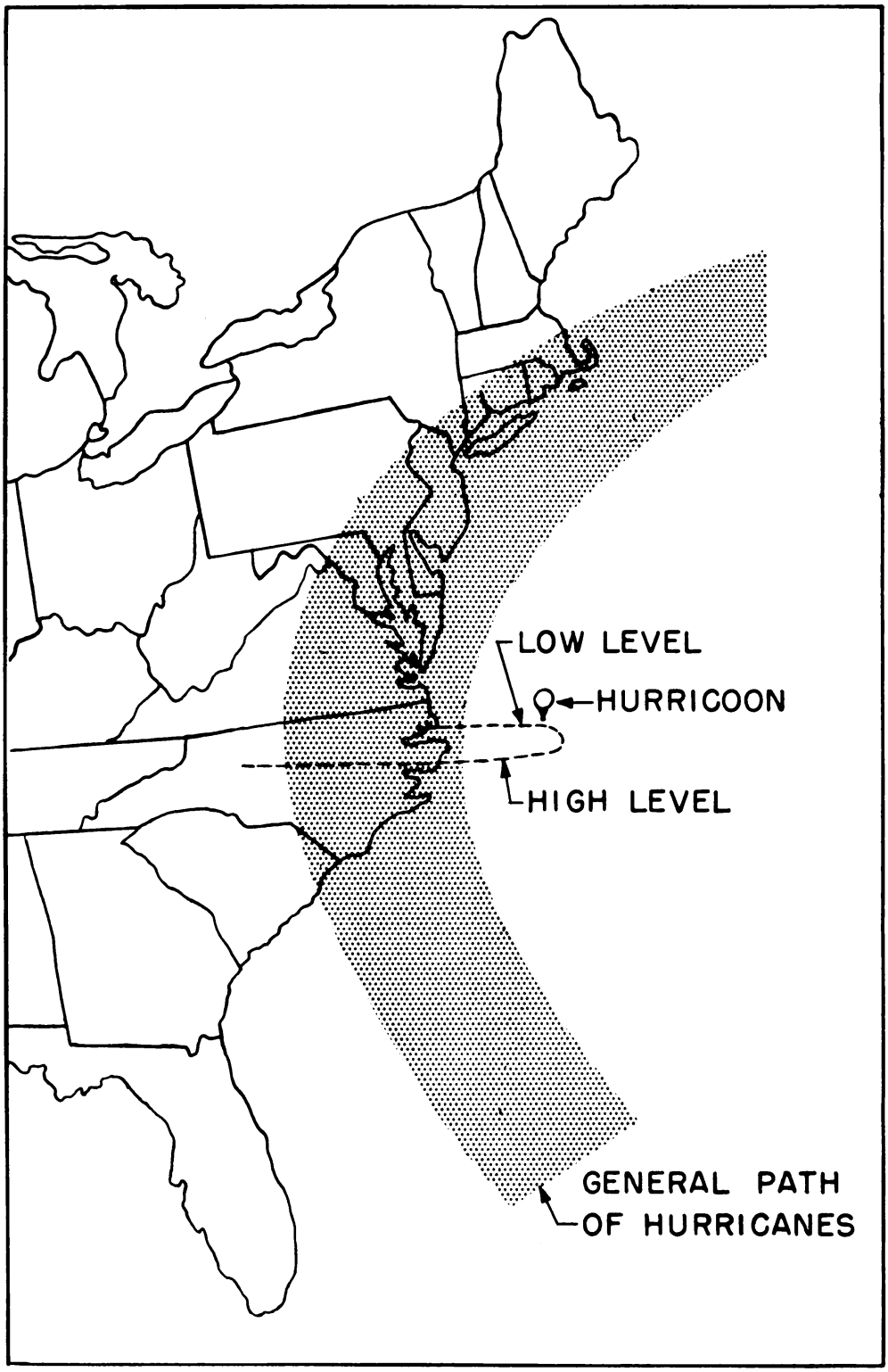
OFFICE OF NAVAL RESEARCH JUNE 1956

RESEARCH REVIEWS

NAVEXOS P-510

DEPARTMENT OF THE NAVY
WASHINGTON, D. C.



The HURRICOON is launched in advance of the hurricane, moves off the coast, then as the hurricane moves up the coast, HURRICOON floats toward the coast and overflies the storm.

HURRICOON - A NEW BALLOON SYSTEM FOR HURRICANE RESEARCH

Malcolm D. Ross
Air Branch, Naval Sciences Division
Office of Naval Research

With vivid memories of CONNIE, DIANE, HAZEL, and other "wicked ladies" still fresh in mind, the Weather Bureau, Navy, and Air Force are redoubling efforts in preparation for the hurricane season this summer. An obvious primary objective is to obtain better operational information to decrease the staggering losses in lives and property which have resulted from previous East Coast hurricanes.

Hurricane research is also receiving renewed emphasis. Various new systems and techniques will be employed by the Weather Bureau and Defense Department groups to obtain a better fundamental understanding of the physical processes involved during a hurricane. Rocket photography 100 miles above a hurricane is planned in a Navy - Weather Bureau joint project. Special instrumented sea buoys are being readied by the Navy for surface measurements of winds and other information off the coast. The Navy's TRANSOSONDE constant-level balloon system (Research Reviews, October 1955) will provide unique wind information at levels of 300 millibars (30,000 ft), and perhaps higher; these will be valuable in analyses of the general circulation associated with hurricanes. Other constant-level balloon systems have been suggested for measurements of the vortex circulation, particularly at lower altitudes, and it is likely that some excellent wind data will be obtained.

HURRICOON is an additional tool, relatively inexpensive, employing the high-altitude floating capability of the constant-pressure altitude plastic balloon for photographic reconnaissance. It will be utilized by the Navy to obtain a complete photographic documentation of a hurricane for a minimum of 12 hours. The photographs, taken from an altitude above 80,000 ft, will provide basic data not obtainable by other means.

Although the rocket photographs will be taken at a significantly higher altitude, and should be spectacular, the data will essentially be a momentary record of the hurricane and adjacent cloud formations. A time correlation of the data would require another photographic reconnaissance rocket with a time interval between. HURRICOON, on the other hand, will provide a continuing record which can be studied to correlate the changes occurring with time. With panorama photographs taken every minute during a period of 12 hours or more, it should be of extreme interest to note the effects of decay or regenerative processes within the storm during the period of photographic observation.

HURRICOON is simply a SKYHOOK plastic balloon equipped with a camera gondola. Its utility for hurricane research (and other planned meteorological experiments) would be less significant except for a fortunate high-altitude wind reversal which occurs during the summer in middle latitudes. This allows for a crude form of navigation which should suffice for the purpose of recovering the photographs taken. By

taking advantage of the above phenomenon the system has been designed for launching in advance of a hurricane. The balloon is allowed to rise to a predetermined altitude of 30,000 to 70,000 ft where it will move in an easterly direction from the coastal launching point (probably Weeksville Naval Air Facility, N.C.) in a westerly wind flow. When HURRICOON has arrived at an appropriate position off-shore, it will then climb on radio command above the "turn-around-point" between easterly and westerly flow and start its return journey toward the coast in the opposing wind stream above 80,000 ft. By proper planning it is expected that the high-floating altitude will be reached about daylight and HURRICOON will then start making its unique photographic record as it moves toward the coast and passes near—but far above—the hurricane. After the balloon-borne gondola has passed inland to a satisfactory recovery point the flight will be terminated and its instrumentation will be parachuted to earth.

A study has been conducted by General Mills, Inc., under contract with the Office of Naval Research, and the feasibility of the concept has been established. Included in the study was an analysis of the wind structure (surface, intermediate, and high-altitude) in the Weeksville, N. C. area during, and in advance of, typical hurricanes. Components of the system were also selected from equipment previously developed under SKYHOOK, TRANSOSONDE, and other balloon projects.

Subsequent versions of HURRICOON may utilize television to provide more timely data. The initial study, however, has been directed toward a simple camera system which will provide panoramic photos from horizon to horizon. Since the visual horizon from a balloon at 80,000 ft is approximately 320 mi, the area covered in each picture will represent over 300,000 sq mi. A separate camera, of the type used so successfully by V. J. Schaefer on Project CIRRUS, will take lapse-time photographs of the cloud tops. These will be analyzed by B. Vonnegut and C. B. Moore, of Arthur D. Little, who are investigating atmospheric electrification processes and cloud physics under contract with the Office of Naval Research. The panoramic camera records will be made available to the Weather Bureau and Navy research groups. The photographs will supplement the wealth of data accumulated by the Navy and Air Force "Hurricane Hunters" routine surface observations, and other information collected by non-standard techniques.

Tests with a wide-angle lens were made by the contractor, General Mills, Inc., on April 9, 1956. The flight attained an altitude of 55,000 ft, and the balloon carried in addition to the familiar 35-mm flight camera, a 20-in diameter spherical ball. This, held in a cradle of wood, was used as a reflecting surface with the camera suspended below by a wire tripod. The decorative spherical ball was silvered on the inside, and therefore was not as satisfactory a reflecting surface as might have been the case had the sphere been silvered on the outside. However, some interesting pictures, such as the sample shown in Figure 1, were obtained. It was possible to identify from the picture taken on the 20-inch reflecting surface, geographical landmarks on the terrain below.

