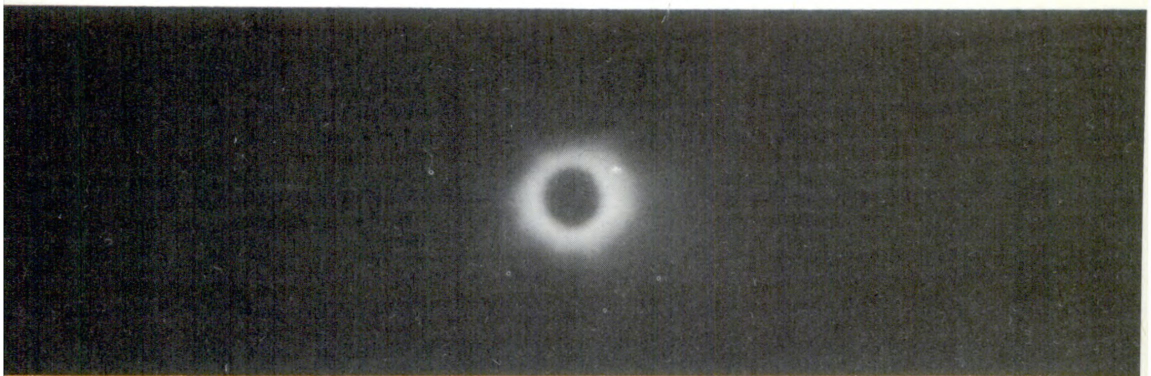
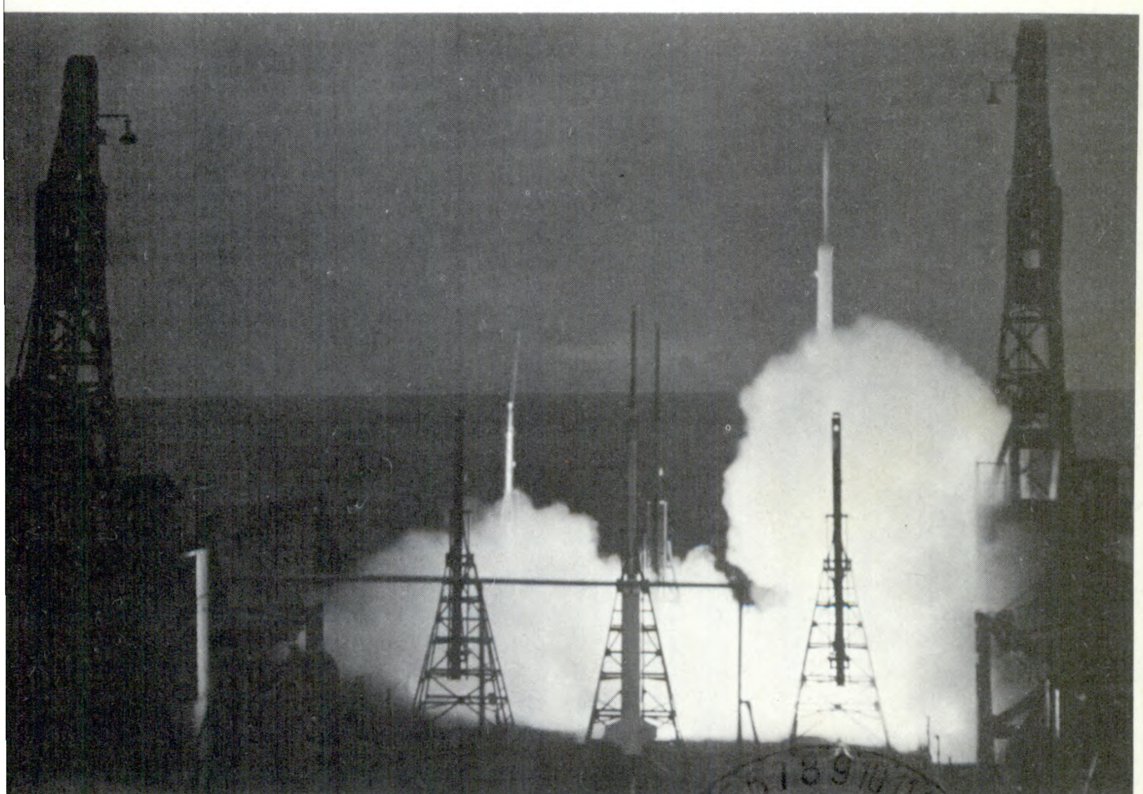
OFFICE OF NAVAL RESEARCH MARCH 1959

RESEARCH REVIEWS





DEPARTMENT OF THE NAVY
WASHINGTON, D. C.

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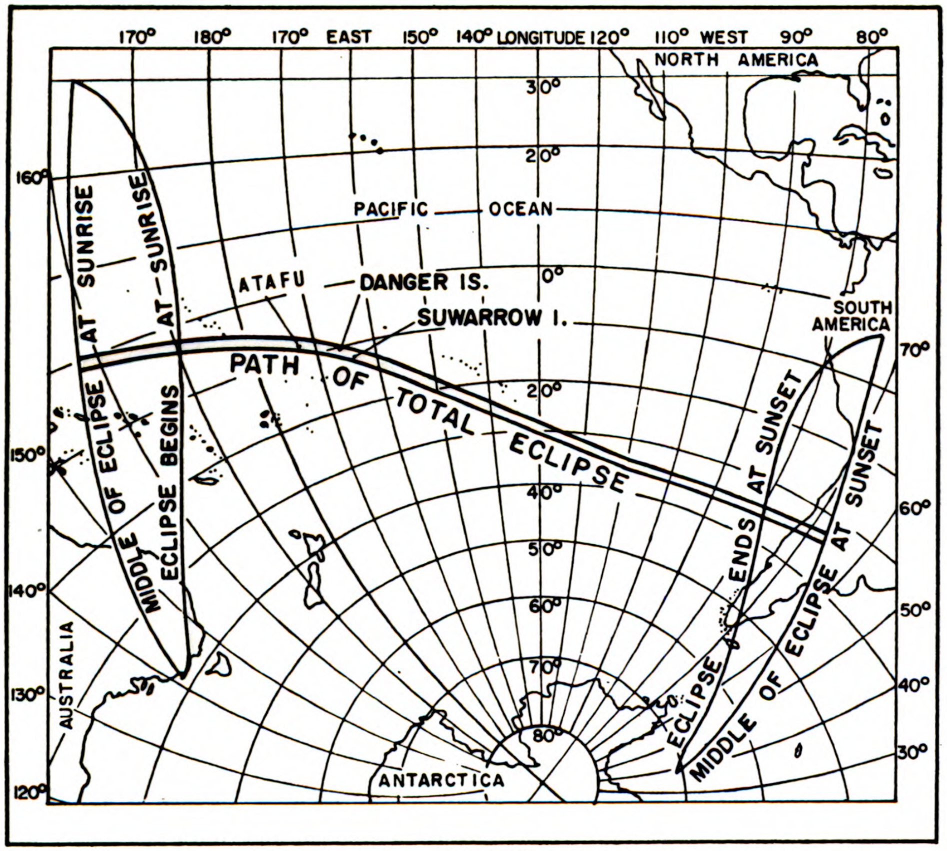


Path of totality of eclipse of October 12, 1958, and location of observation sites of British, American, and Japanese scientists. Courtesy, IGY Bulletin, National Academy of Sciences.

American expedition to the Danger Islands, where six teams of United States scientists conducted observations of the solar eclipse of October 12, 1958. Institutions participating in the experiment included the Naval Research Laboratory, the Naval Radiological Defense Laboratory, the Central Radio Propagation Laboratory of the National Bureau of Standards, the University of Wisconsin, the San Francisco Academy of Sciences, the Sacramento Peak Observatory, and the High Altitude Observatory.

Rocket Astronomy During a Total Eclipse of the Sun

H. Friedman
Superintendent
Atmosphere and Astrophysics Division
Naval Research Laboratory

Although man has been carefully documenting the occurrences of eclipses of the sun for more than 4,000 years, he has been able to apply modern methods of observation to the phenomena for only the past 100 years. These began with the introduction of photography, which made possible photographic spectroscopy and its application to studies of the flash spectrum of the chromosphere. Of the many improvements in technique that have been made since that time, perhaps the most significant has come through the application of rockets to eclipse experimentation. The first attempt at this type of investigation was made during the total eclipse of October 12, 1958, by an American expedition to the South Pacific Ocean. The advantage of rockets is that they permit studies of electromagnetic waves of all frequencies (most of these waves are absorbed by the atmosphere and therefore cannot be measured from the surface of the earth) and allow direct observations of the ionizing radiations responsible for ionospheric phenomena.

The eclipse began at sunrise on the equator near New Guinea and ended at sunset near Valparaiso, Chile, 8,500 miles to the east. Three hours and ten minutes were required for the moon's shadow to cover this distance. The path, which measured up to 150 miles in width, missed all of the large South Pacific Islands, but did touch a few tiny coral atolls. Among these were the Danger Islands, selected by the American expedition as a viewing site. This group of three small atolls—Pukapuka, Motu Koe, and Motu Katava—comprises about 7 square miles of land situated around a barrier reef that encloses a lagoon about 5 miles long and 2 to 3 miles wide. The American base was set up on Motu Katava.

Other groups that studied the eclipse were a British and New Zealand expedition, which established a base on Atafu; a Japanese party, which conducted investigations on Suwarrow Island; and a group of Swiss astronomers, who viewed the phenomenon from the coast of Chile.

THE AMERICAN EXPEDITION

The scientific parties of the American expedition were divided between a shipboard team to handle the rocket experiment and five groups of experimenters based on the islands. H. Friedman led a group of ten scientists and engineers from the Naval Research Laboratory; Dr. T. A. Chubb, Dr. J. C. Lindsay, and Mr. R. E. Kreplin were responsible for various phases of the rocket astronomy program. In the mounting and arming of the rockets, the NRL group was assisted by Mr. R. E. Cox and two engineers of the Cooper Development Corp. of Monrovia, Calif.

On the shore, Dr. J. C. Evans of Sacramento Peak Observatory, Sunspot, New Mex., led a group of sixteen scientists representing projects

SOME DEFINITIONS

Photosphere:	The surface of the sun. Most solar radiations originate in a surface layer about 300 miles thick.
Chromosphere:	The sun's atmosphere between the photosphere and a height of 15,000 miles. At the time of an eclipse it can be seen as a reddish rim.
Corona:	The thin outer atmosphere of the sun. It has been observed to extend millions of miles from the photosphere. The gas has a temperature of millions of degrees.
Plages:	Clouds of calcium or hydrogen vapor that show up as bright patches on the sun.
Spicules:	Jets of gas, 500 miles in diameter and about 600 miles high in the chromosphere. They shoot out from the sun's disc at speeds of 20 miles per second and last for about five minutes.
Prominences:	Scarlet clouds of gas floating high above the sun's surface. A typical prominence may be 125,000 miles long, 30,000 miles high, and 6,000 miles thick.
Airglow:	Light emitted by excited and ionized gases in the earth's atmosphere. Characteristic colors are yellow (of sodium), red and green (of oxygen). Its total intensity is about 1/100th that of the full moon.
Solar cycle:	The periodic increase and decrease in the number of sunspots. One cycle is completed and another begins after a period of about 11 years.

from the High-Altitude Observatory, Boulder, Col.; the Central Radio Propagation Laboratory of the National Bureau of Standards; the University of Wisconsin; the San Francisco Academy of Sciences; and the Naval Radiological Defense Laboratory. Assisting the scientists were teams of Navy and Marine Corps specialists, including an underwater demolition team of seven frogmen; nine Marines who expertly maneuvered the latest types of amphibious crafts; and three helicopter pilots with a ten-man supporting group.

