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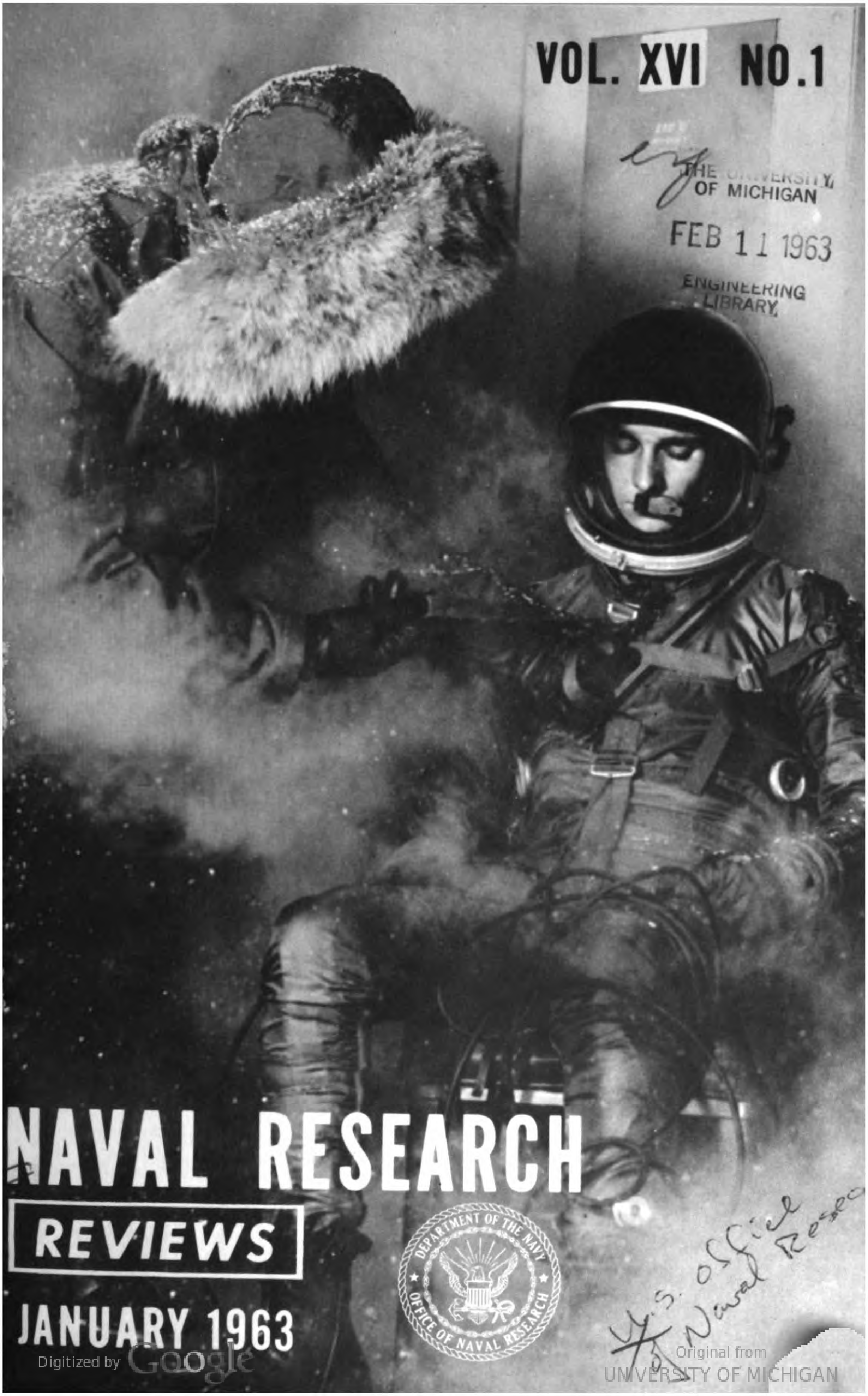


# NAVAL RESEARCH REVIEWS

JANUARY 1963

DEPARTMENT OF THE NAVY · OFFICE OF NAVAL RESEARCH

U.S. Office of Naval Research

# ONR Volunteer Awarded Legion of Merit

One day last spring, a Navy aircraft circled several times over a remote area of the polar ice pack, then made another pass during which an Air Force major and a Navy lieutenant leaped from the plane and descended by parachute into the vast white wilderness. Equipped with survival gear and instruments air-dropped at the same time, the men began a five-day study to obtain technical data for Project COLDFEET, a tri-service Arctic venture. At the end of that period, an airplane reappeared, and employing the aerotriever ground-to-air recovery system (Naval Research Reviews, October 1960)—for the first time operationally—snatched up the investigators by long lines which they had strung in the sky by balloon, and returned them to their base.

Obviously pleased and proud, Lorraine LeSchack looks on as the Chief of Naval Research, RADM L. D. Coates, expresses his gratitude to her husband for his exceptional service to the Department of Defense.

Last October, the Department of Defense, represented by the Honorable James H. Wakelin, Jr., Assistant Secretary of the Navy for Research and Development, gave the Legion of Merit to LTJG Leonard A. LeSchack of ONR's Geography Branch in recognition of his role as one of the two investigators in the unprecedented operation, as well as for other of his valuable activities last spring as a member of COLDFEET's Surface Evaluation Team. The other investigator was Air Force MAJ James F. Smith. As the citation accompanying the award points out, the lieutenant volunteered for the hazardous assignment, then carried it out "with extraordinary skill and initiative."

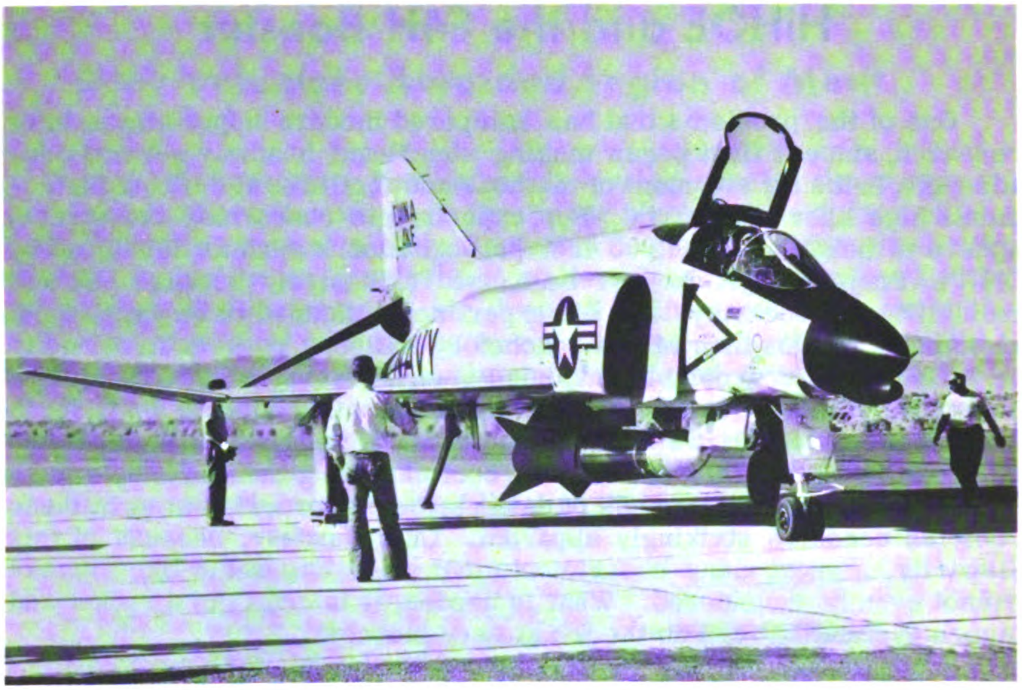
# HiHOE and the F4H Booster

One of the problems that has hampered modern upper atmosphere research, since it first began making significant headway several decades ago, is the development of methods and facilities for lifting instruments high above the earth. For experiments concerning the stratosphere to heights of 100,000 feet or so, balloons such as developed by ONR's Project Skyhook have been used extensively because of their reliability and economy. But for experiments planned to be carried out at higher altitudes than can be reached by balloons, rockets have had to be relied upon, unavoidably involving launch towers, high-acceleration boosters, or complicated guidance systems. Considering that, for a great many research projects, instruments weighing only 100 pounds or so need to be sent aloft, and that the cost of putting them up may run as high as hundreds of thousands of dollars, the inappropriateness of these vehicles becomes strikingly apparent. Unfortunately, because of this disparity, a great many experiments that scientists would like to make cannot even be considered. What is needed, it is clear, is a rocket and launch system that can do the job at very low cost.

