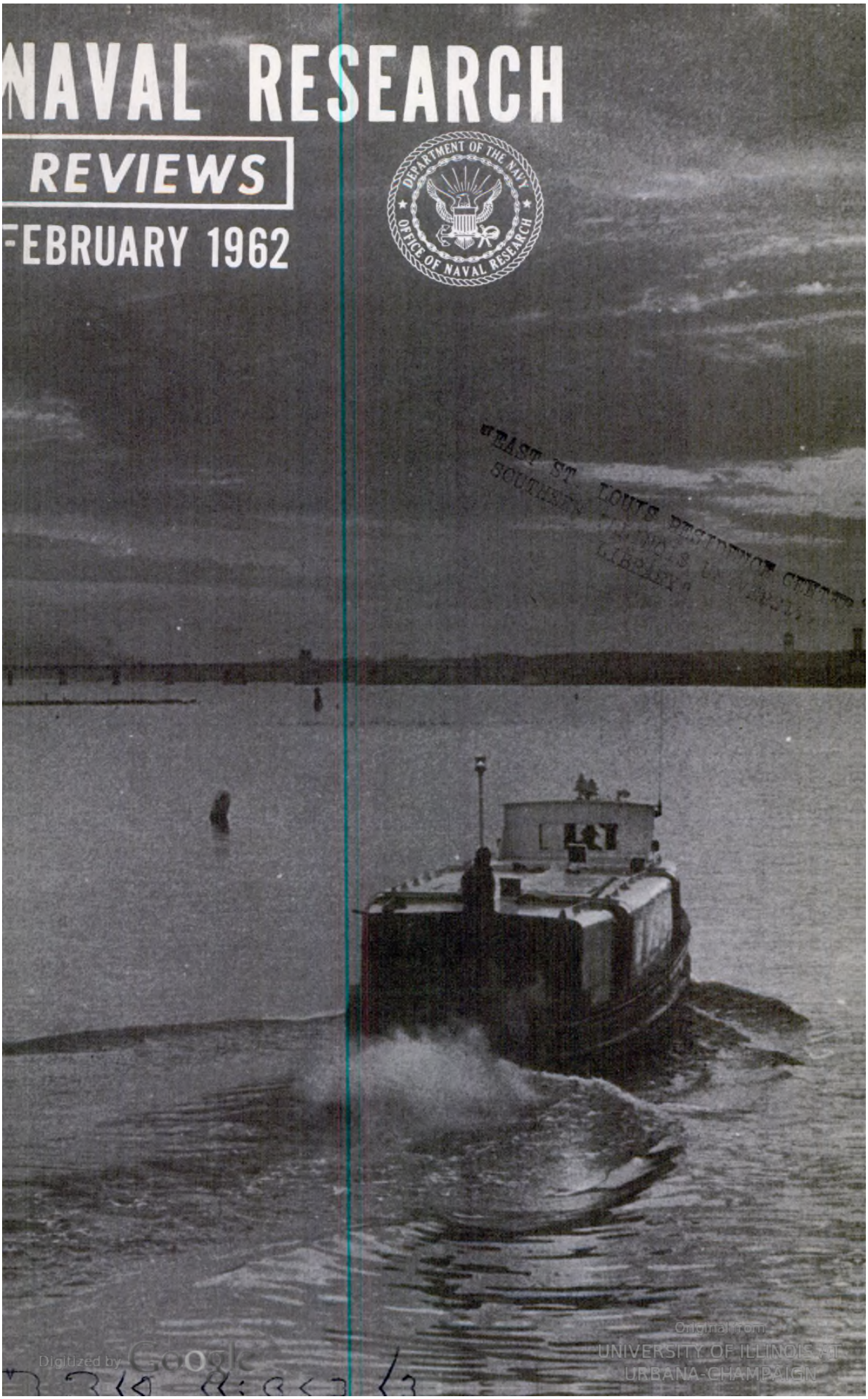
NAVAL RESEARCH REVIEWS

FEBRUARY 1962



Road to Under Ice Tunnel, Camp Tuto.
Tunnel entrance is dead center.

Entrance to tunnel; Phase I weather conditions outside.

Expedition's plane and British-type "pole cats."

SCIENTIFIC EXCURSION TO THE ARCTIC

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Scientific research is traditionally viewed and conducted by subject-matter fields. It is, however, useful and sometimes necessary to plan and conduct research projects from a geographical and regional point of view. This is particularly true in the Arctic and Antarctic, where operational problems loom large and where the overriding control of climate is so pervasive that nearly all problems tend to have a common climatic denominator. Accordingly, the Office of Naval Research has organized its program of support of research in the Arctic into a single program. This program of research is of the broadest character. Some projects deal with those attributes of the region or those aspects of fundamental science which can be studied only in the Arctic. Other projects take advantage of the fact that the Arctic provides a great natural laboratory for basic studies related to the environment.

Administration of a program which includes nearly all scientific disciplines requires advice from experts in the subject-matter fields and from specialists on the problems of the region itself. Such advice is provided to the Office of Naval Research by the Arctic Institute of North America. Since the establishment of the Arctic Research

Laboratory and the Arctic research program in 1948, several inspection trips to the Arctic have been conducted to obtain an appreciation of programs and facilities for Arctic research by an on-the-ground evaluation and review.

The most recent such trip was held in October 1961. The 26 participants included military leaders, administrators, and scientists from both the United States and Canada. The group was so diverse that the commands and institutions they represented are worth naming, as follows: Office of Naval Research (Ass't. Chief for Research, Earth Sciences Div., Geography Branch, the Arctic Project, and Operations Research), the Deputy Assistant Secretary of the Air Force, AF Terrestial Sciences Laboratory, USN Underwater Sound Laboratory, Environmental Programs of BuDocks, ASW Laboratory of NADC, BuShips, Hydrographic Office, Dartmouth College, New York and McGill Universities, and the Arctic Institute; Canada was represented by the Scientific Advisor to the Chief of Air Staff and by representatives, respectively, of the Defence Research Board, the Department of Northern Affairs, and the Department of Mines and Surveys. The fields of science represented by this group include Geology, Geophysics, Geography, Anthropology, Botany, Ecology, Zoology, Meteorology, Acoustics, Civil Engineering, Physics, Aeronomy, Oceanography, and Chemistry.

The tour departed Anacostia Naval Air Station at 0800 on Monday, October 2, and made its first stop at Ottawa, where a luncheon was arranged with local members of the Arctic Institute and where the Canadian contingent joined the tour. The first overnight stop was Knob Lake, at Schefferville, site of the Labrador iron mines and the McGill University Sub-Arctic Research Laboratory. Sondrestrom AFB provided the next overnight stop, where Dr. Trevor Lloyd gave a talk on Greenland geography, government, and development. The next night was spent at Thule AFB, where the Air Force Geopole project and Army Signal Radio Propagation stations were visited. On the following day the U. S. Army Camp Tuto was visited, and the group accepted an invitation to an inaugural luncheon in the Army's Under-Ice Tunnel Camp.

Weather conditions were reported in Phase I (alert for possible severe blizzard) as the bus negotiated the ramp road to the edge of the ice cap and tunnel mouth. When the group departed from the tunnel after the ceremony, however, Phase III conditions, which make outdoor activity extremely hazardous, were prevailing. Winds of 70 knots or more, sweeping fine ice-pellet snow off the Greenland Ice Cap, rocked the bus as it moved forward. Although all windows were shut, the bus was rapidly filling with snow, and after making only a few hundred yards, it came to a halt.

The passengers, unable to stand on the slippery ice road surface in face of the wind, staggered and crawled on hands and knees back to the tunnel. Panting from exertion and the almost suffocating effect of the icy blasts, all 25 reached the tunnel safely, realizing that they had had first-hand contact with the full authority of Arctic weather. For two days they remained warm, comfortable, and well fed while the blizzard raged outside.

Station Headquarters at Resolute.

The Tunnel and Prototype Under Ice Camp were constructed to test the feasibility of providing housing for troops or polar installations within a glacier. The main drift is 1100 feet long and 16 feet in diameter. Cross drifts 182 to 233 feet long and 24 to 36 feet wide provide space for buildings. The members of the research review team can attest to the fact that the buildings are warm and comfortable and that the facilities are modern and satisfactory in operation.

Electricity for light, heat, and power is produced inside the tunnel by a 100-kw diesel main unit and a 45-kw standby unit for emergency. Domestic water is obtained by melting ice through the use of waste heat from the engine coolant and exhaust from the power plant. Hot water from the heat exchanger is piped to a reservoir dug in the ice floor of the tunnel, producing water which is distributed to a conventional pneumatic pressure tank in the mechanical room. It is then piped to the mess and latrine through insulated pipes. Sewage flows by gravity through heated pipes to a sewage disposal drift, where it is allowed to freeze. Odors are contained and heat removed by a suction line of the ventilation system.