THE BASE OF OPERATIONS

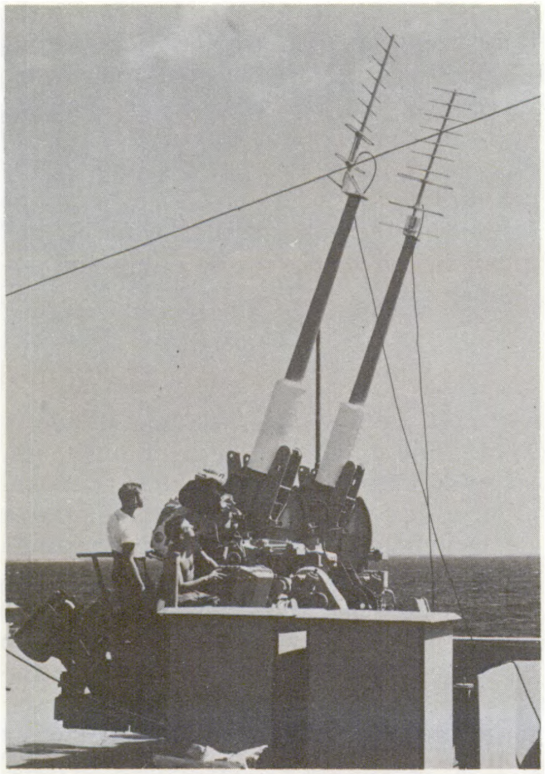
The Naval Research Laboratory's experiment utilized the helicopter deck of the USS POINT DEFIANCE, LSD 31, under the command of CAPT E. H. Woodhead, USN. This remarkable ship was a floating hotel, machine shop, and laboratory for the NRL rocket experiments. The ship is almost the length of two football fields and has a beam of 84 feet. It has a displacement of 13,000 tons and a speed of 25 knots. Its unique feature is the well deck, which runs almost the full length of the ship. By dropping the tail gate and balancing down the ship, the well deck can be flooded to a depth of 10 feet, so that it is possible to embark a large number of fully loaded landing craft or amphibious vehicles of various sizes and types. The ship is equipped with all the facilities necessary to serve as a dry dock and repair shop for landing craft and vehicles. Its two cranes, each capable of lifting 50 tons, were more than adequate to handle the mounting of rockets at sea, and its extensive shops can handle most types of construction work. To support the shore operation, the ship carried two LVT's, two LCM's, one DUKW (Duck), and a 70-ton pontoon barge. In four days, August 27 to September 1, 325 tons of scientific equipment and camp supplies were moved from the ship to the island. Navy personnel prepared the camp and operated a field kitchen for almost 50 days.

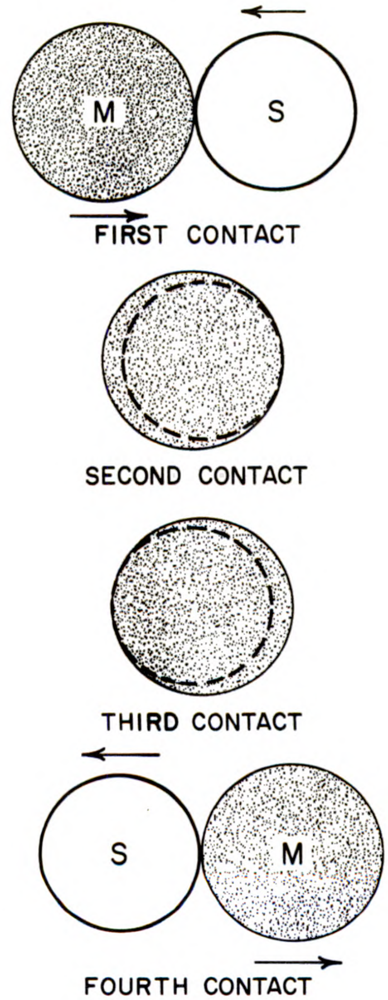
THE "TARGET"

We see the visible sun as a simple yellow disk, whose surface is clear except for occasional dark blemishes in the form of sunspots. Eclipse observations long ago revealed the faint continuous coronal atmosphere extending out millions of miles beyond the rim of the solar disk and the red chromospheric prominences arching tens of thousands of miles above the photosphere. When the disk itself is examined with the aid of color filter devices (which pass narrow wavelength bands corresponding to the emissions of excited hydrogen, helium, or calcium atoms), the solar surface takes on a mottled turbulent appearance resembling the skin of an orange. Observed in these monochromatic wavelengths, the sun presents a continually varying picture. Solar "weather" is a dynamic complex of magnetic fields, sunspots, plages, spicules, prominences, flares, and coronal hot spots.

Rocketry has contributed to our knowledge of the solar spectrum by revealing powerful fluxes of ultraviolet rays of very short wavelength and of x-rays. These radiations create the ionospheric layers of the high atmosphere. But although rocketry has given us a picture of the variation of the ionizing radiation, it has not yet given us positive locations of these sources on the sun. Are the ultraviolet and x-ray emissions concentrated in localized regions of the chromosphere or corona, and how are they related to visible phenomena in the solar atmosphere? What we need are photographs of the sun in x-rays and ultraviolet light. Such photographs will ultimately be achieved when lengthy exposures are possible in satellites, but in the meantime an eclipse offers a means of crudely differentiating the emissions from portions of the sun's disk and corona and also offers the possibility of scanning the emission from the limbs of the sun up to heights of the order of 10,000 miles.

Ionospheric soundings with pulses of radio-frequency waves have shown that the ionosphere does not disappear completely during eclipse totality. Is this due to the sluggishness of recombination processes, or to a residual ionizing flux capable of bypassing the eclipsing edge of the moon? If there is such a residual flux coming from coronal heights in the solar atmosphere beyond the visible disk, is it composed of x-ray or ultraviolet radiations? These are two of the questions that rocket astronomy is capable of answering. Furthermore, radio soundings seem to indicate abrupt discontinuities in the rate of decline or recovery of ionospheric electron density with the progress of an eclipse that are identifiable with localized sunspot regions. Here again rocket astronomy during an eclipse could indicate the variation in intensities of ionizing radiations originating in such active solar regions.

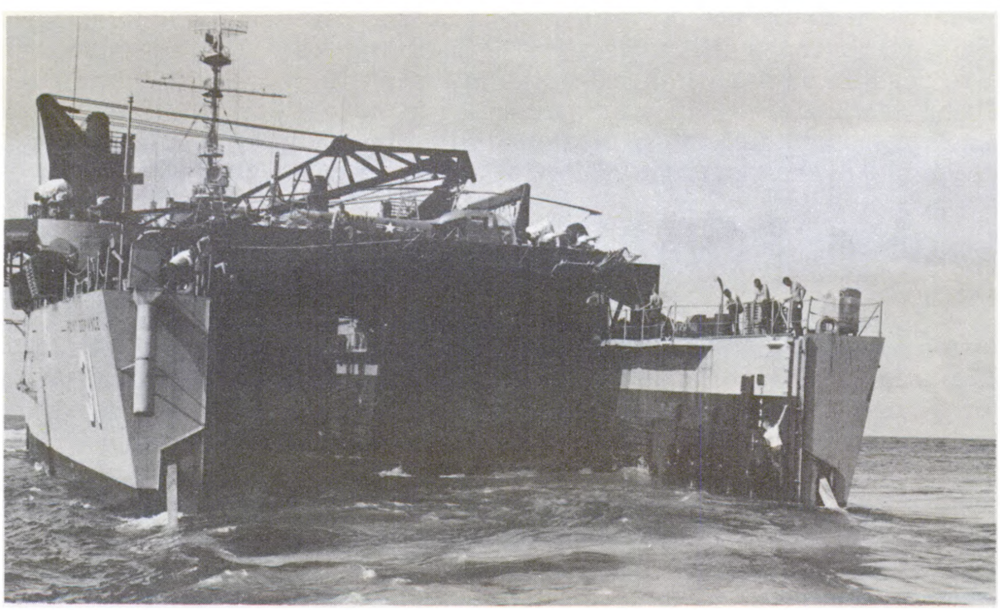


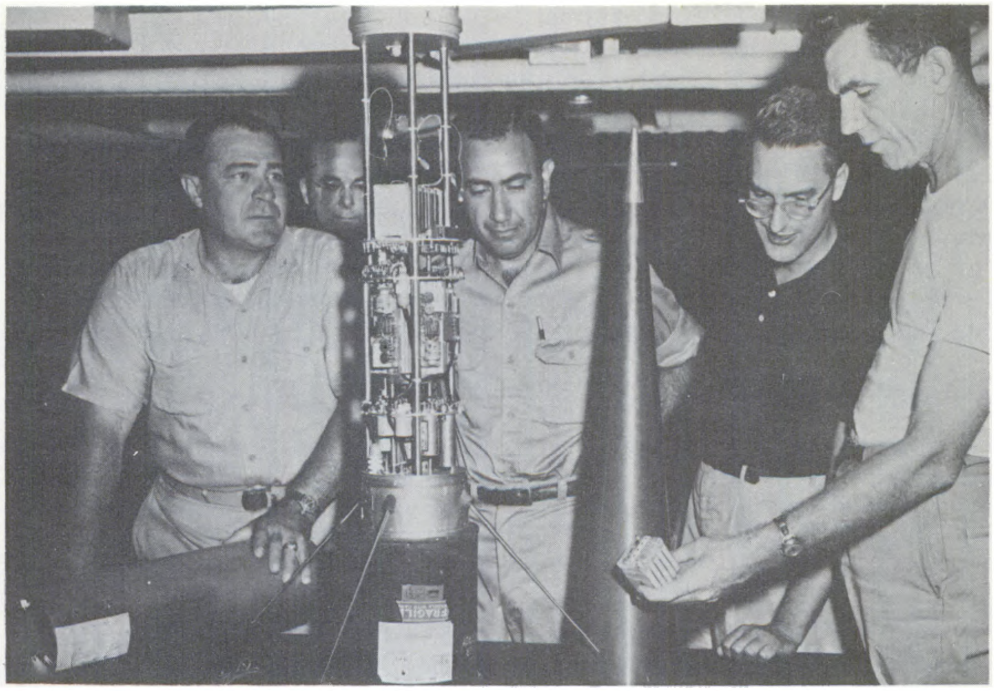


Above, antennas mounted in the muzzles of 3-inch guns follow the flight of a rocket.

Right, contacts of the moon and sun during a total eclipse of the sun.

USS POINT DEFIANCE

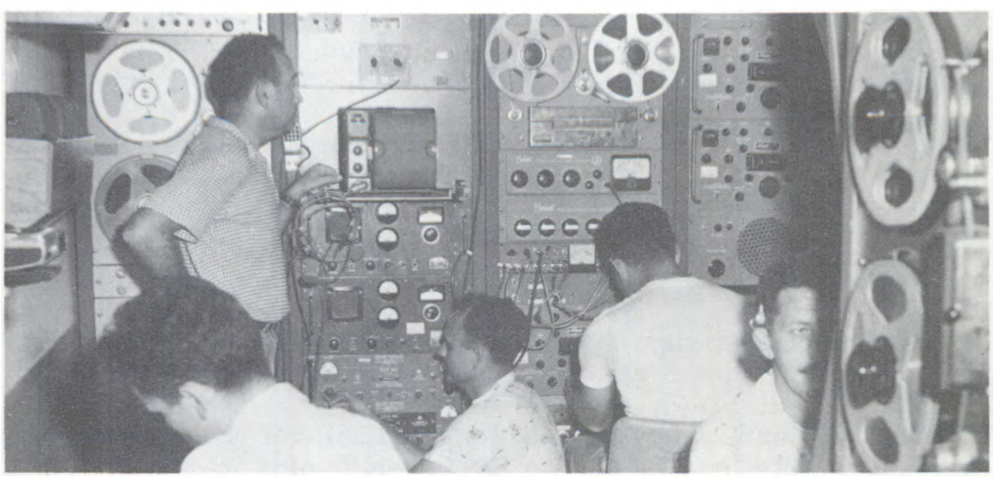




Above, instrumentation section being prepared for rocket installation. From left to right, CAPT E. H. Woodhead, USN, Commander of the USS POINT DEFIANCE; CDR W. T. Doyle, IGY Rocket Program Officer; H. Friedman; T. A. Chubb; and J. C. Lindsay.

Right, members of the NRL team examine records of solar eclipse data telemetered during the rocket flights.

Below, interior of the NRL trailer where tape and oscillographic records were made of solar eclipse data telemetered during the rocket flights.



