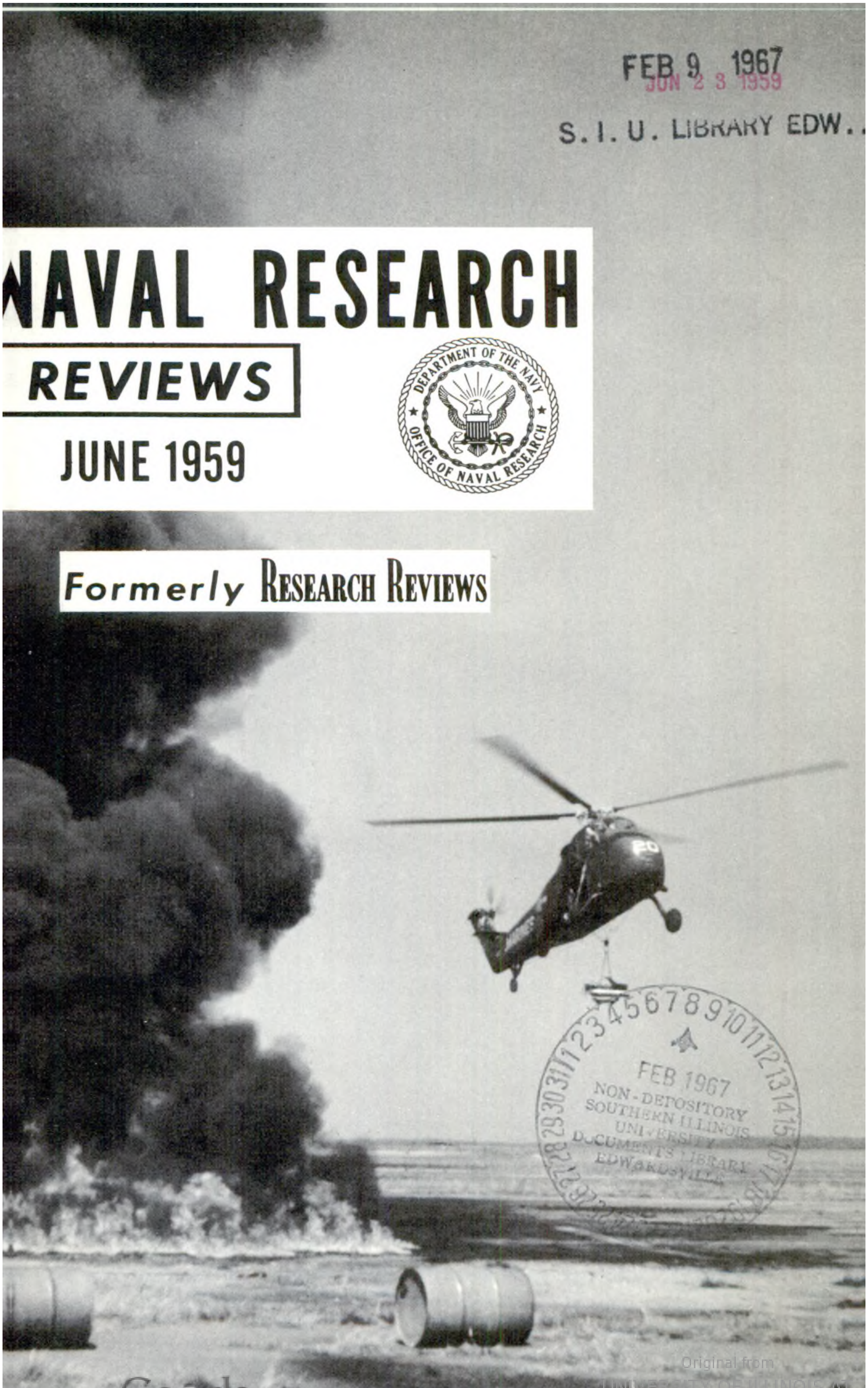
NAVAL RESEARCH REVIEWS

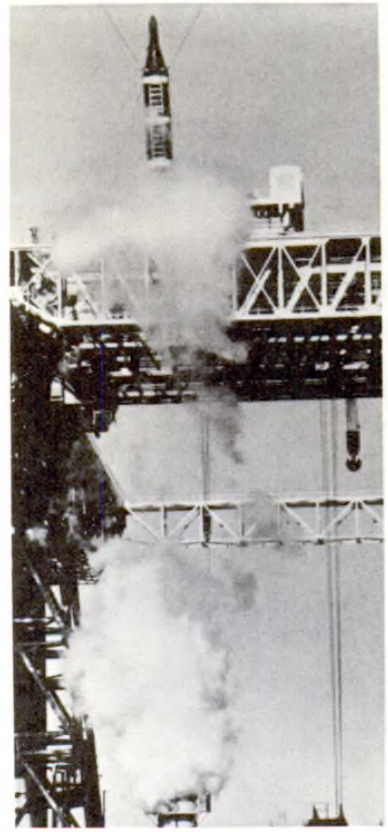
JUNE 1959

Formerly RESEARCH REVIEWS

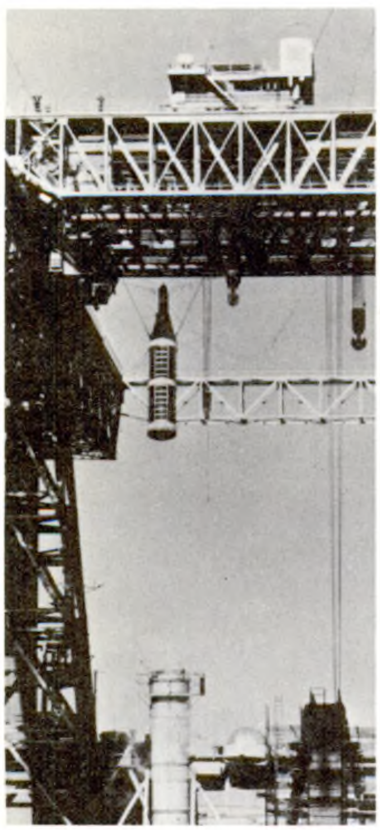


Operation Skycatch

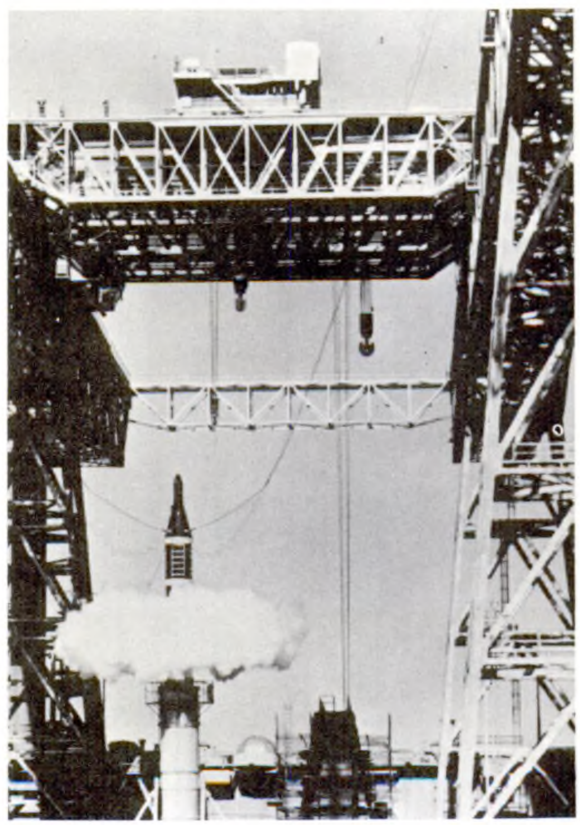
By means of a towering steel structure at the San Francisco Naval Shipyard, dummy missiles are caught in mid-air after launching. The procedure, called appropriately Operation Skycatch, is a new one in the development of the launching system for the Polaris Fleet Ballistic Missile. It permits accurate study of the effects of launch stresses on the dummy missiles, which are structurally identical to operational Polaris missiles. The tests are being conducted by engineers from the Westinghouse Electric Company and Lockheed Aircraft Corporation.



The missile's flight is arrested.



The missile rises above launcher.



Polaris dummy is launched.

Human Adjustment to Antarctic Isolation

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Antarctica is a cold, unfriendly continent. There is virtually no life there. The topography is rugged. Most of the land is covered by thick layers of ice. Over large areas are to be found numerous crevasses, those thinly covered chasms in the snow. There is very little daylight during the winter and very little darkness during the summer. Temperatures range from a high of only 40° F to a low of -105° F. The wind may blow at velocities as high as 140 knots and may change speeds very rapidly—as many as 50 knots in 15 minutes. One could go on pointing out additional features that set Antarctica apart from other continents. However, enough has probably been said to indicate that the basic problems of living there are highly complicated.

What are some of these complications? All supplies, including food, must be brought in. All water used must be melted from snow. Waste materials cannot be disposed of in the usual way becuase of the absence of bacteria. Finally, the men are completely isolated for about six to eight months at a stretch. There is no possible way for them to escape their confinement, and no way for help, if needed, to reach them.