The next two stops on the itinerary, the Canadian stations at Resolute and Inuvik, were short-changed in order to get back on schedule. Only a couple of hours were available for visiting the research projects at each of these stations.

The next major stop was the Arctic Research Laboratory, at Pt. Barrow, operated by the University of Alaska for ONR. Here we were

also disappointed by the fact that an engine failure on the ARL R4D made it impossible to visit the drifting ice-island station ARLIS II. The Station was overflown by the R5D, however, as was the Air Force Station on Ice Island T-3. A seminar at ARL provided an opportunity to review the research programs of both ARL and ARLIS II, and a trip to the Eskimo village of Barrow provided a stark contrast to the modern and well-planned Canadian village of Inuvik.

At Fairbanks we were guests at the Army Fort Jonathan Wainwright, the Air Force Aeromedical Laboratory, and the University of Alaska. At the University faculty members presented five-minute descriptions of Arctic research programs in the fields of aeronomy, anthropology, aurora, biology, climatology, earth currents, geology, geophysics, glaciology, meteorology, and sanitary engineering.

From Fairbanks to Yellowknife we flew over some of the most spectacular scenery in North America—the Yukon area made famous by the Klondike gold rush, the Mackenzie Mountains, the Mackenzie River, and finally the Canadian Shield with its ice-smoothed crystalline rocks, serpentine eskers, and myriad of lakes. Yellowknife, on Great Slave Lake, has all the amenities of a city. The object of the visit at Yellowknife, as at Inuvik, was to inspect the modern water distribution and sewage disposal systems and other facilities such as schools developed by Canadian engineers for arctic and subarctic cities. Like Inuvik, Yellowknife is a new settlement planned and built with government subsidy to replace a poorly located original settlement.

Fort Churchill, on the west shore of Hudson Bay, is the site of Canada's Defence Research Northern Laboratory and of the rocket launching facility established by the United States during the IGY; the latter is now operated jointly with Canada. Because of the importance of Churchill in relation to the earth's magnetic pole and the aurora belt, the research program there is largely concerned with cosmic ray, ionosphere, aurora, and radio propagation investigations.

A report is in process of preparation and will be submitted to the Chief of Naval Research by the Arctic Institute of North America. It would not be proper to anticipate the conclusions of the research review group, but this participant was particularly impressed by the influence military research, development, and operations in the Arctic has had on opening up the area to economic and other civilian pursuits. North America defense forces have demonstrated that year-around operations on a large scale are feasible, that the advantages of the polar regions to aircraft operation tend to cancel the disadvantages, that submarine operations across the arctic basin are possible, that permafrost, snow, and ice not only can be coped with but in many instances can be utilized to advantage. When we add to these major operational accomplishments a list of military developments such as the long-range transport planes, large helicopters, nuclear submarines, special tracked vehicles, navigation aids, improved cold weather lubricants, low-cost arctic clothing, the total contribution becomes mighty impressive. Research is constantly improving weather forecasting, ice forecasting, communication and navigation techniques; meanwhile, better understanding of cold injury and other physiological effects of freezing are enhancing man's adaptability to the arctic environment.

SPACE RADIATION AND COMMUNICATION SATELLITES

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The United States satellite program requires that careful attention be given to the possible damaging effects of the space radiation environment on electronic systems used in such flights. This type of information is of particular importance for communication satellites, where the accuracy and reliability of transmitting and receiving equipment must be maintained over the lifetime of the system.

Considerable information has been compiled on the radiation effects in electronic components exposed to electrons, x-rays, neutrons, and heavily charged particles. The semiconductor materials used in diodes, transistors, and solar cells are the most vulnerable. Next in order of sensitivity are certain types of organic materials and electronic hardware such as condensers, resistors, vacuum tubes. Table 1 gives the approximate doses in different materials where radiation effects become significant. The values are given in rads, where 1 rad represents 100 ergs of energy absorbed per gram of material.

TABLE 1
Typical Radiation Damage Threshold for Ionizing Radiation

Component	Rads
Transistors	10^3 - 10^{-5}
Diodes (point contact)	10^3 - 10^{-5}
Silicon Solar Cells	10^5
Vacuum Tubes	10^6
Plastics	10^6
Capacitors (paper)	10^7
Resistors (carbon)	10^8
Capacitors (mica)	10^9

Note: The radiation damage threshold is nonspecific. It indicates that one of many possible physical properties begin to change. The thresholds are for permanent nonreversible type of damage. Temporary effects for solid state components and solar cells have been observed in radiation fields of 10^3 rad per hour.

INTERACTIONS OF RADIATION WITH MATTER

Energetic radiation passing through matter will lose energy either by excitation and ionization processes or by direct collision processes. Electrons are capable of ionizing and exciting every kind of atom through which they pass. In organic material these processes cause breakage and rearrangement of chemical bonds which ultimately lead to permanent changes. In semiconductors, dislocations in the crystal lattice are created. The radiation effects listed in Table 1 are due almost exclusively to ionization and excitation energy expended in the material,

either by primary electrons or by secondary electrons produced through the interactions of gamma rays.

The particles may also lose energy by direct collisions with atoms, which are then displaced from their normal lattice sites. Damage produced by fast neutrons is primarily of this type. For this reason neutron damage is usually related to the total number of incident fast neutrons per cm^2 rather than to absorbed dose in rads.

Positively charged particles such as protons, deuterons, and alpha particles will lose most of their energy through ionization and excitation, as previously described for electrons. It also is possible for high-energy particles to interact with atomic nuclei and produce atomic displacements, as with fast neutrons. The importance of this effect increases with energy. For a 300-Mev proton the probability of a nuclear interaction in aluminum over the range of the particle approaches 50 percent. More information is needed on the effects of high-energy heavily charged particles on materials and components so that the relative importance of ionization vs nuclear collisions can be determined. The scarcity of high-energy positive ion accelerators presents one of the major difficulties in obtaining this information.

RADIATION ENVIRONMENT IN SPACE

Galactic Cosmic Rays

The galactic cosmic radiation is an isotropically distributed spectrum of high-energy particles extending to energies of 10^{12} Mev. It arrives at equal intensity from all directions in the galaxy. The spectrum consists primarily of hydrogen and helium nuclei, but heavy nuclei extending through iron also are present. The average energy is about 4×10^3 Mev per nucleon. The radiation intensity is constant at 1 milliroentgen per hour or 10 roentgens per year but is modulated by a factor of two over an 11-year period by the magnetic activity of the sun. The relative intensity of galactic cosmic rays as compared with other nuclear radiations in the space environment has been summarized in Table 2. The significance of this table will become more apparent as the different radiation fields are discussed.

Solar Cosmic Rays

Solar cosmic rays are traditionally divided into two classes: high-energy events and low-energy events. The high-energy events can be detected by sea-level monitoring instruments and have been recorded for a number of decades. These are protons with energies extending beyond 1 Bev. They are associated with certain solar flares which occur about once every four years.

Low-energy cosmic ray events consist mainly of protons in the energy range between 40 and 500 Mev. These particles do not reach sea level except at extreme northern and southern latitudes. Their discovery is of recent origin, having had to wait for the development of high-altitude balloons, satellites, and space probes. During the period

TABLE 2
Nuclear Radiations in the Space Environment

Radiation Source	Particles	Range in Energy (Mev)	Frequency of Event	Rad/Hr or Rad/Event	Average Rad/Year	Accuracy of Rad Values
Galactic cosmic rays	Protons, α-particles, etc.	10^2 to 10^{12}	Constant	0.001 rad/hr	10	Fair
High-energy solar cosmic rays	Protons	40 to 1000	About 1 flare every 4 years	50 (inferred from Feb. 1960 flare)		Direct experimental data not available
Low-energy solar cosmic rays	Protons	40 to 500	About 1 per month; flux varies from background to max.	3×10^4 (max reported value of July 1959)	More data required	Poor
Heart of inner Van Allen belt	Protons	40 to 1000	Constant	0.5 rad/hr 10 rad/hr (max. and min. reported values)	5×10^3 and 10^5	Fair
Heart of outer Van Allen belt	Electrons	20 to 1000	Constant	2 rad/hr 100 rad/hr (max. and min. reported values)	2×10^4 and 10^6	Poor; values could be high by 100

Note: Rad values are from x-rays generated by the electrons.

of solar maximum, major flares occur about once a month. It now appears that these low-energy cosmic ray events can produce more intense radiation levels than the high-energy flares. For this reason they constitute the prime source of potential radiation hazard to be found in space. Some of the more interesting physical facts about low-energy solar cosmic rays are summarized as follows:

- They are first detected in the vicinity of the earth approximately one hour following the appearance of a major flare on the sun.