Thinking along this line began in earnest at the Naval Research Laboratory several years ago in connection with a research project called HiHOE (an acronym for H(i)drogen, Helium and Oxygen Experiment), the chief purpose of which was to measure the relative amounts of hydrogen, helium, and atomic oxygen ions present in the earth's ionosphere at heights of about 1,000 miles. NRL's interest in making these determinations stemmed from the desire which has existed for many years among scientists to learn more about the nature of matter at the outermost fringes of the atmosphere, called the exosphere. A number of theories have been set forth to explain the behavior of the minute quantities of gas which are known to exist there, as shown by satellite drag measurements and by studies of radio propagation phenomena, such as "whistlers."

Hydrogen is believed to reach altitudes of 1,000 miles after rising in the form of water vapor and methane gas. The methane gas is emitted by decaying vegetation on the surface of the earth. Upon reaching high altitudes, the elements making up these gases are dissociated by the sun's radiation. Free hydrogen is then produced which can rise much higher and eventually escape the atmosphere into space. Helium enters the atmosphere as the result of radioactive decay of materials at the surface of the earth. It is sufficiently light to escape to the outer fringes of the atmosphere, and also into space.

Because of the tenuous nature of the exosphere, it is difficult to measure its composition directly. However, its composition can be determined by indirect means, namely by measuring the various positive ions produced in the exosphere by the sun's ionizing radiation, such as x-rays. Ion mass spectrometers exist which can identify and measure the ions so formed, and on the basis of this information one obtains an indication of the quantity of neutral constituents present, and also, of course, of the positive ions present. The NRL group chose this method of investigating the exosphere. However, they lacked a versatile,



The F4H Phantom twin-jet figher with two-stage CALEB rocket mounted on its underside for launching at high altitude.

Two-stage, 3,000-pound CALEB rocket slung beneath F4H launching vehicle. Light gray rear section is first stage, and darker center section is second stage. Instrumented payload is contained in nose cone. The latter separates from the second stage when the second-stage motor cuts off. It is then de-spun by yo-yo weights until it revolves only once during each several seconds.

inexpensive probe vehicle which would meet their present and future needs to carry the instrumentation above the earth from different geographic locations.

Fortunately, the Naval Ordnance Test Station, China Lake, California, had designed a group of rockets and conducted several tests to determine the feasibility of launching orbiting vehicles from aircraft at high altitude. They suggested to the NRL group that a variation of this technique might be applied advantageously to the NRL project and, if successful, to many other experiments involving scientific payloads.

The variation, happily, was a simplification of the method NOTS was then testing, for it called for the payloads to be sent nearly straight up, rather than at the low angle required for them to go into orbit. With the vertical air launch, the largest part of the tremendous burden that a rocket must struggle against to rise from the ground to high altitudes is eliminated—air drag. Thus less fuel and fewer stages are required. Important also is the fact that the aircraft used by NOTS was the then new F4H Phantom twin-jet fighter which could launch a rocket of the size required from an altitude of between 35,000 and 40,000 feet, and at supersonic speed. At this height, two-thirds of the atmosphere was below the rocket, which meant that a two-stage, 3,000 pound vehicle was all that was needed to go to the 1,000 mile height required for the NRL experiments, as compared with a vehicle four times that weight launched from the ground. At the same time, enough atmosphere remained to permit the rocket to be fin-guided and roll-stabilized, thus making an expensive guidance system unnecessary. Another advantage of the aircraft launch system was that it permitted the launch to take place at any point within the aircraft's flight range, and for that matter, anywhere in the world available to the aircraft. Furthermore, the F4H was available as a standard Navy aircraft, and it could be used over and over again—quite unlike the conventional booster, which is considered expendable.

Spurred by strong indications that a suitable rocket and F4H launching technique could be adapted for HiHOE, NOTS scientists, who now began cooperating actively in the endeavor, adapted a four-stage orbiting CALEB rocket into an inexpensive two-stage unit, weighing 3,000 pounds, which could be mounted along the centerline beneath the aircraft.

At the same time, the NRL group commenced designing the main instruments for the experiment, a magnetic ion mass spectrometer and associated devices, and the nose cone in which they were to be housed. The spectrometer was designed and built at NRL to analyze positive ions in the mass range from atomic hydrogen (1 atomic mass unit) to molecular oxygen (32 atomic mass units). This range includes all the known major positive ions expected to occur in the earth's ionosphere. The extent of the difficulties involved in preparing this instrument can perhaps best be understood by considering exactly what the instrument had to be capable of doing. In a few words, it had to be made sensitive enough to detect one hydrogen or helium ion per second entering it from the exosphere while at the same time distinguishing that one from about $10^5$ atomic oxygen ions entering it during the same period.

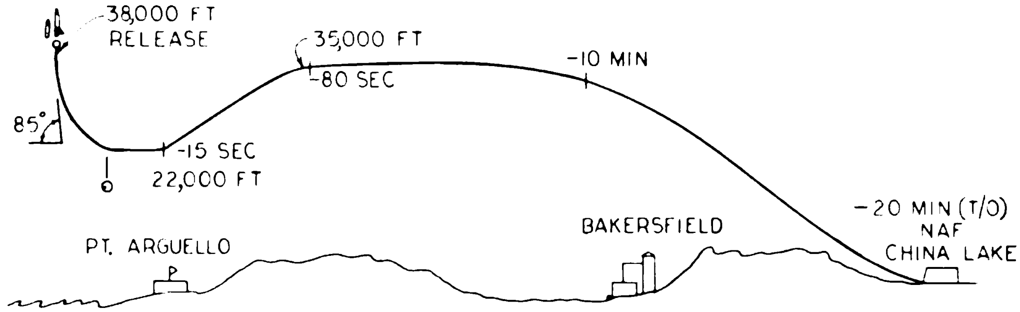



Diagram showing planned flight path of F4H from take-off at China Lake to point over Pacific Missile Range at which CALEB rocket was to be launched for journey 1,000 miles above earth.

