights (Medicine and Dentistry Branch). Jan. 1964. 99 p.

90. Progress Report Abstracts (Microbiology Branch). Jan. 1964. 122 p.
91. Progress Report Abstracts (Biochemistry Branch). Jan. 1964. 116 p.
92. Fourth Symposium on Naval Hydrodynamics: Ship Propulsion and Hydroelasticity. Aug. 27-31, 1962. 1082 p.
93. The Logical Design of a Multichannel Device for the Retrieval of Information. Apr. 1964. 207 p.
94. Second Working Conference on the Liquid Nitrogen Process of Blood Preservation. Dec. 12-13, 1963. 124 p.
95. Visual, Display, and Control Problems Related to Flight at Low Altitude. Symposium, Mar. 3-5, 1964. 51 p.
97. Information Systems Summaries. July 1964. 80 p.

Inventions

Monitoring Radiation Doses Received by Personnel

Atomic blasts are accompanied by several types of radiation that are harmful to human beings. For example, exposure to an excessive quantity of alpha and beta particles may produce surface burns, and exposure to gamma and X-rays, which penetrate the body, may cause damage to internal organs (without noticeable effects on the outer part of the body). It is desirable, therefore, that personnel who may be subjected to this radiation wear or carry a detector, or dosimeter, that reveals immediately the dosage received. The instrument should be responsive primarily to radiation that may harm the internal organs.

Although a great many radiation detectors are available—for example, electroscopes, ionization chambers, proportional counters, Geiger-Mueller tubes, photographic film badges, and scintillation-photomultiplier counters—none has served satisfactorily as a warning device for human beings. What has been needed is a device that is small, simple in construction, light in weight, inexpensive, and that can be carried or worn easily. Electroscopes have small parts, require very delicate adjustment, and they are expensive. Ionization chambers are unsatisfactory for similar reasons, and they are heavy. Proportional counters, Geiger-Mueller tubes, and scintillation-photomultiplier counters contain somewhat complicated electronic circuits and thus are expensive also. Photographic film badges, which are inexpensive and simple to make, are capable of only a single application, and they require the use of suitable film-developing facilities.

An answer to this problem, provided by the Navy, was a phosphor glass dosimeter invented by Charles R. Horner and William F. Gray, former employees of the Bureau of Ships. After extensive prosecution and litigation, U.S. Patent No. 3,169,188, for "Case for Phosphor Glass Dosimeter," was issued on February 9, 1965.

The dosimeter applies a principle discovered by the Naval Research Laboratory, which is that a phosphor glass has the ability to store up energy proportional to the amount of radiation falling upon it. The dosimeter, which can be worn by an individual, consists of a plastic case, a small square of phosphor glass, and two lead shields, one situated above and one below the glass.

After the device has been exposed to radiation, the phosphor glass becomes "energized." If the glass is then exposed to ultraviolet light, it gives off fluorescent light in a quantity which is indicative of the amount of radiation the glass has received.

More than one million units incorporating this principle have been procured by the Navy.

On the Naval Research Reserve

Summer Seminars

The Research Reserve is sponsoring the following four seminars in the first quarter of fiscal year 1966:

Seminar	*Convening Date*
Antisubmarine Warfare Newport, Rhode Island	19 July
Applied Research Albuquerque, New Mexico	2 August
University Research in Relation to Government and Industry State College, Pennsylvania	9 August
Electronic Computers College Station, Texas	30 August

An insight into the proposed seminar program is given below by the chairmen of the August seminars.

APPLIED RESEARCH

The quantity and quality of the scientific activities that are conducted within the borders of the State of New Mexico are increasing rapidly. As a result, the skilled manpower, both military and civilian, that is available in this section of the country is above the national average and, to a great degree, is unique in character. For these reasons New Mexico offers an unusually fertile field and suitable area for Research Reserve companies to hold training seminars.