- Since the earth's magnetic field acts as a magnetic spectrometer, the particles can come in undisturbed only over the poles. Except during periods of intense magnetic storms, the particles are observed only north or south of 60° geomagnetic latitude.

- The proton spectrum cuts off at a minimum of about 40 Mev and extends to higher energies (E) as $1/E^5$. Thus doubling the energy will reduce the flux by 2^5 or to 1/32 of its initial value. The maximum energy is approximately 500 Mev.

- Particles are observed as early as 30 minutes following a flare. The intensity reaches maximum over the first hour or so and then decays with time (t) at $1/t^2$. A similar decay law is also observed for high-energy flares. The protons are believed to be accelerated over the first few hours and then stored in some sort of a magnetic bottle or plasma cloud from which they slowly leak out.

- The total particle flux in free space resulting from solar cosmic rays varies over wide limits. Early in a large event, maximum dose rates up to 10,000 rad per hour are believed possible. The decay is such that the main integrated dose is obtained within the first several hours. The frequency with which bursts can produce 10^4 rads in free space has yet to be determined.

Van Allen Belts

The inner Van Allen belt consists of high-energy protons which are trapped in fixed orbits within the geomagnetic field of the earth. They are assumed to originate from the radioactive beta decay of free neutrons produced in the earth's atmosphere by cosmic rays. Some of these neutrons ultimately escape into space and spend a finite portion of their lifetime passing through the inner belt. The belt extends from 1500 to 10,000 km above the earth's surface. The peak intensity occurs in a narrow band at an altitude of 3600 km on the geomagnetic equator. The proton flux in the heart of the zone is approximately 10^4 particles per cm^2 per sec. The protons range in energy from 40 to about 1000 Mev and exhibit a $1/E^2$ energy spectrum. The maximum dose rates within a satellite passing through the proton belt, as estimated by the use of various possible assumptions, range from 0.5 to 10 rads per hour.

The outer Van Allen belt is far more extensive and is characterized by a high density of electrons between 50 and 1000 kev. There are

two points of view on the origin of these electrons. One school holds that the neutrons responsible for the trapped protons also produce the trapped electrons. This would limit their energy to 780 kev, which is the maximum energy of the beta decay neutron spectrum. Others believe that the electrons are of solar origin. It should be pointed out that protons and electrons are actually found in both belts, but the maximum flux densities in their dominant zone will be at least 100 times greater than in the other.

There is much uncertainty as to the exact extent of the outer belt and the electron particle flux within the belt. A peak electron intensity of 10^{11} per cm^2 per sec has been reported at an altitude of 16,000 km on the geomagnetic equator. Others infer a value of 10^8 electrons per cm^2 per sec for the same event. The information on energy spectrum also is sketchy. The distribution appears flat to 100 kev and then decreases rapidly with energy. At 400 kev the electron is down to about 1 percent of the value at 100 kev. The electrons are limited in range to less than 1/16-inch aluminum and thereby constitute only a superficial hazard; however, 10^{11} electrons per sec with an average energy of about 50 kev would produce a surface dose of 10^8 rads per hour.

The secondary bremsstrahlung or x-radiation produced by electrons stopped in the wall material of a communication satellite also may present a problem. Quantitative calculations of the x-ray spectrum and intensity produced under these conditions are not possible. Most of the dose values given in the literature are probably valid to no better than a factor of two for the particular assumptions used in making the calculations. For an electron flux of 10^{11} per cm^2 per sec, the dose rate under 1 gram per cm^2 of light material was calculated as somewhere between 10 to 100 rad per hr by one calculation and as about 2 rad per hr by another. The second calculation stresses the importance of the high-energy end of the electron spectrum in producing x-rays and points out that the contribution from the bulk of electrons below 100 kev is a minor one. Future experiments designed to improve the accuracy of electron spectral measurements above energies of 100 kev, together with a firmer assessment of maximum electron flux, are necessary before anything approaching reliable x-ray dose rates can be predicted. Table 2 summarizes the radiation levels to be expected from various radiation zones.

RADIATION EFFECTS OF SPACE ENVIRONMENT

The study of radiation effects in semiconductors is a relatively new field. Because of the importance of the problem this research has been greatly accelerated over the past few years, and a growing body of literature is now becoming available. The data are collected by the Radiation Effects Information Center, at Battelle Memorial Institute, and compiled into technical reports for the benefit of designers and engineers.

Gross changes in the electrical conductivity of a semiconductor are the most directly observable phenomena. The mobility of electrons is another important property, among others, that has been studied in

irradiation damage. It is not always clear at what point these effects will manifest themselves as component failures. When temporary effects are to be considered (as in the event of a major solar flare), radiation effects on semiconductors may, for the most part, be qualitatively compared with temperature effects. The principal effect is a change in leakage current in transistors and diodes. Careful choice of transistor components, together with properly compensated circuits, could significantly extend the effective threshold for this effect. In a similar way, direct radiation damage in noncritical circuits could be tolerated several orders of magnitude above the threshold without adverse effects. The other point to be made is that radiation damage in semiconductors can affect many parameters grossly defined as electrical, magnetic, or optical properties. These effects are not always interrelated and in some cases may have little influence on the accuracy or reliability of a given piece of electronic component. Thus "damaging" amounts of radiation from a purely technical sense may still be tolerable from an operational point of view.

Solar cells present a more critical problem since it is necessary to locate them on the surface of a vehicle with only a minimum amount of shielding. The principal effect of radiation is a direct impairment in their efficiency as photovoltaic generators. When they are relied upon as the prime source of electrical power, potential radiation damage becomes a serious matter. An extensive program aimed toward improved efficiency and radiation resistance is being carried out at the Naval Research Laboratory.

Table 1 shows that "radiation damage" to solid state devices has a threshold of about 1000 rad. From Table 2 one observes that it is possible to obtain radiation levels greater than 1000 rad from: (1) exposure in free space to a major low-energy solar flare and (2) a continuous exposure of sustained duration in the heart of the Van Allen belt. Some degree of shielding from solar flares can be obtained with orbits along the equatorial plane at an altitude below the earth's atmosphere. For example, an atmospheric umbrella of 25 grams per cm^2 exists at an altitude of 30 km. Whether this approach is practical or even feasible will depend on a number of factors not discussed in this paper. At these altitudes one would be well inside the inner reaches of the proton belt.

The probability of encountering radiation from the Van Allen belts will be entirely dependent on the orbit and altitude chosen for a particular satellite. Bypassing the heat of either belt presents no formidable problem. Equatorial orbits above the outer belt are completely feasible. The planned ADVENT communication satellite will be placed in a 24-hour circular equatorial orbit about 40,000 km from the earth's center, well beyond the fringes of the outer belt. One should also bear in mind that the average radiation levels within the belts are several orders of magnitude lower than the listed maxima. Where entry into the outer belt is anticipated, a modest amount of lead shielding about critical components would prove effective. A 1/8-inch-thick lead shield will reduce the x-ray intensity by a factor of 50. The same shield in the proton belt would only attenuate by a factor of 3. Thus, if one can avoid or even minimize the radiation from the belt regions, all that

apparently remain in the way of potential danger are the major low-energy solar flares. To date, the flare of July 1959, with a reported peak intensity greater than 40,000 rad per hr, has never been duplicated or even approached. One has every reason to expect similar events; but until some cyclic pattern is definitely established one cannot assess their true potential as a radiation damage mechanism.

In the present gamble of getting a vehicle into space the additional danger of space radiation affecting critical communication equipment does not appear to be particularly great. This does not imply that the problem does not exist nor that nothing needs to be done to improve the situation. Quite clearly the pattern and the spectrum of our space radiation environment must be more carefully explored. The mechanisms by which the higher energy particles interact with matter and, particularly, by which they affect critical components must be better established. Once these problems are understood, positive measures can then be taken to protect radiation-sensitive equipment, to replace them with less vulnerable devices, or to design circuits which automatically compensate for typical damage effects.

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The foregoing article was adapted from a brief summary of potential radiation damage to electronic equipment in communication satellites, presented by the author to the Joint NASA-DOD Technical Committee on Communications Satellites on October 3, 1961. A more fundamental approach to the subject is provided by the generous bibliography which accompanies two reports: REIC Memorandum 21 of Battelle Memorial Institute, "Space Radiation and Its Effects on Materials," by R. F. Redmond (June 1961), and Report No. 63270-50-01 of Arthur D. Little, Inc., to NASA, "Principles for the Evaluations of Radiation Dose Rates in Space Vehicles," by R. D. Evans (July 1961). These two reports are the source of all values quoted in this article.