The NRL rocket experiment was designed to measure x-ray and ultraviolet emissions from the uncovered portions of the sun at various stages of the eclipse. As the eclipse progresses, it is possible to measure the contributions of sunspot regions as they are covered or uncovered. During totality, the photosphere is completely covered, and any residual radiation must come from the outermost layers of the chromosphere and from the corona. If a rocket is in the air for a couple of minutes leading up to second contact (see diagram on page 4 for explanation of contacts) and for a corresponding interval just after third contact, its detectors should see the variation of emission with altitude above the limb up to the top of the chromosphere and perhaps into the inner corona.

THE ROCKET AND ITS INSTRUMENTS

The Nike-ASP rocket combination selected for the experiment had undergone a series of five test shoots from San Nicolas Island during the month of July and appeared to be well suited to meet the requirements of the eclipse experiment. The ASP rocket (manufactured by the Cooper Development Corp.) contains a high-performance propellant having a specific impulse in excess of 200 pound-seconds per pound and a total impulse of 31,000 pound-seconds. It is 107 inches long, 6-1/2 inches in diameter, and weighs 210 pounds, excluding the weight of the instrumentation section, nose cone, and thrust skirt. These latter items totaled 75 pounds. The Nike stage was a standard Nike I, designated XM-5, 16.5 inches in diameter and almost 12 feet long, weighing close to 1300 pounds with fins and coupling.

The ASP is coupled to the Nike rigidly by a separation ring fabricated from ductile cast iron. The Nike booster burns for about 3 seconds, in which time it carries the ASP to a height of about 1 mile. When the thrust of the Nike booster begins to decrease, an acceleration switch ignites two blast caps which break the separation ring into halves, thereby freeing the ASP. At approximately 22 seconds, the ASP has coasted to a height of 50,000 feet, where barometric pressure switches close the firing circuit. The ASP burns for 6 seconds and reaches an altitude of 80,000 feet and a velocity in excess of 7000 feet per second at burnout. It then coasts to a peak altitude of 800,000 feet with its 75-pound payload and falls back to earth after a total flight time of 8 minutes.

The rockets were equipped with detectors designed to measure x-rays in two wavelength bands, from 8 to 18 Angstrom units and from 44 to 60 Angstrom units, and to measure ultraviolet rays at a wavelength of 1216 Angstrom units (called Lyman-alpha). These data were to be telemetered to the ship, where they would be picked up by antennas mounted in the muzzles of pairs of 3-inch guns trained to follow the flights of the rockets. The information would then be passed on to an instrumented trailer, housed forward on the well deck, where tape and oscillograph recordings would be made.

PREPARING FOR THE EXPERIMENT

A rocket operation aboard ship introduces certain difficulties. First of these is the effect of roll. To avoid azimuthal deviations in launching direction, it was necessary to fire when the ship was horizontal. This was accomplished by the use of a gyrostabilizer which delayed the firing signal until the ship was horizontal within plus or minus 1/4 of a degree. Since the rockets could not be handled safely in a rough sea, all mounting work was accomplished while the ship was docked in Samoa. As a result, the rockets were exposed to weather for six days before firing, and suitable water proofings had to be devised to keep the ignitor circuits dry. Instrumentation sections were installed the day before the eclipse and were protected by waterproof sleeves of vinyl plastic which were removed shortly before eclipse time. The rigid coupling between the Nike booster and the ASP was essential to withstand the stresses imposed by the pitching and rolling of the ship. Finally, expert navigation was required to locate the ship at the planned position 40 miles from Pukapuka and out of radar range at exactly the proper time.

It was originally planned to launch two rockets for test purposes and background data on September 28 and October 1, and to launch six rockets during the progress of the eclipse on October 12. Two of the six eclipse rockets were to be in the air during totality, and the remaining four were to be distributed so as to observe portions of the disk exposed before second contact and after third contact. On the day preceding the eclipse a number of active sunspots were observed on the sun's east limb. It was then decided to launch the first rocket about 10 minutes before second contact to expose a crescent on the east limb containing the sunspots. The second and third rockets were to be fired during totality. Shortly after third contact, the fourth rocket was to be launched so as to measure radiation from a crescent of the disk on the west limb. This portion was almost clear of activity except for prominence. The fifth and sixth shots were to follow the fourth at 10-minute intervals.

The rockets were mounted on fixed launchers spaced in a pattern about the helicopter deck, allowing about 20 feet between rockets. To send the rockets off the stern of the ship, the launchers were inclined at an angle of 82 degrees to the deck. Since the rocket measurements were to be made at ionospheric altitudes, it was necessary to shoot from outside the ground level shadow. At eclipse time the ship was headed on a course of 115° 40' NE of Pukapuka at a position approximately 10° 21' S, 165° 28.8' W. The totality rockets were to be launched at an azimuthal angle of 295 degrees so as to enter the eclipse shadow cone from the east at an altitude of about 120 miles. Assuming ideal performance, the rockets would reach 150 miles altitude inside the shadow cone and then pass out of the cone on the west side as they fell back toward the ocean.

LAUNCHING THE ROCKETS

On eclipse day, the sky was overcast. At 0700, large tropical thunderheads and cumulus clouds formed toward the southeast. Rain squalls hit the ship at 0725, but the sky cleared considerably 15 minutes later. Plastic bags protecting the instrumentation sections were removed at 0745 and the rockets were armed. The first four shoots went off as scheduled at 0832:06, 0842:03, 0843:18, and 0852:49. Trouble arose when the time came to fire the fifth rocket. When the signal was sent to turn on the instrumentation, nothing happened. It appeared that the blast of the first four shoots had loosened the external pull-away plug carrying the starting signal to the rocket. An attempt to start the sixth rocket revealed a similar open circuit there. While everyone watched with bated breath, Don Brousseau of the NRL group ran from the telemetering trailer in the well deck, up the ladders to the helicopter deck, climbed the rocket, and re-inserted the loose plug. He then raced for the protection of the nearest gun tub. As he huddled behind the protective steel armor plate, the fifth rocket was fired at 0910:09, 8 minutes later than originally planned. Because of this delay, the fifth rocket launching coincided with the time originally planned for the last rocket. There seemed little to be gained by firing the sixth rocket late in the final phase of the eclipse, and it was decided to hold it for a background measurement on the following day.

ANALYZING THE DATA

Preliminary examination of the telemetering records showed that the rockets reached peak altitudes of 139, 148, 152, 150, and 55 miles. The Lyman-α radiation appeared to follow the uneclipsed area of the disk very closely and almost disappeared within a few seconds after the rockets entered totality. In strong contrast, the flux of 50A x-rays persisted throughout totality. Measurements before second and after third contacts indicate that the sun may be ringed by a bright x-ray halo.

In the totality shoots, an attempt was made to scan the region about the sun in Lyman-α with an angular resolution of about 3 degrees of arc. Unfortunately, the two totality rockets were very stable, and neither developed enough yaw to scan closer than 7 degrees to the sun. At that distance, some Lyman-α was recorded, but the quantitative evaluation of its intensity will require careful analysis of the data. The aspect indicators used in the totality shoots were photomultiplier tubes which view the sky through gun-sight type reticles. The photomultipliers, which were set to receive a flux equal to half of a full moon in the visible, were heavily overexposed, apparently owing to airglow, which was brighter than expected in the totality cone.

Detailed analysis of the telemetering records should yield quantitative information on the residual flux of x-rays at totality. Any asymmetry related to the sunspot distribution on the east limb as compared with the absence of sunspots on the west limb should be apparent in data recorded in the first and fourth shots.

The degree of success achieved in this first attempt to apply rocket astronomy to the study of a solar eclipse should encourage more diversified measurements in future eclipses. It shall be interesting to compare the residual x-ray flux measured at the minimum of the solar cycle with the flux which was observed at maximum in the 1958 eclipse. It is well known that the corona assumes a more or less symmetrical shape near maximum, but takes the form of long equatorial streamers at minimum. The unexpectedly intense airglow at totality would be another interesting phenomenon to scan in time and geometry from rocket altitudes.

An unexpected bonus was granted the NRL experimenters when the last rocket was fired at 0839:56 on October 13. Entirely unknown to them at the time of firing, a large flare was in progress. The rocket reached its highest altitude shortly after the flare reached its peak. The rocket performed exceptionally well, and good data were received on x-ray fluxes and on Lyman-α emissions. The latter showed no significant variation in intensity, but the x-ray fluxes increased considerably.

Self-Luminous Sources of Light

Among the many important provisions that must be made for nighttime operations of Naval ships, aircraft, and shore installations is that reliable emergency sources of light be available in the event the regular sources fail. In one approach to this problem, scientists at the Naval Research Laboratory have been studying the utilization of self-luminous lights. Those fabricated recently consist of zinc sulfide phosphors and an exciting agent, particularly the gaseous isotope krypton-85 or tritium. With these combinations up to sixfold increases in brightness have been obtained over self-luminous materials used previously. Other advantages of the new lights are that they are rugged, they have a long life (more than ten years), and they require no maintenance.

Self-luminous lighting equipment that has been designed and built by manufacturers for testing at the laboratory includes railroad switch lights, lanterns and flashlights, emergency signs, markers, and aircraft drogue lights.

The railroad switch light was designed to replace ordinary lights in remote areas to insure that the signal will not fail and to reduce maintenance costs. The source of light is a glass bulb, slightly less than 1 inch in diameter, coated on the inner surface with zinc sulfide. After enough krypton-85 gas is placed in this bulb to produce the required luminance, the bulb is sealed and supported in the switch-light case at the focus of a metal mirror about four inches in diameter. The appropriate color is produced either by the use of phosphors which radiate at particular wavelengths or by means of an optical filter. In the daytime the color of the lamp is determined by the color of the painted portion surrounding the radioactive assembly.

The self-luminous lantern and flashlight are rugged, simple, and convenient. Here, too, the source of light is a glass bulb coated internally with zinc sulfide and filled with the radioactive isotope krypton-85. The luminous bulb is placed at the focus of a spherical mirror and mounted in a cylindrical metal case which also serves as a radiation shield.

So that the pilots of planes flying in formation at night can readily determine their positions relative to the other aircraft, special lights called drogues are often placed on the planes' wing tips. For this application of self-luminous lights, ruggedness and reliability are essential. Similar lights are used to facilitate the refueling of planes in the air at night. In carrying out this operation, the tanker plane trails a refueling hose, funnel shaped at the end, to which the aircraft to be refueled attaches a line. To help the pilot of the latter aircraft maneuver into position, a number of self-luminous drogues are placed around the funnel-shaped end of the tanker hose. Both types of bulbs contain zinc sulfide phosphor and krypton-85. The maximum distance at which they can be seen at night is about 1,100 feet.

An important application of luminous surfaces excited by radioactive means is as emergency or directional signs. Here, the need is

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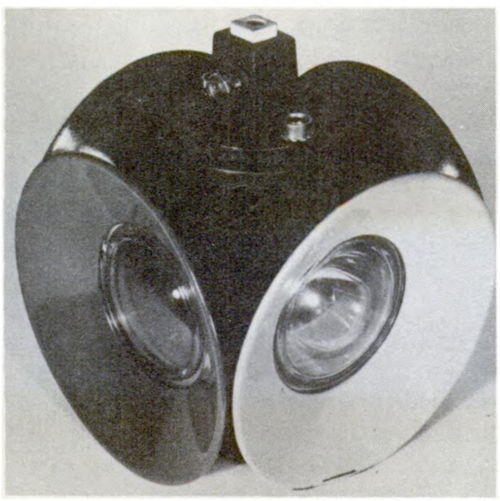
for simplicity of construction, ease of maintenance, ruggedness, visibility, and legibility. Such signs, designed for use in both aircraft and buildings, consist of a transparent sheet of plastic covered with an opaque sheet having the desired characters. Along one edge of the plastic sheet is a glass tube coated inside with zinc sulfide and filled with either krypton-85 or the radioactive gas tritium. The light from the tube is scattered throughout the volume of the plastic, thus illuminating very satisfactorily the area which underlies the characters.