Included in the instrumentation will be a radio transmitter operating on several frequencies. The entire flight will be tracked and fixes

will be obtained by radio bearings from coastal tracking stations. An additional camera inside the balloon gondola will photograph an instrument panel which will include a simple compass and clock. Instrument panel photos will be made simultaneously with the panoramic camera exposures. A continuous pressure-altitude record of HURRICOON will also be kept and all essential data should thus be available for post-flight analysis to obtain the time, altitude, and position when each photograph was taken, and the North-South orientation of each exposure.

Simple in concept and relatively inexpensive, HURRICOON may, nevertheless, obtain fundamental scientific data of great value to meteorologists when it takes its grand-stand seat in the stratosphere this summer and starts leisurely obtaining a continuing photographic record of one of Nature's most awesome and destructive creations.

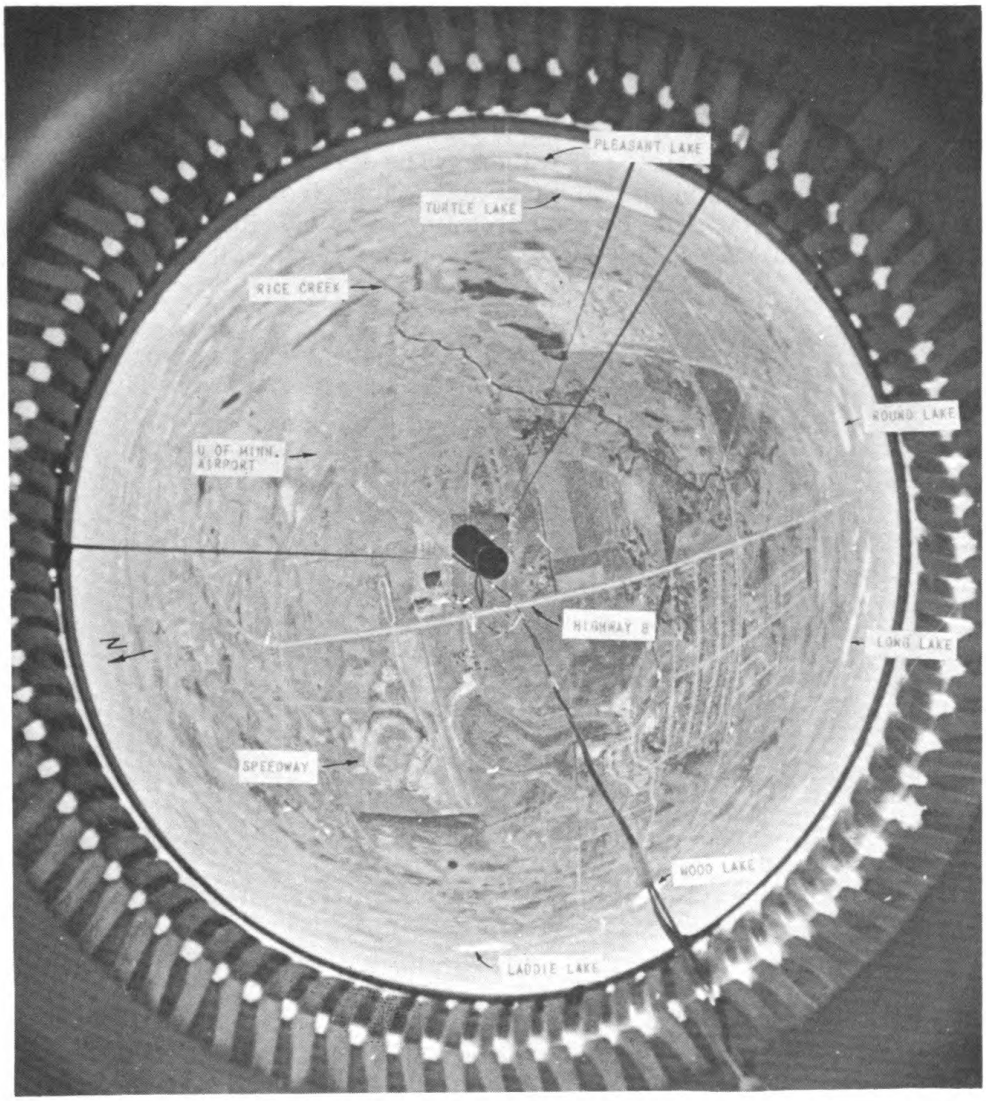


Figure 1 - Picture obtained on a 20-in diameter sphere during test flight. Photo courtesy of General Mills, Inc.

ROCKET PHOTOGRAPHY OF HURRICANES

CDR John E. Masterson, USN
Geophysics Branch, ONR

To combat the devastation caused by hurricanes in recent years, the National Hurricane Research Project has been established under the sponsorship of the U. S. Weather Bureau. Its purpose is to learn more about hurricanes in order to provide more accurate forecasts of their movement and intensity.

One phase of the program, under sponsorship of the Office of Naval Research and the Naval Research Laboratory, will be to photograph, from an altitude of approximately 100 miles, the entire hurricane cloud system. Assisting in this phase, the ROCKET PHOTOGRAPHY OF HURRICANES PROJECT, will be the National Advisory Committee for Aeronautics, the VW-2 Squadron at the Naval Air Station, Patuxent River, Md., (See Cover Photo) and ships attached to Destroyer Flotilla FOUR.

In order to improve hurricane forecasting it is first necessary to learn as much as possible about them. The feasibility of photographing meteorological phenomena, such as hurricanes, from rockets was demonstrated by the Naval Research Laboratory in 1954 (Research Reviews, September 1955). An Aerobee rocket, launched from White Sands Proving

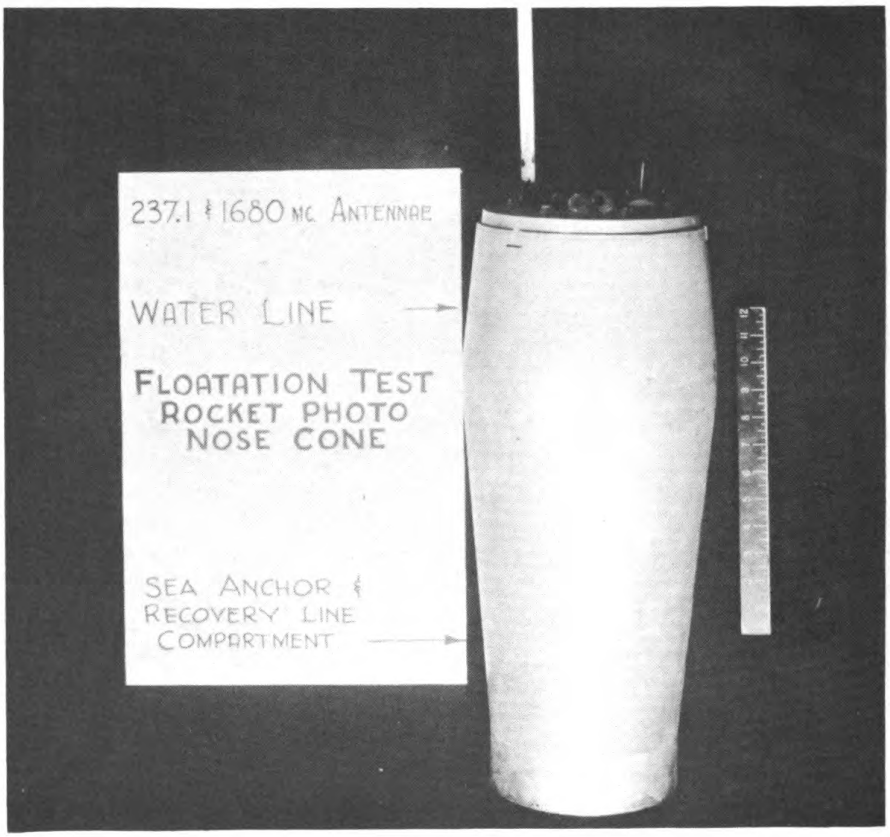
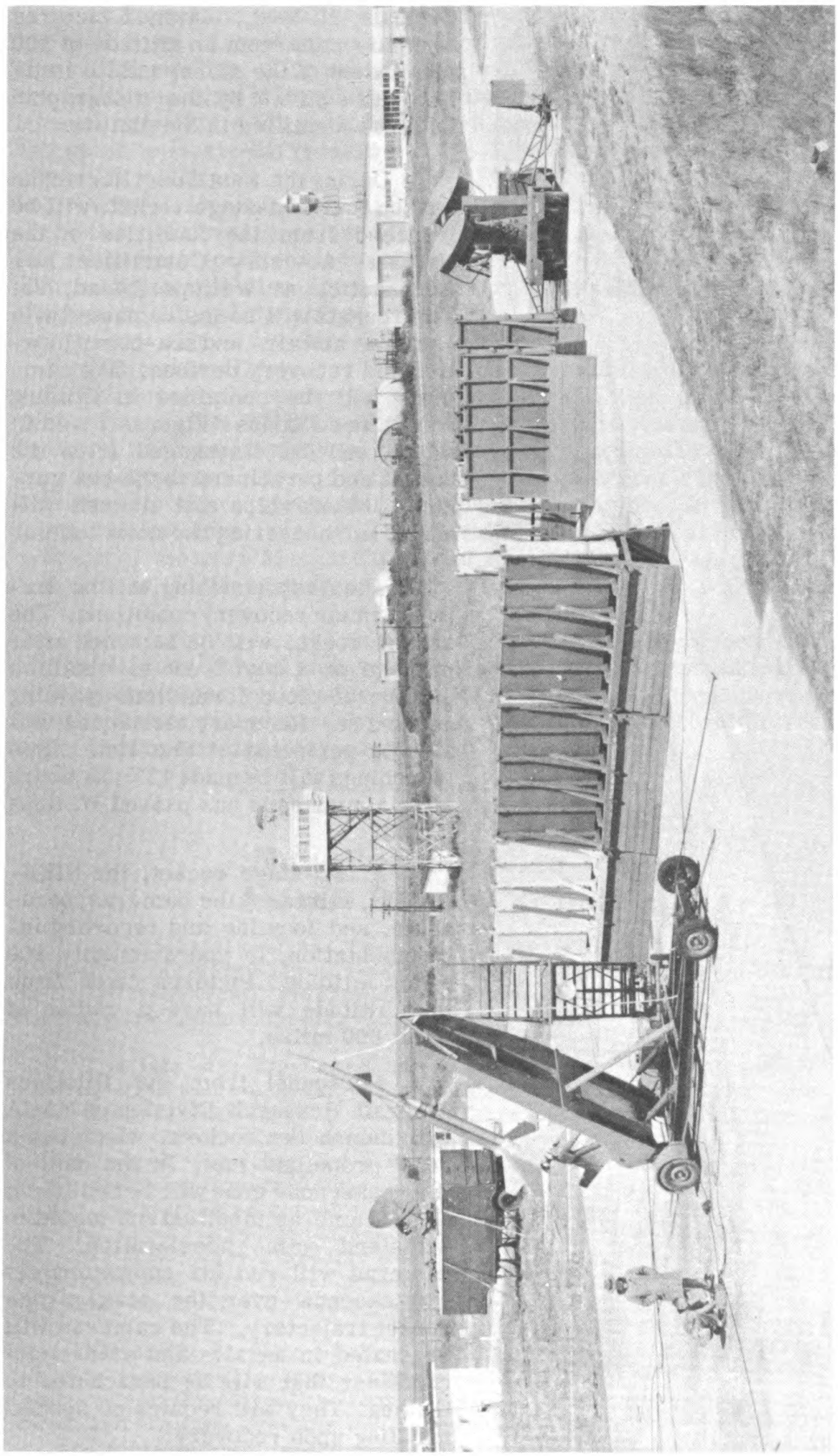