The first of these research seminars was held in August 1964 and was attended by 36 officers of the Navy and Army Reserve programs. It was an outstanding success. Due mainly to the efforts of CDR Nelson E. Spurling, USNR, of NRRC 8-7 in Albuquerque, New Mexico, the lectures and laboratory and facility tours at Defense Atomic Support Agency, Kirtland Complex, Lovelace Foundation for Medical Research, Sandia Corporation, and Los Alamos Scientific Laboratory were interesting, instructive, and informative. The pleasant New Mexico surroundings and weather as well as the a above-average living quarters at Sandia Base assured a pleasant tour as well as an informative one. The second Research Reserve seminar will be held August 2-13. The preparations for this effort form the main extra duties of the members of NRRC 8-9 of Los Alamos, New Mexico, the managing unit for the 1965 program, and NRRC 8-7, which will assist this year. According to LCDR Robert H. Dinegar, USNR, NRRC 8-9, the seminar chairman, the same high-level lectures on fundamental applied research topics will be held. Special emphasis will be on civilian and military nuclear weapons development and peaceful applications of nuclear research and medical academic programs. Ninety Reserve officers are expected to take part in this major Naval Research Reserve seminar.

ELECTRONIC COMPUTERS

Under the joint sponsorship of Texas A&M University and NRRC 8-3, the Third Annual Research Reserve Seminar on Electronic Computers, College Station, Texas, is scheduled for the period August 30 to September 10, 1965. This seminar is called a working seminar, and participants feel that such a characterization is well justified.

No previous computer programming experience is required. If the officer participant is already a qualified programmer, he works hard teaching his skills to other participants. Also, he is given time to write programs of his own choice, and these are run for him on the University's IBM 7094 without any charge to him.

If the participant has no programming knowledge or experience, he is taught enough of the art to write programs involving simulation and elementary mathematical calculations; these programs are run for him. The type of simulation program he writes demonstrates the validity of some of the theories developed in the informal lecture sessions. For example, his programs may simulate good and bad strategies in the distribution of fleet forces or airplane flight plans, and the running of his program gives him the results of these strategies.

If the participant is more interested in data processing, he is helped in writing a program which analyzes data obtained from the seminar group.

If the participant is a specialist in a field, such as medicine, operations research, engineering, psychology, or mathematics, he is encouraged to develop a program which will help him in that field.

Some of the new disciplines associated closely with the phenomenal growth of computers are presented in a basic elementary descriptive way at the seminar. The military applications and implications are generally stressed. Some of these fields are linear programming, random number generation, simulation, PERT, wave analysis, activation analysis, and, of course, space travel.

A casual remark by one of the former participants is considered by the chairman as one of the most convincing compliments the seminar has received: "The time surely goes fast at this seminar."

UNIVERSITY RESEARCH IN RELATION TO GOVERNMENT AND INDUSTRY

Naval Reserve Research Company 4-4, University Park, Pennsylvania, announces its first seminar, which will be held August 9 to 20 on the Pennsylvania State University campus. LCDR J. Carroll Dean, USNR, is commanding officer of the company and CAPT Harry H. Chisman, USNR, will serve as seminar chairman. The seminar, co-sponsored by this company and the Office of Naval Research, is endorsed by Dr. Eric A. Walker, president of the University and chairman of the Naval Research Advisory Committee.

The University, which has an annual sponsored research budget of 17 million dollars, will be open for your inspection. During the seminar, highlights of the research program that affect government and industry will be presented. Topics for the two weeks will include space research, environment, bio-sciences, materials research, and research analysis.

Pennsylvania State University is located in the mountains of Central Pennsylvania. The surrounding area is rich in history, encompassing the Pennsylvania Dutch Country, Gettsyburg, Valley Forge, and other scenic and interesting places that are within easy driving distance.