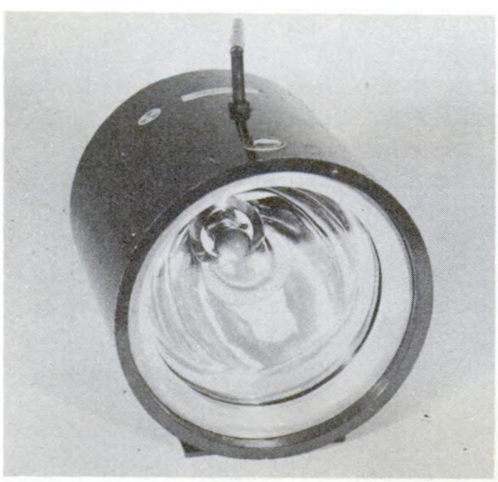
Another illumination aid that has been developed through NRL research is a self-luminous marker designed to be worn by personnel to indicate their whereabouts or to be used in other ways, such as to mark equipment. Its luminous surface, excited by krypton-85, is only 1-3/4 inches in diameter, but can be seen on a dark night by a fully dark-adapted eye at a distance of about 1,000 feet.

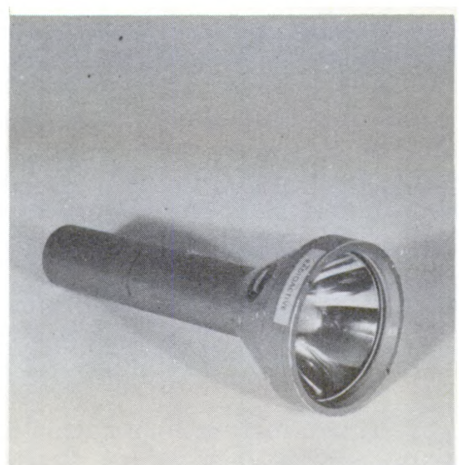
As radioactive materials are utilized in these illumination aids, the question arises as to how dangerous they are to handle. The most hazardous radiation from the sources described here are secondary gamma rays caused by the high-energy beta emission from krypton-85.

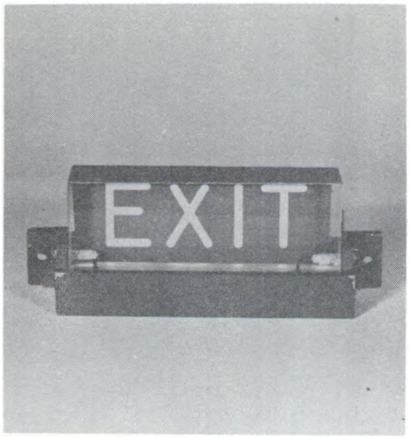


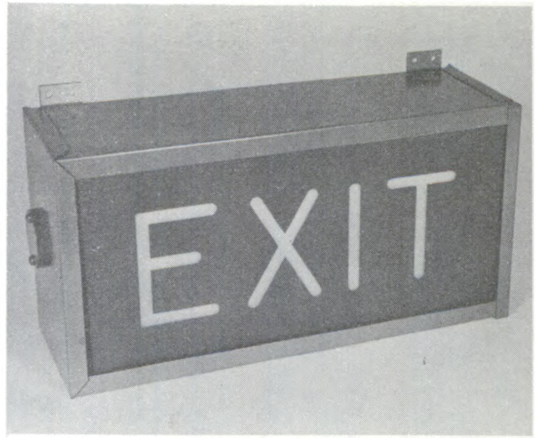
Self-luminous railroad switch light.

Below, self-luminous lantern (left) and flashlight (right).



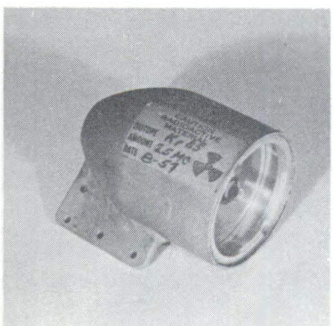


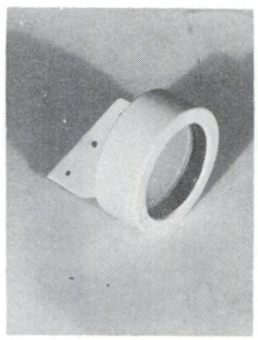




Self-luminous emergency signs.

Self-luminous drogue lights for aircraft.





Self-luminous marker.

However, these are absorbed by the protecting shield containing the source of light. Also, with the possible exception of the lantern, flashlight, and markers, personnel have no reason to handle the lights unless they are servicing them. Thus, if these implements are handled with reasonable care and are stored a few feet from spaces occupied by people, their radiation danger is negligible.

The outstanding characteristics of these sources of light are simplicity, ruggedness, long life, and freedom from complicated and short-lived power sources. However, because the illumination intensity of the lights is low, they are limited in usefulness to situations requiring low levels of light. Within these limitations, the materials perform successfully. Used as deck and personnel markers, the low intensity is desirable. For exit and emergency signs, the luminosity is high enough to serve the purpose. The luminance of the lanterns, flashlights, and railroad-switch light could well be more intense; however, for emergency use, when the eye is fully dark adapted, they are adequate.

Undoubtedly, work now in progress and that contemplated for the future will result in further improvements in the lights and will lead to many applications not now being made.

A New Look in Research at Sea

LCDR Earle W. Sapp, USN
Undersea Branch
Office of Naval Research

The January issue of Research Reviews discussed the history and status of the research fleet that takes our physicists and oceanographers to sea. This article discusses the latest additions to that fleet, the USNS CHAIN (T-ARS 20) and USNS JOSIAH WILLARD GIBBS (T-AGOR 1).

In recent years, the increasing importance of antisubmarine warfare, coupled with accelerated efforts to gain greater knowledge of the ocean depth as an operational environment has greatly exceeded the capacity of our research ships. There have not been enough ships to take our research programs to sea, and the ships available do not entirely satisfy the demands of new developments and new fields of investigation in terms of space for experimental equipment, weight-lifting capacity, quarters for larger scientific parties, data-processing facilities, and an all-weather operating capability.

FILLING THE GAP

In a major effort to remedy this shortcoming, the Office of Naval Research recently initiated a program to obtain three additional research ships as soon as possible. In order to augment offshore research at leading institutions which study the Pacific and Atlantic Oceans, one of these ships was to be placed at the Scripps Institution of Oceanography (SIO) and another at the Woods Hole Oceanographic Institution (WHOI). The third ship was to be a new type of research platform—a seagoing physics laboratory, designed to conduct basic and applied research on the physics of the ocean, and to investigate and develop new techniques in support of the Navy's antisubmarine warfare research program. It was to be placed at Hudson Laboratories of Columbia University, which are supported by ONR to conduct basic and applied research in undersea warfare problems.

Because of the urgent need for the ships, it was decided to obtain them from the U. S. Navy Reserve Fleet and alter them for research use. As a further means of speeding the project through its various stages, it was decided to involve as few organizations as possible. Thus, in preparing ships for WHOI and Hudson Laboratories, the Military Sea Transportation Service (MSTS) was requested to do most of the work. This Service is set up to handle the redesigning, activating, overhauling, altering, and operating of the ships. The responsibility for operating the ships was turned over to MSTS because neither WHOI nor Hudson Laboratories had the personnel and facilities to do the job themselves at that time. Also, since these are private institutions, civilian rather than Navy crews are desirable. That MSTS was effective in carrying out its assignment as indicated by the fact that the entire program—from planning the alterations to putting two of the converted ships in service—was accomplished in just eight months.

WHICH SHIP?

Selecting ships that could be adapted to meet the requirements of the two oceanographic institutions was a difficult task. This is not surprising when one considers that studies of the sea encompass just about every branch of science and therefore require many different shipboard facilities. Furthermore, the ship's had to be so designed that they permitted the oceanographer to work close to the water, and they had to be of a size that could be accommodated by existing dock facilities at the two institutions to which they were to be assigned. Of course, there were many other requirements. Thus, a ship that provided the space needed for scientific activity might not provide easy access to the water, or might require too large a crew, or perhaps could not be operated at the required speeds. So it was a matter of striking a balance—choosing the ship which in most respects measured up to the standards. After thoroughly studying and inspecting the many vessels of the Reserve Fleet, the oceanographers found this balance in the salvage ship (ARS). The principal characteristics of this class of ship are given below:

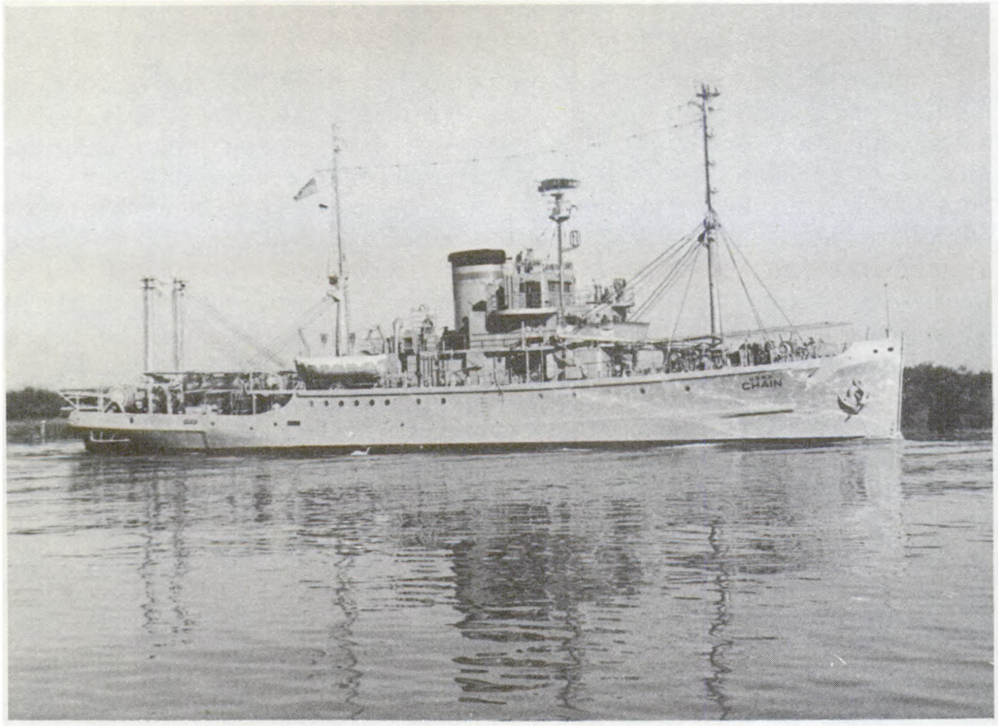
Length, overall	214 feet
Beam	40 feet
Displacement, full load	1,800 tons
Speed	1-14 knots
Propulsion	Twin screw diesel electric

Shortly after this choice was made, the Office of the Chief of Naval Operations assigned the ARS 20 and ARS 27 for conversion to oceanographic research ships. The USS CHAIN (ARS 20) was earmarked for WHOI, and the USS SNATCH (ARS 27), for SIO. The alteration of the CHAIN has been completed (the ship is now in service), but work on the SNATCH is still underway and will not be finished until next summer. In the discussion which follows, only the completed ship, the CHAIN, is considered.

USNS CHAIN

The general arrangement of the ARS lent itself quite well to the alterations required for her scientific mission. Particularly welcome were the expansive decks and numerous shops that had been required for salvage activities. Perhaps the greatest difficulty experienced in preparing the ship for its new role was in changing over from open berthing areas to staterooms, the problem being that the staterooms required more space. However, a satisfactory arrangement was worked out, and quarters were provided for up to 40 crew members (38 are now assigned) and 28 scientists. This proportion of crew members to scientists is reasonably close to the 1 to 1 ratio which oceanographers consider ideal.

A rough idea of the amount and variety of research that can be conducted aboard the CHAIN can be had by noting, simply, that her capabilities are about three times as great as those of most of our other oceanographic research ships. What accounts for this superiority? Let's run down the list of her principal facilities and see. These include:



The CHAIN

- Four major laboratories—an electronics laboratory, a chemistry laboratory, a wet laboratory, and a bridge laboratory or scientific operations center.

- A high-capacity storage-battery system used to provide power for experimental equipment and for essential ship electrical equipment while acoustic tests are being made.

- A conference room or scientists' lounge, darkroom, machine shop, and laboratory storerooms.

- The kind of scientific equipment installed is governed primarily by the purpose of each cruise; however, some semi-permanent installations have been completed. These include—

  - Four fathometer hydrophones.

  - Three depth recorders.

  - A 600-foot thermistor chain and associated equipment which permit continuous recording of the ocean's temperatures from the surface to a depth of several hundred feet as the ship cruises throughout the oceans.