Figure 1 - Floating rocket nose cone



NACA launching facility at Wallops Island, Va.

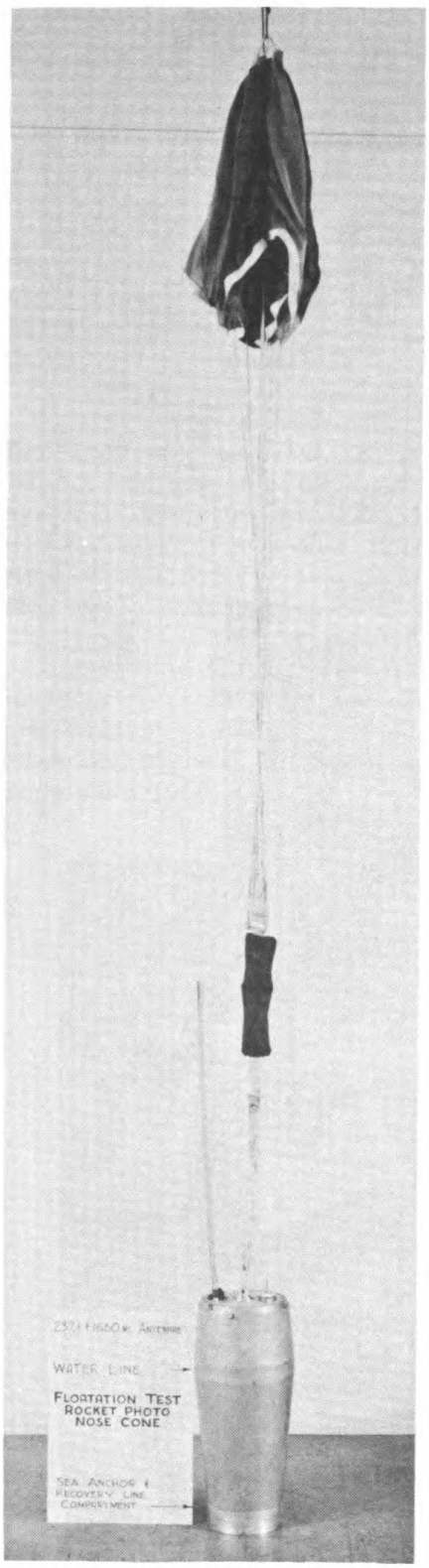


Figure 2 - Nose cone is carried by a metalized parachute

Grounds, N. Mex., obtained pictures of a hurricane from an altitude of 100 mi. Extent of the storm and its location were shown by the topographic features identified in the picture.

During the East Coast Hurricane season four two-stage rockets will be launched from the facilities of the National Advisory Committee for Aeronautics at Wallops Island, Va. The rockets will be instrumented with cameras and air- and sea-borne location and recovery devices. The cameras will be contained in floating rocket nose cones (Figures 1 and 2) which will be disengaged from the rocket and parachuted to the sea surface. Naval ships and aircraft will assist in recovering the nose cones.

The first launching will be during optimum recovery conditions. The second rocket will be launched after passage of a cold front to obtain a picture of cloud formations passing out to sea. Recovery techniques will also be perfected at this time. Two launchings will be made 12 to 18 hours after a hurricane has passed Wallops Island.

A two-stage rocket, the NIKE-CAJUN, will carry the cameras, parachute, and locating and recovery instrumentation, to approximately 100 miles altitude. Pictures taken from this altitude will have a radius of about 800 miles.

Personnel from the Pilotless Aircraft Research Division of NACA will launch the rockets, which use a solid propellant fuel. In the base of the rocket nose cone will be two 16mm GSAP cameras modified and tested to withstand great acceleration. The cameras will run for approximately 330 seconds over the peak of the rocket trajectory. The cameras will be sealed in an air- and water-tight container that will be parachuted to the sea. They will require no special handling upon recovery.

At impact the metalized parachute will be detached from the floating nose cone. A separate sea anchor will deploy 100 ft of 150 lb test line on the surface. The sea anchor will also afford a means to hook the nose cone when it is picked up. Dye markers, which leave a continuous water stain for periods up to 8 hours, will further aid aircraft and ships to locate the cameras.

A WV-2 aircraft from Airborne Early Warning Squadron Two will track the metalized parachute and vector the recovery ships into position for immediate location and recovery (See Cover Photo). This Super Constellation will also act as a communication link between NACA Wallops Island and the ships.

Commander Destroyer Flotilla FOUR is making destroyers available to recover the cameras. In a preliminary test of the nose cone recovery the USS WREN and the USS ROSS participated. The ships, equipped with electronic gear capable of receiving signals from the nose cone beacon-transmitter and "homing" in on the nose cones after they land on the ocean, successfully recovered the cone. Instrumentation for the rocket nose cones will be provided by the Physical Science Laboratory of the New Mexico College of Agriculture and Mechanic Arts, Las Cruces, N. Mex., under contract with the Office of Naval Research.

After recovery of the cameras the film will be developed, mounted in a mosaic, and broad aspects of the storm will be studied. Analysis of the photographs will enable scientists to learn more about hurricanes. Research may thus some day permit more rapid and accurate forecasting of hurricanes and save countless lives and property.

New Bomb Device for Atomic Defense Training

A successful test has been completed on a new training bomb developed by the USN Special Devices Center, a field activity of the Office of Naval Research. This mock bomb training device is to be used by the Navy for atomic defense training exercises.

The test was conducted at the Brookhaven National Laboratory Testing Area and consisted of the explosion of a training bomb released from a small aircraft at an altitude of 1000 ft. The bomb was released to evaluate the characteristics of the ballistic shape of the device, volume of sound, the color and size of the fireball, and the configuration of the resulting smoke cloud, which is designed to simulate the "mushroom" created by an actual atomic bomb. The test appeared successful and the device was judged adequate for use by the Navy, according to officials at the Navy's Special Devices Center at Sands Point, L.I., which sponsored the test. It is expected that the use of the device will considerably improve the fleet atomic defense training programs.