Before the Navy undertook DEEPFREEZE II, the Neuropsychiatry Branch of the Bureau of Medicine and Surgery began making psychiatric assessments of all men (civilian and Navy) volunteering for a year of duty in the Antarctic. The value of these assessments is indicated by the fact that of about 700 men who were assigned to duty in the Antarctic during DEEPFREEZE II and III, only six had to be evacuated for psychiatric reasons. As part of this project, which is still underway, the author made two field trips to Antarctica, one from November 1957 to February 1958 and the other from September to the middle of November 1958. The purpose of the trips was to gather information that would enable the Navy to develop better criteria for its personnel assessment program. Data were collected at Scott Base (the New Zealand IGY station) and at the following Unites States stations: McMurdo, Little America, Byrd, Pole, and Hallett. The IGY complement from the United States was made up of volunteers representing two distinct groups: civilian scientists and U. S. Navy personnel supporting the scientists in their work.

Two major factors affect man's adjustment to Antarctic isolation. One is the size of the population of the station at which he is located, and the other is the duration of his stay in the Antarctic.

Reactions to isolation are entirely different at the so-called "large" and "small" stations. At the small stations (numbering from 12 to 23 people) the men tend to develop a "family-like" set of interrelationships. This is because each man comes face to face with all other members of the camp many times throughout the day. Also, because "replacement" personnel are not available, each man is needed to perform essential chores. Thus, a feeling of interdependence develops between station members.

Perhaps the most important problem that arises in the small camp is learning to live with only a few other people—representing a limited number of personality types—over a long period of time. Generally, when a man first arrives at the small station, he is not acquainted with any of the other men there. Yet, because he must constantly interact with each of them, he is forced to "bend over backward" to get along with them. By contrast, at the larger stations (having complements of 100 to 125 persons), enough men are present for informal cliques to form, bringing together people of similar interests. Thus, if a person is not interested in the company of the scientist, he can go off with one of perhaps several groups that are concerned with maintenance of the station. Although this person still comes in contact with the scientist, he is not dependent upon him for gratifying social needs. This freedom to choose one's friends does not exist at the small stations.

The second factor that greatly influences the kind of behavior exhibited is the length of time a person is isolated. The needs and concerns of a man staying only two or three months are quite different from those of one staying from nine to fourteen months. The short-termers are concerned with very much the same things they were concerned with before they came to the Antarctic. For example, they worry about the absence of "liberty spots"—places where they can escape from the boredom and immediate surroundings of the camp—and about the fact that they are deprived of sexual gratification. The long-termers, on the other hand, tend to ignore or repress these deprivations; they give more attention to such problems as the absence of fresh fruits and vegetables.

The observation that was made of all people arriving in the Antarctic for the first time was that they exhibited greater anxiety than they had shown previously. For people so predisposed, this heightened anxiety is sufficient to precipitate mental illnesses, such as psychoses and hysterical states. Of the six people that had to be evacuated from the Antarctic for psychiatric reasons, all developed symptoms of mental disturbances in from one to four weeks after "getting on the ice."

The initial anxiety over "not knowing what to expect" was alleviated considerably by the work which the men engaged in upon arriving in the Antarctic. As a matter of fact, work soon becomes the most meaningful of the social roles that the isolated men have. The reason it does is that the men can no longer engage in many of the social roles that were so meaningful to them previously, such as the roles of husband or father. The more an individual is able to occupy himself working, the better he is able to adjust to isolation. It is quite understandable, therefore, that some men engage in more than one line of work. For example, a physician who had to spend a minimal amount of time at his professional calling, took over the additional responsibilities of housing officer. This kept him busy three or four more hours a day.

The values attached to work roles in the Antarctic are organized somewhat differently from those at most places in the United States.

For example, the cook, who is directly related to one of the few socially approved gratifications permitted the men, achieves far higher social placement within the group than do the scientists who are making observations. The radio operator, who maintains contact with the world outside the camp, is held in similar esteem.

Considering how important work is to men at Antarctic stations, and that only a limited amount of it can be done in the winter due to low temperatures and darkness, it is not surprising that as winter comes on signs of depression appear. These mark the beginning of the second phase of adjustment to polar isolation. It is during this period that some of the chronic types of "adjustment casualties" occur. For example, more of the men go sleepless for longer intervals, some getting no more than an hour's sleep a day for a week at a time. A few develop symptoms quite similar to those reported in experimental studies of sensory deprivation (Research Reviews, April 1958), such as hallucinations and inability to concentrate. Another effect is that all persons are more irritable; however, reactions to these feelings are generally inhibited. For some there tends to be a rather marked increase in the number of headaches experienced. It is interesting to note that the group bothered by the headaches are, for the most part, the intellectualizers—the scientists as well as some of the Navy men who work on jobs largely of an intellectual nature and who had, generally speaking, at least two or three years of college work.

"Regressive" behavior increases also during the winter. The form it takes varies with the personality structure of the individual and his dynamics. For some, it means being able to sleep as many as 18 hours a day—a return to an infantile way of living. For others, as has been pointed out, it means just the opposite—the inability to sleep. Many of these men sit for hours on end listening to hi-fi recordings. Regression also takes the form of increased sensitivity to minute sounds. Often this sensitivity gives rise to an almost child-like apprehension of noises. This reaction, which is reported also in the literature of polar explorers, occurred at both large and small stations.

It should be evident that men living in isolation in the Antarctic are often bored. This is the case in spite of the fact that numerous facilities are available to alleviate boredom. For example, all of the Antarctic stations have relatively well supplied hobby shops. The problem is that the men do not make much use of them. They seem to prefer simpler types of "recreation," such as reminiscing about earlier experiences, listening to recordings, and playing cards. One of the more interesting of these outlets is the invention and propagation of rumors. Unlike the rumors that one might hear during war, such as those developing aboard a Navy ship preparing for an engagement, those dreamed up at Antarctica are harmless, intended to do no more than introduce a bit of humor into the dull life of the station. The following rumor, started at one of the Antarctic stations last year, will serve as an example.

One fellow, while walking through the garage, noticed some copper trimmings near a drill press. He picked them up, melted them, and dropped the molten copper slowly into cold water. He then took his copper beads and placed them in the filter of the snow melter, used for obtaining water. That evening he and his buddies, whom he had "let in" on the hoax, spoke to one of the drivers who brought the snow in from the glacier pit to be melted. They said a "doctor" had told them that an active valcano nearby had probably erupted gold and other minerals. If so, they speculated, there must be gold in the area. Then they talked about the possibility of prospecting for it. Later in the week, when the filter was cleaned, the "gold" nuggets were found. Word of the "find" spread to the other members of the water-making crew and from them to other personnel in the camp. As a result, there was a sudden increase in the number of volunteers for assisting in the snow mining, all to the vast amusement of the group that had perpetrated the hoax.

In Antarctic stations, as in other social settings, a person who tends to create difficulties for others is a person who has difficulties involving his own character structure. For example, he may be overly dependent, self-centered, or narcissistic, or may feel basically unable to cope with the world in which he finds himself. Persons of the latter type may try to prove in an exaggerated way that they are more than able to cope with the situation. Likewise, those people with marked insensitivities to the needs and feelings of others cause difficulties.

Men with fairly strong neurotic predispositions, while not a "problem" for other camp members, reported that not enough "privacy" exists at the stations. The fact is, however, that there is more living space per man at these stations than there is aboard most Naval vessels. One is led to believe that the isolation which the men were subjected to in the Antarctic gave them a greater feeling of confinement. One other point should be noted. While there was considerable aggression displayed by personnel at each station, most of it was directed toward groups outside the station. Thus the men were able to give vent to their aggressive feelings without threatening the disruption of their own group.

The third stage of adjustment to the Antarctic is reached when the men are given difinite signals that the period of isolation is about over and that they will soon be off the ice. These signals consist of the sun coming up, planes making air drops, ships coming in, and people arriving to occupy the station for the summer. At this time, the men are not as depressed as they were during the winter, symptoms of boredom disappear, and the regressive kinds of reaction, such as infantile behavior, are less obvious. However, more headaches occur. The men attribute them to the bright sunlight, but it is more likely they are due to unverbalized wishes to get off the ice.

The final phase of adjustment to Antarctic isolation takes place during the period just prior to returning home. During this period, much anticipatory behavior is noted, as if the men were already off the ice. This feeling disrupts the routine of the camp considerably. Work assignments are perfunctorily carried out, and the maintenance of equipment and facilities is slighted. Once off the ice, the men rapidly readjust. Sleeplessness, depressions, and other behaviors noted on the ice disappear as the men return to the complex society that they had left.

A number of benefits grew out of the field trips to Antarctica in so far as the Navy's psychiatric assessment program was concerned. Chief among those was the finding that persons diagnosed as having personality or character disorders, such as those described above, caused a greater disruption of camp life and activities than did persons diagnosed as having neurotic tendencies. As a result of these and other findings, criteria for the psychiatric screening of men volunteering for Antarctic duty have been revised in order to make the program even more effective in contributing to the efficient operation of Antarctic station.

NATO ASW Center Established in Italy

An international research laboratory whose aim is to study and help solve basic problems in antisubmarine warfare has been established at the Italian naval base at La Spezia, midway between Genoa and Leghorn. It will be known as the SACLANT ASW Research Center. "SACLANT" stands for Supreme Allied Commander Atlantic.

In informing the NATO Council of the plans for this center, ADM Jerauld Wright, USN, NATO's Supreme Allied Commander Atlantic, said, "I am confident that the SACLANT ASW Research Center will make highly important contributions to the capability of the navies of our alliance to counter the Soviet submarine threat and secure the seas for use by the free world."