  - A deep-sea winch capable of reaching depths of 30,000 feet and performing coring operations involving loads as heavy as ten tons. A hydraulically operated coring frame mounted on the side of the ship is also used in this work.

  - A separate navigation and communication system for controlling experiments.

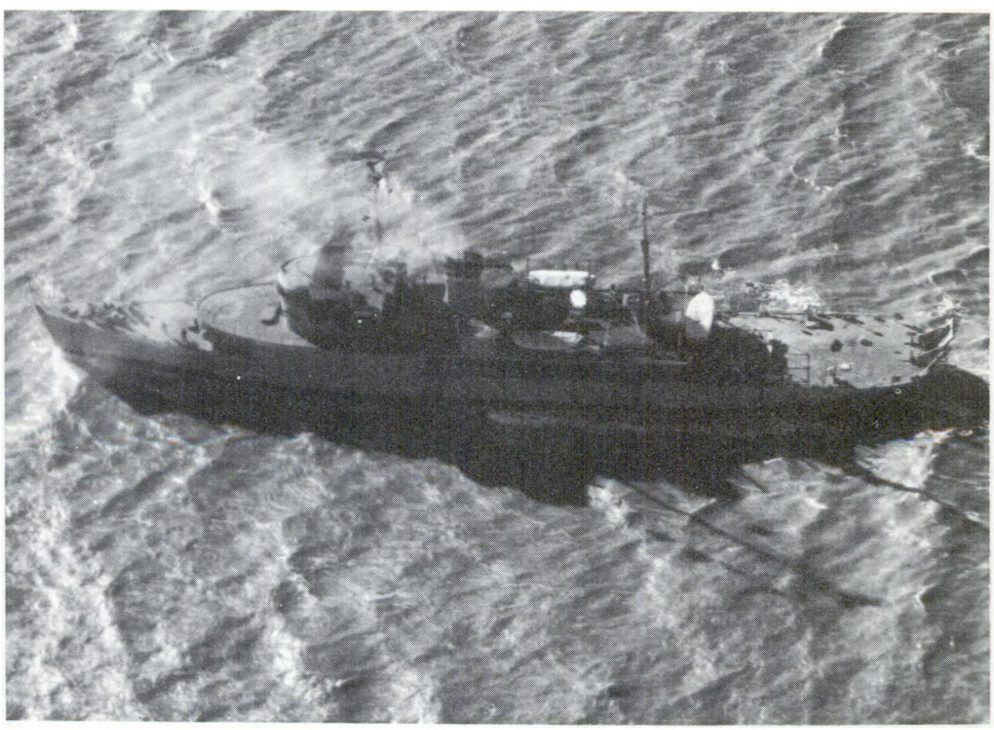
The CHAIN was altered by the Savannah Machine & Foundry Company, Savannah, Georgia, and was completed on November 18, 1958, at a cost of about $1,100,000.

USNS GIBBS

Although the basic requirements for the seagoing physics laboratory were similar to many of those for the CHAIN and SNATCH, several of the requirements were quite different, making it necessary to select a different class of ship for this application. The main additional features needed were large laboratories to contain extensive electronics equipment in breadboard form; provisions for conducting several major experiments on each cruise; space for data analysis at sea; facilities for placing instruments weighing up to 20 tons at various ocean depths; facilities and space for the preparation, testing, and assembly of major instrumentation at sea; and excellent stability to permit accomplishing all of these tasks under a wide variety of sea conditions.

The class of ship found to be best suited for this mission was the small seaplane tender (AVP). From the scientists' point of view her most important asset was ample room for setting up equipment and conducting experiments. This was available because about half of the total space in the ship was used to support an air group and thus became available to science when the ship was altered.

In addition, the ship has excellent sea-keeping qualities. These have been demonstrated over and over by the Coast Guard, which uses



The GIBBS

the AVP as weather stations in the North Atlantic, and by the Hydrographic Office and the Coast and Geodetic Survey, which use it for making ocean and coastal surveys. The principal characteristics of the seaplane tender are listed below:

Length, overall	310 feet
Beam	41 feet
Displacement, full load	2,750 tons
Speed	5-18 knots
Propulsion	Twin screw geared diesel

The USS SAN CARLOS (AVP 51) was selected and assigned to the research ship program. Because she was to become the largest research ship in the United States, it was decided that she should be appropriately reclassified and renamed. Accordingly, the Secretary of the Navy approved the new classification AGOR (Auxiliary, General, Oceanographic Research) and the name JOSIAH WILLARD GIBBS, in honor of the man generally considered to be America's greatest physical scientist.

The ship was altered to permit use of its after half for science and its forward half for the crew. All main-deck shop spaces were converted to laboratories. Providing berthing for the scientists and civilian crew posed no problem in this ship, as space was not a critical factor. Accommodations for 30 scientists were installed on the after half of the second deck, and quarters for 48 crew members were installed in the forward part of the ship.

Research facilities aboard the ship include the following:

- Six laboratories
  - A mechanical engineering laboratory for preparing, assembling, and testing underwater instrumentation (this laboratory serves the fantail).
  - A 600 square foot electronics laboratory with facilities for almost any type of electronics experiment.
  - Two smaller electronics laboratories.
  - A data-reduction laboratory.
  - A scientific operations center containing equipment for communications, navigation, and control of experiments.
- Machine shop, conference room or scientists' lounge, and darkroom.
- A 3,000 square foot work area on the fantail serviced by a 10-ton crane, a 5-ton winch and "A" frame over the starboard side, and a 20-ton winch and hydraulically powered "U" frame over the stern. The 20-ton winch, which is under construction, will be able to handle up to 40,000 feet of wire with an average diameter of 1/2 inch.
- Two sound-isolated diesel electric generators which supply power while the ship is conducting acoustic measurements.

One of the disadvantages of this type of ship for oceanographic research is its geared diesel drive, which does not permit speeds less than 5 knots. This is a serious shortcoming when precise maneuvering is necessary near underwater instrumentation. To overcome this problem, a 250-horsepower Murray and Tregurtha auxiliary propulsion unit was installed between the propellers (see inside back cover). This unit might be regarded as an oversized outboard motor, for the propeller can be rotated 90 degrees either side of dead astern, and by reversing the engine, effective 360-degree rotation is obtained. The unit has performed exceptionally well in maneuvering the ship at low speeds (up to 4-1/2 knots), probably better than can be done with finely controlled twin propellers.

The GIBBS was altered by the Mobile Ship Repair Company, Mobile, Alabama, and was completed on December 18, 1958, at a cost of about $1,250,000

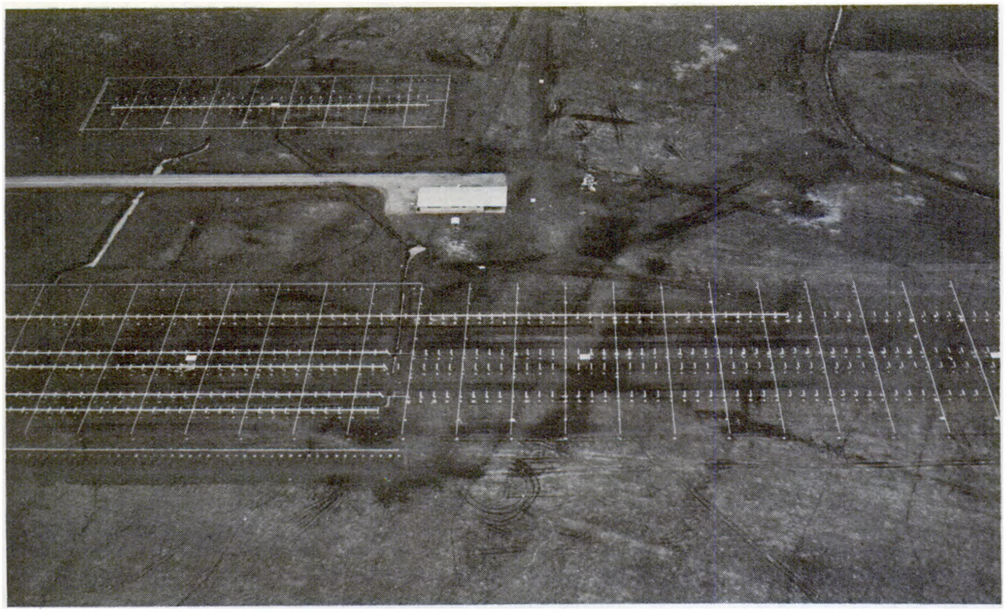
BETTER SHIPS = BETTER RESEARCH

Both ships have now completed their shakedown cruises and have been praised highly by the scientific parties that have sailed in them. An example of the kind of performance that is pleasing the scientists is this recent achievement of the CHAIN: Working in heavy seas and against a 45-knot wind, this ship was able to successfully complete an experiment requiring that a wire lowered from the ship to a depth of several hundred feet be maintained at a "zero (vertical) angle"—a feat rarely attempted in the past under such conditions.

Although a conversion is never as good as a ship designed for research from the keel on up, it nevertheless offers capabilities not achieved by existing craft, and thus will permit a significant increase in our undersea research program. We can expect additional ships designed specifically for the task to be launched and to occupy stations at sea before many more years have passed—ships such as the SCB-185 (Research Reviews, December 1956 and January 1959) and others not yet off the drawing boards.

But for the time being, our new conversions—the GIBBS and CHAIN, soon to be joined at sea by the SNATCH—are enabling us to increase our knowledge of the oceans. Although many of the ways they are doing this are not as spectacular as the CHAIN's feat, described above, they are equally as important in the long run, for they pay off in greater convenience and time saved. Aboard these ships, for instance, the oceanographer no longer loses many days time waiting for weather good enough for the ship to work in. Also in the past are those evenings when he had to make his bed on deck or behind a bank of hot electronics. Or will he again have to return to port to change equipment after completing only one experiment because the ship could not accommodate the equipment for others. Gone, too, are those long, slow (5 to 10 knot) cruises back to port, eating up time that the oceanographer could put to good use if the ship were able to move faster.

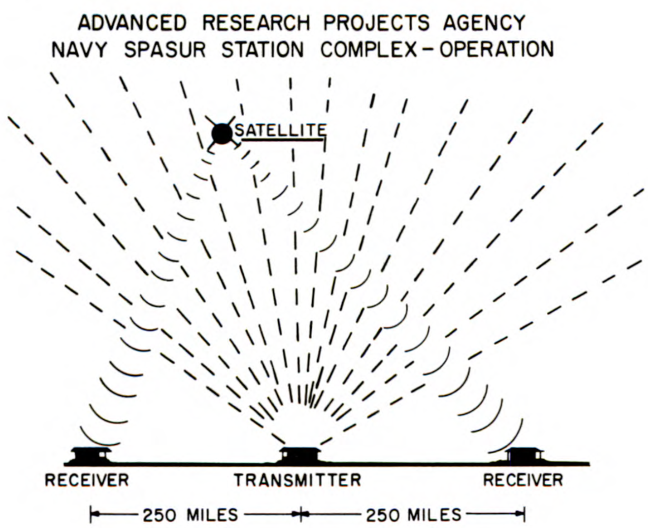
Although not the final answer to the problem of conducting scientific investigations at sea, the GIBBS, CHAIN, and SNATCH provide a distinctly new look and capability among the ships of the research fleet.