Dead Accelerator Revived With the Help of a Hearse

The Notre Dame Van de Graaff accelerator recently shut down because of a faulty accelerating tube. Duke University offered to supply a replacement tube to avoid a long delay in obtaining a new one from a commercial supplier. Dr. Miller of Notre Dame hit on a novel idea to avoid possibility of vibrations or handling damages in shipment. He rented a Cadillac hearse from a local funeral parlor and had the delicate tube driven from Durham to South Bend. The Notre Dame accelerator has now returned to full operation.

A New Signaling Beacon

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At present, day-time optical signaling between U. S. Navy vessels is accomplished with highly directional searchlights which project a narrow beam of relatively high candle power. Three in current use are: a 12-inch incandescent-type searchlight visible to five miles; a 12-inch mercury-xenon light visible from eight to ten miles; and a 24-inch carbon-arc light, which can be seen to the horizon in clear weather. All have a narrow beam-spread (one to two degrees), which limits their use to communicating with only one ship at a time. The result can be a delay of four to five hours between the transmission of an order—for example, from the flagship of a combat task force—and its execution. At night, simultaneous communication between ships are possible with a presently available, low-candle-power, nondirectional, yardarm blinker, but this cannot be seen by day. Thus, the development of a high-intensity, omnidirectional, daytime beam has become of considerable importance to the Navy.

A new high-intensity, omnidirectional, signaling beacon designed by the Material Laboratory can transmit information visually and simultaneously between several ships at sea (Figure 1). It has a daylight signaling range of five miles in average clear weather and can easily be adapted for night use.

Two beacons are required for each ship—one for the starboard side and one for the port. Each unit is equipped with a 225-degree, 300 mm, two-piece Fresnel lens; a high-intensity, 2500-watt, mercury-xenon lamp mounted at the geometrical center or focus of the lens; a starting assembly on which the lamp is mounted; and an internal mechanical shutter. The high-pressure, 2500-watt, mercury-xenon lamp has a high initial brightness and reaches maximum brightness quickly. With the lamp at the focus of a 300-mm Fresnel lens, the required 100,000 candles and 15-degree vertical beam-spread are attained.

A signal lamp may be operated in one of three ways: by switching it "on" and "off," by flashing it "bright" and "dim," or by leaving it on and using a mechanical shutter in front of the lamp. The first two methods were found to be unacceptable for use with the new beacon; the first because it causes radio interference, and the second because it requires a "bright-dim" ratio of 20:1, which cannot be obtained with the mercury-xenon lamp. Use of a mechanical shutter, then, seemed to be the best method and was the one finally adopted.

Previous shutters, however, had proved to be too complex; consequently the beacons in which they were fitted frequently failed during Fleet trials. To solve this problem, the Material Laboratory designed a simple shutter mechanism capable of signaling at least eight words per minute. To accomplish this, the two semicircular blades of

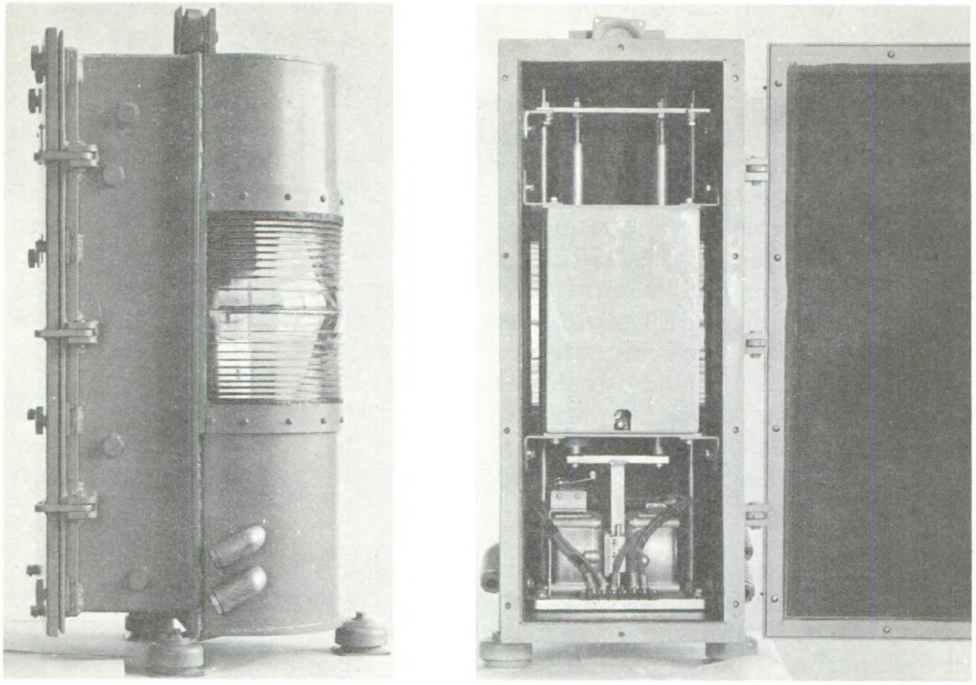

Figure 1 - Omnidirectional signaling beacon designed by the Material Laboratory, New York Naval Shipyard. Left: side view. Right: with door opened to show replacement components.

previous models were reduced in size and placed as near as possible to the lamp bulb rather than near the lens as in previous models. Thus, each shutter need move only 1.5 inches to reach the maximum "open" or "closed" position. The latest model of the new shutter has been operated at 360 cycles per minute, which is equivalent to a signaling speed of 18 words per minute. To operate the new shutters, an ac rotary solenoid was selected as the simplest and most direct driving device.

The beacon's performance, as evaluated ashore and in fleet tests aboard an aircraft carrier and a destroyer, proved it to be an efficient time-saving device capable of transmitting messages simultaneously to all ships within a 360-degree arc. The vertical beam-spread of 15 degrees was found to be adequate, and the signaling was not affected by the roll and pitch of small naval vessels, such as destroyers. Under ideal conditions, the beacon is comparable in range, signaling-speed, and ease of reception to the standard Navy 12-inch incandescent signaling searchlight. Under conditions which make searchlight aiming difficult, (hazy weather, excessive pitch roll, or when the target is small and distant), the beacon is superior to the standard searchlight in signaling efficiency.

Adaptation to night-time signaling is through the use of an external infrared filter, which should provide a much greater signaling range than the standard yard-arm blinker. The beacon is currently undergoing field tests by Operational Test and Evaluation Forces to prove its reliability under all possible conditions of Fleet operation.

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As for future developments of the new beacon, several possibilities may be noted. The nuclear age will require that ships' crews spend more time below decks. At the same time, there will still be a need for optical communications during radio silence, demanding the use of physical detectors sensitive to the ultraviolet, visible, and near-infrared regions of the spectrum. The omnidirectional characteristic of the beacon could be coupled with an omnidirectional receiver to transmit information over distances out to the horizon. Once such physical detectors are developed, the mechanical shutter of the present beacon could be eliminated, because the detectors can discriminate between smaller differences in radiant energy than is possible with the human eye, which requires a minimum candlepower difference of 20 to 1 for satisfactory distinction. Messages would then be transmitted by either "bright-dim" electrical modulation, voice modulation, or high-frequency modulation. Gas-discharge lamps, such as the one used in the present beacon, could be modulated by the "bright-dim" technique without the need of additional equipment.

Finally, the standard teletypewriter found on most Navy vessels, when used in conjunction with a suitable detector system, could be adapted to transmit and receive messages by "bright-dim" modulation of the source. Not only would such transmission be superior to manual signaling, it also would possess certain advantages over voice communications.

Nuclear Power Plant and Weather Station Installed in Antarctica

Late last fall--spring down under--the "atomic age" met the "ice age" in Antarctica. USNS ARNEB steamed into McMurdo Sound behind an icebreaker escort, carrying with it a prefabricated nuclear power plant and a nuclear powered automatic weather station. Both systems, built under contract with the U. S. Atcmic Energy Commission by Martin Marietta Corp., will be installed this season as aids to the Naval Support Forces which help maintain an extensive scientific research program throughout the Antarctic continent.

Navy SeaBees from Mobile Construction Battalion I have already prepared a site for the reactor plant on a plateau overlooking the McMurdo Sound Base. A pit for the 30-foot reactor tanks was blasted out of solid rock last year, and steel supporting structure has now been erected. Insulated buildings to shelter the 1500-kilowatt power plant also have been assembled.