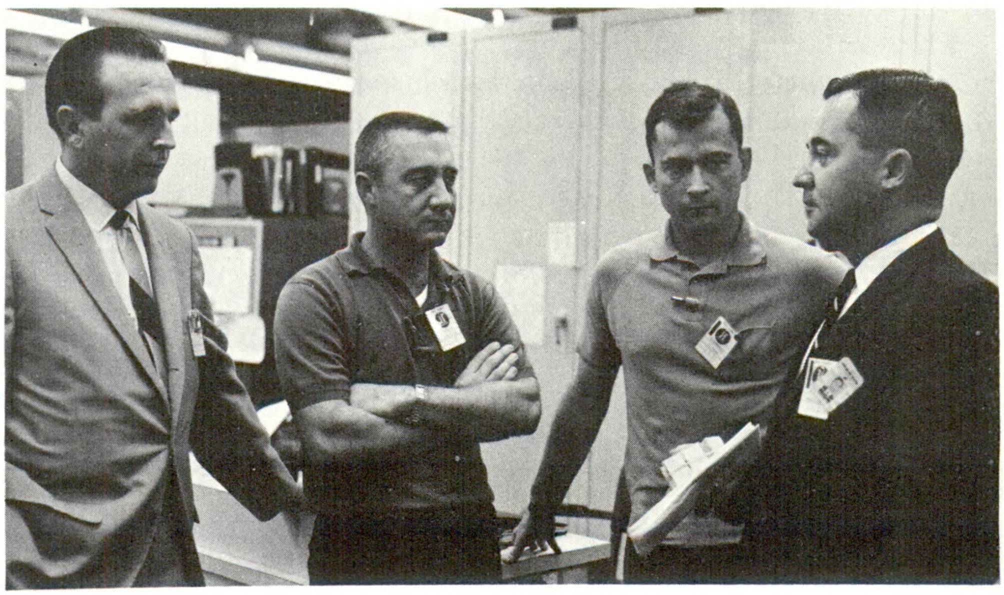
Reservists Participate in Search for THRESHER

Participating in the search for the THRESHER conducted by the Naval Research Laboratory during 1963 and 1964 (see story beginning on page 1) were five members of Naval Reserve Research Company 5-9. All of these officers—CAPT A. J. Hiller, USNR; CDR C. L. Buchanan, USNR; LCDR J. J. Gennari, USNR; LTJG R. M. Lee, USNR; and MAJ E. A. Abbott, USAF—are employed in the Sound Division of the Laboratory.

CDR Buchanan was named a member of the "Chief of Naval Operations Advisory Group for THRESHER Search Operations" and was designated head of the THRESHER Search Project for the Naval Research Laboratory. LCDR Gennari was responsible for the towed instrument vehicles and the provisions for tow cables and hoisting and towing gear. CAPT Hiller drew the assignment of senior scientist on the first deep towing operation. LCDR Gennari and CDR Buchanan followed him in this assignment on succeeding operations. LTJG Lee was responsible for backup equipment prepared for the second ROCKVILLE cruise, and MAJ Abbott was involved in the preparation of cameras and special batteries and in the pressure testing of various equipment for use deep in the ocean where a force of more than two tons per square inch is exerted. See photograph on front cover.

Launching the Astronauts

LCDR J. M. Verlander, USNR, a member of NRRC 6-16, Patrick Air Force Base, was responsible for the checkout and launch of the Gemini launch vehicle in support of the recent Gemini two-manned space flight of astronauts Grissom and Young. As project director, he is responsible for all Martin Company support of the receipt, checkout, launch, and evaluation of the Gemini launch vehicle.



LCDR Verlander (right) briefs F. X. Carey, chief test conductor, Gemini launch vehicle, Martin Company, and astronauts Grissom and Young prior to the GT-3 operation.

EIGHTH NAVAL DISTRICT REPORTS

New Mexico Research Reserve Companies Visit Scripps Institute

On a weekend late in March 1965, two New Mexico Research Reserve companies—NRRC 8-7, Albuquerque, and NRRC 8-9, Los Alamos—attended a seminar at the Scripps Institute of Oceanography, La Jolla,

LCDR Jack R. Halliday, USNR, left, is welcomed to San Diego by Dr. Marston C. Sargent. Looking on are LCDR Thos. J. Kennedy, USNR, Reserve Assistant at ONR, Pasadena, and CDR Raymond D. Tuttle, USNR, a representative of NRRC 11-5, which hosted the Eighth Naval District Reservists during their San Diego visit.