The next step was to combine the efforts of NRL and NOTS and place the instruments in the sky. The instrumented two-stage CALEB rocket would be attached beneath an F4H Phantom, which had been equipped to carry the load and to release it at the proper time. For the first experimental flights the plane would take off from NOTS, China Lake (see diagram, this page) and fly to the Pacific coast north of Point Arguello, California, at the edge of the Pacific Missile Range (see article on page 11). It would then turn south, proceed to a designated point off the coast, and go into its launch maneuver. At that time, -80 seconds on the countdown, the plane was to be flying at an altitude of 35,000 feet. Its next maneuver would be a shallow acceleration dive lasting 65 seconds, which would bring it down to 22,000 feet and -15 seconds on the countdown. After leveling off for a moment, the pilot was to execute a 4G pullup and, upon attaining an angle of ascent of 85 degrees from the horizontal and an altitude of 38,000 feet, release the rocket; a computer would do the job of determining the exact moment of release. The plane would then loop over, and the rocket, having left the plane's path on a tangent, would be a considerable and safe distance away when, 5 seconds after release, its first-stage motor would ignite to carry it 28 miles above the earth at a velocity of 6,500 feet per second. The second stage would ignite 67 seconds after release and burn for about 40 seconds, carrying the payload the rest of the way on its journey.

The first successful launch of the CALEB rocket with a scientific payload aboard was made July 25, 1962. After its release, the 180-pound instrument section climbed to an altitude of 725 miles and traveled a horizontal distance of 810 statute miles. Before the rocket disappeared over the radio horizon, it had telemetered more than 1,100 seconds of useful data back to Pacific Missile Range sites—most of it concerning the performance of the rocket. This information indicated beyond any question that the original requirement of a 100-pound payload carried to a 1,000-mile altitude could be met. Unfortunately, the entrance cover of the mass spectrometer was heated excessively by friction as the rocket passed through the atmosphere, producing enough gas in the instrument to prevent it from functioning properly.

This first successful flight has been an important phase in the development of rocket and instrumentation techniques. However, the project still has many flights to go before determinations can be made concerning the amount of neutral and ionized matter in and beyond the exosphere, and about its behavior. Thus, as HiHOE moves into its next phase, the NRL group is still enthusiastic about the air-launch system as an answer to the problem of sending inexpensive vertical probes to exospheric altitudes for scientific purposes.

The flight of last July 25 has demonstrated conclusively the advantage of the air-launch technique in reducing the amount of rocket propulsive power required to lift nominal payloads to high altitudes. If this system turns out to be the one used for future HiHOEs, the choice will very likely have an invigorating effect on high-altitude research in general—not only because it will make the CALEB rocket available for this work, but also because it will stimulate the development and use of a variety of smaller rockets which can be launched effectively by the same method. The build-up of this research "arsenel" will permit numerous experiments to be carried aloft and thus will speed man's understanding of the high atmosphere and space.

## Navy Human Factors Institute Announced

The Office of Naval Research has arranged Navy Human Factors Institutes for February and March to acquaint Navy personnel with the identification and solution of human factors (human engineering) problems in systems development. Each Institute will consist of tutorial and problem-solving sessions concerned with a typical, but hypothetical, human factors program as applied to systems development. Each day's session will begin with a lecture in the morning, in which a topic will be presented and discussed, techniques described, illustrative examples presented, and questions answered. In the afternoons, the attendees will be separated into smaller, working groups in order to apply the techniques described in the morning to a specific problem.

The Navy Human Factors Institutes will be presented from Februray 11 through 15 in Washington, D. C., and from February 23 through March 1 in San Diego, California. Persons will be designated to attend by the various Navy bureaus and organizations whose operations entail systems development in which the human is an integral part of the system. The consulting firm of Dunlap and Associates, Inc., of Stanford, Connecticut, will provide the instructional and staff personnel.

## Underwater Acoustics Reviewed

About 400 of the nation's leading scientists assembled at the Navy Electronics Laboratory on Point Loma, California last November to take part in the 20th Navy Symposium on Underwater Acoustics. The conference was sponsored by a number of Navy laboratories including the Office of Naval Research, Office of Naval Operations, Bureau of Ships, and the Bureau of Weapons, and was given for scientists and officers engaged primarily in technical rather than administrative work in branch laboratories and on contractors' projects.


# AGOR-4

Since far back in history, the oceans have been used as a source of food, as lanes of commerce, and as the site of military operations. As time has passed, each of these uses has increased in importance, until now they are vital to the welfare of many nations, including, of course, the United States. Our security now depends upon our capacity to understand the oceans in a great many ways and then utilize this knowledge to the fullest advantage. To develop the capacity, we need to put into service a large amount of equipment, many and diverse vehicles, and an impressive force of scientists.

Because of this need, the Chief of Naval Operations, in 1959, approved Project TENOC (short for TEN years of OCeanographic endeavour) as the basis for a concentrated program (see Naval Research Reviews, March 1959). Soon thereafter, the ONR-sponsored Committee on Oceanography of the National Academy of Sciences—National Research Council issued a similar report calling for an expansion of oceanographic research. These expressions of concern for U. S. progress in the ocean sciences were followed, in 1961, by the writing of a comprehensive TENOC plan. Among other aims, this plan called for the construction of many new oceanographic ships. One of these vessels, completed recently, is the USNS JAMES M. GILLISS (AGOR-4)—the first Navy-operated ship to be built under the construction program. A sister ship, the USNS CHARLES H. DAVIS (AGOR-5), has already been launched and will soon join the GILLISS in her research mission.

The GILLISS, named for a Navy captain who was instrumental in setting up the Naval Observatory, is 209 feet in length, has a beam of 37-1/2 feet, and displaces 1,370 tons. Her single-screw propeller is driven by a diesel electric motor capable of developing 1,000 horsepower, which enables her to operate at a speed of 15 knots. The ship's crew will number 26 (9 officers and 17 men), and the scientific group may consist of as many as 15 persons. Other details about the GILLISS are given on succeeding pages.

The new ship is under the technical control of the Commander, U. S. Naval Oceanographic Office. However, it will be operated by the Military Sea Transportation Service (MSTS), using civilian crews. This

other Ship
Research

The USNS JAMES M. GILLISS moves up the Potomac River opposite old Fort Washington on her first visit to Washington, D. C.

procedure follows earlier NAS-NRC Committee recommendations relating to noncombatant ships used primarily for research, development, and surveying.

In addition to the Naval Oceanographic Office, many other naval activities will conduct studies aboard the GILLISS, including the Naval Air Development Center, Naval Ordnance Laboratory, Naval Ordnance Test Station, Naval Research Laboratory, Navy Electronics Laboratory, and the Navy Underwater Sound Laboratory. Other participating organizations include the Applied Physics Laboratory of the Johns Hopkins University, and the University of Washington.

The GILLISS and DAVIS will be joined in their world-wide investigations in basic and applied oceanography by four similar ships scheduled for construction in the next 5 years; keels for two of these ships already have been laid. TENOC planning also calls for the construction of many Navy surveying ships. The first of these will be launched in 1964. Each succeeding year will see new TENOC ships added to the Navy's fast-growing fleet. All will be dedicated to keeping the United States a leader in oceanography and surveying.

Continued....

## Ship Features

Stern view of the USNS GILLISS showing crane and other facilities used to conduct investigations at sea. Photograph courtesy MSTS.

MANY KINDS OF OCEANOGRAPHIC ACTIVITIES can be performed concurrently aboard the GILLISS. This potential for diversity, which exists because the ship was designed specifically for basic and applied research, has been augmented by a provision to carry a specially instrumented van just forward of the stack. Vans are planned to be interchangeable; thus each Naval activity making special investigations will provide its own van, equipped to satisfy its peculiar needs.

A 33-FOOT UTILITY BOAT is carried aboard the GILLISS to assist in conducting special surveys. Because of its shallow draft, this boat can be used for inshore support work as well as for work in deeper water. Ammunition storage lockers on the boat permit her to carry small quantities of explosives to be used for underwater acoustic surveys.

NOISE, SHOCK, AND VIBRATION disturb delicate scientific instruments and so must be minimized. In the construction of the GILLISS, particular attention was given to this problem. Much of the ship's equipment is placed on sound-isolation mountings; even the piping and pipe fittings leading from machinery are isolated acoustically from the ship's structure. For operation requiring ship silence, a large electric storage battery will be available for use.