The plant will give the base five times as much electricity as at present, and without the enormous problem of hauling in bulk fuel. It should make life here safer and more comfortable by replacing about half of the oil stoves.

The automatic weather station, powered by a 10-watt radioisotope-fueled generator which can operate for ten years without refueling, will be flown shortly to the abandoned U. S. station at Little America V--about 400 miles away. Once buried in the ice there, equipment in the eight-foot-high cylinder will record and transmit information about outside temperature, winds, and barometric pressure at least four times a day.

TSUNAMI*

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A series of meetings on tsunami was held in conjunction with the Tenth Pacific Science Congress last summer at the University of Hawaii. These meetings brought together scientists in various disciplines, particularly geologists, oceanographers, and fluid dynamicists. Inasmuch as "tidal waves" are a practical problem in Hawaii, the public also showed strong interest in these sessions. Frank Press, Director of the Seismological Laboratory of CalTech, and Walter Munk, Director of the Institute of Geophysics of the University of California at San Diego, were among the contributors.

The origin of tsunami is closely associated with earthquakes. Undersea volcanic activity and earthquakes seem to produce many of the "tidal waves" experienced in Japan. Japanese scientists have studied this phenomenon for a long time, compiling records of damage and estimated wave energy that go back several hundred years. The effects of the Chilean earthquake of 1960 have been intensively studied by tsunami scientists around the Pacific. The fracture zone that caused the quake was estimated to be 700 miles long and to have propagated at a rate of two miles per second. It extended SSW under the Pacific Ocean. In addition to setting the earth into free oscillation, it sent tidal waves across the entire Pacific. The town of Hilo, Hawaii, particularly vulnerable to such waves, suffered considerable damage and loss of life as a consequence.

In the open ocean, the usual tsunami wave is one foot high and 100 miles long; thus reported tsunami sightings by aircraft and ship crews must be pure imagination. The tsunami's characteristic wave velocity is 230 miles per hour. The shape of shoreline and ocean bottom may magnify the tidal-like effect and create waves 50 or more feet high. The harbor at Hilo, shaped like a calypso horn, magnified even those waves which had to travel around the island to get there. Tsunami waves are long with respect to sea depth, because they are produced by displacement of the bottom along great distances. This characteristic indicates that the disturbance is almost constant from bottom to surface. Thus, instrumentation for a tsunami observatory need not be confined to the surface. Strike-slip (predominantly vertical) quakes may have a minor effect whereas dip-slip (more horizontal) quakes should have a large effect. Focusing of the energy propagation may occur perpendicular to the slip; thus two earthquakes of a given magnitude may or may not produce tsunami. Seismologists are not able to determine immediately which type of earthquake is occurring. Project VELA (of the Advanced Research Projects Agency) includes research to distinguish large underground explosions from earthquakes. Results of these

*A great sea wave produced by a submarine earthquake or volcanic eruption; commonly called a "tidal wave."

Tsunami damage at Hilo, Hawaii. (Photo courtesy of The Honolulu Advertiser.)

studies may give scientists more knowledge in distinguishing the type and direction of the fault slip. Other sources of tsunami include land and shoreline motion, undersea land slides, and volcanic eruptions. Van Dorn, of Scripps, dramatized the effect by saying that a large meteorite, such as the one that produced the Arizona meteor crater, would, if it fell in the ocean, cause 300-foot waves which would sweep 300 miles inland on a low-lying coast.

Dr. Munk cited several interesting possibilities in connection with the dissipation of the energy of tsunami and tides. For one, the reverberation-time of a tsunami in the Pacific is thought to be about one week and the process of decay to be similar to that of ocean tides. Anomalies in the lunar orbit have been thought for many years to be due to tidal effects. Keplerian and Newtonian laws on the subject still leave a discrepancy. The effect of tide is to add a mass of water at the point on the earth below the moon. He further stated that, since friction delays the tide and results in a force that slows the earth's rotation, an equal and opposite force must cause the moon to accelerate. For proof, he stated that estimates of energy dissipated in tides seem to agree with the associated energy of lunar-orbit anomalies. Also, if the tidal energy were dissipated in a smooth basin, its decay rate would compare to that of sound in a room. Thus a large number of oscillations would be required for the decay of a fraction of the energy. With a typical period of 15 minutes in the ocean, it would take 1000 oscillations to achieve one-millionth decay of the energy. Flow into narrow harbors and shallow areas at high speeds helps dissipate the energy. Flow under ice shelves and arctic tides may also account for a large part of the decay. If the tidal energy were caused to dissipate along inlets in a controlled nature, it

Epicenters (focal points) and magnitude of shocks in Chile during the May 1960 earthquakes. (Map courtesy of U. S. Coast and Geodetic Survey.)

■ Magnitude >8
■ Magnitude 7-8
● Magnitude <7

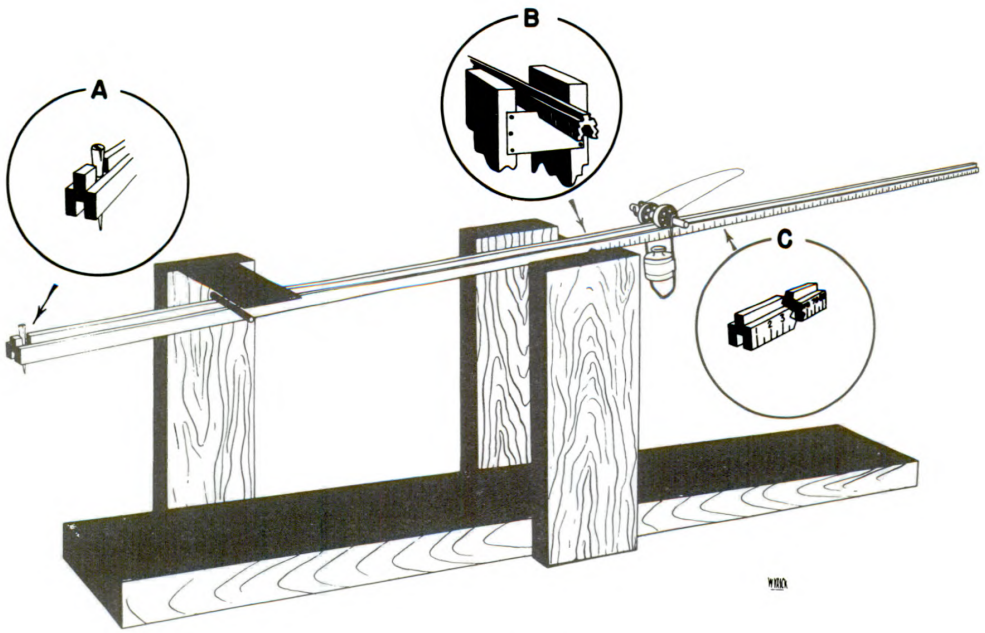
might be possible for man to control tsunami and the secular motion of the moon.

Dr. Munk illustrated the present state of inadequate knowledge on tsunami by the following experience. When the Chilean earthquake occurred, San Diego Harbor was placed on an alert. The ferry suspended service and commuters waited. Scripps people manned the tide gauges and watched. A series of small waves swept by and were followed by about six hours of waiting. The chief of police called and said most people know that the first four waves are the worst and what are we waiting for. Munk agreed, although he couldn't quite understand the lack of a large disturbance. The order was given to continue service in the harbor. As soon as the ferry cast off with a full load of commuters, a series of large waves swept by and a fifteen-knot current developed in the harbor. The ferry was swept three miles up stream. When it finally labored down to the other dock, the outflow caught it and it was swept three miles toward the ocean. As a result, Munk isn't sure of his reputation with the local harbor police.

As a tip to beachcombers, the clue that a tidal wave is coming is not a wall of water but a rapid and large tidal oscillation, often beginning with an extremely low tide.

Controlled Experiment in the Removal of Ticks

Entomologists of the Naval Medical Field Research Laboratory at Camp Lejeune had a mechanical problem. In a phase of their research on insect pests, they wished to conduct a series of experiments aimed at finding a dab-on ointment or drug that would induce wood ticks to remove themselves from Marines. The experimental animals were on hand; plenty of ticks were readily available; what was needed was some kind of dynamometer to measure accurately the force required to remove the ticks. The ingenious "tick-puller," illustrated in the sketch, was the simple yet effective answer.



Dynamometer used to measure the force necessary for removing ticks imbedded in the skin.