The main purpose of the Special Devices Center is to provide training equipment to improve the effectiveness of military training in the Navy and throughout the Armed Forces. Through training aids, devices, and training systems developed at the Center, Navy personnel are trained more quickly, more economically, more effectively, and without danger of loss of life.

AN OCEAN IN MINIATURE

Dr. Wayne V. Burt
School of Science
Oregon State College

How often has a Navy scientist, grappling with a knotty problem, wished for wind and sea scaled down to laboratory size! In a less exaggerated way, he may have wished for a full-blown manageable ocean not more than a couple of miles across, but deep enough to get down to cases on the problem at hand. Perhaps he did not know of the "Ocean in Miniature" that exists at Puget Sound, and furthermore that many times it has served as a facility for scientists with problems in such fields as marine biology, hydrology, and oceanography.

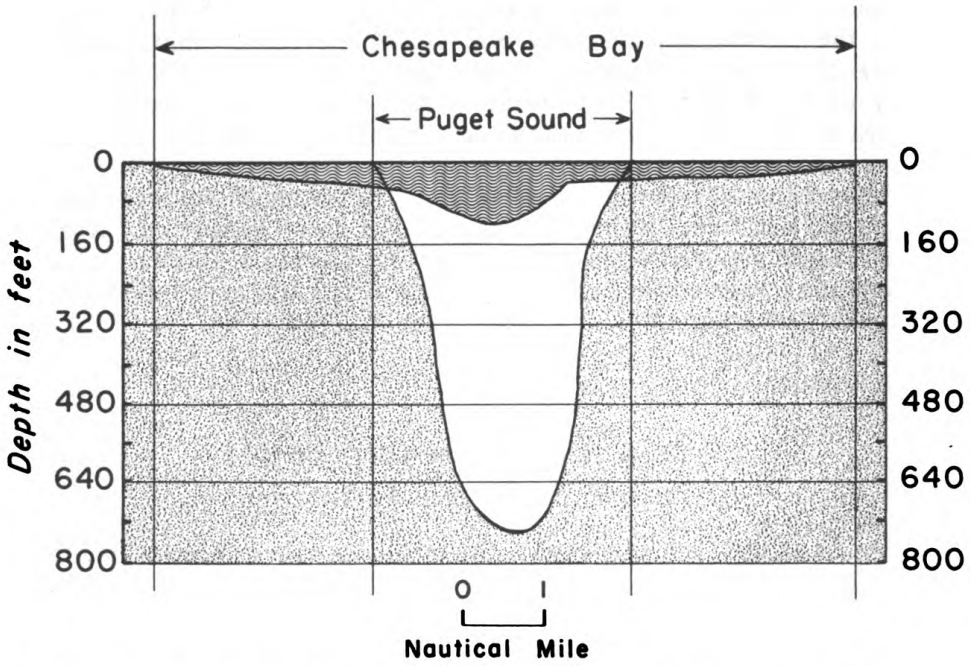


Figure 1 - Typical cross sections through Puget Sound and Chesapeake Bay showing relative depths and the contrast in shape.

The advantages of Puget Sound may be brought out by comparing it with Chesapeake Bay (Figure 1). The latter has an average depth of less than 25 ft and is easily warmed and cooled by changes in the air temperature above it. The change in water temperature with season ranges up to 50°F in some locations. Puget Sound, on the other hand, has an annual water temperature range of less than 10°F on the surface layers while temperatures of the bottom layers change scarcely at all.

Chesapeake Bay has a yearly inflow of fresh water that is equal to the volume contained in the bay—thus the salinity is affected at all depths. Puget Sound receives annually fresh water equal to only about one-third the amount contained in the Sound, and much of the inflow remains near

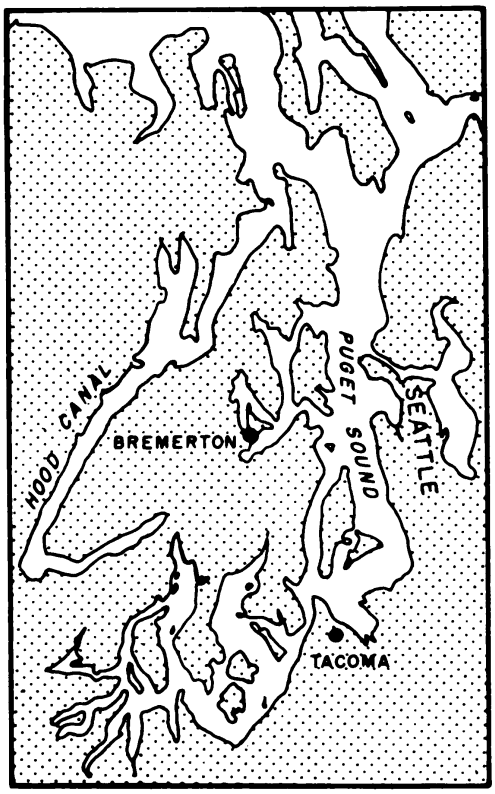


Figure 2 - Puget Sound area containing "An Ocean in Miniature."

the surface and has little effect on the bottom layers. A shallow body of water, like the Chesapeake, is considerably affected by strong winds; the whole vertical structure of the water may be changed by a virile series of summer thunderstorms. In the case of Puget Sound, a layer relatively undisturbed by winds lies under the disturbed surface layer. The undisturbed layer may be as much as 500 ft deep and affords unequalled opportunities for study and research. As a variation, Puget Sound has several narrow channels with strong tidal currents. The action of these currents mixes thoroughly the water all the way to the bottom, and in so doing provides for the scientists who would make use of them, water mixtures that vary greatly and move along speedily to be replaced by others.

One of the outstanding possibilities for scientific investigation is presented by the center portion of Hood Canal (Figure 2). This natural channel is straight for more than 20 miles and has a cross section that is nearly U-shaped with constant depths of about 500 ft. The flow of water is essentially horizontal toward one end or the other of the canal, and the mixing of salt and fresh water is usually in a vertical direction neatly restricting most problems to two directions. No cross-channel restrictions are present to introduce excessive tidal mixing in this region.

In some years during the winter, the cooling in Hood Canal and its approaches is insufficient to bring about a complete exchange of water. As a result, a shallow, nearly stagnant layer of bottom water is held over during the winter. During the following spring and summer, mixing is reduced to almost zero in the intermediate layer as the surface water becomes warm. Whenever this occurs, there is a very slow diffusion of dissolved materials between the newly formed intermediate water and the old, nearly stagnant bottom water of the year before. This is similar to what occurs in places where the ocean is deep, only the deep water may have been away from the surface for hundreds of years rather than only one season. A parallel is drawn as the behavior of the water over the shallow sills at the entrance of Hood Canal is much like that of high-latitude convergences in the oceans during the season when the bottom water is formed.

Rivers contribute fresh water to the heads of the bays of the Sound, and, although strong mixing may occur over the entrance sills, there is

a net outflow toward the ocean of surface waters and a net inflow of bottom waters. This tends to maintain a slight difference between the surface and the bottom waters and has its counterpart in the oceans when there are northward-flowing surface currents with a return flow of subsurface water toward the tropics. In the case of the Canal, however, the complete action can be observed in a matter of months; in the open ocean, the time lapse may be hundreds of years.

There are various locations along the borders of this miniature ocean simulated by Puget Sound which provide good observation points for investigators. Results have been obtained, for instance, on the measurement of vertical currents that indicate higher velocities than expected. It may be possible to apply this knowledge to problems associated with larger convergences and divergences which extend hundreds of miles in the open sea. The Office of Naval Research is actively sponsoring a program of oceanographic research conducted since 1948 by scientists with the University of Washington.

The "Ocean in Miniature" is also used by the Navy's Bureau of Ordnance which has a torpedo range in the Sound. Research readily extends into such fields as marine biology, chemistry, physics, geology, and meteorology. Detailed studies can be made with the time factor reduced to a fraction of the time of a natural occurrence in the ocean. Likewise, the dimensions are manageable as only a few miles are involved instead of the hundreds of miles that might be the linear dimension of a current or stream in the ocean. Investigators have at times one added advantage, as in some parts of Puget Sound the third dimension is to all intents a constant and the problem is reduced to two dimensions. An example is the mixture of fresh and salt water in a narrow channel; from top to bottom the mixture simulates ocean conditions. The investigator is able to work out his problem in terms of the length and width of channel under observation. These smaller "laboratory" situations within the ocean in miniature afford continuing possibilities to scientists who seek answers to some of the questions posed by the vast oceanic areas which cover 71 percent of the earth's surface.

Other areas have been developed or possess advantages as aqueous laboratories. Some of these are being used by the Navy for specialized problems. With research in oceanography commanding wider attention, interested scientists will be more active in looking for and using marine areas scaled to laboratory size.---Editorial Note.

The universe can be best pictured, although still very imperfectly and inadequately, as consisting of pure thought of what, for want of a wider word, we must describe as a mathematical thinker.