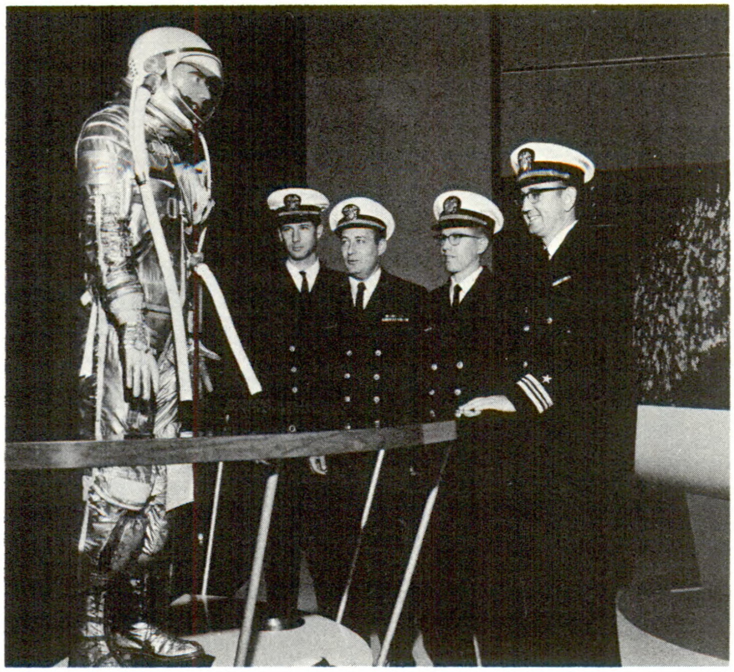
California. The seminar was arranged by NRRC 11-5, San Diego, California, with the assistance of the Office of Naval Research Branch Office, Pasadena. The technical program was coordinated by Dr. Marston C. Sargent, ONR's scientific liaison officer at the University of California at La Jolla.

The purpose of the visit was to obtain information from University scientific authorities on some of the ocean projects now in progress and to examine various facilities used in ocean research.

The tour director was LCDR J. R. Halliday, USNR, of NRRC 8-7. Transportation was provided by the Naval Weapons Evaluation facility at Kirtland Air Force Base.

Weekend Seminar Held at Houston

Members of Naval Reserve Research Company 8-4, Houston, Texas, sponsored the Third Annual National Aeronautics and Space Administration—Manned Spacecraft Center (MSC) Seminar over the weekend of April 2-4, 1965. General arrangements were under the direction of LCDR M. G. Gugenheim, Jr., USNR, commanding officer of the Reserve company. LCDR R. J. Ward, USNR, a member of NRRC 8-4, was seminar coordinator. Two hundred and twenty-two Reservists took advantage of this opportunity to acquaint themselves



Members of NRRC 8-4 observe features of a pressure suit dur the Third Annual NASA-M Seminar. The Reserve offic from left to right, are LT C. W Fulcher, USNR, session chairn for flight operations; LCDR M Gugenheim, Jr., USNR, comma ing officer, NRRC 8-4; LT R. Towsend, USNR, seminar fa ties officer; and LCDR R. J. W USNR, seminar coordina

with the latest developments at NASA's MSC. All branches of the Armed Forces were represented at the seminar.

The opening session on Friday evening was held at the Burke Baker Planetarium in Houston. Mr. Ben D. Hall, curator, demonstrated the operation of the planetarium and gave the registrants a simulated Gemini flight around the earth.