The lone star tick (Amblyomma americanum) is a particularly annoying pest because it has a long snout, called a hypostome, which the tick works into the victim's skin until much of the head is embedded. The tick can be pulled off easily enough, but the head may be left in the skin to cause intense itching and sometimes local infection. Thus Ambly. amer. presents a substantial morale and medical problem to maneuvering troops, who may have to go for some time without an opportunity to undress for a tick hunt.

Adult ticks of both sexes were collected in the open woodlands and along trails, roads, and clearings where they are normally abundant during the period April through mid-July. In the Laboratory, the ticks were allowed to feed on the shaved ears of live rabbits. The ticks were confined in cloth cages covering the ears, fifteen to twenty of the arachnids being enclosed in each cage. After the ticks had been given 24 hours to get themselves well embedded, the infested ears were drenched with the test chemical. One end of a thread was then tied around a tick's neck and the other end was pressed into the notched peg at the pulling end of the dynamometer rod (Inset A). Next, the 100-gram weight was rolled outward along the graduated balance (Inset C) until the tick pulled free. The distance from the fulcrum (Inset B), measured in one-half centimeters, was then converted to grams. From time to time untreated ticks were pulled, in the same manner as controls.

The experiments turned up some interesting information about ticks. For one thing, the hypostome of the female is considerably longer (average 0.93 mm) than that of the male (0.65 mm). It was reasoned, therefore—and turned out to be true—that the male would be easier to remove than the female: the average pull to remove the male was 80.54 grams as opposed to 124.88 for the female. Within each sex, however, a tick with a longer snout was no harder to remove than one with a shorter one. So apparently the female is merely more tenacious (or greedier) than the male; for that reason only females were used in the subsequent tests with various chemicals.

In all, 31 candidate materials were tested. As measured by the tick-puller, some of them reduced by 50 percent or more the force required for removal. Deodorized kerosene and camphorated phenol in petrolatum were the most effective agents, requiring only 15 grams of pull; in 25 percent of the tests with these two chemicals the ticks backed out voluntarily.

An ideal preparation, of course, would be one that could be dabbed on and would cause the tick to remove itself and die. Such a chemical was not found in these preliminary experiments, but it is hoped that continuing tests will eventually turn up a formula that can be packaged for Marine Corps issue.

The men who carried out the experiments were CAPT K. L. Knight, USN, Head of the Entomology Division, NMFRL; his assistant, CPO C. W. Taylor, USN; and LCDR D. E. Bryan, USNR. The latter is an Associate Professor of Entomology at Oklahoma State University and a member of Naval Reserve Research Co. 8-13. He participated in the tick experiments while he was on active duty at Camp Lejeune in May 1960 and June 1961.

Underground Shelter Tests

A construction contract has been awarded for a 100-man underground personnel protective shelter at the National Naval Medical Center, Bethesda, Md. Upon its completion, extensive shelter tests will be conducted by the Naval Medical Research Institute and the Office of Naval Research.

RESEARCH NOTES

Tears Aboard the USS SNOOK

During her first sea trials in August 1961, the USS SNOOK's internal atmosphere caused extensive eye irritation and lachrymation. Later in the month personnel from NRL and BuShips went aboard the submarine for four days but were unable to discover the specific cause. The situation was so critical that the Navy postponed acceptance of the Snook until the atmospheric contamination was eliminated, although this did not affect the SNOOK's commissioning on October 24.

Further visits by a team of NRL chemists entailed much sampling and analysis of the air and additional checking of composition of materials exposed to hot surfaces. At first, the leading culprits seemed to be decomposition products from the asbestos sealing compound used on the superheated steam pipes, ingredients in the green-gray paint used on these pipes, and the decomposition products from overheating the steam turbine oil.

In a series of intensive, controlled experiments aboard the SNOOK from October 26 to November 2, the NRL team located the major source of contamination, the engine room, and then pinpointed its cause to be overheated turbine oil in the oil centrifuge preheater system. The preheater pipes had been installed with a slight inclination to the deck to improve accessibility. The tilt caused pockets of air released from the oil to collect in the upper end of the pipes in the vicinity of the electrically heated elements. The result was poor heat transfer—the heater surface temperature soon exceeded 400°F—and serious oil decomposition resulted.

The difficulty was corrected by installing vents on the upper ends of the oil heater pipes. A 30-hour sea test, with the NRL men on aboard to analyze the air, verified that the source of eye irritation and lachrymation had been eliminated. The SNOOK was accepted by the Navy on November 4.

Project Talent for the Navy

A battery of psychological tests is currently being given to 8000 Navy enlistees in an effort to determine how Navy men compare with their civilian counterparts. Qualities to be measured include aptitude, achievement, background, interest, and personality.

The study is an outgrowth of "Project Talent," an earlier inventory of aptitudes and abilities of non-Navy youth, which was sponsored jointly by several government agencies and administered by the American Institute for Research and the University of Pittsburgh. Nearly half a million secondary-school students throughout the country were tested, in additions to samplings of individuals in the same age group who either were not in school or were in lower grades. The data obtained are still being evaluated, and arrangements have been made for

periodic follow-up of the test population in order to relate later behavior to test results.

The present tests for Navy personnel are being carried out by the American Institute for Research under contract to the Office of Naval Research for the Bureau of Naval Personnel. By giving the Navy enlistees the same type of tests that were given to the high-school students, investigators will be able to make comparisons in the areas of career motivation, interest in and preference for occupational fields, and military-service plans. Data obtained in the earlier tests on a representative sample of males just below recruiting age is expected to provide the Navy with a basis for personnel planning. The cooperative study will also aid in determining the relationship between the tests of Project Talent battery and the comprehensive battery routinely administered to Navy personnel.

RV CHAIN Entertains Royalty

The research vessel CHAIN, an MSTS ship assigned to Woods Hole Oceanographic Institution, arrived in Monaco on November 21—a scheduled stop during an ONR-supported Oceanographic trip. The master and chief scientists of the ship attempted to pay their respects to Princess Grace (the former Grace Kelly) and Prince Rainier but were unable to see them. Upon return to the ship, however, the seamen found a message from the Monagasque royalty, requesting permission to visit the vessel. An invitation to commemorate Thanksgiving with the officers, scientists, and crew of the CHAIN was thereupon extended to the Royal Family. The captain later wired the Institution that the experience of entertaining the former actress, her husband, and their two children was "hectic but exciting."

–M. C. McLean, ONR Boston

Moon Used to Transmit Shore-to-Ship Radio Messages

Radio signals sent to a ship from shore via the moon on December 15 marked another first in the Navy's role in the space age. At Stump Neck, Maryland, a Naval Research Laboratory transmitter with a 60-foot dish-pan-shaped antenna was used to direct messages from two high-ranking Navy personnel at the moon. Reflected from the surface of the moon, the messages were picked up by a 16-foot antenna mounted by NRL aboard the USS OXFORD.

The shore-to-ship system is similar to the Navy's Communication Moon Relay System, which has been carrying regular two-way radio traffic between Washington, D. C., and Hawaii for over a year. One difference is that the shipboard antenna is necessarily smaller than the large equipment employed by shore-based CMR stations, so its communication capacity in words per minute is consequently somewhat less. The Navy scientists are conducting further tests of the shipboard circuit to determine the number of additional channels it can support without exceeding the allowable limits of error.

Principal advantage of the moon circuit is reliability. The system is unaffected by the magnetic storms, sun spot cycles, and ionospheric blackouts which often disrupt conventional long-distance earth communication.

For this system to operate, however, the moon must be in simultaneous radio view of both the transmitter and the receiver equipment. Since the moon is so far distant from the earth (about 240,000 miles), it is visible for a sufficiently long period each day to permit a large amount of message traffic to be passed. Round-the-clock operation capability can be provided by supplementing the moon with artificial satellites such as those used in Project ECHO in 1960.

The messages relayed were originated by Admiral G. W. Anderson, USN, Chief of Naval Operations, and Dr. R. M. Page, Director of Research for the Naval Research Laboratory.

The two messages read as follows:

> "Signaling another first in communications by the Navy, this message being sent to you from the U. S. Naval Research Laboratory Field Station, Stump Neck, Maryland, via the moon, conveys my congratulations and best wishes for further success in your research and development work and substantial improvements in Naval Communications based on your scientific efforts.
>
> The Navy, long an advocate of mobility and dispersion for survival, is now taking another significant step forward in developing the survivability of communications by the inauguration of this experimental circuit.
>
> To all involved in this significant event, "Well done!"
>
> (Signed) G. W. Anderson
> Admiral, U. S. Navy
> Chief of Naval Operations

> "This communication from the U. S. Naval Research Laboratory at Washington, D. C., to the USS OXFORD at sea, using UHF radio via the moon-bounce path, marks a significant new "first" in radio. The laboratory is proud of its many great contributions to radio communications over the years and is pleased to welcome the USS OXFORD to the large family of Naval vessels which has participated significantly in the Navy's Radio Communication Research Program."
>
> (Signed) R. M. Page
> Director of Research

Terrain Model of North Atlantic Floor

The "Terrain Model of the North Atlantic Ocean Bottom," recently completed at TDC, is one of the first known attempts to represent in three dimensions an extensive underwater area on an accurate and detailed basis. The terrain model is a synthesis of hydrography, oceanography, coastal topography, military intelligence, and terrain model construction. It's development required detailed examination of available data, and in many instances involved the evaluation of conflicting and unconfirmed information.