OBSERVATIONS made from the ship can cover a large vertical range—from the earth's crust through the water, regardless of its depth, and through the air to points beyond the troposphere. When the ship is underway, her gravity meter will measure the earth's gravitational force as it varies geographically. At the same time, a towed nuclear precession magnetometer will measure the intensity of the earth's total magnetic field. Also, a deep echo sounder will trace profiles of the ocean bottom. Correlations based on these data will be made between gravitational and magnetic fields and bottom topography, helping scientists to develop a better understanding of the earth's crust.

WHILE THE SHIP OCCUPIES OCEANOGRAPHIC STATIONS, a wide variety of observations will be made from her. The taking of bottom cores and bottom samples will be supplemented by underwater photography. Nansen bottle casts will be made to obtain water samples from various depths, and these will be analyzed by means of a wide variety of equipment, including a salinometer, spectrophotometer, gas partitioner, pH meter, carbon-14 productivity kit, oven, and freezer. Current measurements will be taken with direct-reading current meters. Dye tests will also be used to determine water movement. For taking measurements above sea level, the GILLISS will employ wind vanes and anemometers, barometers and barographs, and absolute and relative humidity recorders. Furthermore, operational deck space has been provided for firing meteorological rockets, and special racks have been installed for storing the rockets until they are needed.

WHILE THE SHIP IS UNDER WAY, many basic oceanographic measurements can be made. Two bathythermograph winches permit simultaneous streaming of conventional or electronic measuring devices. A large deep-sea towing davit located on the stern can handle midwater trawls, plankton nets, and various special equipment. It is stressed for tensions as great as 50,000 pounds. In addition, equipment will be installed for making measurements of hydrostatic pressure, sea temperature, sound velocity, and currents while the ship is moving. These data will be displayed and recorded in consoles located in one of the ship's laboratories.

LABORATORY SPACES are large in comparison to those to be found on most ships used for research that are the size of the GILLISS. Furthermore, in addition to the expected facilities, the ship contains a chart and scientific instrument room, a dry lab, wet lab, photo lab, and machine shop.

THE L-SHAPED DRY LAB is the center of scientific operations. It contains workbenches, shelves, bins, lockers, and sinks. Also, panels have been set up to display information derived from the gyrocompass, speed and distance logs, and instruments measuring wind speed and direction. Centered on one wing of the "L" is a large electronic console rack designed to accept standard-size instrumentation consoles. Doors are provided for servicing individual consoles with a minimum of inconvenience.

THE WET LAB is equipped with workbenches, shelving, bins, lockers, a sink, and a large freezer. With this outlay of equipment, scientists can study a wide variety of wet substances, including bottom cores, bottom sediments, material obtained from midwater and surface biological tows, and water samples.

THE GRAVITY METER occupies another specially equipped room. This space is adjacent to the engineroom, is insulated acoustically, and has its own air conditioning system.

THE DRAFTING ROOM, LIBRARY, AND STUDY ROOM have been combined so that the laboratories could be larger. Equipment in this room includes conventional drafting tables, light tables, chart files, book shelves, and desk.

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ONLY ONE MACHINE SHOP was set up in order to avoid duplication of equipment. The scientists and ship's crew will share the lathe, drill press, grinders, vises, workbenches, and switchboards. Welding equipment is also available aboard ship.

ACCOMMODATIONS. Getting the most use out of equipment and spaces devoted to research is especially important aboard ships used for oceanographic investigations. Consequently, careful planning is necessary to keep all 15 scientific berths occupied continuously. This will be done primarily by an Oceanographic Office scientist who will act as liaison officer between the ship's master and the other 14 members of the scientific party. Maximum use of the ship will be effected also through the sharing of its facilities by many Navy laboratories and allied activities. Other oceanographic ships operated by MSTS consistently have produced records of more than 250 days per year at sea; the GILLISS is expected to equal or extend this activity.

SCIENTISTS ARE BERTHED in either one- or two-man rooms. The chief scientist's quarters, located topside, contain complete built-in living facilities. The room can also double as an office, for it contains an overhead hinged chart table, a desk with typewriter, a file cabinet, and a book cabinet. Other accommodations for scientists include two double-berth rooms which are similar to the chief scientist's room, four other double-berth rooms, and two single-berth rooms.

THE MESSROOM is shared by scientists and ship's officers. In it are two six-man tables, a serving cabinet, and a refrigerator. The shelves will be well stocked for coffee breaks and night "lunches."

AIR CONDITIONING installed in the ship makes most of its rooms habitable regardless of weather conditions. Spaces aired include the control rooms, offices, quarters, messroom, and all the laboratories except the wet lab.

FOUR PASSIVE ANTI-ROLLING TANKS have been installed to keep the ship relatively steady in rough weather so that many investigations can be continued during these periods.

BOW PROPULSION UNIT. Much oceanographic data collection depends on sensors lowered over the side. When on oceanographic station, the ship's heading must be maintained to avoid fouling the many cables suspended in the water. If the main propulsion unit is used, the ship may attain undesired headway, which can cause the cables to become tangled. To overcome this difficulty, a special bow propulsion unit was installed on the GILLISS. Normally, this unit is retracted within the ship's hull. On oceanographic stations, it can be lowered into the water by controls in the pilot house. Although the power-transmission shaft is vertical, a 90-degree coupling places the propeller shaft axis in a horizontal plane (parallel to the water surface). The propeller, which is three feet in diameter, can be rotated through 360 degrees to give horizontal thrust in any direction; propeller speed and thrust direction can be controlled from the bridge.

# Preparing to Launch at Point Mugu

About 40 miles north of Los Angeles, there is a flat narrow valley between folded, arid hills. Between the valley and the sea there was, until a few years ago, a fringe of swampland and brackish lagoons and the jutting sand-bar known as Point Mugu. The swamps are gone now; their place has been taken by the buildings and runways of the Pacific Missile Range (PMR) and its sister activity, the U. S. Naval Missile Center (NMC).

The Pacific Missile Range is a DOD facility, operated by the Navy in support of the Nation's efforts in space exploration and in the development of weapon systems. In addition to the station at Point Mugu, PMR includes a vast launching facility 100 miles north at Point Arguello (adjoining Vandenberg AFB), a large instrument complex on San Nicolas Island, 50 miles at sea, and a string of observation posts stretching far across the Pacific to Eniwetok, Kwajalein, and Canton Islands. The Range installations provide every known facility for launching, tracking, and assisting in the recovery of missiles and satellites. Thus PMR, operated in cooperation with Vandenberg AFB, is the West Coast equivalent of Cape Canaveral and its chain of ocean bases.

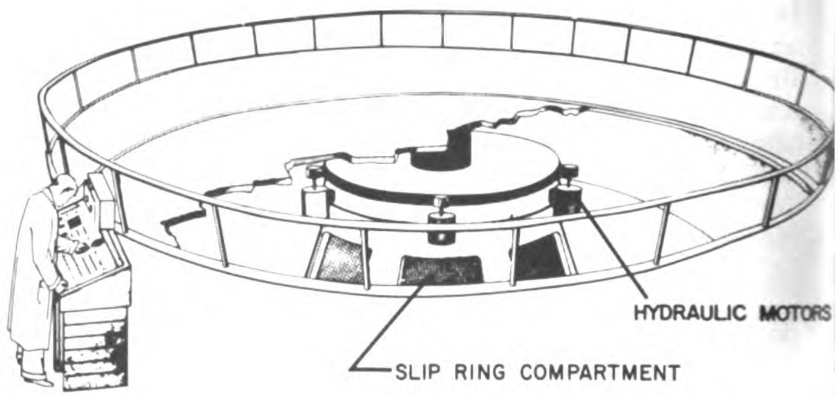
NAVAL MISSILE CENTER

NMC, subordinate to the Bureau of Weapons, is PMR's working partner and is the primary user of the latter's facilities. Because the missions of the two commands require many of the same tools and functions, NMC and PMR assist each other with various services. For example, the missile center uses PMR's range support, air station, and technical facilities, in addition to staff services such as administration, comptroller, and communications. In return, NMC provides PMR with operational support, technical information, patents counsel, and other services.