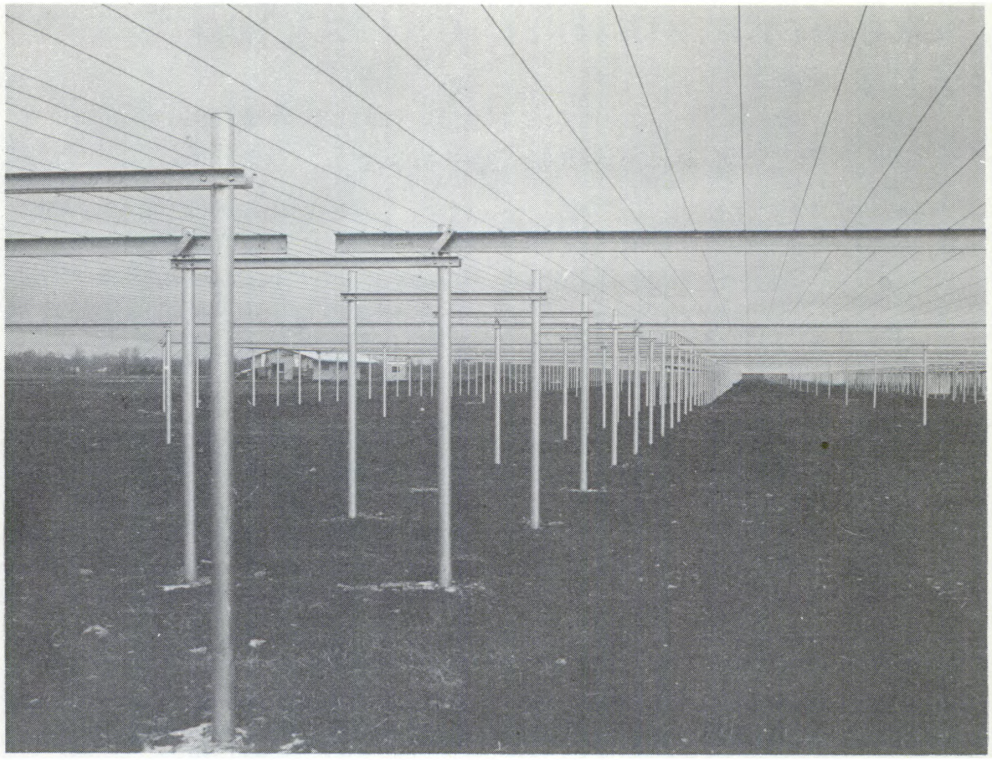


Network for Tracking Silent Satellites

The favored way of tracking a man-made satellite is by sensitive receivers which detect and follow the radio signals emitted from the satellite itself. But there are satellites whose radios have stopped transmitting, and some might be launched which do not have radio beacons.

To locate and track these silent satellites, two experimental systems have recently been established in the United States, one by the Army Ballistics Research Laboratories, using doppler tracking, and the other by the Naval Research Laboratory, using interferometer techniques. Both are under the over-all direction of the Advanced Research Projects Agency.

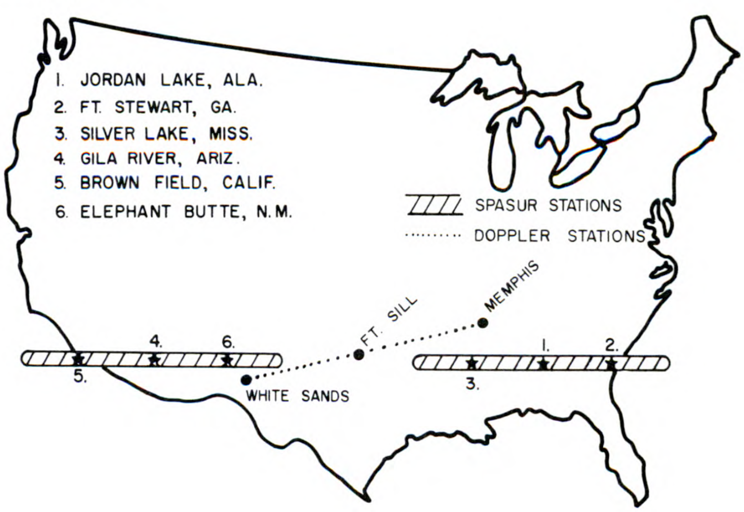




The Navy calls its network of stations SPASUR, which is a contraction of SPAce SURveillance. It consists of six stations in two groups of three stations each, located as shown on the map.

As can be seen on the diagram, the SPASUR transmitter station sends out a fan-shaped wave of electronic radiation. The reflections from a satellite are picked up by the receiver stations about 250 miles on each flank. The data are then relayed directly to Washington, D. C., for analysis and evaluation.

The first SPASUR station was completed in July 1958 and the last one in January 1959.



Ocean Research: The Next Ten Years

During the first two months of this year, bold preparations were made on two fronts for the expansion of United States capability for research at sea. In January, the Chief of Naval Operations approved Project TENOC (short for TEN years of concentrated OCeanographic research), planned by the Office of Naval Research to enlarge the Navy's scientific effort on the seas, while in the following month, the ONR-sponsored Committee on Oceanography of the National Academy of Sciences—National Research Council issued a report outlining an accelerated national program in this field.

The need for the two plans and how they will bolster U. S. capacity for ocean research over the next ten years are explained on these pages.

TENOC

The importance of the Navy's research effort on the oceans is stressed by the fact that it encompasses between 80 and 90 percent of the National effort in this realm. This responsibility requires that the Navy continuously examine its existing programs with an eye to modifying them to meet the needs of the future. Accordingly, it has sponsored several major study groups, from which have come numerous recommendations for expansion of oceanographic research. In addition, several other groups, including the Office of the Chief of Naval Operations, members of Congress, and the Committee on Oceanography of the National Academy of Sciences—National Research Council, have requested that a broad long-range program of oceanographic research be formulated to meet our needs in this critical area. The TENOC program has been drawn up to provide for a large part of this research.

The need for an accelerated program of oceanographic research is clear when one considers the challenge posed by Russian research of the seas. The seriousness of this threat was pointed out in the article "Ships for Research," which appeared in the January 1959 issue of Research Reviews. But if reminders are still needed to show how the Russians are using their capability for research at sea, consider the following account of one of their programs. The story was filed in London on December 10, 1958, by the Associated Press.

"Russian submarines are to range the world's oceans on special charting missions. Moscow Radio today said the submarines would follow up work done by Soviet scientists in connection with Russia's International Geophysical Year program. Together with surface vessels, they will conduct oceanographic surveys 'in various areas of the world's oceans,' particularly in the southern hemisphere. The broadcast said the first of a fleet of specially equipped submarines will put to sea shortly to make a survey for the Russian Research Institute of Marine Fishery and Oceanography."

Considerations of the magnitude of research which must be accomplished to obtain needed information about the seas leave no doubt that the Navy must increase its ranks of competent oceanographers by large numbers and must build many more oceanographic facilities, including laboratories and research ships. This expansion must be gradual, in order to give all aspects of the science an opportunity for equal growth. It is on this basis that the Navy's TENOC Program has been planned.

Report by NAS-NRC Committee on Oceanography

The Committee on Oceanography of the National Academy of Sciences - National Research Council warned last month that the United States must—within the next ten years—double its present rate of deep-sea research or face serious economic, political, and military hazards.

"Action on a scale appreciably less than that recommended," the Committee declared, "will jeopardize the position of oceanography in the United States relative to the position of the science in other major nations, thereby accentuating serious military and political dangers, and placing the nation at a disadvantage in the future use of the resources of the sea."

The Committee followed up this warning with a list of detailed suggestions for assuring this nation's future high standing in oceanography. Its three principal recommendations were—

- The United States government should expand its support of the marine sciences at a rate which will result in at least a doubling of basic research activity during the next ten years.

- The increase in support of basic research should be accompanied during the next ten years by a new program of ocean-wide surveys. This will require a two-fold expansion of the present surveying effort.

- The United States should expand considerably its support of the applied marine sciences, particularly in the areas of military defense, marine resources, and marine radioactivity.

The Committee's specific proposals include the following:

EDUCATION

It advocated the broadening of educational opportunities in oceanography for graduate scientists through action by universities, the Federal Government, and the scientific community at large. This might be accomplished, the report stated, by increasing the size of oceanographic faculties, by the affiliation of oceanographic research institutions with university faculties, the development of new oceanographic centers at universities with adequate existing faculties, and the creation of long-term fellowships tenable at more than one university. The

Federal Government was asked to aid in the financing of the recommended faculty increases to the amount of $500,000 a year for salaries and other costs associated with the positions. The scientific community was asked to undertake more active recruiting of prospective oceanographers among undergraduate students of physics, chemistry, biology, and geology.

NEW SHIPS AND SHORE FACILITIES

The Committee's recommendations call for the construction of 70 research ships of 500 to 2,200 tons displacement between 1960 and 1970, which would result in the modernization of the present fleet of 45 small vessels and its increase in size to a total of 85 ships of various capacities, at a cost of $213,000,000. Responsibilities for construction would be assigned to government agencies with appropriate interests, including the Navy, Coast and Geodetic Survey, Bureau of Commercial Fisheries, National Science Foundation, and the Maritime Administration.

The report also recommended that the Maritime Administration be consulted in the designing of all research ships paid for from public funds and that all non-combatant surface ships used for research, development, or surveying be manned by civilian crews.

The report further advised that the addition of each ship to research activity would result in an accompanying need for about 60 shore-based technicians, the construction of about $1,500,000 in shore facilities, and the expenditure of about $1,200,000 per year in their operation. It was recommended that these costs be divided between the Navy and the National Science Foundation.

Shore facilities will also be needed for survey ships, the report added. It recommended an initial allocation of $750,000 for construction costs and an equal annual allocation for operations for each new survey ship placed in operation. These costs would be divided between the Navy and the Coast and Geodetic Survey.

ENGINEERING NEEDS

The Committee declared that the advancement of our knowledge of the oceans depended greatly upon the development of radically new devices, the improvement of currently available vehicles, and the working out of new research techniques. The report called for the development of manned submersibles that can operate down to and on the bottom of most of the oceans; stable, mid-ocean research platforms; anchored and drifting deep-sea buoys; and ice-breaking submarines. Need was also anticipated for assigned aircraft, up to four-engined; new engineering techniques for deep-sea drilling and bottom-sampling; and more effective instrumentation. A ten-year budget of $100,400,000 was proposed.

RADIOACTIVITY IN THE OCEANS

The report recommended that one agency be given overall responsibility and authority for regulating the introduction of radioactive materials into the oceans and another the responsibility for monitoring. Vigorous programs should be launched, the report continued, to study circulating and mixing processes in the oceans, inorganic transfer of radioactive elements to sedimentary deposits, and effect of radioactive elements on marine organisms. It was estimated that ten-year costs of new research in this area would amount to about $44,130,000.

OCEAN RESOURCES

Many activities to add to our understanding of marine biological resources were recommended, including laboratory studies of fish mortality, behavior, and genetics; feasibility studies on the addition of nutrients to increase the productivity of marine organisms, and on marine transplantation; and surveys of ocean life.

Concerning mineral resources, the report stated: "Existing knowledge is inadequate to determine the feasibility of creating a marine mineral industry."

A ten-year budget for new research of $78,540,000 was proposed.

INTERNATIONAL COOPERATION

In the field of international cooperation, the Committee recommended that the U. S. offer financial support, through the National Science Foundation, to the Special Committee on Oceanic Research of the International Council of Scientific Unions, and that additional funds be sought to support participation in the Special Committee's proposed year-long study of the Indian Ocean. The report further recommended the promotion of increased intergovernmental cooperation in oceanographic studies and the encouragement of international programs in the use of protein foods from the sea for human nutrition, particularly in underdeveloped areas.

Following is the proposed ten-year (1960-70) budget for new oceanographic activity by Federal Agency:

Navy	$278,240,000
Coast and Geodetic Survey	78,040,000
Bureau of Commercial Fisheries	123,160,000
Maritime Administration	10,900,000
National Science Foundation	121,040,000
Office of Education	5,000,000
Atomic Energy Commission	32,430,000
Bureau of Mines	2,600,000
Total	$651,410,000

The Committee on Oceanography is supported by the Office of Naval Research, the Atomic Energy Commission, the Bureau of Commercial Fisheries, and the National Science Foundation.

Research Notes

Speeding the Flow of Ocean Traffic

Thanks to the work of investigators at the Navy's Hydrographic Office, ships can now be guided from port to port along routes that save many hours or days time at sea. The following article, adapted from a report published in the New York Herald Tribune for January 26, 1959, describes how this is being done.

Two lieutenants in a tiny, cluttered office at the Norfolk Naval Air Station exchanged pleased grins when the message came in: "Fastest trip ever. Thanks." This was just one of many similar messages sweated out by LT Albert T. Buckmaster and Lt. Hugh W. Albers. It meant the Atlantic fleet service force ship Antares had crossed from Norfolk to Gibraltar in record time using a route plotted daily by the two lieutenants, who run the Navy's Optimum Ship Routing System.