Terrain model of North Atlantic Ocean bottom.

Cast in white reinforced polyester epoxy resin, the model is lightweight and easily handled. It represents the entire North Atlantic Ocean bottom, depicting submarine topography with mountain ranges, sea mounts, valleys, plains, volcanoes, canyons, chasms, and undulating terrain of tidal and current drifts in rippled patterns. A band of coastal topography one-half inch wide is included. The three-dimensional Mercator projection measures 33 to 36 inches, covering an area from the Mississippi River to mid-Europe and from the West Indies to Northern Greenland, on a scale of 1 to 10 million; the vertical exaggeration is about 1 to 25.

The terrain model lends itself directly to numerous applications, including instruction in logistics, strategy, navigation, geography, oceanography, and many other areas of study. Prominent features of the terrain model include the Mid-Atlantic Ridge, Continental Shelf, Abyssal Plain, Hudson River Canyon, Puerto Rican Trench, Islands as Submarine Volcanoes (Azores), and Sea Mounts. Utilizing the master mold of the terrain model, investigators can vacuumform transparent plastic overlays portraying marine and meteorological intelligence; the overlays can then be superimposed over the model for the precise location and display of data. –R. L. Wyener, USN Training Device Center

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NOL Makes Big Blasts from Little Ones

The Navy has constructed a 180-foot conical shocktube in which five-pound explosive charges have produced blastwaves as powerful as those generated by simultaneously firing six of the most destructive blockbusters ever dropped during World War II. And it's practically noiseless, too.

Installed at the Naval Ordnance Laboratory, in Silver Spring, Maryland, the device was conceived and developed by physicist William S. Filler of NOL's Explosions Research Department. It is a scale-model, designed to predict the performance and aid in the design of a 2000-foot shocktube in which a blastwave from a 1000-pound charge can be effectively amplified to correspond to that from a nuclear explosion of many kilotons. Such a large-scale shocktube will give the Navy a facility capable of economically creating, "inside the laboratory," repeated radiation-free blastwaves of nuclear size at relatively short intervals.

In light of the nuclear test ban which had been in existence for the past two and a half years, the shocktube has had particular significance. It was undertaken as an economical means of performing ship structure damage tests of nuclear proportion by the Ship's Protection Section of the Preliminary Design Branch in the Navy's Bureau of Ships. Nuclear blast simulators would be equally valuable for testing Army and Air Force vehicles and structures above and below ground as well as bomb shelters for Civil Defense purposes.

The first of its kind ever built, NOL's 180-foot shocktube is a result of NOL-originated research studies which recently announced that such devices make it possible to create and study large-scale blastwaves under controlled conditions without actually firing nuclear charges.

A blastwave from a five-pound explosive charge fired at the small end of the new shocktube is amplified 25,000 times. Such a wave represents a sector of a spherical shockwave generated by about 75 tons of explosives fired in the open. In effect, the small charge shockwave expands within the confines of the cone in the same manner that it would if it were part of the full 75-ton spherical blast pattern. Coupled with the small end of the cone is a "retired" 6-inch naval gun which serves as a firing block for explosives charges. Almost all the noise from these charges can be muffled in the cone by bolting a heavy metal cap over the cone's mouth. Pressure gauges placed along the interior of the cone are used to obtain blastwave measurements.

Charges fired in the gun are one-inch in diameter by nine feet long cylinders of pentolite explosive which rest in the center of the gun barrel's diameter on styrofoam holders. In this position, they subject the gun to no more pressure than it received during service as a weapon.

The cone's developer emphasizes the fact that a shocktube is not a tactical weapon nor would it be feasible to use one as such. He explained that if a blastwave is released from an open-end conical shocktube, it then spreads out in all directions to dissipate in a full blast sphere like that of a small charge if it were fired in the open.

Transatlantic Tuna Tagged

Two giant bluefin tuna that swam across the North Atlantic Ocean from the Bahamas to Norway in less than four months have been reported by the Woods Hole Oceanographic Institution. Frank J. Mather III, in charge of the Institution's tagging program, said the fish were tagged off Cat Cay in the Bahamas on June 1 and 10 of this year. The tags were recovered near Bergen, Norway, on September 28 and October 6.

The distance between the two points is more than 4500 nautical miles. The time between tagging and recovery was 123 and 122 days, respectively. That means an average speed of at least 33 miles per day, assuming the fish started the day they were tagged, swam steadily in a beeline for Norway with no side trips or coffee breaks, and were caught the day they got there. The cruising speed of the giant bluefin is thought to be about three knots, but these fish may have had some help from the Gulf Stream during part of their trip. Mr. Mather noted that the recoveries were interesting not only because of the short time and long distance involved but because the tunas' long migrations are usually thought to occur in spring and fall rather than in the summer.

The long-distance swimmers were tagged by two of the most enthusiastic sport-fishermen participating in the tagging program: Mr. William K. Carpenter, of Wilmington, Delaware, and Captain George Staros, of Ft. Lauderdale, Florida, owner and skipper, respectively, of the sport-fishing boat Caliban II. Mr. Carpenter is president of the International Game Fish Association and a member of the Associates of the Woods Hole Oceanographic Institution. Between them, he and Captain Staros have tagged nearly 100 giant tuna. The one they tagged on June 1 weighed about 484 pounds, the other was about 350 pounds.

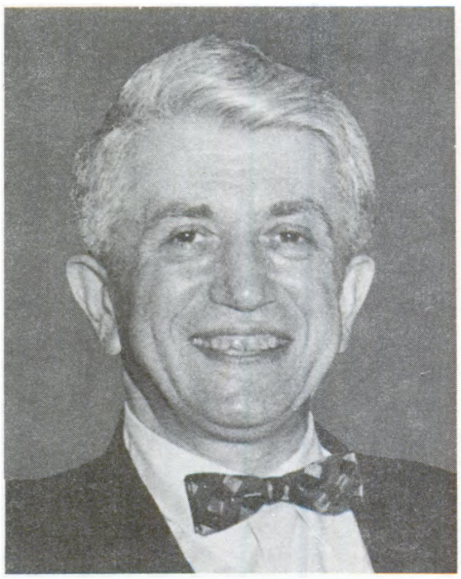
The recovery of both fish was reported by Dr. Johannes Hamre, of the Norwegian Institute of Marine Research in Bergen. He wrote that it was only by a stroke of great luck that one of the tags was noticed at all, for it was found lying on the dock after a catch of 192 bluefins had been unloaded. The tag is a bright yellow streamer attached to the fish with a small barb. Each tag is numbered and bears a legend, in several languages, offering a reward for its return.

Satellite Turned Off

The NRL Solar Radiation I Satellite was turned off after about nine months of useful data transmission because its spin had damped out and it was providing only infrequent solar signals. During its lifetime it measured a variety of solar events. The question of enhancement

of Lyman-α during solar flares was clearly answered, at least for flares of class 1 to 2 importance. Within the accuracy of measurement, no variation of Lyman-α could be detected. In sharp contrast, almost every evidence of solar activity was accompanied by an enhancement of its x-ray emission. The findings indicate that x-ray emission is an extremely sensitive gauge of solar activity.

ONR Investigator Receives Canadian Award



Dr. Albert E. Sobel

Claude Bernard Medal

Dr. Albert Edward Sobel, Head, Department of Biochemistry of the Jewish Hospital of Brooklyn, was awarded the Claude Bernard Medal by the University of Montreal on November 9, 1961. Dr. Sobel received this recognition in scientific achievement on the basis of the outstanding research and significant contributions he has made in the field of calcification of hard tissues. In addition to the medal, the award carried with it an appointment entitled "Visiting Claude Bernard Professor of the University of Montreal" for the year following the award.