Nine NATO nations will participate in the work of the Center. They are Canada, Denmark, France, Germany, Italy, the Netherlands, Norway, the United Kingdom, and the United States. The Italian government will make available laboratory buildings and other facilities.

Policy direction for the laboratory will be furnished by SACLANT in coordination with pertinent NATO agencies. Raytheon Manufacturing Co. of Waltham, Mass., a leader in ASW development since 1901, will manage the Center through an Italian subsidiary, which has a non-profit contract. The subsidiary's board of directors will include, among others, ADM Robert B. Carney, former Chief of Naval Operations, and Charles Francis Adams, President of Raytheon Manufacturing Co. A scientific council of eminent scientists from the participating countries will provide advice and recommendations to SACLANT concerning the Center's program and progress. The laboratory will be staffed initially by about 20 senior scientists plus 60 to 80 supporting personnel. Named as the Laboratory's Scientific Director is Dr. Eugene T. Booth, an ASW expert now on leave from Columbia University where he served as head of the Physics Department.

The ASW Research Center will monitor and analyze oceanographic measurements in selected waters. Among other chief functions will be operational research and analysis plus limited development in various phases of antisubmarine warfare. Present ASW scientific knowledge of the nine nations will be pooled in the Center, and findings of new studies funneled back to the participants. All NATO nations with ASW potential also will have free access to the findings.

The 100-Inch Airborne Radiometer

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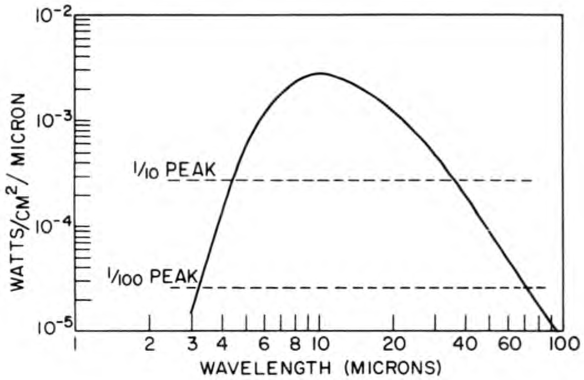
The Naval Research Laboratory has been engaged for the past few years in a study of physical properties of the oceans as revealed by measurements of radiant energy from their surfaces, with particular emphasis on the optics of the atmosphere and sea. One of the tools developed for this study is a massive radiometer designed to be flown in the larger Navy airships, such as those of the ZPM and ZPG series, at an altitude of 1,000 feet. The instrument measures and records continuously the thermal power radiated by the sea, plus that small portion which originates in the sky above and is reflected from the sea.

All objects whose temperature is higher than absolute zero emit radiation, the spectral distribution of which depends upon the temperature of the objects. The sea is essentially a "blackbody," or perfect radiator, with maximum output in the wavelength region between 8 and 13 microns, depending upon the water temperature. A typical blackbody spectral distribution curve for a temperature of 293° K is shown in Figure 1. Figure 2 is a graph indicating the amount of radiation the atmosphere transmits at various frequencies. Fortunately, over the region of maximum output, radiation from the sea is transmitted very well by the atmosphere. Under average conditions, about 30 percent of this radiation is transmitted. As can be seen from Figure 3, liquid water is a strong absorber of 8- to 13-micron radiation. Almost complete absorption takes place between the surface of a body of water and a depth of 0.1 millimeter. Thus, only the radiation from this very thin surface layer is observable from the air. Because of these selective characteristics, the NRL radiometer is used specifically to study the surface properties of the sea in the 8- to 13-micron region.

Radiometers of two different configurations are employed. The first, shown in Figures 4 and 5, utilizes a single receiver. It consists of a parabolic mirror which is 100 inches in diameter and which has a focal length of 70 inches. This mirror collects the radiation from the surface of the sea and focuses it on a single, large radiation thermopile. However, before reaching the thermopile, the radiation is interrupted (chopped) mechanically at a 5-cps rate by a "butterfly" shutter. Upon reaching the thermopile, the radiation is converted to an electrical voltage which is amplified and mechanically rectified by a segmented commutator mounted on the shaft of the shutter. The rectified signal is recorded after suitable electronic filtering. With the single-receiver arrangement, it is possible to measure the absolute magnitude of the power radiated by the sea. From these measurements and a knowledge of the total atmospheric transmission in the optical path, it is possible to calculate the temperature of the sea's surface.

The second radiometer configuration (Figures 6 and 7) is a differential one. The 100-inch mirror is split along a diameter and is

Figure 1--Typical spectral distribution curve for a "blackbody," or perfect radiator, at a temperature of 293° K. Note that maximum output is in the wavelength region between 8 and 13 microns.



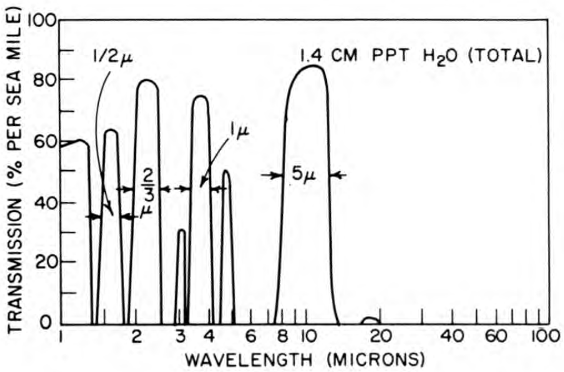


Figure 2--Ability of the atmosphere to transmit radiation of various wavelengths. Note that maximum transmission occurs for wavelengths between 8 and 13 microns. From J. H. Taylor and H. W. Yates; Journal of the Optical Society of America; volume 47; 1957.

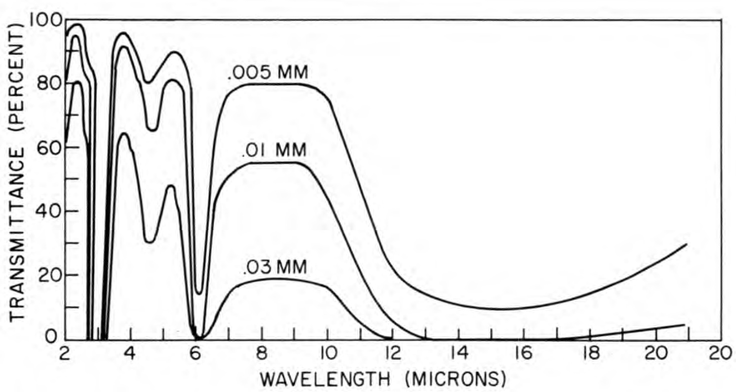


Figure 3--Ability of liquid water to transmit radiation. From E. K. Plyler and N. Acquista; Journal of the Optical Society of America; volume 54; 1954.

opened outward 15 degrees, thereby forming two independent collecting areas. Mounted in the focal plane of each collecting area is a large radiation thermopile which accepts radiation from its respective mirror section. A "butterfly" shutter, which is common to both thermopile receivers, interrupts (or chops) the incident radiation at a 5-cps rate. The resultant electrical signals are subtracted one from the other and the difference is amplified, mechanically rectified, and recorded after filtering. With the differential arrangement, very small changes in

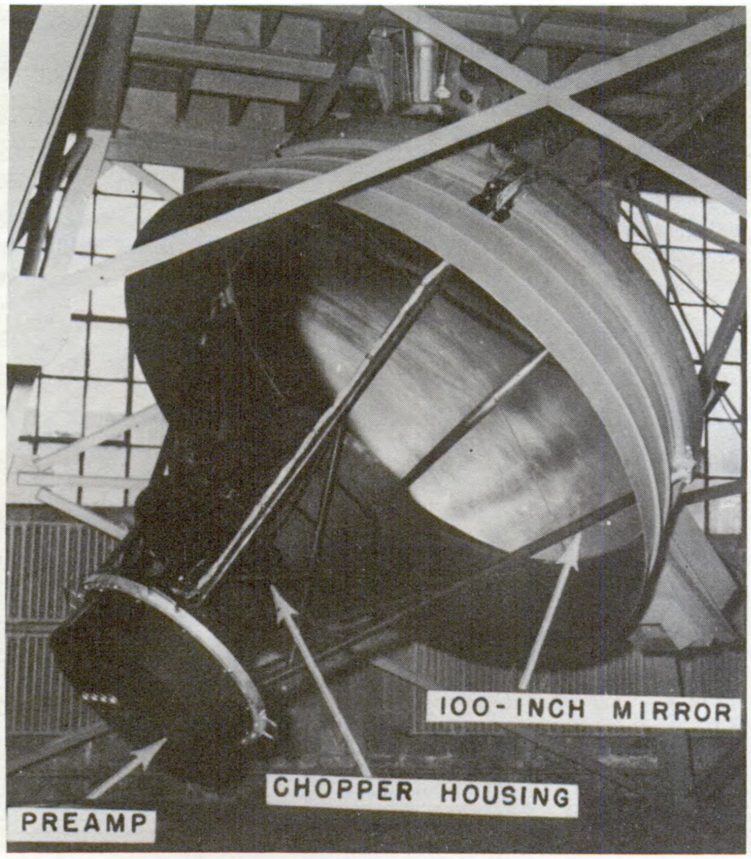
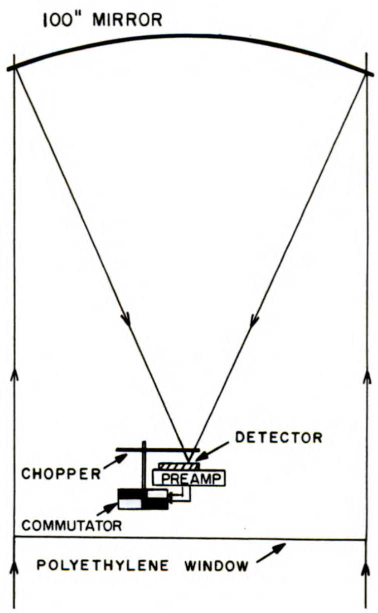


Figure 4--Radiometer with single-receiver configuration.