Much of NMC's support also goes to other naval organizations such as the Naval Ordnance Test Station, China Lake; the Naval Ordnance Laboratory, Corona; the Naval Air Development Center, Johnsville; and the Naval Air Test Center, Patuxent. In addition to supporting Government agencies, the Naval Missile Center assists civilian contractors during research and development flight tests of naval programs. At a given time, NMC may be furnishing test pilots, missile assembly space, office space, and bench test area for as many as six hundred contractor personnel representing some 30 different companies. While the Pacific Missile Range is used for national range programs, NMC's business is exclusively naval programs, most of which are eventually flight tested on the PMR for final evaluation by NMC.

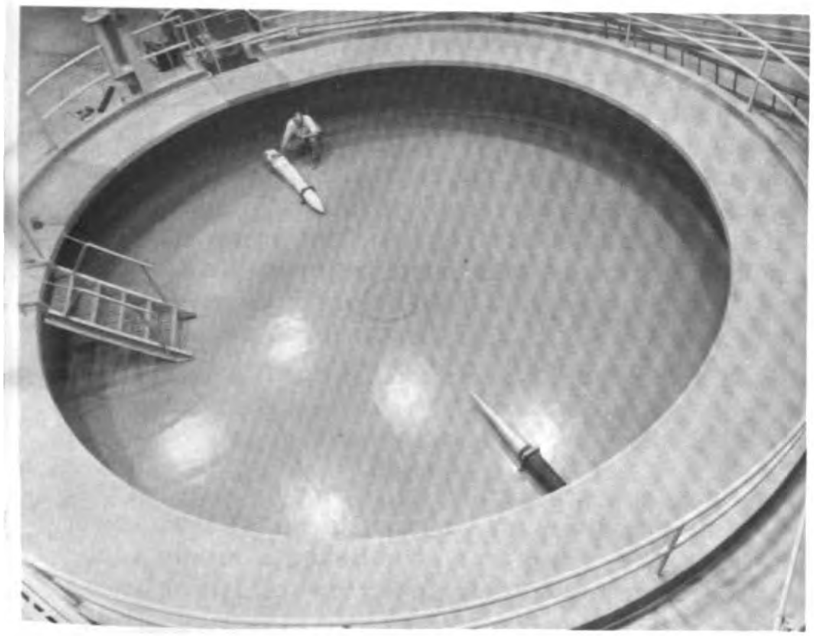
The Naval Missile Center is the last staging area for guided missile weapon systems before their delivery to the fleet, and here the parts of a system are brought together for the first time as they come from the various manufacturers. Early in the test and evaluation program, the missile components, such as guidance or nose-cone units, are "tormented" by extremes of altitude, temperature, speed, pressure,

NMC's new laboratory designed for systems research and life sciences.




Disc centrifuge. See photo at right.

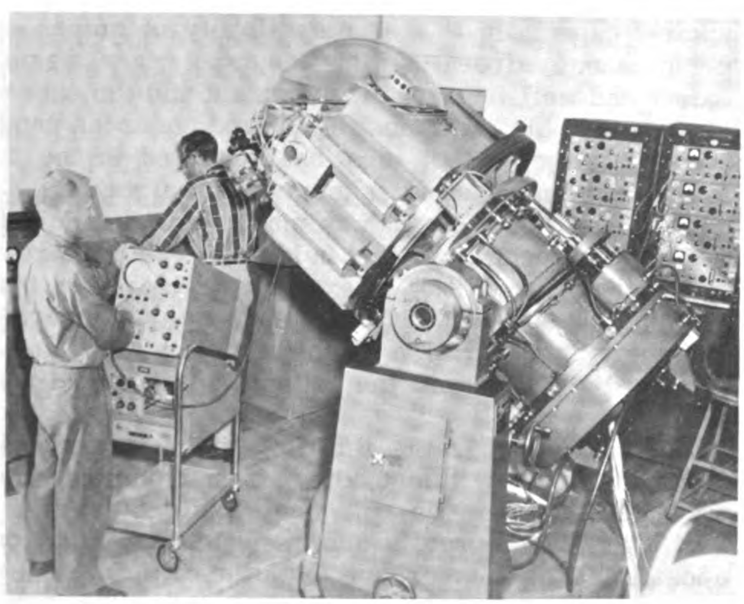
Mobile bio-science laboratory is loaded for an investigation.



NMC's Environmental Laboratory.

The 32-foot-diameter disc centrifuge located in NMC's Environmental Laboratory.

Bendix three-axis flight table.



vibration, and shock: temperatures range from 100 degrees below zero to 350 degrees above, altitudes from sea level to 150,000 feet, and pressures from high levels to those found at 500,000 feet. A disk centrifuge 32 feet in diameter subjects the parts to violent gravity forces up to 100g's, while at the same time it carries equipment creating other major environmental conditions.

The high-intensity sounds that occur within missiles are also considered, for sound can destroy. In the missile center's acoustic chamber, the test items tremble under 155-decibel sound intensities—agonizing enough to permanently damage the human ear. They are shaken in a brute force vibrator or a complex wave simulator at 5,000 cycles per second; and, in a 90-foot atmospheric chamber, they are encrusted with snow and sleet, while outside, the Southern California sun shines brightly.

Once the components pass the tests, they are assembled to form the complete missile and re-tested under the same unsparing conditions, thus showing the interaction of one part with another. In the last of the non-firing tests, the missile and the aircraft or vessel it will arm are combined for what is called "serviceability evaluation." Aboard the launching craft, the missile is handled entirely by fleet personnel—the men who will use it, not the engineers who have fostered its development. Can it be moved from storage to the firing or loading site efficiently? Could it be done more easily if . . . ? Does vibration, acceleration, or normal handling affect the missile adversely?

## THE RESEARCH PROGRAM AT NMC

With all of this development testing going on, it is only natural that NMC's engineers have come up with many original ideas of their own. To foster and support these, the center has established a modern laboratory and a research program oriented principally toward life sciences and astronautics.

A major part of the effort in life sciences is human engineering, as applied especially to the compatibility of human operators with high-performance aircraft, missiles, and space vehicles. To assure the safety and well-being of the astronaut and the success of his space mission, he and his craft must be proved under the conditions to be encountered, and these, too, must be simulated in the laboratory. Although NMC's equipment was designed to test aircraft and missiles, it may be used as well for work with animal and human subjects. Especially useful are the disk centrifuge that holds equipment to create a nearly complete environment in addition to extreme acceleration, the atmospheric chamber, the 500,000-foot-altitude simulation chamber, and various acoustic chambers and vibration machines which will all have definite places in serving the Navy's and the nation's space objectives.

Man himself is the limiting factor in space flight, and a capsule alone cannot adapt him to the new environment. Hence, NMC has been testing a full pressure-suit, one which protects the man from conditions such as extreme gravity and low pressure, and from conditions he will encounter if he must escape from the craft. The need for pressure suits is a standing one to the Naval Missile Center; certain models are routine equipment for crews of high-performance aircraft used in daily operations.