Based on the research of Dr. Richard W. James of the Navy Hydrographic Office, the system seeks to overcome the ancient bugaboo of the seas—changeable currents and weather conditions which often result in reduced speed and heavy ship damage. Since September, when the two lieutenants opened their office, they have shepherded 100 Navy and Military Sea Transportation Service (MSTS) ships across the Atlantic. By July, they expect to handle all Atlantic traffic for MSTS and a major portion of the Atlantic Fleet's business. In the few months of its operation, the system has improved speed of ocean transportation and saved more than $1,000,000.

For years scientists have been trying to devise a way of avoiding the navigational problems presented by rapid, unexpected changes in weather and currents. Dr. James' efforts, put into motion by the Navy, have produced what could be the first logical approach to a solution. Stated simply, Dr. James concept provides ship captains with constant and controlled guidance through the potential treachery of oceanic weather.

Needless to say, the program holds exciting implications for commercial shipping, where the cold facts of economy are vital. An idea of what these are can be obtained by reviewing some statistics. During fiscal 1957, American shippers lost $2,665,441 in foundered and damaged ships, and $443,730 in cargo damage. During the period 1952-56, a total of $12,766,132 was recorded in ship losses, and cargo damage was set at $953,020. These are commercial figures. The monetary losses to naval vessels during the same periods have not been determined.

Some shipping companies reportedly have begun providing OSR service for their own operations in an effort to reduce weather-damage costs and speed schedules.

Armed with Dr. James thesis, Lt. Buckmaster and Lt. Albers labor long hours every day herding ships across the Atlantic—ships they are not likely ever to see. As explained by Lt. Buckmaster, OSR is "a matter of improved forecasting machinery, close communications, and confidence. . . .and a spot of luck."

Asked how many ships they can accommodate at a given time, Lt. Albers pointed to a wall covered with clipboards. "Well, we have 60 nails up there and I guess we can drive in a few more," he said. He noted that at the time thirteen ships were under surveillance and six more were preparing to depart for Europe.

Committee on Bio-Astronautics

Finding answers to the many questions that are being asked these days about space exploration is a gigantic task, requiring the highest degree of coordination between the Armed Forces and the many institutions probing the subject. In the field of bio-astronautics, this problem is particularly acute because many of the answers being sought must come through the integration of work in a number of different areas of study. To provide the liaison needed to make these answers readily available to the Armed Forces, and to provide sound advice where the answers are lacking, the National Academy of Sciences—National Research Council last month established the Committee on Bio Astronautics. The new group will assist the Armed Forces in any matter concerning the biological or medical aspects of space flight.

The full Committee will consist of more than 100 members, of whom at least half will be nominees of the Armed Forces. It will serve as a conference or forum of active investigators, meeting periodically to review scientific and technical problems, exchange information, and establish liaison between investigators with allied interests. Guiding this group in its work will be an executive council made up of scientists representing many different fields of endeavor in universities, private research organizations, and the armed forces. Navy membership on the council includes CAPT Charles F. Gell of the Office of Naval Research and Dr. James D. Hardy of the U.S. Naval Air Development Center, Johnsville, Pa.

At a recent organizational meeting, the executive council agreed to the following goals:

- Acquainting scientific investigators with the military requirements for establishing space as an operational medium for man.

- Considering and reporting upon military problems related to manned space operations.

- Assisting in providing scientists and military personnel with access to scientific and technical information pertaining to the bioastronautical problems of life in space.

- Promoting the exchange of research information on bioastronautical problems through such media as meetings, symposia, and forums.

- Stimulating research on all problems of life in space where deficiencies of knowledge warrant special effort.

- Furthering the science of bio-astronautics by encouraging the contributions of the many related fields of science.

The Committee will concern itself with any field of science or of technology that it finds necessary in pursuit of its objectives, including pertinent aspects of astronautics, biology, chemistry, medicine, physiology, psychology, and related interdisciplinary sciences. Specific examples of problems that will be considered are closed-system environments; stress; crew selection, motivation, surveillance and control, including group dynamics; ground support facilities; weightlessness—physiological and psychological aspects; metabolic requirements, such as nutrition, water balance, and electrolyte balance; cosmic and other forms of radiation; isolation and confinement; displays, controls, and communication; acceleration, deceleration, and vibration; escape and survival; orientation; and man-machine-systems problems.

Pioneering Chemist Honored by Navy

Dr. Hermann I. Schlesinger, Professor (Emeritus) of Chemistry, University of Chicago and Dean of Inorganic Chemistry in the United States, was presented the Navy's Distinguished Public Service Award at a ceremony held at the Naval Research Laboratory on February 11. Dr. Schlesinger was selected for the honor for introducing a new field of research—boron hydride chemistry—in this country, and "for his pioneering research, his leadership, and his guidance" in that field, which has resulted in "the discovery of new reactions and compounds" contributing "vitally" to the United States' military and industrial fuel programs.

Dr. Hermann I. Schlesinger receives Navy's Distinguished Public Service Award from RADM Rawson Bennett.

The award, the highest recognition given to an individual who is not an employee of the Department of the Navy, was presented by RADM Rawson Bennett, USN, Chief of Naval Research. It was granted on the recommendation of NRL, for whom Dr. Schlesinger has conducted research since 1944.

Dr. Schlesinger's work on the preparation of alkali metal hydrides and borohydrides served as a foundation on which the High Energy Fuels or "ZIP" program, begun in 1952, was developed. Spectacular advances in propulsion systems have resulted. Application of boron fuels to weapons has led to increased range, higher altitudes, greater flight speeds, and better over-all performance.

The by-products of Dr. Schlesinger's work in boron-hydrides have resulted in new uses of boron in pharmaceuticals, plastics, and high-temperature materials of construction.

In his latest work—on boron polymers—Schlesinger has demonstrated that boron, adjacent to carbon in the periodic table, exhibits in some of its compounds chemical characteristics similar to those of carbon.

An important factor leading to the presentation of the Navy's Distinguished Public Service Award to Dr. Schlesinger was his encouragement of students to continue studies in boron hydride chemistry and its related fields. As a result, his former students have directed, guided, or aided many of the boron hydride programs, both military and industrial.

New Literature on Group Behavior

The first of a projected series of volumes on group behavior co-edited by Luigi Petrullo, Head, Group Psychology Branch, Office of Naval Research, has been published by the Stanford Press. The first volume, entitled "Person Perception and Interpersonal Behavior," consists of technical papers presented at a symposium on this subject held at Harvard University. Dr. Joan H. Criswell, Assistant Head of the Branch is also represented in the book. A second volume, entitled "Leadership and Interpersonal Behavior," is planned for publication late in 1959 following a symposium to be held at the Louisiana State University this month. This will be followed, in 1960 and 1961, by "Groups and Interpersonal Behavior" and "Communication and Interpersonal Behavior." The objective of the series is to stimulate thinking and experimentation in one of the youngest branches of psychology.

Ketch Joins WHOI Fleet

The sea-going fleet of the Woods Hole Oceanographic Institution was increased to five ships last month by the addition of the auxiliary ketch ARIES. The vessel, now at Bermuda, will arrive at Woods Hole about April 1st to be fitted out for research at sea.

The ARIES' first assignment will take her on a one-year cruise of Bermuda waters to study subsurface ocean currents. This work, which will be directed by Dr. John Swallow, will utilize the same "pinging" buoys by means of which a counter current was discovered under the Gulf Stream in 1957 (Research Reviews, May 1957). These buoys were used also to study the outflow of water from the Mediterranean Sea through the Straits of Gibraltar in the cooperative IGY effort of the British National Institute of Oceanography and the Woods Hole Oceanographic Institution.

Built in 1953 of teakwood over steel frames, the ARIES was designed for world-wide cruising. She is 92-1/2 feet in over-all length, measures 70 feet on the water line, has a beam of 19-1/2 feet, and a draft of 12 feet. She is driven by a 100-horsepower diesel engine, and she can carry enough fuel to travel 2,000 miles. Aft is ample room for nine persons, and her forecastle can accommodate six. A bath and three showers are included in these quarters. Facilities for navigation include radar and an automatic pilot. On deck are a dinghy and a small launch.

The fleet of the institution now consists of the 213-foot CHAIN (see article beginning on page 12), the 142-foot ATLANTIS, the 125-foot CRAWFORD, and the 110-foot BEAR. Two small vessels, the ASTERIAS and the RISK, are used for inshore work.

Mathematical Methods of Operations Research

The growth of operations research—the scientific approach to operational problems for the greater fulfillment of objectives—parallels an increased realization of the usefulness of staff planning and analysis. The implementation of these functions has led to rapid development of new methodology and application of old methodology to new problems. In the past, books concerned with operations research have concentrated mainly on case histories. Now, however, a book dealing with mathematical methods of handling operations problems is available. The graduate-level text was written by Thomas L. Saaty of the Office of Naval Research (London) and published by the McGraw-Hill Book Company, Inc., 330 West 42nd St., New York.

Saaty covers the principal mathematical methods and brings together theoretical and illustrative literature. Included are discussions of optimization, probability, and statistics, which are essential to any scientific pursuit. These topics are presented with illustrations for stimulating interest and giving insight into the mathematical structure involved in order that it may be effectively used.

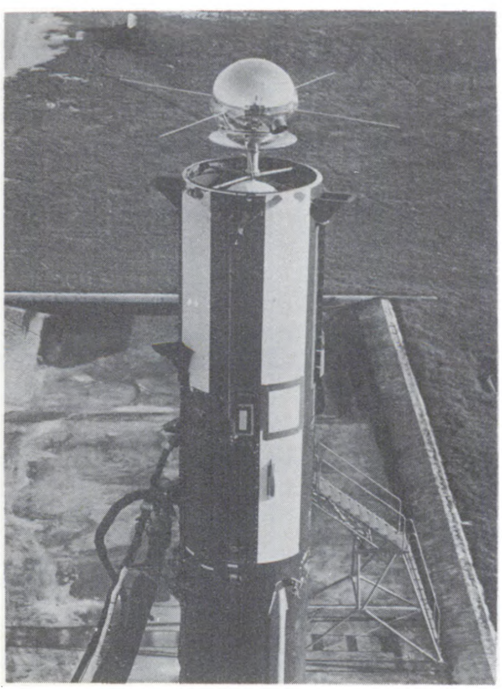
The book also contains an essay on creative thinking. It emphasizes the fact that operations research is not simply a collection of techniques, but depends in large measure on the creative ability of an individual to select and develop the scientific and mathematical ideas which will lead to the solution of operations problems.

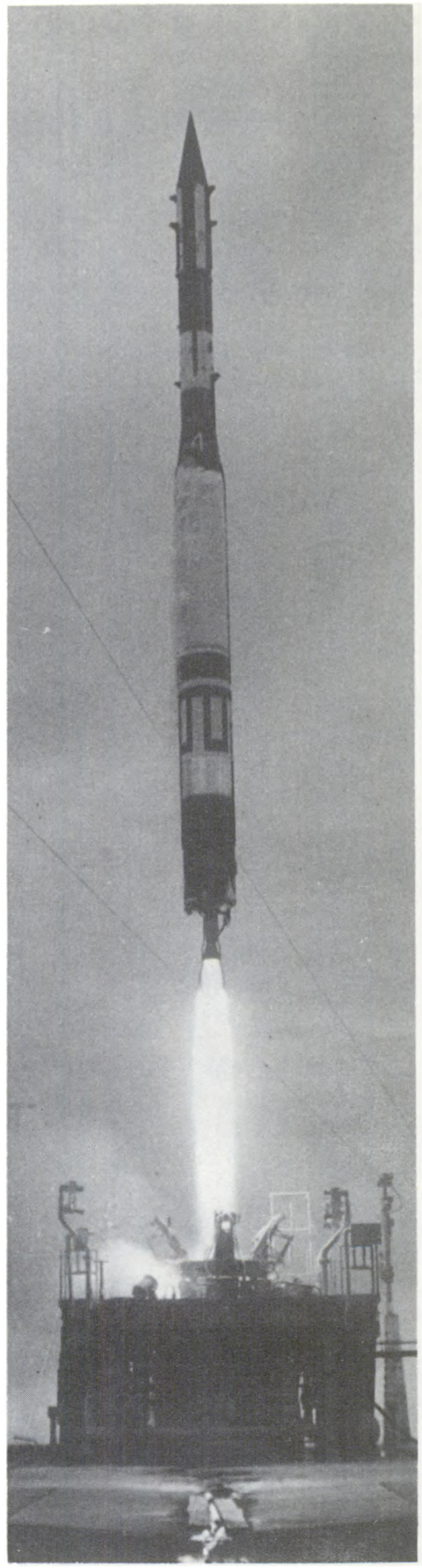
Launching the Weather Satellite

Within minutes from the time it was fired from Cape Canaveral on February 17, the towering Vanguard rocket had completed the tremendous job assigned to it. During the brief period of its flight it placed a 20-inch weather satellite in an excellent orbit around the earth. For about two weeks from the time it was carried into the sky, the new satellite experimentally transmitted data on cloud cover to interrogating receivers on earth. The satellite's voice is now about gone, but not the momentum given the sphere by the Vanguard rocket. Like its little brother, placed in orbit by the Navy a year ago, it will be up there for many years to come. (It will be recalled that the Vanguard Project and personnel were transferred from NRL to NASA on October 1, 1958.)