Figure 5--Diagram of radiometer with single-receiver configuration.



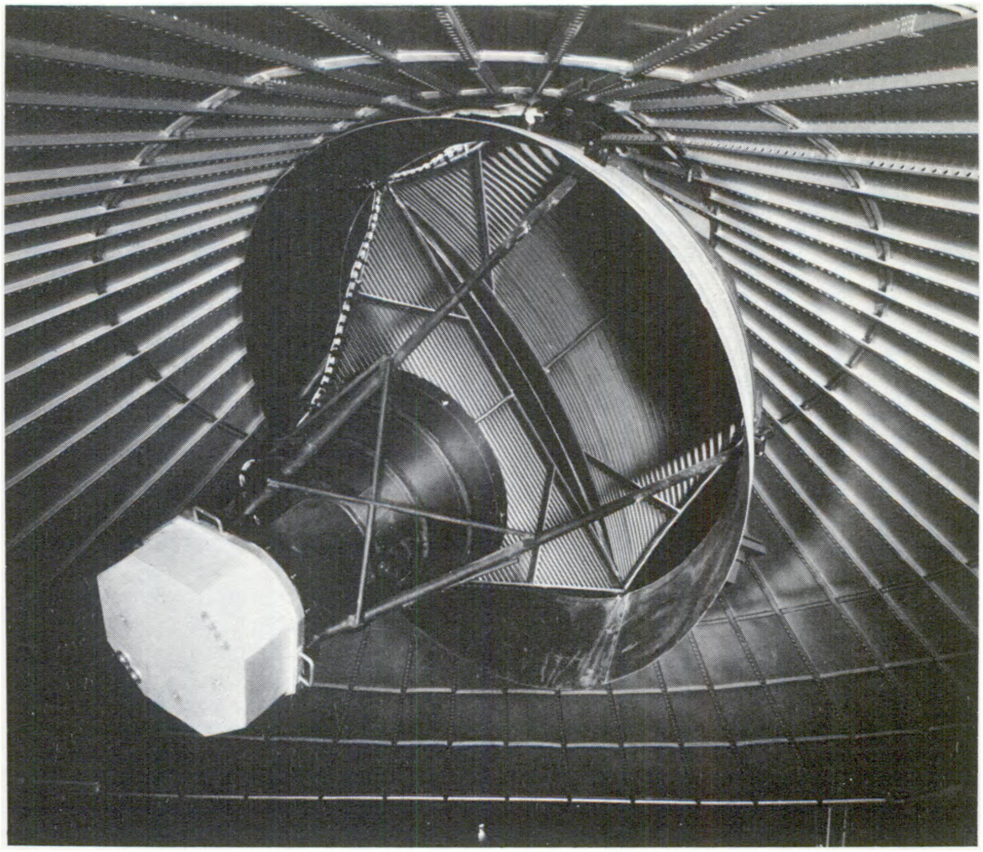
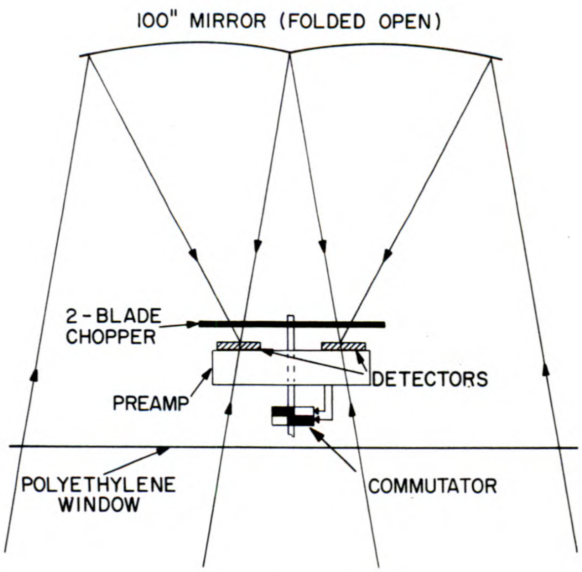


Figure 6--Radiometer with differential configuration.

Figure 7--Diagram of radiometer with differential configuration.



power radiated from the sea can be measured, thus permitting a study of the microthermal structure of the sea's surface.

In the laboratory the performance of the radiometer in each configuration is similar, with the noise level of each approaching the thermal-agitation noise limit of the radiation thermopiles. In flight, however, the noise level of the single-receiver radiometer increases considerably owing to inhomogeneities in the atmosphere, small changes in altitude, and the roll and pitch of the aircraft. The noise signals due to change in altitude are the result of changes in atmospheric absorption which are due, in turn, to changes in optical path length. An increase or decrease in path length of as little as 1 foot in 1,000 feet increases several times the noise level of the single-receiver radiometer. Roll and pitch produce changes in path length also; their main contribution to

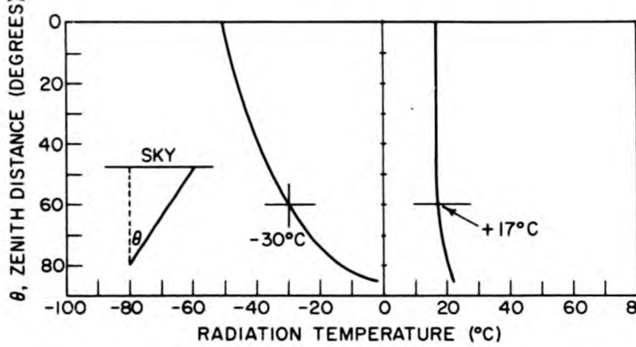


Figure 8--Radiation temperature of the sky. Left: clear sky, 26° C, 2.3 cm. precipitable water per sea mile. Right: overcast sky, 27° C, 3.4 cm. precipitable water per sea mile.

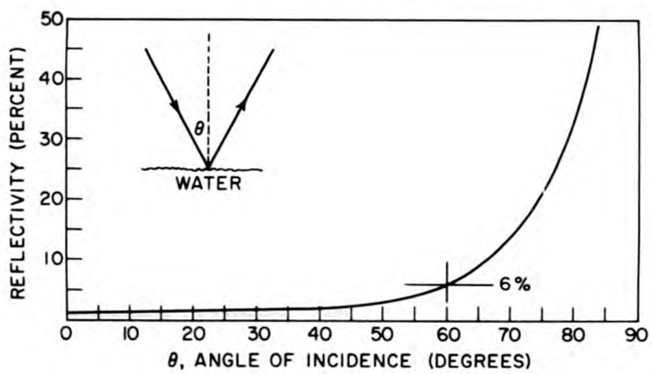
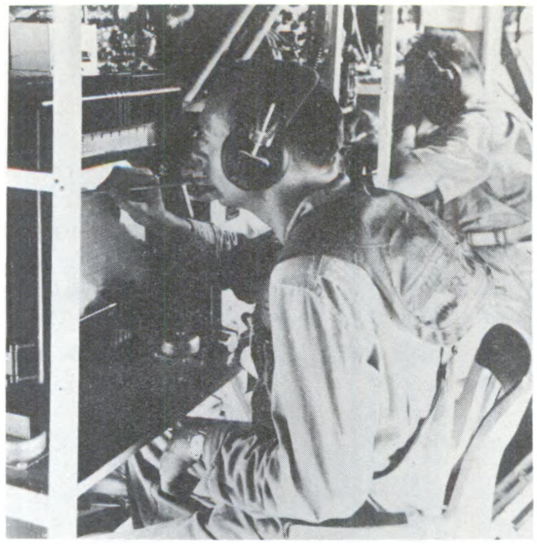


Figure 9--Reflectivity of pure water.

the noise, however, is the result of a change in the reflectivity accompanying the repeated changes in the angle of incidence and the radiometer "seeing" more or less of the reflected sky radiation (Figures 8 and 9).

The magnitude of interference is dependent on cloud cover and absolute humidity. For example, if the single-receiver radiometer views the water at an angle of 60 degrees, where the reflectivity is 6 percent, then 6 percent of the total radiation received originates in the sky, where the radiation temperature can vary from -30° C on a clear day to +17° C on a day with a complete overcast. Roll and pitch, therefore, permit the radiometer to "see" more or less of this sky radiation. In the most recent installation of the single-receiver radiometer, an angle of incidence of zero degrees was employed. In other words, the radiometer was mounted vertically in the aircraft. Under these conditions,

Figure 10--Monitors at console of radiometer.



roll, pitch, and changes in altitude produced a noise level equivalent to temperature changes of 0.05° C on the surface of the water. Uncertainty in the exact value of atmospheric transmission at all times during flight created a maximum error of ±5 percent in the determination of radiant intensity at the sea's surface and in the calculation of the surface temperature.