## PROJECT HYDRA

One of the most exciting outgrowths of research at NMC is the concept of Project HYDRA. This idea contemplates using the ocean itself—or any other body of deep-enough water—as the launching pad for large missiles. An ICBM, for instance, might be built just buoyant enough to float vertically—like a half-filled pop bottle in a pond—with just its nose above water. It could be fired by remote control from shore or a nearby ship. The advantages of the scheme are most appealing, for it would do away with expensive launching complexes, the take-off location could be almost anywhere, and the logistics would be greatly simplified.

NMC's scientists and engineers have proved that a rocket designed for ignition in the air can be successfully ignited underwater with only minor modifications; no instability results from the rocket exhaust; and there is no choking of the supersonic exhaust by the water inertia. As missiles continue to increase in size, NMC's HYDRA concept will inevitably increase in importance.

## WEATHER FORECASTING

Turning back to PMR, that complex activity also includes considerable research—most of it carried out in support of operations. For instance, the necessity for up-to-the minute weather data, which must precede long-range missile flights, has resulted in the development of one of the most competent and comprehensive meterological services in the Navy. Its routine weather studies blanket North America, the northern Pacific Ocean, and eastern Asia, from the surface to 100,000 feet altitude, and can be expanded to take in the entire northern hemisphere and upper air to 210,000 feet. PMR experts can forecast weather from the wheat fields of the mid-United States to the rice fields of China. The Tiros satellite regularly beams television pictures of the entire Pacific cloud cover to Point Mugu, one of the two stations selected by the U. S. Weather Bureau to receive such data.

Consideration for future needs has been an important factor in range development, and PMR has taken new programs in its stride. Range facilities tracked and instrumented the first polar-orbiting satellite lofted from Vandenberg Air Force Base; and to recover nose cones and manned Mercury capsules on re-entry from orbit, PMR equipped ships with telemetry, communications equipment, search radar, frogmen, helicopters, and meteorological instruments. In stressing mobility of its equipment, PMR has benefitted greatly, for it pays off both in quick adaptability and in financial savings.

## TRANSIT TRACKING SYSTEM

In April 1962, the Navy Astronautics Group was formed at Point Mugu to carry on the development of the Transit tracking system. A navigational satellite, Transit is a Department of Defense program of

A HYDRA missile is rolled into the ocean for tests.

particular use to the Navy, for its omnipresent signals will provide reassuring guidance to navigators anywhere on or under the earth's oceans. In planning the establishment and operation of the satellite's worldwide tracking network, PMR has erected towering radar scanners to search the skies over warm blue waters and ice-bound reaches . . . off Hawaii, the Philippine Islands, Alaska, Australia, Puerto Rico, Japan, and the Union of South Afrcia. The principal command injection transmitter—a mammoth 60-foot dish—will be raised above Point Mugu's Laguna Peak, and from the brush-covered canyons of Point Arguello, the new Transit satellites will be boosted into space.

Because PMR has the responsibility for the human components in its far-flung system, it must provide medical-laboratory and clinical services on island bases and on range ships at sea. To carry out these services, the medical department has developed "bioscience vans." These are mobile laboratories built into large trailer bodies and equipped for medicine, physiology and toxicology. They can be quickly stocked for a specific mission and be shipped directly to the area of support.

Point Mugu has developed as a major center for testing space-age weapons because missiles are becoming evermore prominent in the Navy's arsenal, and because it is situated on the doorstep of one of the world's finest missile proving grounds—the Pacific Ocean. The importance of the Navy Missile Center and the Pacific Missile Range can only increase in the future. In realization of this fact, the commands of both PMR and NMC are placing greater emphasis on research. A chief scientist has been installed at PMR, and the research organization for astronautics and biosciences has been augmented. At NMC, a new laboratory has been built, to be used principally for systems research and life sciences now, but for the exploration of other fields as the need arises.

# Research Notes

## Serendipity Extends to Outer Space

Unforeseen discoveries made through basic research can have a tremendous impact on purely practical problems. This fact has been demonstrated many times over in recent years, often in research sponsored by the Office of Naval Research. In November another story of ONR serendipity was told—this one in several installments—at a meeting on "Protection Against Radiation Hazards in Space." The meeting was sponsored by the National Aeronautics and Space Administration, the American Nuclear Society, and Oak Ridge National Laboratory.

The story concerns two related discoveries which have been extremely important to current preparations for space exploration, as well as a new and vital application of existing equipment as part of that same effort.

The first discovery revealed that the sun ejects intense beams of protons having high energies—a few hundred million electron volts (Mev.)—during some large solar flares. These proton beams constitute the chief radiation hazard to instruments and people aboard spacecrafts on long flights. They were discovered by several ONR contractors with detectors carried to the outer edge of the atmosphere by Skyhook balloons. The first evidence was gathered quite accidentally, but in the past few years the detailed study of the particle fluxes has become a major research endeavor.

The second unexpected discovery was made by ONR contractor Professor James A. Van Allen, also while studying cosmic rays. With detectors carried on NASA satellites, he discovered the large flux of electrons and protons trapped by the earth's magnetic field. These Van Allen Belts, as they are now called, constitute a second, but less serious, radiation hazard.

The third part of the story concerns the ONR cyclotrons at Harvard University (150 Mev.) and the University of Chicago (450 Mev.), which were designed for research on elementary particles. By sheer coincidence, these accelerators produce proton beams in the energy range covered by the solar protons. Therefore, upon the discovery of the solar protons, the cyclotrons were brought into use to conduct experiments on the effects of such beams on biological specimens and solid-state electronic devices, and to make fundamental measurements of the penetration of the protons through shielding materials. Thus, once again basic research projects sponsored by ONR have rendered important practical service in a way that could not have been anticipated when the projects were initiated.

To return briefly to the meeting on "Protection Against Radiation Hazards in Space": The conclusions reached by the speakers were that adequate shielding apparently can be incorporated into spaceships used for the Apollo mission without having to pay too high a price in weight.

But for extended trips in space, such as to the moon and the planets, much thicker shielding (about 50 grams per square centimeter of spaceship surface area) will be required. Unfortunately, in shielding this thick, the dosage due to secondary particles generated in the shield is comparable to the dosage caused by the primary particles. Hence, additional basic shielding studies are needed.

## The Transatlantic Tuna

The fastest long-distance swimming time ever recorded for a giant bluefin tuna has been reported by Frank J. Mather III, research associate in charge of game fish research at the Woods Hole Oceanographic Institution. The record was set by a tuna tagged in the Cat Cay area of the Bahamas and captured about 5,000 statute miles away, off Bergen, Norway, only 50 days later. Assuming a straight-line, uninterrupted trip—an unlikely event according to Mather—the minimum cruising speed for the bluefin was about 100 miles a day. The previous record for this course was 118 days, set in 1961.

As might be expected, tuna caught so soon after making such a long journey are found to be extremely slender. On the other hand, those which were marked in 1960 and retaken in 1962 were very heavy, indicating that they had participated in the summer feeding in European waters and therefore had crossed the ocean in an earlier season. One of these, in addition to his transatlantic migration, had moved northward through 43 degrees of latitude, from just above the tropics to well inside the Arctic Circle. Altogether, about 1300 bluefin tuna have been marked.

Although Mather is impressed by the tuna's speed and endurance, he is even more interested in the over-all picture emerging from his eight-year study of large fish migrations in the Atlantic Ocean. For example, considering that only 77 tuna were marked in the Cat Cay area in the years 1960-62, it seems certain that at least a large fraction of the giant bluefin passing the Bahamas in those years migrated to Norwegian waters. This determination is in marked contrast to the widely held belief that these fish spend the summer in northwestern Atlantic coastal waters.