Right, the Vanguard rocket at the start of its successful flight.

Below, the weather satellite atop the Vanguard rocket before installation of the nose cone.





On The Naval Research Reserve

Ninth Naval District Presents Awards

Two Research Reserve companies, NRRC 9-2 and NRRC 9-5, received awards from the Commandant, Ninth Naval District, for general excellence of activities in fiscal year 1958.

COMMANDANT'S TROPHY AND PERMANENT PLAQUE

For the second consecutive year, NRRC 9-2, Urbana, Illinois, has been evaluated the outstanding Research Reserve company in the Ninth Naval District and has received the Commandant's general excellence trophy. About 40 Reservists attended the award ceremony, including 14 from Decatur and 8 from Peoria who are affiliated with the company, which is based on the University of Illinois campus.

PERMANENT PLAQUE

In a joint meeting of NRRC 9-5, Ames, Iowa, and NRRC 9-13, Des Moines, Iowa, the Commanding Officer of NRRC 9-5, LT Lawrence F. Simmering, USNR, was presented a letter of commendation as commander of one of the outstanding Research Reserve companies in the Ninth Naval District. The Ninth Naval District "Second Place" plaque, awarded annually for permanent retention, was also given to the Commanding Officer. CAPT J. P. Aymond, USN, Special Assistant to the Chief of Naval Research, made the presentations. He was assisted by LT C. S. Lardis, USN, Reserve Assistant of the ONR Branch Office, Chicago.

CDR W. C. Jacobs, USNR, seated, Commanding Officer of NRRC 9-2, holds the plaque which his company won as the outstanding Research Reserve company in the Ninth Naval District. Standing, left to right, are CDR E. T. Curry, USNR, former Commanding Officer; CAPT E. T. Carr, USN, Commanding Officer, Chicago branch office of the Office of Naval Research, who made the presentation; and LT C. S. Lardis, USN, Reserve Assistant, ONR Branch Office, Chicago.

Research Studies Completed

The Chief of Naval Research has recently sent letters of appreciation to Research Reservists of two companies for the successful completion of scientific and technical studies.

"ANALYSIS OF CLOSED CIRCUIT TELEVISION AS A TRAINING MEDIUM"

The members of NRRC 4-4, State College, Pennsylvania, completed a television evaluation study as a part of company drills. For the final report of this study, which was initiated in 1956, the participants published a booklet summarizing their findings and made recommendations on the future use of closed circuit television as a training medium.

"AN ANALYSIS OF HUMAN RADIATION INJURY"

Four members of NRRC 3-9, Brookhaven National Laboratory, Upton, New York, completed two reports on a research study on human radiation injury. The reserve Medical Corps officers who initiated and conducted this study were CAPT Robert A. Conard, CAPT Eugene P. Cronkite, LCDR Victor P. Bond, LCDR James S. Robertson. The reviewers of the study recommended that the reports be submitted to a scientific journal for publication. In addition, the Bureau of Medicine and Surgery requested copies of the report for forwarding to selected naval medical laboratories interested in the biological aspects of ionizing radiation. Activities interested in these reports were pleased to learn that the members of NRRC 3-9 plan to continue the study as a company project during regular drill meetings.

Seminars Planned For Fiscal Year 1960

Nine Research Reserve seminars are planned by the Office of Naval Research for fiscal year 1960. Final approval on these seminars must be given by the Bureau of Naval Personnel. Further information will then be promulgated officially in BUPERS Instruction 1571.4E. This Instruction is expected to be available in May 1959. The titles, places, and dates of the seminars presently planned are as follows:

Research Methods, Columbus, Ohio	July 13, 1959
Training Device Center, Port Washington, N.Y.	July 20, 1959
Nuclear Science, Idaho Falls, Idaho	July 20, 1959
Naval Research Laboratory, Washington, D.C.	August 17, 1959
Research Methodology, San Francisco, Calif.	August 17, 1959
Life Sciences, Brookhaven National Laboratory, Upton, N.Y.	September 14, 1959
Nuclear Science, Oak Ridge, Tenn.	November 30, 1959
Submarine and Diving Medicine, Naval Medical Research Laboratory, New London, Conn.	March 21, 1960
Research Reserve Seminar, ONR, Washington, D.C.	June 6, 1960

Reservists Selected for Promotion

Two hundred and twenty three Naval Reserve officers have been selected for promotion to Captain and 1035 to Commander by the fiscal 1959 Inactive Reserve Selection Boards. Of this number, 52 are Research Reservists. Congratulations are extended to these officers.

FOR CAPTAIN

A. A. Chester	3-2	U. Liddel	5-10	D. H. Robinson	11-5
H. W. Lockhart	4-1	J. E. Boyd	6-1	A. P. Kelley	11-6
F. C. Powell	4-2	S. B. Sudduth	6-18	S. Naymark	12-2
R. A. Kempf	5-4	H. Allen	9-3	B. D. Mills, Jr.	13-1
A. J. Hiller	5-9	J. O. Long	11-5	A. L. Petitjean	13-1
		C. R. Moe	11-5		

FOR COMMANDER

M. Callum	1-1	H. D. Cubbage	5-9	R. P. Thacker	9-1
E. E. Lindsey	1-3	W. C. Hodgson	5-9	E. H. Young	9-3
H. V. B. Kline, Jr.	3-6	W. M. Carleton	5-10	R. L. Davis	9-7
L. A. Baker, Jr.	3-9	R. D. Rouse	6-2	W. J. Stadelman	9-7
H. Stange	4-1	A. V. Faloon	6-3	P. J. Fassett	9-11
M. S. Allshouse, Jr.	4-3	C. O. Smith	6-3	R. S. Kirby	9-12
A. R. Gregory	4-3	M. E. Forsman	6-4	H. Hellmers	11-2
S. J. Parker	4-3	F. D'Italia	6-5	E. G. Laue	11-2
C. E. Ranck	4-5	B. E. Harris, Jr.	6-16	J. W. Stull	11-7
W. S. Lee	4-12	E. F. Knott	6-16	J. A. Drenth	11-9
S. H. Wright	4-12	B. C. Moore	8-3	W. A. Burns	13-2
P. H. Kratz	5-8	F. J. Boudreaux	8-13	M. H. Russ	13-2

ONR Plans Research Reserve Seminar

The last Research Reserve seminar for fiscal year 1959 will convene in Washington, D. C., for two weeks beginning June 1, 1959. About 100 officers are expected to attend the meeting, which is open to all services.

The ONR seminar is under the general direction of CAPT J. P. Aymond, USN, Special Assistant to the Chief of Naval Research (Research Reserve). Technical direction will be supervised by the Director of the Research Group, Dr. F. J. Weyl.

Again this year the conferees will meet as a complete group and later will form into smaller groups to study particular fields of research and development. The fields of study will be Research and Antisubmarine Reconnaissance, Surveillance, and Communications; Methods and Applications of Operations Research; New Concepts of Power and Propulsion; and Biological Aspects of Military Environments. Insofar as possible, officers will be allowed to select the area in which they have primary interest.

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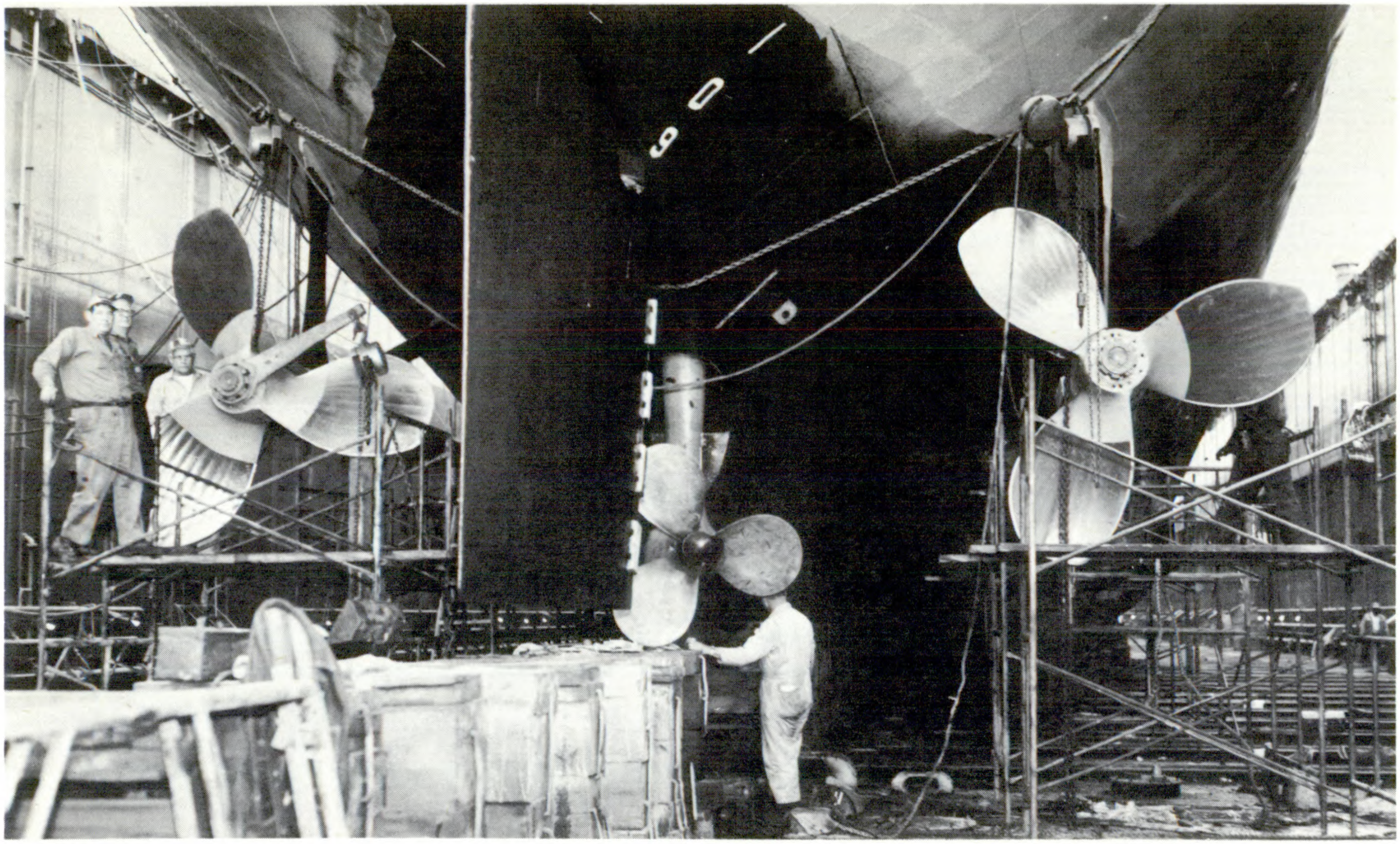

The three propellers of the research ship JOSIAH WILLARD GIBBS. The auxiliary unit at center was installed to permit better maneuverability at low speeds. See article beginning on page 12.

In This Issue

COVER PHOTO: An instrumented rocket is fired from the deck of the USS POINT DEFIANCE in the South Pacific during the total eclipse of the sun on October 12, 1958. See article beginning on page 1.

RESEARCH REVIEWS 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.