With the radiometer in the differential configuration, the effects of altitude changes, roll, and pitch are minimized greatly. Changes in radiant intensity equivalent to 500 microdegrees can be observed with an uncertainty of only 5 percent.

Three men are required to monitor and operate the equipment (Figures 10 and 11) in flight. Two men monitor the recorders, associated amplifiers, power supplies, and calibrating equipment; the third man operates a special drift sight which, when used in conjunction with a flare dropped on the water, provides a linear calibration of distance on the recorder tapes along with the signals from the radiometer. With

Figure 11--Operating the drift sight.

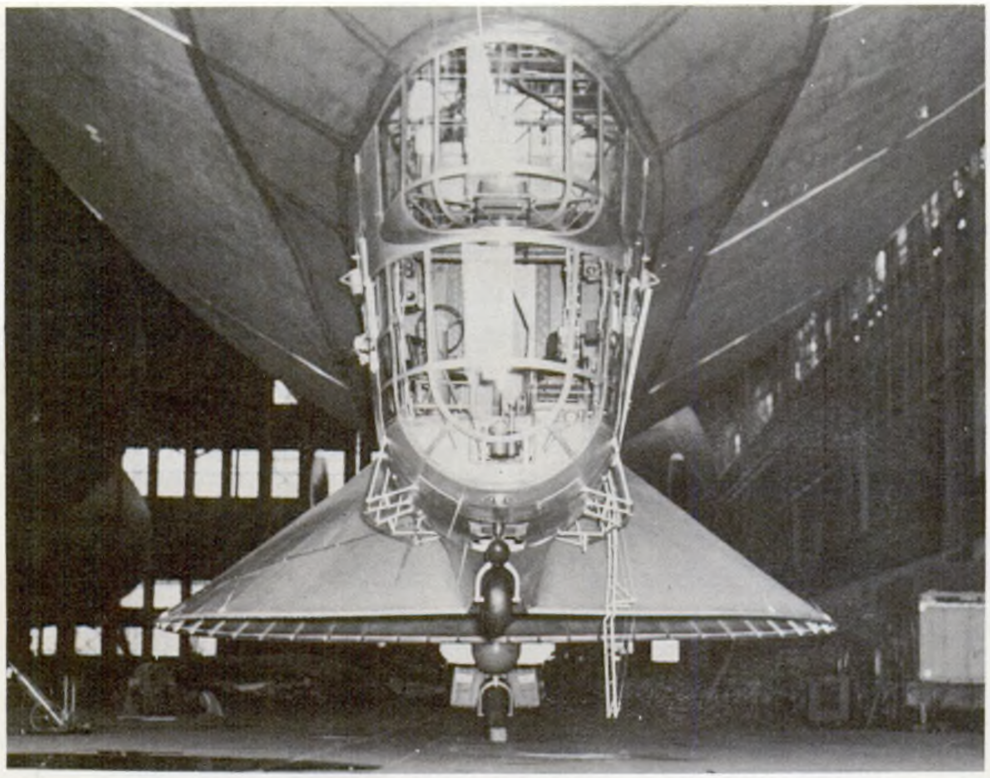
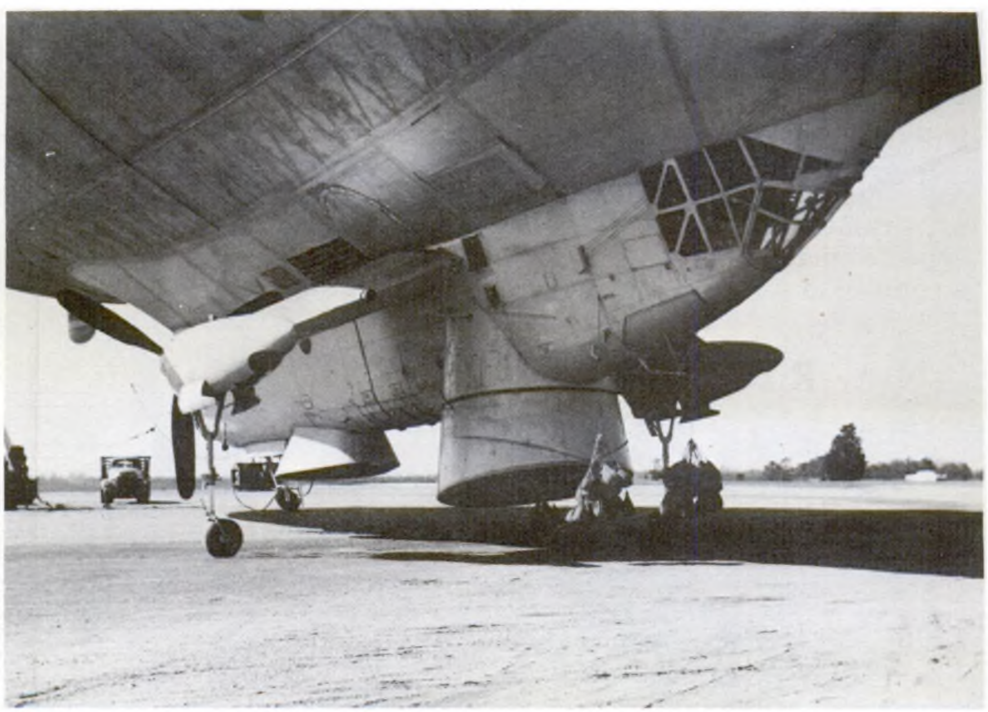


Figure 12--Cabin of a ZPM-4 airship, showing skirt beneath which radiometer (differential configuration) is mounted.

Figure 13--Cabin of a ZPG-1 airship. Skirt beneath forward part of cabin contains radiometer (single-receiver configuration).



this arrangement, it is possible to measure the span of the thermal irregularities on the sea surface as well as the intensity of their radiation.

The complete installation, which has a total weight of about 4,000 pounds, was flown initially in the ZPM-4 airship (Figure 12) over the North Atlantic and Oriente Deep near Cuba during 1955 and 1956. In 1958, the radiometer was transferred to the ZPG-1 airship (Figure 13) for additional flights over the North Atlantic and Gulf of Mexico.

By means of the radiometer, much has been learned about the radiometric properties of the sea and their relationship to sea state. For example, it has revealed that man-made oil slicks alter the wave structure enough to effectively improve the reflectivity of the surface where the slicks occur, thereby enabling those surfaces to reflect more sky radiation. This means that the slicks appear colder in general than the surrounding water.

The radiometer has also shown that isolated clouds casting their shadows on the water during the daytime produce colder areas, while the same clouds at night produce warmer areas. The opacity of the clouds acts as a shield against incoming solar radiation during the daytime and similarly against reradiation to the cold sky at night. When these clouds drift on, they leave detectable warmer or colder patches on the water.

Cat's-paws—water surfaces which have been ruffled by the wind—are different radiometrically from the surrounding sea. The difference is determined by many variables, such as cloud cover, time of day, and absolute humidity.

Finally, many local ocean currents are identifiable because their radiometric qualities are slightly different from those of the surrounding sea. For example, it is easy to plot the edges of the Gulf Stream. Under some conditions it is possible also to follow the flow of rivers out into the ocean.

A great deal more has to be learned about the radiometric properties of the sea and the dynamic processes which control them. It is expected that NRL's 100-inch airborne radiometer will contribute substantially to the task of gathering such data.

New R & D Office Established by Bureau of Supplies and Accounts

The Bureau of Supplies and Accounts has established the Office of the Assistant Chief for Research and Development. The office takes over and consolidates the functions of the Bureau's Research and Development Division and the former Afloat Facilities Branch. The reorganization has as its immediate aim the concentration and strengthening of increasing research and development activities in the Bureau and by the Navy Supply Corps. Named to head the new office is CAPT J. G. Dean, SC.

Submarine Tactical Games

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War gaming has had a long and honorable military and naval career since the Prussians first developed the technique from "military chess" 300 years ago. In the United States, development of war games for the Navy's use has been pursued primarily at the Naval War College. There, many advances have been made in the comprehensive display of situation information to the participants, ranging from large game boards many hundreds of feet in area to the combined projection and plotting screen of the new Navy Electronic Warfare Simulator (NEWS). Until recently in the conduct of war games, the outcome of any interaction between forces, such as detection and gunfire, has been decided by umpires. Their on-the-spot decisions were based on expert opinion, usually aided by graphs, probability tables, or a roll of the dice. In the NEWS facility, this procedure has been formalized, and some of the decisions about uncertain events are made automatically, based on empirically derived statistics programmed into a computer before the game begins.

War games have been used primarily for training the higher echelons of command—the tactical decision-makers. Because they have been used at the command level, the games have also provided insights into the analysis and development of tactics. Although analysis is not the usual purpose of war games, the gaming technique can uncover possible weaknesses and strengths of certain forces, deployments, and maneuvers in the face of varied opposition.

OPERATIONAL GAMING

Modern operational gaming methods have been built upon the ancient heritage of war games. The term "operational gaming" as it is currently used embraces a wide variety of techniques serving many purposes. Business games, for example, have been devised which emphasize training in production and marketing. Other operational games, more statistically oriented, have analysis as their primary purpose. These techniques have in common the simulation of conflict situations which require human decision-making. They emphasize playing the game as a method of accomplishing particular objectives.