The Woods Hole tagging program involves many fish in addition to tuna. Among the others that have been marked are about 3,000 Atlantic sailfish, 1,600 white marlin, 225 amberjack, 575 Pacific sailfish, 170 yellowfin tuna, 175 striped marlin, 40 blue marlin, and about 500 fishes of various other species. Tags have been received from 14 Atlantic sailfish, 12 bluefin tuna, 2 white marlin, 28 amberjack, and 1 yellowfin tuna, as well as 3 dolphin, 4 striped bass, 2 jack crevalle, 1 bar jack, 1 barracuda, 1 sea bass, and 1 fluke.

More than 1,200 sports fishermen have cooperated in the tagging program, which is being financed primarily by the National Science Foundation. Indirect support is given by the Office of Naval Research.

Converted gunmount being used as launcher for rockets weighing as much as 20,000 pounds.

## Gunmount Rocket Launcher


A twin 5-inch gunmount, recovered from the carrier USS PRINCETON, has been modified and was installed recently at the Naval Missile Facility, Point Arguello, California, to launch rockets weighing up to 20,000 pounds. The launcher is directed by remote control, right down to launch time, using gun-pointing systems. Vehicles to be launched are attached to a horizontal boom and raised to elevation by steel cables attached to the top of the gunmount.

About $25,000 was saved by converting the gunmount for this purpose rather than by designing a "ground up" version to perform the same function.

## Luis de Florez

One of the most influential of the men who placed the Office of Naval Research on a sound working basis shortly after it was established (originally as the Office of Research and Inventions) died last month at his home in Pomfret, Connecticut. He was RADM Luis de Florez, USNR, Ret.

The admiral took over the job of organizing the Office of Research and Inventions in May 1945 as assistant chief. ORI had just been established by the merging of the Naval Research Laboratory, the Special Devices Division of the Bureau of Aeronautics, the Office of Research and Development, and the Office of Patents and Inventions. Earlier, as a commander, de Florez had headed the Special Devices Division. Even at that time, he was an internationally known engineer, and was credited with inventing two devices which proved very helpful to the allied forces in World War II—an anti-aircraft gunsight and a flame thrower. For assignment to the SDD and then to ORI and ONR, de Florez was just the type of enterprizing man needed.

Luis de Florez was born in New York City on March 4, 1889. He attended preparatory schools in Paris and New York and graduated from the Massachusetts Institute of Technology in 1912 with a degree in mechanical engineering. While a student at MIT, he wrote "Thrust in Flight of Propellers," the first thesis in aeronautics presented at the school. Later, he obtained the degree of Doctor of Engineering from the Stevens Institute of Technology.

During World War I, de Florez served as an inspector of aviation construction in the Navy's Bureau of Construction and Repair, and organized the Division of Aircraft Instruments and Accessories in that Bureau. His research, design, and production of aircraft instruments and accessories at that time set the pattern for similar but more extensive work done during World War II.

In 1931, de Florez received a commercial pilot's license, and the next year, a transport pilot's license. In 1940, he became a Naval aviator, seeing service aboard a carrier. Next, he was assigned to the Bureau of Aeronautics as special assistant to the Chief of the Bureau, and then to positions in the Bureau's Engineering and Training Divisions.

Among the many awards made to RADM de Florez are the Legion of Merit, for his contributions while director of BuAer's Special Devices Division; the Distinguished Service Medal, for his service as director of SDD and assistant chief of ORI; and the Distinguished Flying Cross, for his important contributions to the progress of naval aviation and aviation in general throughout his career.

The admiral's dedication to naval research did not come to an end upon his retirement. Until near the time of his death he continued to carry on special research projects for ONR.

## The Quiet Sun

During the International Geophysical Year, scientists obtained an unprecedented amount of information about the sun and its effects. But as was to be expected, they were not satisfied. Although the concerted effort had opened the door to understanding a crack farther, it had also revealed many new and more profound mysteries waiting to be solved. Even before the "Year" had ended, therefore, plans were being formulated for extending the program and for initiating new, large-scale investigations into closely related solar phenomena.

Consequently, as early as 1958 we began hearing of a new "Year"—the IQSY, meaning "International Year of the Quiet Sun." Whereas the IGY coincided with a period during which solar activity was at a peak, the IQSY will coincide with a period when that activity reaches a minimum—during 1964-65. The IQSY will take as much advantage of the quiet phase of the solar cycle as the IGY took of the active one. But it will have a distinct advantage—it can get off to a faster, surer start because it will use as a springboard the vast knowledge and sophisticated techniques produced during and after the previous "Year."

The 1958 discussions of the IQSY took place at a International Union of Radio Science—IGY meeting in Edinburgh, Scotland. They were followed, in August 1960, by agreement by the International Geophysics Committee on preliminary proposals for the program. This program was approved by the International Council of Scientific Unions in 1961. Then in March 1962, the plans for each discipline were discussed, and an IQSY Committee was formed to organize the enterprise in all its aspects.

These plans, now well underway, call for an effort that will be truly international and global. It will involve more than 30 nations which will man hundreds of stations in all latitudes and longitudes. It will be an interdisciplinary effort, requiring the cooperation and mutual dependence of many sciences. And it will rely upon a wide variety of scientific tools, including satellites, rockets, balloons, aircraft, and ships, as well as a massive array of stationary facilities.

One of the major advantages of conducting studies of the sun during its quiet phase is that at that time the solar activities which do occur are not seriously complicated by other solar activities, because relatively few of them are taking place. Another important advantage is that the knowledge gained will enable investigators to make more meaningful comparisons of the two phases, providing a better understanding of each as well as of the total phenomenon.

As was the case during the IGY, considerable emphasis will be placed upon making synoptic observations; in fact a number of the same networks of stations and equipment that were established during the IGY will be operated during the new "Year." Of interest also will be many special projects. The latter, which will be carried out both on the earth's surface and in space, will be either of an exploratory nature or intended to provide data for testing old hypotheses or propounding new ones.

United States participation in these investigations will be financed by several Government agencies. Among them will be the Navy, whose activities will be arranged or performed by the Office of Naval Research, the Naval Research Laboratory, the Naval Observatory, and the Naval Ordnance Laboratory at Corona, California.

A detailed report of the role to be played in the IQSY by the Navy will be given in a later issue of Naval Research Reviews.

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## High-Speed Missile-Model Launcher

A new two-stage launcher that propels fragile missile models of complex design at velocities greater than 18,000 feet per second, or 16 times the speed of sound, without damaging them has been designed at the Naval Ordnance Laboratory, White Oak, Maryland. This speed is the highest known to have been achieved with such models, and it increases by more then 50 percent the velocity at which they could be tested in the past. The launcher will be used to evaluate the ability of ballistic missile designs to withstand the forces encountered upon reentry into the earth's atmosphere.

The launcher imparts higher propulsion speeds because it heats the gas used to drive the models and thereby increases the gas pressure by compression rather than by combustion. As a result, the gas is lighter and more efficient. In a combustion system, a chemical explosive is detonated directly in the driver gas to raise its temperature. The main problem with this method is that the gas becomes contaminated with residue from the chemical explosive. Consequently, it becomes heavier and less efficient.

The launcher consists of a combustion chamber, a pumptube containing a polyethylene piston and driver gas, and a 40-foot propulsion barrel which extends into NOL's 1,000-foot Hyperballistics Range. In operating the device, gunpowder is ignited in the combustion chamber, which also contains helium, causing pressure to be exerted on the piston. The piston then moves forward, compressing the driver gas—hydrogen—which propells the model down the range.