---Sir James Jeans

SH - A "SLEEPER" IN THE CONQUEST OF DISEASE

Erwin P. Vollmer
Endocrinology Branch, Division of Physiology
Naval Medical Research Institute

From time to time a drug or chemical attracts the interest of scientists in many fields, and its name may even become a journalistic byword. Usually such a wide spectrum of interest reflects a useful property: the scurvy-preventive effect of Vitamin C, arthritis-relieving effects of cortisone, the germ-killing action of penicillin. The substances to be discussed in this article have never been in headlines, but they have commanded scientific interest for a long time by reason of their importance in fundamental structures, biochemical reactions, and physiological responses of living things. These are naturally occuring organic compounds of sulfur—the sulfhydryl compounds.

As the name suggests, a sulfur-and-hydrogen group (SH) is attached to the organic portion of these compounds. They are sometimes called "thioalcohols" or thiols (RSH), by analogy with the better known oxygen-containing alcohols (ROH). The hydrogen is unstable and therefore replaceable in a variety of reactions, among which the reversible self-oxidation of sulfhydryls to disulfide is of special interest:

(1) $$2\ RSH \rightleftharpoons RSSR + 2\ H^+ + 2\ e^-$$

Different sulfhydryl compounds may combine in this way, and since some of them are amino acids it is not surprising that many proteins are found, upon analysis, to contain SH groups or disulfide (S-S) bridges. Knowledge of these compounds has been growing at a fantastic rate, and the importance of this growth will best be appreciated against the background of our previous ignorance. This involves a story that is intrinsically interesting, and also a good example of what an outstanding scientist has referred to as, "a trail of research."

The story started in the last century, from which we need salvage only one item. In 1888 a Frenchman named Rey-Pailhaud reported finding, in yeast, a sulfur-containing material to which he gave the name "philothion." After that the trail lay dark for a whole generation, at the end of which, in 1908, a chemist named Heffter demonstrated that "philothion" was a sulfhydryl compound. Now it happened that at that time medical scientists were deeply concerned with the question of protoplasm's reaction with poisonous metals like arsenic. Ehrlich, speculating on this question before a scientific gathering, picked up Heffter's clue and suggested that the sulfhydryl groups of protoplasm might be "receptors" for metallic ions.

The concern about the toxicity of heavy metals was not due to their use in any "arsenic-and-old-lace" crime wave, but to their place in the new chemotherapy that was developing. Arsenicals were being used to cure disease, particularly for treating syphilis. There was no doubt

that, with luck, they killed the parasites, but not infrequently they hurt the patient too; as the syphilis waned, the patient often showed signs of metal poisoning. How to spare the patient while spoiling the parasite was a nasty medical dilemma, which could be solved only by fundamental knowledge of the mechanisms involved. This knowledge emerged, in outline at least, during the decade 1920-30, as a product of the work of Carl Voegtlin and his associates in the Public Health Service. Voegtlin's work was undoubtedly supported and stimulated by concomitant work of others, especially F. G. Hopkins, who were intent on getting a clearer picture of the chemical nature of the sulfhydryl compounds in tissues.

From three diverse sources—yeast, muscle, and liver—Hopkins crystallized a relatively simple, nonprotein sulfhydryl compound. This he showed to be a tripeptide, a string of three amino acids: glutamic, cysteine, and glycine. Cysteine is a sulfhydryl compound, and hence the bearer of the SH group of the tripeptide, which was given the euphonious name, "glutathione" (Figure 1).

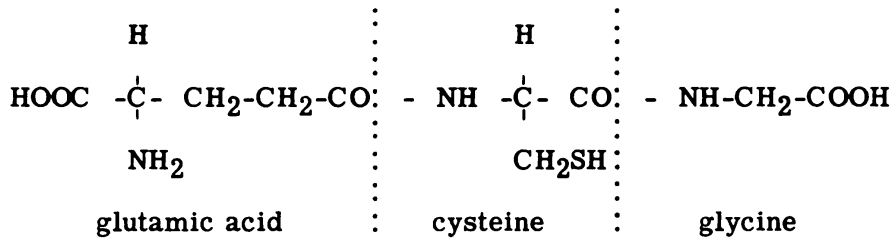


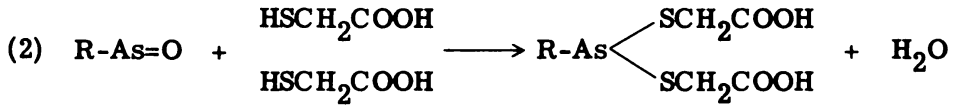
Figure 1. Glutathione

Glutathione is rather unstable in solution unless kept at low pH. Like other sulfhydryls it can double up to form disulfide (Equation 1) when conditions are right. Hopkins pointed out that this reaction is reversible, and suggested that glutathione might form an oxidation-reduction system with ascorbic acid, which thereby would be kept in its reduced, and biologically most active, form. Whatever the functions of glutathione within the living cell—and to this day they are more speculated about than known—they are surely essential. Glutathione is found in all cells, including red blood cells. It is especially abundant in growing and metabolically active cells, and it is the principal nonprotein sulfhydryl compound found in all cells.

The same year that Hopkins reported the isolation of glutathione, Voegtlin described some interesting observations on the toxicity of arsenical drugs. He showed that there was a sharp dosage threshold below which the drugs had no effect on parasitic trypanosomes, and surmised that this was due "in part to the nature of the reaction between the drug and the parasites and in part to absorption of the drug by the tissues of the host." This was an extension of Ehrlich's notion of receptors, and Voegtlin later identified the SH groups of glutathione and proteins as the arsenic receptors of protoplasm. Experiments of the following sort supported this idea. When animals poisoned with lethal doses of arsenicals were treated with glutathione, they survived instead of dying. When other animals, in which trypanosome infection was being kept in check by arsenicals, were treated with glutathione, the infection flared up disastrously: the extra glutathione interfered with the action

of the drug on the parasites. Similarly, trypanosomes being poisoned with arsenicals in the test tube could be protected by adding some glutathione or other sulfhydryl compound. Thus, in any situation, the added sulfhydryl apparently protected the receptors of protoplasm.

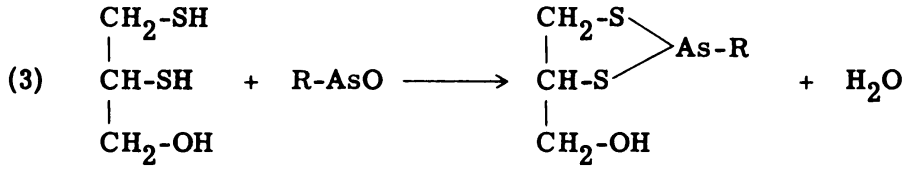
This is how Voegtlin represented the detoxification of an arsenical by a sulfhydryl compound (thioglycollic acid):



(2) $R\text{-}As{=}O + \begin{matrix} HSCH_2COOH \\ HSCH_2COOH \end{matrix} \longrightarrow R\text{-}As\begin{matrix} SCH_2COOH \\ SCH_2COOH \end{matrix} + H_2O$

In the clinic, arsenicals were given in the hope of killing the parasites, and this involved the assumption that the sulfhydryl compounds involved in Equation 2 would be those of the parasites. Actually, Voegtlin suggested, the sylfhydryls of the host competed with those of the parasite for the metal, and the outcome of the struggle was tipped by internal chemical conditions still unfathomed. Voegtlin's work did not solve the medical dilemma, but rather exposed it more nakedly, by indicating that the root of the clinical problem was the essential identity of mechanism of host and parasite susceptibility to the drug. This dilemma was really never solved; but it was circumvented by the development of more effective germ killers than the arsenicals. Only the knowledge of the mechanisms involved remained as a permanent scientific accession.

As the second world war approached, this knowledge was a weapon on hand for the scientists studying the ugly threat of gas warfare. Since one of the gases most likely to be used was lewisite, whose deadliness depended upon its arsenic, these investigators started checking the sulfhydryl compounds for an antidote. They found the available compounds too weakly and briefly acting to promise effective field use. The key to improvement lay in the fact that it took two molecules of these sulfhydryls to inactivate one of arsenoxide (Equation 2). Someone pointed out that a single molecule, bearing two sulfhydryl groups, properly spaced, might be more effective. And so it turned out. A double-pronged SH compound was synthesized, and found to have prolonged beneficial action, at relatively low dosage, in animals exposed to lewisite. It prevented blister formation on human skin even if applied as late as an hour after exposure to lewisite. The pride of creation is in its name: "British anti-lewisite" or BAL. Its reaction with lewisite:



(3) $\begin{matrix} CH_2\text{-}SH \\ | \\ CH\text{-}SH \\ | \\ CH_2\text{-}OH \end{matrix} + R\text{-}AsO \longrightarrow \begin{matrix} CH_2\text{-}S \\ | \quad \diagdown As\text{-}R \\ CH\text{-}S \quad\quad \\ | \\ CH_2\text{-}OH \end{matrix} + H_2O$

Once more, events outrode intentions: no legions in the field were saved by BAL, although the progress of such investigations may have contributed to the reluctance of the beligerents to resort to gas. The threat died away, but BAL and its little aura of new knowledge remained. Practicality was eventually served to some extent, since BAL proved clinically effective in treating mercury and arsenic poisoning. But even

in this small corner of medicine the place of BAL has already been challenged, since it is claimed that some of the new chelating agents remove toxic metals more efficiently.