Recently, operational gaming has been adapted to meet the specialized requirements of submarine warfare. This project has been carried out by the Research and Development Department of the Electric Boat Division, General Dynamics Corporation, under contract with the Office of Naval Research. Through this contract, research assistance is provided to Submarine Development Group Two in support of its task of developing new tactics for the submarine ASW mission. Officers of

Naval Reserve Research Company 3-12 assisted in the development by participating in some of the games played to test the rules.

As an analytical device, an operational game—such as the submarine tactical game—lies between the uncontrolled observations of actual combat and a highly systematic mathematical analysis. In fact, the operational game can serve as a step toward analysis by high speed computers. Out of a large number of combat variables, the game serves to highlight the critical ones. These important variables, then, are the ones closely studied in a computer experiment which, by rapid iteration, searches for "optimum" tactics. Operational gaming itself has limited usefulness in the actual validation of tactics. However, it does provide a good intermediate step between the reality of combat and a computer analysis since it retains the important variable, human decision-making, for which an electronic simulation must be substituted in any complete computer set-up.

It would be a wise precaution to point out here that operational gaming differs from game theory. Game theory is a theoretical approach to the determination of optimum strategy in a conflict situation. Operational gaming is essentially simulation, providing a framework within which human operators make trial-and-error decisions. Obviously, this simulation cannot duplicate reality. Nevertheless, it requires the players to exercise some of the skills and make some of the value judgements which are a part of the actual situation.

While operational games make possible the observation of many elements of real or hypothetical situations which could not otherwise be easily investigated, the results are observational in nature and must be treated as suggestions or "best guesses" rather than as conclusive evidence. Hypotheses generated in this manner can subsequently be tested in a more rigorously controlled experiment, evaluated directly in exercises at sea, or even used to formulate the problem for a game-theory solution.

The operational game, like the war games from which it grew, makes a realistic training device. In this capacity it is particularly useful for training the reserve officer who seldom has an opportunity to exercise at sea. It enables him to become familiar with tactical problems and to practice solving them. Similarly, a Commanding Officer can prepare himself, at least on the theoretical level, for an operation before he embarks on it. Gaming is especially suited to training because it provides strong motivation; the interest and sense of participation shown by the players makes them highly receptive to learning. Members of Reserve Research Company 3-12, who assisted the Electric Boat Division in developing the submarine tactical game, were enthusiastic about its realism. Of course the technique is not intended to replace other types of training. Thus, where possible, it should be supplemented by further practice at sea.

DESCRIPTION OF A GAME

The focus of attention in Electric Boat's operational gaming studies has been the submarine ASW barrier. In a typical game, five players are assigned the roles of submarine captains. One team of three submarine captains is assigned to maintain a barrier, while two other captains take the part of the enemy and try to transit the barrier. Two umpires supervise the game.

The umpires begin by explaining the rules which cover the capabilities of each ship, including speed, battery life, communications, detection equipment, and weapons. These rules may be varied from one game to the next. As different equipment is simulated the rules are changed and the effect of such changes on the outcome of the game can be observed. Each team has time to plan its tactics. Then the men take up their separate stations in isolated rooms, where the only means of communication is the telephone. Each man has a chart, marked off in grid squares, on which he plots his own position, and, when possible, the other ships' positions.

The umpires notify each player over the telephone when it is his turn to make a move, and he responds by indicating what he will do during the next move (in most of the games, a move represents 7-1/2 minutes of real time). For instance, he reports whether he is proceeding submerged, at snorkel depth, or on the surface, and gives his next position. He also states when he is using radio, radar, or sonar, and when he fires torpedoes or other weapons.

After each player has completed a move, the umpires tell him the outcome of his action: for example, that he has detected an enemy. Where the outcome in a real situation would depend on chance and is expressed as a probability, the umpires consult a table of random numbers and determine a definite answer for each case. As an illustration, if the probability of scoring a hit by firing a torpedo at a given range is estimated to be .42, they pick at random a number between 1 and 100: if it is 42 or below, they credit the submarine with a hit; if it is 43 or higher, they do not.

Under certain circumstances which simulate actual communication conditions, the umpires will connect the phones of team members and let them talk to each other. These conversations, as well as all the other moves, can be recorded for future analysis.

The game ends when the transiting submarines either succeed in crossing the barrier or are sunk. This is usually followed by a lively "post-mortem" discussion from which valuable conclusions can be drawn.

A considerable savings in time results from the use of this game compared to real operations. A 24-hour transit can be completed in about three and one-half hours of game time. This saving results from the use of a compressed time scale in the game and from elimination of the necessity for forces to get into position, as they would have to do in a sea exercise. Using gaming methods prior to real operations also saves time and increases the efficiency of these exercises, because any procedural "bugs" will have been identified in the game and corrected.

The game described above could be applied to a study of communications. It would incorporate in its rules some of the actual limitations on communications peculiar to a submarine: that it cannot use radio while deeply submerged, and that it is vulnerable and its sonar is less effective while it is on the surface. Such a game impresses these limitations on the players and gives them an indication of how the problem might be solved.

ADVANTAGES

The advantages of operational gaming are as follows:

- It is realistic. Conditions can be set up to closely approximate the actual situation.
- It is versatile. Conditions can be controlled or varied to study any particular aspect of the situation.
- It is inexpensive. Materials consist primarily of a simple telephone circuit and a table of random numbers.
- It saves time. Whereas an entire day might be required to solve a particular problem at sea, only two or three hours would be taken to solve it in a game.
- It can be used almost anywhere. Access to a major installation is not required.

SCAR

One of the important factors contributing to the record-setting undersea voyages made recently by the NAUTILUS, SEAWOLF, and SKATE was a navigation system that enabled crewmen to determine the ships positions from the stars. The system is called SCAR, which means Submarine Celestial Altitude Recorder.

The ideal, always-reliable method of navigating and of checking the accuracy of inertial and other advanced system is to take a celestial "fix." In the past, if a submarine was to to this, it had to surface and thus risk exposing itself to the enemy. Now, however, with SCAR fitted into the periscope, a celestial fix can be taken while the ship is submerged. When the star, moon, or sun is sighted, a switch on the scope is pressed, and the exact altitude of the celestial body is computed automatically, giving the angle of sighting in degrees and minutes as well as the time in hours, minutes, and seconds. This information is printed instantaneously on a slip of paper that looks very much like the bill rendered in a supermarket at the check-out counter. The timing device used in SCAR is accurate to within a second a day.

After two or more stars have been sighted through the periscope, all the navigation officer has to do is consult the Navy almanac and work out a fix on a chart. The point where the lines of the star fixes intersect indicates the position of the ship.

Research Notes

Navy Scientists Occupy Second Ice Island

The nation's newest scientific drift-ice station was put in operation early this month on a 25-square-mile ice floe now located about 500 miles north of Point Barrow, Alaska. The station, called Drift Station Charlie, is the second of its kind to be inhabited by this country for scientific purposes. It accomodates 32 men, including 16 Navy civilian scientists and 16 Air Force men. The first such outpost, called Drift Station Alfa, was established in April 1957 and abandoned in November 1958 when the ice on which it was located began breaking up.

The project was undertaken jointly by the Navy and Air Force. The Office of Naval Research is administering the scientific activities, while the Alaskan Air Command set up the station and will provide housekeeping facilities. The Chief Scientist is Dr. Kenneth O. Bennington of the University of Washington, and the station commanding officer is CAPT Tom Smith, USAF.

Investigations to be conducted on the ice island concern many subjects of interest to the Navy in its effort to learn more about the features of the ocean and atmosphere as they are related to drift ice. They include the following: micrometeorology, with special attention being given to the heat exchange between the drift ice and the atmosphere and between the ice and the water below it; the study of ice structure and characteristics of ice movement; geomagnetism and gravity; seismology; oceanography; ocean-bottom geology and topography; underwater acoustics; upper-air observations; and observations of aurorae and studies of the electrical potentials of the earth (to begin in the fall).

Organizations participating in the scientific program, in addition to the Office of Naval Research, are the University of Washington; Lamont Geological Observatory, Columbia University; the U. S. Navy Underwater Sound Laboratory; the U. S. Navy Hydrographic Office; and the U. S. Weather Bureau.

A detailed report on activities at Drift Station Charlie will be given in a forthcoming issue of Naval Research Reviews.

The Effects of Allergies on the Heart

For some time, medical investigators have recognized that allergies can give rise to certain heart disorders. However, not very much has been known about the ways in which these conditions act on the heart and about the allergy-produced substances which are involved. In a research project now underway at Stanford University, a team of investigators under the direction of Dr. George Feigen is making good progress in an attempt to solve this problem. The work is sponsored by the Office of Naval Research.

Allergic reactions are involved in certain types of injections, some kidney diseases, and in asthma. They are caused when the human body is invaded by so much of a given foreign substance—bacteria or some other protein (called antigens)—that antibodies available in the body cannot counteract it. Allergies may be thought of as disorders in this antigen-antibody balance. Dr. Feigen has found that when antigens are tested on hearts of sensitive animals, this balance is upset in the heart, the organs beat rapidly and ineffectively, and may falter or stop. Substances produced by the heart under these conditions affect the electrical conduction system that is necessary for the heart to beat regularly. The same substances may also cause a constriction of the coronary arteries which interferes with the blood flow to the heart muscle itself.