Before a model is placed in the propulsion barrel, it is covered with protective plastic. During flight, this covering is stripped from the model by air drag, much in the same way a loose cover is ripped from a hard hit baseball. The aerodynamic forces affecting the model as it continues unhampered down the range are studied later on numerous photographs which are taken by high-speed cameras situated along its path.

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A 300-pound swordfish is hopelessly snagged by the braids of a line suspended from the research ship MISSION CAPISTRANO.

## Final Thrust

While the USNS MISSION CAPISTRANO was serving as a platform for acoustics research conducted not far south of Bermuda last fall, a polypropylene line suspended from the ship was viciously attacked by a large swordfish. The fish rammed its spear about a foot into the tightly braided line at a point which had earlier been at a depth of 1,000 feet. Not even the more than 300 pounds of weight pulling on the line, or the jerking of the fish's body, were sufficient to free the animal as it was hauled aboard ship.

As can be seen in the photograph, the fish had rolled over on its side as it made its attack (the line was hanging vertically from the ship at the time). Apparent also is the excellence of the swordfish's aim, which the crew and scientific party had reason to appreciate that evening at mess. "Very good!" was the report.

The CAPISTRANO was being operated by MSTS for the Office of Naval Research and the Naval Research Laboratory.

# On the Naval Research Reserve

## NRRC National Awards Announced

The winners of the second national competition among Research Reserve companies was announced by the Chief of Naval Research on December 10, 1962. Naval Reserve Research Company 11-4, Compton, California, was adjudged the winner of the A. Hoyt Taylor Award, an award based on the best scientific or technical study completed by a research company. The winner of the Award for General Excellence was determined to be NRRC 3-9, Upton, Long Island, New York. Award plaques designed specially by the Institute of Heraldry will be presented to the winning companies at a later date for permanent retention. The designation of the winning companies will also be added to the larger plaques displayed in the Office of Naval Research.

National competition among Research Reserve companies was established by the Chief of Naval Research on August 9, 1960 and the first awards were made for Fiscal Year 1961. These winners were NRRC 3-9, Upton, Long Island, New York, for the A. Hoyt Taylor Award and NRRC 13-6, Idaho Falls, Idaho, for the Award for General Excellence.

In announcing the results of the second annual competion, the Chief of Naval Research paid the following tribute to the Research Reserve:

> "It is especially pleasing to pass along by this announcement the information that members of the panels convened to designate the winning companies expressed high satisfaction regarding the Research Reserve. Their comments constitute further convincing evidence that the Program is sound, and that it reflects the able and patriotic effort of its more than 2,500 members. You of the Research Reserve are a great credit to the Navy. I am glad to express my appreciation and that of the Navy for your successful endeavors to increase your abilities to serve with competence if needed."

A. HOYT TAYLOR AWARD

NRRC 11-4, 16-member company under the command of CDR Victor H. Hunsaker, USNR, was designated the winner of the second A. Hoyt Taylor Award. Project chairman for the research study since its inception was LCDR C. V. Bergstrom, USNR. This award, which is based on scientific achievement, is named after the late Dr. A. Hoyt Taylor, a retired Naval Reserve officer, who was for many years superintendent of the Radio Division of the Naval Research Laboratory. Dr. Taylor supervised the small group of radio engineers who developed radar in this country.

The award was based on an investigation entitled "Scientific Study on Control of Salt Water Piping Marine Fouling." This report, is considered to be a most useful reference to naval offices and scientific investigators concerned with the control of marine fouling. Accordingly, copies of the study have been distributed to the Bureau of Ships, Bureau of Yards and Docks, U. S. Naval Civil Engineering Laboratory, and to other cognizant scientific investigators.

Members of the panel who considered scientific and technical studies submitted by Research Reserve companies were as follows: CAPT J. C. Wootton, USN, Assistant Chief for Research, ONR; Dr. L. L. Larrick, Executive Assistant (Scientific Information), ONR; and Dr. L. O. Quam, Director, Earth Sciences Division, Naval Research Group, ONR.

## AWARD FOR GENERAL EXCELLENCE

The Award for General Fxcellence was based upon company achievement for the Fiscal Year ending June 30, 1962. During this period, CDR Jere C. Austin, USNR, was in command of the winning company, NRRC 3-9.

The panel established to review the records, inspection marks, and other material used as criteria, and to recommend the winning company was composed of the following officers: CAPT R. G. Black, USN, Submarine Warfare Officer, ONR; CAPT D. J. Mooney, Jr., USNR, Assistant for Training and Mobilization, Office of the Assistant Chief of Naval Operations (Naval Reserve); and CDR J. E. Peek, USNR, Specialist Programs and Special Projects, Naval Reserve Division, Bureau of Naval Personnel.

Other Research Reserve Companies nominated for this award by Naval District Commandants are listed below along with their commanding officers:

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| NRRC 1-2, Providence, R. I. | LCDR Warren M. Hagist, USNR |
| NRRC 4-4, University Park, Pa. | CDR Earl P. Strong, USNR |

CDR James E. Wadsworth, USNR, Commanding Officer, NRRC 6-6, Chapel Hill, North Carolina (at center) receives the first-place plaque award for the Sixth Naval District from CDR Robert N. Jennings, USNR, Research Reserve Assistant for the Sixth Naval District. CDR W. A. Stockdale, USNR, Commanding Officer, Naval Reserve Training Center, Durham, looks on.



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| NRRC 5-12, Dahlgren, Va. | CAPT John J. Glancy, USNR |
| NRRC 6-6, Chapel Hill, N. C. | CDR James F. Wadsworth, USNR |
| NRRC 8-1, New Orleans, La. | LCDR Idas W. Lohmann, USNR |
| NRRC 9-5, Ames, Iowa | LT Thomas J. Kieffer, USNR |
| NRRC 11-10, Ventura, Calif. | LCDR George B. McNeely, USNR |
| NRRC 12-4, Fresno, Calif. | CDR Herman D. Graham, USNR |
| NRRC 13-6, Idaho Falls, Idaho | CAPT Thomas J. Wadsworth, USNR |

## Group Training at Oak Ridge

On a weekend late last November, Naval Reserve Research Company 6-3, Oak Ridge, Tennessee, conducted a three-day seminar on nuclear reactors. Sixty-five officers from six Research Reserve companies in Tennessee, Georgia, Alabama, and South Carolina attended the training seminar which was conducted on a no-cost-to-the-Government basis. The seminar was under the overall direction of LCDR J. N. Robinson, USNR, Commanding Officer at NRRC 6-3. LT J. L. Redford, USNR, a member of the company, served as seminar chairman.

Speakers were obtained from the Oak Ridge Operations Office of the Atomic Fnergy Commission, Oak Ridge National Laboratory, and the Office of Naval Research. Subjects discussed were: power reactors, gas cooled reactor program, fusion reactors, space applications for nuclear power, peacetime uses for nuclear explosives, and the role of the Atomic Energy Commission in reactor development. Tours were arranged to the Oak Ridge National Laboratory and the Oak Ridge Museum of Atomic Energy.

At a dinner meeting on Saturday evening, CDR R. N. Jennings, USNR, Research Reserve Liaison Officer for the Fifth and Sixth Naval Districts, discussed late developments in the Research Reserve Program.

Reservists during group training at Oak Ridge.

# IN THIS ISSUE



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EDITORS. A. T. Drury and Richard D. Olson

NAVEXOS P-510

Spaceman undergoes tests in cold-weather simulation chamber at the Navy Missile Center, Point Mugu, California. See article beginning on page 12.