At this point one may object that all this trail has led to is ghost towns: it failed in the dilemma of the arsenicals, it provided a hypothetical but never utilized answer to the gas threat, and it gave a real antidote only in a limited field, in which other antidotes are already found superior.

The philosophy that prevails in answering such a comment, which perhaps implies the uselessness of research not aimed directly at the heart of a problem, is of supreme concern to the health and vitality of our scientific institutions. Pressing, immediate problems are rarely solved by direct attack, except by way of concepts and know-how previously developed. These concepts may seem remote and even esoteric, up to the very moment when they are needed. Directed research becomes effective only in the last stage, when established knowledge can be dropped, like figures into a computer, into the design of experiments. In terms of our metaphor, trails are picked where the wilderness is most yielding, and specific destinations are best reached from established trails. If gas warfare had broken out BAL might have saved many lives; at any rate BAL was readied in a relatively short time. This could not have been so, had the past not included a Rey-Pailhaud, a Hopkins, and a Voegtlin, mulling over seemingly remote problems.

Few of us have had personal experience with the sulfur-and-molasses foisted upon children as a Spring tonic a few generations ago. However, many old remedies are being found to have excellent reasons for being, and it would not be surprising if treacle came into vogue again. Sulfur compounds, often as sulfhydryls, turn up regularly as key reactants or modifiers of important biochemical or physiological responses. For example:

- Native proteins such as albumen contain sulfhydryl groups, some in protected sites and S-S bridges. The latter become detectable as protein is denatured. Eggs cannot boil, meat spoil, or blood coagulate without suffering sulfhydryl changes.

- The keratins of hair and skin contain S-S bridges essential in their structure. Skin changes like sun-tanning involve sulfhydryl chemistry.

- The haem of cytochrome, according to Theorell, is held to its protein by the sulfur of two cysteine components. Hemoglobin has active SH groups, and the presence of glutathione with it in the red cell is a biological mystery shouting for a detective.

- Many enzymes and co-enzymes have SH groups which are apparently the sites of their characteristic action. Insulin on the other hand consists of peptide chains united by S-S bridges, rupture of which destroys its hormonal action. ACTH, pitressin, and other hormones have sulphur groups of unknown significance.

• The liver and kidney of animals in shock release a substance which has profound effects on their circulatory systems. This is ferritin, which loses its physiological activity in the presence of sulfhydryl inhibiters and regains it in the presence of glutathione.

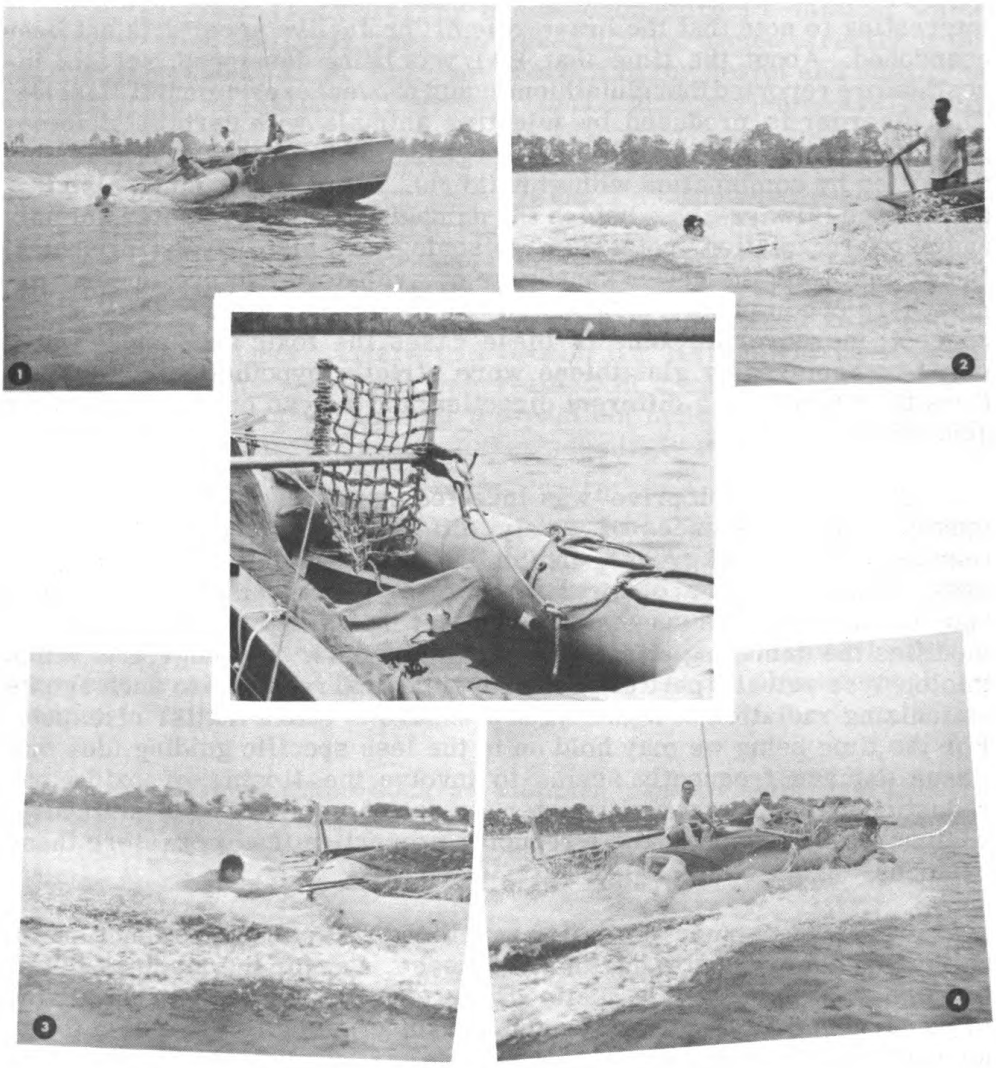
• Sulfhydryl reactions are involved in nuclear division, growth, respiration, muscular contraction, and even rigor mortis. Thus, they are part of us from conception to the grave.

In the midst of these important parts played by sulfhydryl, it is interesting to note that the brave role of "protective agent" has not been abandoned. About the time that BAL was being developed, several investigators reported that glutathione could prevent experimental diabetes. This disorder is produced by injecting animals with certain "diabetogens," which, by analogy with the Voegtlin reaction (1), are presumably detoxified by combination with glutathione. Later, it was found also that glutathione (always given before the damaging agent) protected animals against x-irradiation, potassium poisoning, and high oxygen pressure. But by this time the newer knowledge of sylfhydryl had produced an atmosphere of complexity, unfavorable to simple application of the Voegtlin concept; moreover in some of these cases the toxic substances which might be removed by glutathione were strictly hypothetical. Explanations therefore took a different direction, and we can only indicate their general nature here.

The term "thioloprive" was invented by a French scientist to designate "toxic substances of widely different structure which deprive tissues of their thiol groups, inhibit the same enzyme system and possess common pharmacological properties." The existence of such a body of substances is suggested by the fact that glutathione, for example, modifies the damaging effects of so many agents. The degree to which thioloprives actually participate in physiological response to such agents as ionizing radiation or high oxygen pressure is still a matter of dispute. For the time being we may hold on to the less specific guiding idea that tissue damage frequently seems to involve the tipping of oxidation-reduction balances toward greater oxidation, and that the sulfhydryl compounds by reason of their reducing properties tend to restore these balances.

These ideas may embody part of the truth about the functions of sulfhydryl compounds in health and disease. But for the medical scientist who is physiologically inclined a great task of integration remains to be carried out. How is the metabolism of glutathione related to the normal behavior of the nervous system or cardiovascular system? What is the true meaning of the "protective" effects of glutathione? How are these effects to be understood in relation to homeostasis, alarm reaction, and other modern theories of stress?

The sharp facts of sulfhydryl chemistry and biochemistry must be related to the more amorphous but no less valid biological facts, those of physiology and pathology of organ systems, and the behavior and symptomatology of whole animals. In terms of our now well-worn metaphor, new paths must be cut and old ones must merge, before such questions can be answered.



SWIMMER PICK-UP

1 Navy's new rescue system at the beginning of the pick-up cycle; **2** rescue cycle continues with swimmer gripping the snare attached to the rubber lifeboat; **3** tension on the bungee cord has gone into reaction like a slingshot; swimmer goes forward faster than rescue boat as pick-up cycle nears climax; **4** swimmer slithers into boat--pick-up cycle completed. In the center is the equipment of the rubber lifeboat with its safety net to protect snareman in case bungee cord slips from swimmer's grasp as he is about to be retrieved.

SLINGSHOT RECOVERY FOR NAVY SWIMMERS

A slingshot type device, which catapults a swimmer from the water into a fast-moving boat in three seconds or less, is the U. S. Navy's spectacular new method of speeding up the recovery of one or more men who have been on a mission such as frogmen with demolition assignments.