In earlier work, the Feigen team established the relationships that exist between the mineral environment of the heart and its mechanical performance and showed that the level of bicarbonate was an important factor in restoring a vigorous beat to the experimentally fatigued heart. Their recent work suggests that cardioactive drugs, such as digitalis, may exert their beneficial effect by keeping down the amount of sodium in the heart cells. —ONR Branch Office, San Francisco

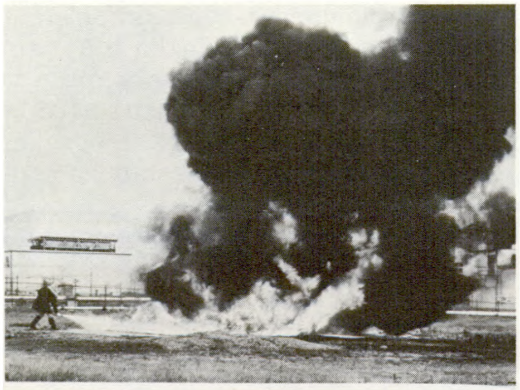
Microminiaturization in Electronics

Under the direction of Mr. Ken Shoulders, formerly with the Massachusetts Institute of Technology and now at the Standford Research Institute, an important advance toward the microminiaturization of electronic circuits is taking place. The procedure presently being explored at the Stanford Research Institute is as follows:

First, a conducting film, such as molybdenum (a dielectric film can also be used), is deposited on a clean, smooth surface. Next, this film is exposed simultaneously to a low-pressure decomposable gas (ethyl orthosilicate) and a sharply focused electron beam. Using an inverted electron microscope, electron beam diameters on the order of 10 angstroms have been obtained. Where the electron beam hits the surface, the adsorbed gas molecules decompose and deposit on the surface a "resist", which affords protection to the underlying metallic film. The entire surface is then exposed to a gaseous etchant, which removes unprotected metallic areas. Finally, the thin-layer "resist" is removed by another etchant, leaving a microminiature printed circuit, the pattern of which is defined by the electron beam. Simple spots, lines, and other figures may be produced by proper beam control. Resolutions better than 100 angstroms (one millionth of a centimeter) have been achieved for the entire process.

As a result of this work, micro-transistors are now a distinct possibility. In fact, the experimenters are thinking in terms of millions of components per square inch. If successful, the technique will drastically reduce the size of computers and permit the extravagance of component redundancy, which is apparently a necessity in self-organizing systems such as the human brain.

Further development of the procedure is soon to be sponsored by the Office of Naval Research. —ONR Branch Office, San Francisco



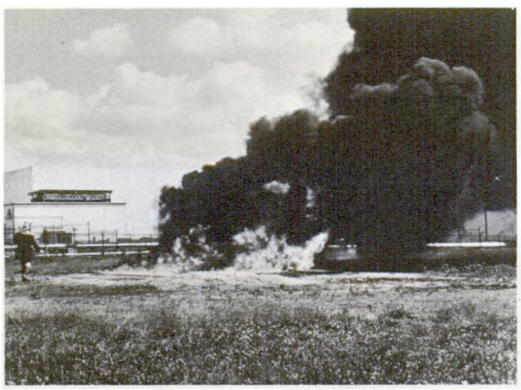
1 second

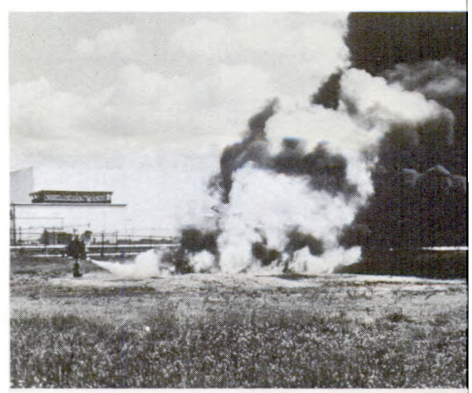
5 seconds

Extinguishing oil fires with potassium bicarbonate (above) and sodium bicarbonate (below). The intervals at which photographs were taken after extinguishants were first applied to the fires are indicated beside each picture. Note that after 11 seconds the fire on which potassium bicarbonate is being used (above) has been extinguished, as indicated

1 second

5 seconds

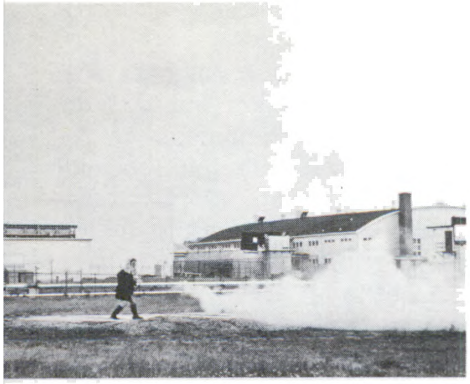




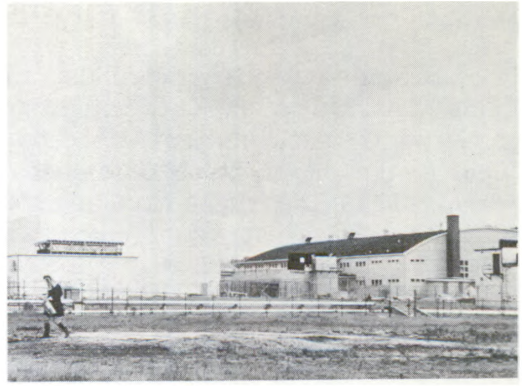
Purple K Powder

A revolutionary development has occurred in the search for more powerful chemical agents for controlling gasoline and oil fires. It is the discovery, by chemists at the Naval Research Laboratory, of a powder that will put out gasoline and oil fires twice as fast as the best extinguishants available currently.

The new agent, called "Purple K Powder," consists of dense-white, flame-shielding, fire-quenching clouds of very finely powdered potassium bicarbonate. It was given the name "Purple K Powder" because of its ability to change the color of flames from yellow to lavender during fire extinguishment. More significant than the change in color, however, is the simultaneous reduction in the amount of heat emitted by the fire. This enables fire-fighters to move in closer to the flames and fight them more effectively. Other advantages of the new agent are that it can be



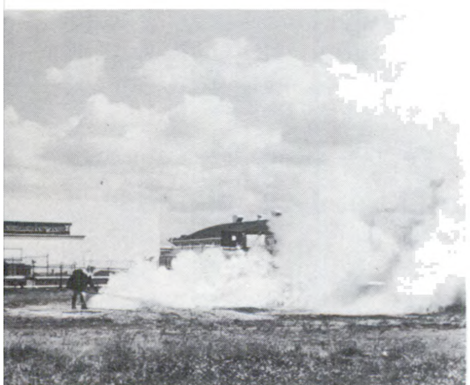
11 seconds



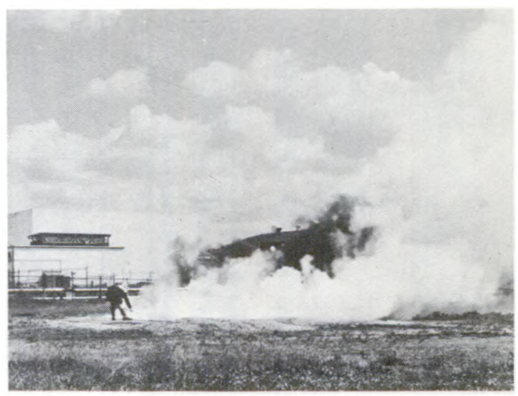
16 seconds

by the fact that fire fighter no longer sprays extinguishant on it. By the time 16 seconds have passed, even the last smoke has drifted from this fire. The fire on which sodium bicarbonate is being used, on the other hand, is still burning brightly after these intervals.

11 seconds



16 seconds



obtained easily and thus is inexpensive, that it is not toxic, and that it can be used in conventional fire extinguishers.

Since 1913, when bicarbonate of soda was first used to put out oil fires, many attempts have been made to develop a better powder for this purpose. The old powder was treated with various substances to improve it, and many special agents were added to it to make it more effective, but it continued to have its limitations. Preparation of the new powder is the latest achievement in a 20-year program of fire research conducted at NRL for the Bureau of Aeronautics. This work has led to the development of many important fire extinguishing devices now being used to protect naval aviators from fires that break out as the result of plane crashes.

Purple K Powder is now in the process of commercialization. Large quantities will probably be kept on hand at places where oil fires are likely to break out, such as petroleum refineries. The powder also shows promise of becoming an important fire extinguishant in homes and shops.

Air-Lift Fire Extinguisher

Rescuing men from airplanes that crash and burn on or near airfields is not only a matter of using a good fire extinguishant, but also one of getting the extinguishant to the fire quickly. For plane crashes that occur on the runway itself, this second problem is not serious because crash-rescue fire trucks have been built which, from a post on the air-station apron, can convey as much as four tons of water down the runway within 55 seconds. But what if the crash occurs beyond the airfield, in an area inaccessible to the truck? To put out these fires, the Navy is now experimenting with the air-lifting of fire-fighting equipment to the crash sites. Naval Research Laboratory engineers, working with industrial engineers, have developed a new type of lightweight apparatus for this purpose.

In field trials held recently, two crewmen and the fire-fighting equipment were transported by helicopter one quarter mile to the site of a gasoline fire 40 feet across (see cover photo). The crewmen and equipment were then unloaded and the fire extinguished. All of this action took place in three minutes.