The Saturday and Sunday sessions were held at NASA's MSC at Clear Lake, near Houston. Briefings, which were conducted on both Saturday and Sunday mornings, featured both military and civilian authorities on the space program. Excellent presentations were made by the following military speakers: CDR R. C. Duncan, USN, Chief, Guidance and Control Division of the Manned Spacecraft Center; CDR Allen Smith, USN, North American Air Defense Command (NORAD); LCDR Alan L. Bean, USN, astronaut at the MSC; and MAJ William Barr, USAF, Ellington Air Force Base, Houston, who discussed "Spacecraft Drop Testing." The NASA-MSC aerospace engineers who spoke at the briefings and the subjects of their talks were as follows: Dr. Joseph F. Shea, manager, Apollo Spacecraft Program Office, "Apollo Program Status"; Mr. Aleck C. Bond, manager, Systems Test and Evaluation, "MSC Test Facilities"; and Mr. Leon Hodge, Flight Operations, "Spacecraft Landing Systems and Recovery Techniques."

The Saturday afternoon session featured a tour of the MSC facilities, including the mission control center, crew systems facilities, and the space environment and flight acceleration test and evaluation facilities.

The Reservists who attended the seminar were enthusiastic about the weekend group training provided by members of NRRC 8-4.

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Conrad Award Given to Navy Captain

CAPT Ashton Graybiel, USN, head of the research division of the Naval School of Aviation Medicine, Pensacola, Florida, was presented the Captain Robert Dexter Conrad Award for scientific achievement on May 14. Dr. Robert W. Morse, Assistant Secretary of the Navy for Research and Development, presented the medal and citation to Dr. Graybiel during ceremonies dedicating the new $2.6 million School of Aviation Medicine Building at Pensacola.

"The Captain Robert Dexter Conrad Award is the Navy's analogue to the Nobel Prize," Morse said. "It was established in memory and in honor of a scientist in uniform whose foresight and sensitivity helped the Navy assume a role of major national leadership in supporting basic research among the nation's universities and other research institutions. Unlike other Navy awards, the Captain Conrad Award for Scientific Achievement is open to civilian scientists, to military scientists, and to scientists engaged in research under contract with the Navy."

Dr. Morse noted that this was the first time the award had been given to a Naval officer on the basis of his preeminence as a research scientist.

In lauding Dr. Graybiel's contributions to aeromedicine and related fields, the Navy Secretary said, "He has been able to devote practically his full Naval career to creative research....His career is a landmark of encouragement for other Naval officers whose creative talents in research might also be given the same opportunity for full expression within the Naval environment."

Speaking both as a scientific member of the national community and as a spokesman for the Secretary of the Navy, Dr. Morse said he was presenting this award to Dr. Graybiel "as a simple token of our great esteem for your brilliant career as a scientist and Naval officer."

In addition to being one of the Nation's top aviation medicine specialists, Dr. Graybiel is known widely as a research physician and cardiologist.

s. Moria Graybiel ›udly examines the ›BERT D. CONRAD ‹ARD presented to · husband, CAPT ›ton Graybiel.

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NAVAL RESEARCH REVIEWS publishes highlights of research conducted by Navy laboratories and contractors and describes important Naval experimental facilities. Manuscripts submitted for publication, correspondence concerning prospective articles, and changes of address, should be directed to Code 740, Office of Naval Research, Washington, D.C., 20390. The magazine is listed for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Subscription price: $1.50 per year in the U.S. and Canada; $2.00 per year, foreign; $0.15 per individual copy. The issuance of this periodical approved in accordance with Dept. of the Navy publications and printing regulations.

EDITOR: Richard D. Olson

The Naval Research Laboratory's search for the THRESHER in 1963 and 1964 culminated in the photographic observation of several large portions of the hulk, samples of which are shown on the cover and in the story beginning on page 1. The Reserve officers pictured here participated, as civilians and members of NRL's Sound Division, in the successful operations. They are, left to right, MAJ E. A. Abbott, USNR; CDR C. L. Buchanan, USNR; CAPT A. J. Hiller, USNR; LTJG R. M. Lee, USNR; and LCDR J. J. Gennari, USNR. Their discussion concerns some of the equipment, mounted on an NRL research ship which was utilized in the search. See also page 29.