The new system was designed and developed by the All American Engineering Co. of Wilmington, Del., in cooperation with the Amphibious Branch of the Office of Naval Research. Its performance has been proved through a series of exhaustive tests by the manufacturer on Indian River Inlet near Wilmington.

Tests have demonstrated that, with a naval landing craft traveling at 14 knots, swimmers can be snatched from the water and deposited into a rubber lifeboat at the rate of 25 per minute. The elapsed time from the moment the swimmer grasps a retrieving snare until he lands in the lifeboat is 2.4 seconds. The pick-up cycle is illustrated by the accompanying photographs made during tests by the manufacturer.

In case faster rescue boats are built, the present new retrieving system can be modified to permit crews of craft speeding at 50 knots to pull swimmers from the water quickly and safely.

The swimmer pick-up assembly stores accelerating energy in a pre-tensioned bungee cord, which is attached to a boat boom fixed to the rescue craft and extending over a towed rubber lifeboat. At the free end of the tensioned cord is a loop, or snare, for the swimmer to grasp as the boat passes him.

The force of the swimmer's acceleration, from zero speed in the water to the speed of the boat, stretches the bungee cord—as a boy stretches the rubber band of his slingshot—and the stored energy pulls the swimmer into the lifeboat.

During a pick-up, two tensioned bungee cords are used. Here is how the rescue operation is carried on:

A snareman stationed in the rubber boat near the boom hands a snare to the first swimmer and, as that man's energy cord stretches out to deliver the catapulting action, the second snare is handed to the next swimmer. The retrieving cycle for the second swimmer is begun while the cycle for the first man is underway. As each rescued man bounces into the lifeboat, he releases his snare, and the snareman then hands it out to a waiting swimmer. The cycle continues until all men in the water are hauled in.

By combining the energy-absorbing bungee cord and the retrieving power into one unit and by determining correct length of cord, All American reduced both initial impact and accelerating loads. The mechanical source of power relieved the snareman from the arduous chore of hauling each swimmer into the boat, permitting him to devote all his time and energy to handing out snares in rapid succession.

Advantages of the new system are: greater boat speed, shorter retrieving cycle, less over-all time the boat is under enemy fire, and a harder moving target for the enemy to hit.

CREATIVE ABILITY IN MACHINE DESIGN

Dr. J. F. Downie Smith
Dean of the Division of Engineering
and
Dr. William A. Owens
Chairman, Department of Psychology
Iowa State College, Ames, Iowa

During the last war there was a great scarcity of machine designers available to do the many jobs which had to be done by the Armed Services as well as by industry. In general, the situation became so acute that all sorts of devices were adopted to try to upgrade draftsmen to designers and to make draftsmen out of relatively unskilled young men and women. There are several reasons for this scarcity. Among them are the following:

To a large extent, industries in this country have relied upon the immigration of trained draftsmen and designers from certain European countries, and this supply was shut off during the war. It still is shut off to a large extent.

There also was a noticeable lack of training of men for designing, both in college and in industry.

Furthermore a feeling was fostered to some extent in college, and strengthened more so in industry, that a man who goes to work on a drawing board stays there for life. The fact that statistical evidence (among qualified engineers) does not bear out this belief did not change the picture materially, and young men were very reluctant to go on a drawing board after graduation from college.

In addition, the designer did not have the social prestige in this country which he enjoyed in some of the European countries.

There are other reasons also for the scarcity, but the fact remains that at the moment designers are difficult to find, and are in great demand by industry, and also by those colleges which like to teach machine design as a creative subject.

In most of the engineering colleges in this country, Mechanical Engineering is divided into two main branches: one involving heat-power, and the second involving design, particularly machine design. For a long time, heat-power strongly dominated the Mechanical Engineering curriculum, and machine design courses, in general, were not particularly inspiring. This had its effect on the attitude of the Mechanical Engineering student who already tended to concentrate in the field of heat-power, and the percentage interested in machine design was relatively small.

At several colleges, however, an attempt was made to make machine design instruction a creative function and to stimulate the student into utilizing his brain in the solution of new problems. Some colleges

have been noticeably successful in this line of endeavor but the majority still leave much to be desired.

It was clear that some engineering students in Mechanical Engineering do not have the ability, even if they have the desire, to become machine designers. Others have the ability but not the desire. A certain type of mentality is necessary before a man can be a successful machine designer. It was felt at Iowa State College that if we could locate students in the junior year, or, at the latest, at the beginning of the senior year, who have aptitude for machine design, we might be able to give a rather special training to those men to fit them for a very profitable career after graduation. Fortunately the college staff is qualified to do this type of work.

Thus a study was undertaken by Iowa State College under contract with the Office of Naval Research, to determine if tests, or other measuring devices, could be set up which would be answered differently by creative and noncreative machine designers. The two groups were defined:

> Creative designers: Persons who have demonstrated the ability to comprehend the nature of a design problem, and can produce a novel, ingenious, or original solution in the form of a total, functional, and practical mechanism. Creativity, in this sense, does not necessarily involve the conception of an entirely new principle, but does involve the combination of existing principles or mechanisms in such a way as to produce a new and unique solution to a previously unsolved problem.
>
> Noncreative designers: Persons whose major function is to work out the details of a design; that is, the engineers who do not produce original ideas, but who work out the routine problems of what materials to use, and who smooth out the design according to established procedures.

For an initial "trial run" nine measuring devices were ultimately constructed. Three of these were ability tests quite specific to the machine design area; three were broader and more general intellective tests; and three might be designated as more or less direct measures of "personality." These instruments are briefly described below:

1. Power Source Apparatus - Given a power source and a motion sequence, sketch as many intervening mechanisms as possible. Scores: absolute number and number "workable."

2. Design a Machine - Given a particular purpose to be served, sketch as many appropriate mechanisms as possible. Scores: absolute number and number workable.

3. Applications of Mechanisms - Given a particular mechanism, enumerate as many types of machines in which it might function as possible. Score: number listed.

4. Three-Dimensional Space Relations - Fold a flat pattern to form a cube and then indicate the positions of three faces following various patterns of rotation. Score: number correct.

5. Figure Matrices - Derive the rules by which a figure evolves, in two dimensions, and apply these in order to supply a missing figure at any given point. Score: number correct.

6. Number Series - Derive the rule or principle by which a series of numbers is generated and apply it to supply certain missing numbers in each series.

7. Unstructured Test - Given a series of meaningless, incomplete, "mechanical-type" drawings, indicate what they could be, how many different things can be seen in each, and circle the relevant parts. Score: number of objects identified, number of responses per minute, number involving motion, number of line segments used in each response, number of machines identified, and percent of machine responses.

8. Personal Inventory - A paired-statement inventory of 197 items dealing with interests, opinions, attitudes, personal characteristics, and experiences. Score: number of responses typical of the creative machine designer.

9. Personal History Form - A single sheet dealing with personal background and scored like the Personal Inventory.

The values of these tests and questionnaires were determined by trying them on groups of creative and noncreative machine designers, matched for age, education, and experience, and by determining whether or not these two groups tended to respond differently. The procedure was repeated twice in order to assure that "chance" differences did not figure largely in the determination of the tests ultimately selected.

After the first trial, the battery was reduced to include only measures 1, 3, 8, and 9. When these four were combined on the second trial to estimate whether a total sample of 159 engineers would be rated as creative or noncreative by their superiors, there was a 75 percent over-all coincidence of test diagnoses with ratings.

As a final step, a study has already been initiated to determine whether those who score well on the tests in college actually go on to become creative. About 1500 engineers have already been tested at 27 cooperating institutions. One encouraging fact has already emerged—the best of these college juniors in engineering score in the higher ranges of the creative group. It thus seems that the test scores do not, at least entirely, reflect the age, education, or experience of those tested.

In conclusion, a battery of tests has been constructed which promises to be a very substantial aid in the identification of persons possessing creative potentialities in the area of machine design.

On The Naval Research Reserve

CAPT Blanchard Detached

CAPT Theodore Blanchard, USNR, was detached from his duty as Special Assistant to the Chief of Naval Research (Research Reserve) on 4 May 1956. He reported on 14 May to the Commandant, THIRD Naval District, for duty as Deputy Chief of Staff for Naval Reserve. CAPT Blanchard has been directing the Research Reserve for the past two years. His many friends, who appreciate the strong leadership which he has given to the program, congratulate him on his appointment to a post where he can continue his valuable service to the Naval Reserve.

CDR Horace F. Burr, USNR, who has been Training Officer since October 1954, is taking over the direction of the Research Reserve in acting capacity.