A valuable component of the air-lift fire extinguisher is the new Purple-K Powder (see pages 20 and 21). Another important feature is its light weight; including 400 pounds of dry potassium bicarbonate powder, it weighs only 700 pounds. This means that when the extinguisher is not needed for off-station fire fighting, it can be mounted on a small pick-up truck and kept ready for use on the station.

Navy Civilians Given Top D. O. D. Awards

The Department of Defense Distinguished Civilian Service Award—highest honor conferred on civilian employees by the Department—was presented last month at the Pentagon to six employees of the Department. Three of the recipients work for the Navy. They are Mr. Wallace E. Dietrich, Jr., Supervisory General Engineer, Bureau of Ships; Dr. Herbert Friedman, Superintendent, Atmosphere and Astrophysics Division, Naval Research Laboratory; and Irwin H. Whitthorne, Master Plumber and Pipefitter, Mare Island Naval Shipyard.

Mr. Dietrich received the award in recognition of his outstanding contribution to the design of ships for the Navy through development of a unique analog computer. This device, along with Mr. Dietrich's improved methods of ship-design computation, have resulted in savings estimated at more than $100,000 a year.

Dr. Friedman was selected for the award because of his important accomplishments in the development of radiation-detection devices and in the conduct of important research in astronomy and astrophysics, including the first ultraviolet survey of the celestial sphere.

Mr. Whitthorne was given the award for his 50 years of outstanding service in the maintenance of Navy ships ranging from sailing vessels to nuclear submarines.

On the Naval Research Reserve

Some Interesting Drill Meetings

NRRC 11-3. In an attempt to make its members and the community aware of the status of American science relative to that of other nations, NRRC 11-3, Los Angeles, California, CDR Joseph Cryden, USNR, commanding, has recently completed a series of meetings open to the public in which talks on science and technology in foreign countries were presented. The list of speakers included both company members and invited scientists, all speaking from first-hand observation. Reports on an international conference on military psychology, a solid state physics conference at Brussells, progress in geochemistry and mineralogy in Russia, and the status of technology and education in Japan were included in the program.

NRRC 1-1. Dr. William Stone, Jr., who has been working for several years on the problem of using foreign substances in the treatment of eye defects, addressed Naval Reserve Research Company 1-1, Boston, Massachusetts, on the trials and triumphs of his researches. Attention was directed sepecially to his attempts to implant plastics substitutes to improve vision in subjects whose corneas have become cloudy because of injury. Other efforts have been made on the part of Dr. Stone to decrease pressure in glaucomatous eyes and to achieve natural movements of artificial eyes. It was of interest to Research Reservists to note that medicine looks to so many other fields of engineering and science for aid in developing new techniques of surgery.

NRRC 12-1. Naval Reserve Research Company 12-1, San Francisco, California, sponsored a joint meeting of other Research Reserve and Medical Companies in the area for a talk by COL John Paul Stapp, MC, USAF, Chief of the Aero-Medical Laboratory at Wright Air Force Development Center. Approximately 170 Naval Reserve officers attended the meeting at which space travel and the re-entry problems were discussed.

NRRC 5-8. A series of drill meetings in the past quarter in Naval Reserve Research Company 5-8, Washington, D.C., was devoted to the subject of astronomy. To help Naval Reserve officers keep informed on current matters in science, and particularly to enable them to keep abreast of developments in space technology, meetings were scheduled on the following subjects: Background in Astronomy for the Space Age, Astronomical Observations of the Sun, Double Stars and Their Significance in the Determination of Astronomical Quantities, Rocket Astronomy, Radio Astronomy, and Time. The subjects were discussed by specialists in their fields from the Naval Research Laboratory, National Science Foundation, and the U. S. Naval Observatory. By these discussions a background in astronomy was provided to the members for a better understanding of some of the problems that will have to be solved before many space programs can be successful.

NRRC 9-8 Observes Tenth Anniversary

The members of Naval Reserve Research Company 9-8, St. Louis, Missouri, celebrated the tenth anniversary of the company at a dinner meeting held April 9.

The Commanding Officer of the company, CDR Walter L. Wilkins, MSC, USNR, and 13 members of the company and their ladies welcomed two guests from the Office of Naval Research: CAPT J. P. Aymond, USN, Special Assistant to the Chief of Naval Research for Research Reserve, and LT C. S. Lardis, USN, Reserve Assistant from the ONR Branch Office, Chicago. Special congratulations were in order for CDR Wilkins, who was the one officer of the Medical Service Corps selected for promotion to Captain in the Naval Reserve by the 1959 Inactive Reserve Selection Board.

Like Father, Like Son

John Aymond, son of CAPT J. P. Aymond, USN, Special Assistant to the Chief of Naval Research for Research Reserve, entered the Naval Reserve on May 1. The enlistment oath for entry into the Naval Reserve was administered to John by his father. While on inactive duty training, John is assigned to Naval Reserve Submarine Division 5-8, Washington, D.C.

He is a student at Frances Hammond High School, Alexandria, Virginia, and will enter his senior year this fall.

Promoted to Lieutenant Commander

Twenty-five Lieutenants of the Research Reserve Program were among the 918 officers of the Naval Reserve selected for promotion to the grade of Lieutenant Commander by the Fiscal Year 1959 line selection board, which convened on March 10, 1959. Congratulations are extended to these officers, who are listed below along with the Research Reserve companies to which they belong.

W. M. Hagist	1-2
R. S. Jordan	3-1
E. S. Hiller	3-3
J. L. Krumpelman	3-14
C. H. Hosler	4-4
K. N. Arnold	5-6
H. C. Francke	6-3
J. N. Robinson	6-3
D. E. Ray, Jr.	6-13
W. B. Fry	6-17
J. E. Armstrong	8-5
R. L. Crawford	8-9
F. L. Cash	8-12
C. F. Davis, Jr.	8-12
G. J. Legris	9-1
J. E. Housiaux	9-2
W. E. Johnson	9-12
D. B. Lindsay	9-13
R. L. Owen	11-2
A. B. Rechnitzer	11-5
A. L. Markel	11-9
P. F. Deisler, Jr.	12-5
C. J. Nordstrom, III	13-1
R. O. Johnson	13-3
P. R. Duckworth	13-6

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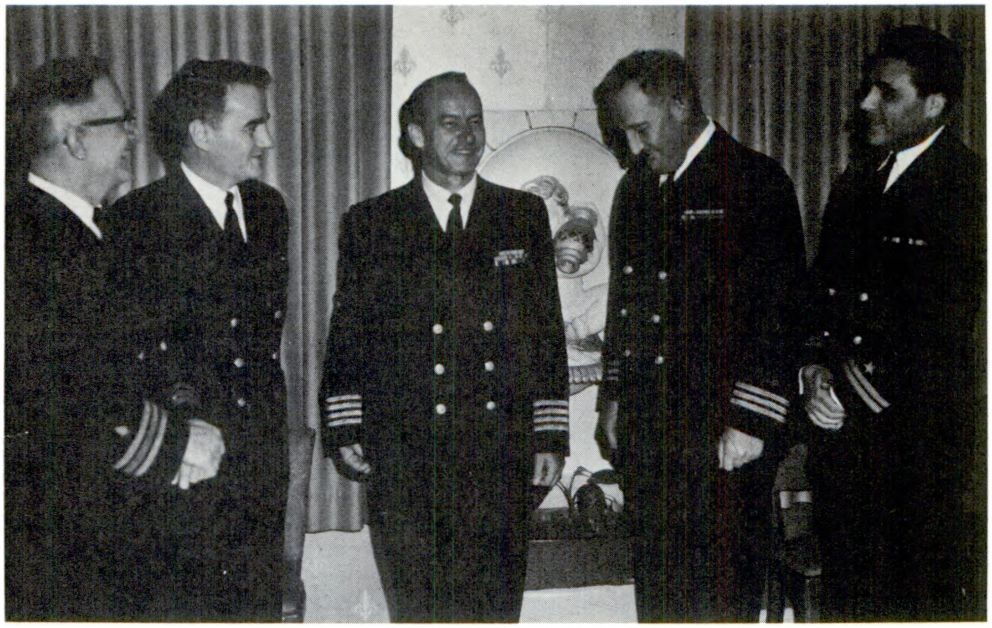

Pictured at the tenth-anniversary celebration of NRRC 9-8 are, left to right, CDR Walter L. Wilkins, USNR, Commanding Officer of the company (1956 to 1959); LCDR E. F. Palmer, USNR, designated Commanding Officer for Fiscal Year 1960; CAPT J. P. Aymond, USN; CDR J. H. Carter, USN, Commanding Officer from 1951 to 1956; and LT C. S. Lardis, USN.

CAPT J. P. Aymond, USN, administers the enlistment oath to his son, John.

IN THIS ISSUE

NAVAL RESEARCH reports highlights of technical progress in research by Navy laboratories and contractors and the development of important naval research facilities. The magazine is listed for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. Subscription price: $1.50 per year in U. S. and Canada; $2.00 per year, foreign; $0.15 per individual copy. Changes of address should be sent to Code 740, Office of Naval Research, Washington, D. C. Use of funds for printing this publication was approved by the Director of the Bureau of the Budget, February 12, 1958.

A helicopter carrying fire-fighting equipment specially designed for rapid air-lift approaches a simulated airplane crash fire. This tactic and a remarkable new extinguishant developed by the Navy to snuff out gasoline and oil fires are described on pages 20 through 22.