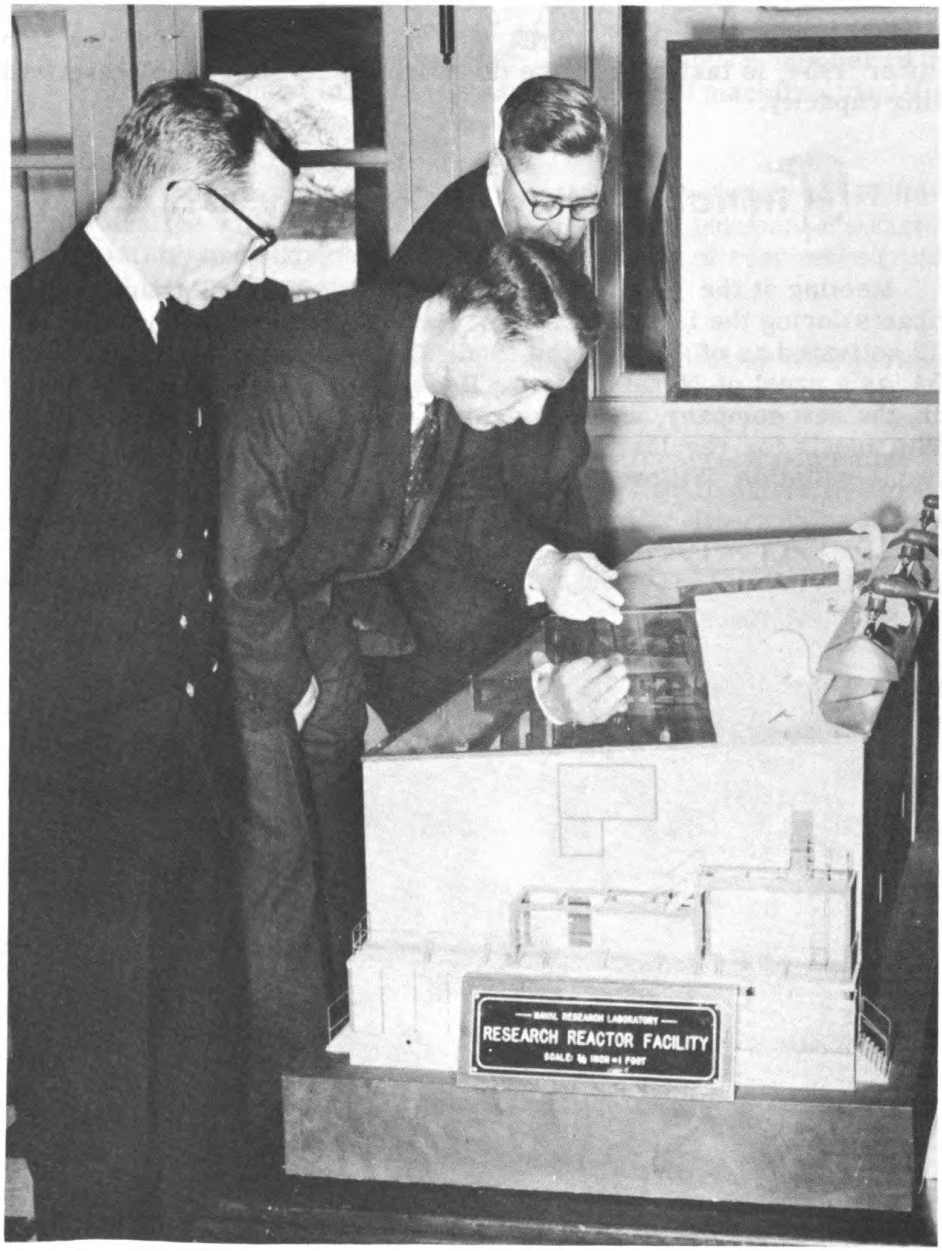
Initial Meeting of Company 4-12

Meeting at the Naval Air Station, Willow Grove, Pa. are the participants during the initial session of Naval Reserve Research Company 4-12 activated as of 1 February 1956. Originally organized in January 1954, as a panel of Naval Reserve Research Company 4-2 of Philadelphia, the new company, under the command of LT Lewis M. Smith, Jr., USNR, meets for regularly scheduled drills on Tuesday evenings at the Naval Air Station, Willow Grove.

Assistant Secretary of Navy is Guest of the Naval Reserve Research Co. W-2

On April 20, 1956, the Honorable Albert Pratt, Assistant Secretary of the Navy (Personnel and Reserve Forces) was the guest of the Naval Reserve Research Company W-2, at the Naval Research Laboratory, Washington, D.C.

After attending a special luncheon as guest of CAPT S. M. Tucker, Director, Mr. Pratt was given a brief tour of the Laboratory. In the figure, Mr. Pratt and CAPT Tucker are observing a model of the NRL



reactor facility being demonstrated by Mr. T. A. Bergstralh, Radiation Division.

At 3:00 p.m., LCDR Arthur O. Parks, Commanding Officer of NRRC W-2, introduced Mr. Pratt to the members of the Reserve and guests from NRL, ONR, PRNC, and the Navy Department. Mr. Pratt gave a very interesting and informative address on the subject, "Recent Naval Developments."

Research Company 6-17 Activated

Naval Reserve Research Company 6-17 was activated at Huntsville, Alabama's U. S. Naval Reserve Training Center on 20 March 1956. LT Howard F. Thames, the Company's commanding officer, receives the congratulations of CAPT Theodore Blanchard, ONR, while LCDR J. T. Bedsole, ONR, LCDR J. B. Walker, commanding officer of the training center, and members of the newly activated unit look on. Shown from left to right below are: LT Roland Griner, LT J. Zarovsky, LTJG J. E. McDonald, LTJC S. C. Likos, LT T. M. Wade, LT W. L. Howard, ENS R. D. Walker, LT A. Steinberg, LCDR Bedsole, LT Thames, CAPT Blanchard, and LCDR Walker.

Reactor Study Program at Hanford Naval Reserve Meetings

A series of talks on reactors and separations are being presented as the current training program of Naval Reserve Research Co. 13-2, Hanford, Wash. Eight scientists and engineers of the Hanford Atomic Products Operation are participating in the series. The subjects cover a wide range to include titles such as "Existing and Planned Reactors in the U.S. and Abroad" and "Separations Technology."

CDR John K. Hicks New Training Officer

CDR John K. Hicks, USNR, reported to the Office of Naval Research on 9 April 1956 for duty as Training Officer, Research Reserve. He is relieving CDR Horace F. Burr, USNR, who is taking over the direction of the program.

CDR Hicks began his Naval career when he was commissioned an Ensign on 14 November 1940. He has been in Commander rank since 1 July 1951. From March to August 1941 he was Assistant Intelligence Officer, Navy Yard, Mare Island, Calif. After instruction in the Basic Intelligence School, Washington, D.C., he became Officer-in-Charge, Branch Naval Intelligence Office, San Luis Obispo, California, where he served until April 1943.

After attendance at the Advanced Intelligence School, New York, he was attached to the DIO at the Twelfth Naval District in June 1943. From August 1943 to May 1945 he was Assistant Port Officer, Cardiff, South Wales. In July 1945 he was in the Cargo Section, Naval Transportation Service, Washington, D.C. In January 1946 he became Assistant Operations Officer, Staff ComNavEu and Com 12th Fleet, London, England.

During the year 1947, CDR Hicks was on duty with the ACNO (Naval Reserve). After being on inactive status from July 1947 to June 1951, during which time he was employed in the Marine Department, Standard Oil Company of California in San Francisco, CDR Hicks returned to active duty on the staff, Commander, Military Sea Transportation Service, North Pacific Sub Area, Seattle, Washington. In October 1953 he was assigned duty as Assistant Naval Attache, Taipei, Taiwan, China. Leaving this post in October 1955, he was attached to the Bureau of Personnel until his recent assignment to the Research Reserve.

SEMINAR MEETINGS

Nuclear Science, Idaho Falls, Idaho	23 July 1956
Naval Research Laboratory, Washington, D. C.	20 August 1956
West Coast, San Francisco, Calif.	20 August 1956
Great Lakes, Great Lakes, Illinois	15 October 1956
Nuclear Science, Oak Ridge, Tennessee	26 November 1956
Reserve Research Seminar, ONR, Washington, D.C.	28 January 1957
Special Devices Center, Port Washington, N. Y.	8 April 1957
Aviation Medicine, USN Sch. Avia. Med., Pensacola, Fla.	13 May 1957
Nuclear Science, Brookhaven Nat. Lab., Upton, N. Y.	3 June 1957
Research Methods, Columbus, Ohio	17 June 1957

U. S. GOVERNMENT PRINTING OFFICE : 1956 O - 387529

In photographing a hurricane (see Article beginning p. 4) the parachuted rocket cone and camera will be retrieved by a destroyer like the USS ROSS above.

In This Issue

COVER PHOTO: When a program gets under way to photograph hurricanes during the East Coast Hurricane season, WV-2 aircraft will track parachuted rocket cones and cameras to assist recovery by surface craft when the gear reaches water and floats until ships make the pick-up.

RESEARCH REVIEWS endeavors to report briefly highlights of technical progress in research by Navy laboratories and contractors and the development of important naval research facilities. Articles which meet these broad criteria and possess a good degree of readability are welcomed. Manuscripts and changes of address should be sent to Code 740, Office of Naval Research, Washington, D. C. . . . Research Reviews 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; $.15 per individual copy.

Approved by Bureau of the Budget, 28 February 1955