Dr. Sobel has been pursuing a research program on the mechanisms of calcification for the Medicine and Dentistry Branch, Office of Naval Research, since September 1, 1952. An example of Dr. Sobel's research is as follows. In a skull fracture where preserved bone has been used to repair the injury, healing occurs in a few months. Dr. Sobel has shown that if the minerals are removed from the bone to be used for the graft, followed by treating the demineralized bone with collagen and chondroitin sulphate, the repair of the bone defect is accelerated, that is, the time of healing is reduced to about six weeks. Some other examples of his research are: composition of diet in relation to the composition of bones and teeth (related to dental caries); learning more about the mechanism through which mineralization takes place in hard tissues; the effects of adding phosphate to the diet as a potential inhibitor of dental caries; and means for the prevention of the deposition of radioactive strontium in bones and teeth.

On the Naval Research Reserve

On-the-Job Training Opportunities

Along with the excellent seminar programs sponsored by the Research Reserve, it is considered most beneficial to intersperse practical on-the-job training at an activity which will enhance the mobilization potential of Research Reservists. In answer to an inquiry initiated by the Office of Naval Research, 54 Navy research and development shore activities reported that they offered such on-the-job training to Research Reservists. Only one of the activities queried gave a negative reply; the type of operation did not lend itself to the training program.

A list of the activities which do have training programs was published in an ONR letter dated January 3, 1962, copies of which have been sent to Commanding Officers of all Naval Reserve Research Companies (one copy for every five members). Additional information includes type of training provided, qualifications necessary for the applicants, and number of billets available in a fiscal year.

Request for active duty for on-the-job training will be handled on an individual basis through the regular channels; i.e., the request originates with the research reserve officer and is addressed to the Commandant of his Naval District via the Commanding Officer of his Research Reserve Company and the Branch Office Reserve Assistant. If the request is approved by the Commandant, the Branch Office Reserve Assistant establishes a billet at one of the participating activities. In order for the training to be as meaningful as possible, the activity is provided with the qualifications of the applicant. Such information includes security clearance, active duty billets, inactive duty training billets, academic attainments, and present occupation or specialty.

Naval Leadership Program at NRRC 12-5

The naval leadership program, despite its desirability, is difficult to present. Last year, members of Naval Reserve Research Company 12-5, Berkeley, California, instituted a program which was a deviation from the usual method of considering the subject. Instead of devoting an entire drill period to the topic of leadership, NRRC 12-5 reserves a period of approximately twenty minutes at the end of each drill for considering a particular problem, such as one selected from NAVPERS 15924, "Principles and Problems of Naval Leadership." The problem is presented to the members, and a junior officer, by assignment two weeks in advance, presents his recommended course of action for solving it. One of the senior officers then comments on the recommended solution and adds his own comments. The problem is then thrown open to the general membership. Frequently, it turns out that some of the members have encountered similar problems before, and the action taken at that time is compared with the recommended course of action. The underlying principles and recommended approach are summarized by the executive officer at the end of each discussion session. NRRC 12-5 reports favorable results from this procedure.

Pass the Word

The "Research Reserve" section of Naval Research Reviews is intended as a medium of exchange of information for companies of the Research Reserve Program. But in order to provide for this exchange, we need to hear about newsworthy happenings within the companies. These happenings may concern company activities or individual Research Reservist's accomplishments. There may be an outstanding or unusual training program in progress; a company may be working on a company research project; or some member may have performed an outstanding service or received special recognition. Let us hear about them.

Reporting is easy. Just send the item to the Chief of Naval Research (Code 120), Office of Naval Research, Washington 25, D. C. If a photograph is available, send it along, too. The deadline for each issue is the 5th of the month.

Award-Winning Study Available for Drill Meetings

Winner of the first A. Hoyt Taylor Award was announced in the January issue of Naval Research Reviews. This award is based upon scientific achievement in national competition among Research Reserve Companies. The study submitted by the winner, NRRC 3-9, was entitled "An Evaluation of the Need for Filtration Systems for Protection of Personnel in Structures Against the Acute Hazards of Radioactive Contamination of the Atmosphere."

Material for the study has been submitted to the Office of Naval Research and is available to Naval Research Reserve Companies for presentation at drill meetings. Included are a two-track tape recording, twenty-two 3-1/4 by 4-inch slides, and an instruction book, all unclassified. Requests for the material should be submitted to the Office of Naval Research (Code 120), Washington 25, D. C. The date desired and an alternate date, if possible, should be specified.

Research Reserve Seminars Postponed

Two Research Reserve Seminars have been indefinitely postponed because of unavailability of funds:

- Submarine and Diving Medicine Seminar, New London, Connecticut, originally scheduled to convene March 19, 1962.
- Electronic Computer Seminar, Newburgh, New York, originally scheduled to convene April 2, 1962.

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Nation's Largest Radar Dish at NRL-CBA

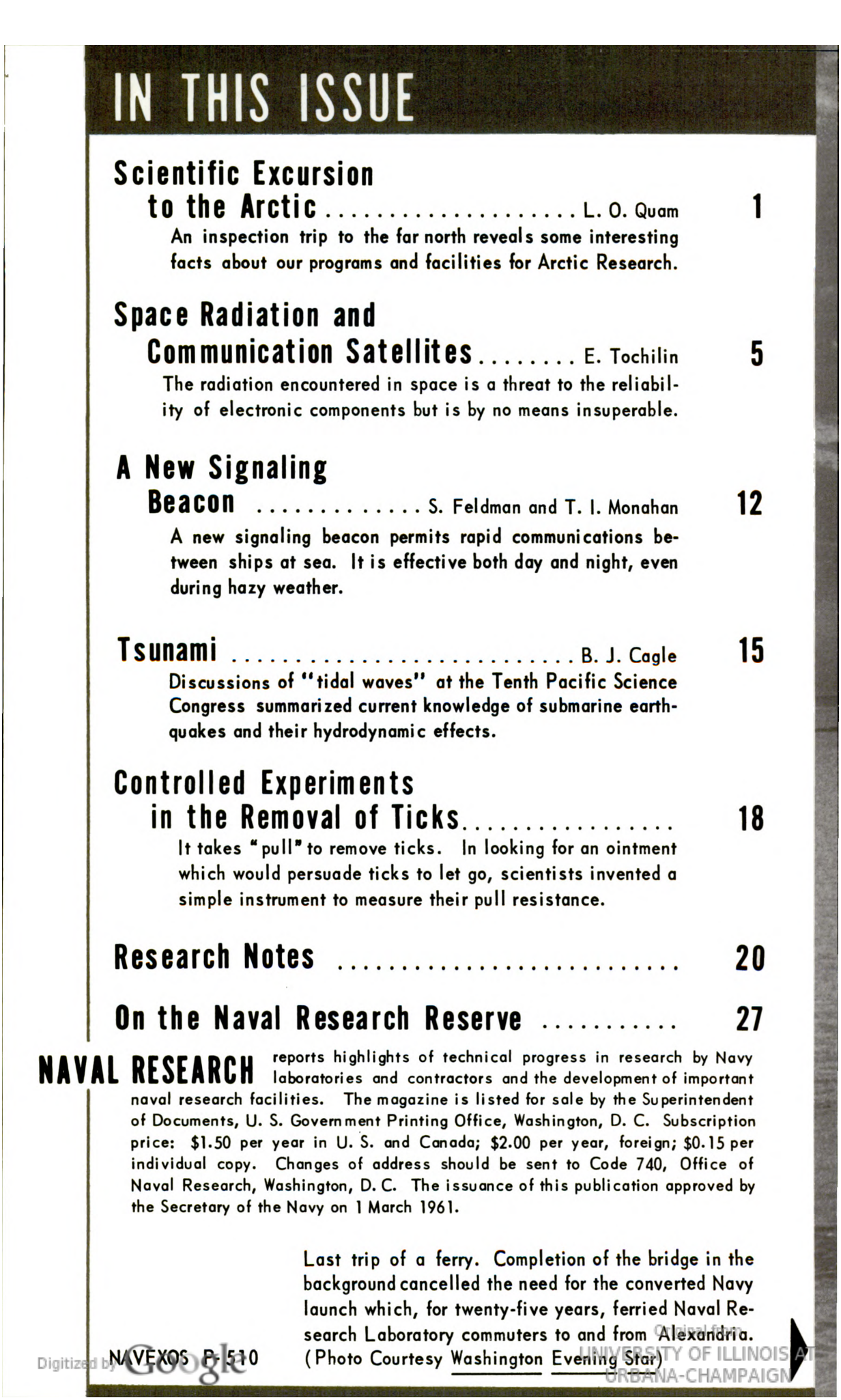
The photograph shows steelworkers putting the last panel in the Navy's newest king-size radar antenna. The 150-foot dish, the largest in America, was erected at the Naval Research Laboratory's Chesapeake Bay Annex. It will shortly be turned over to the Navy by the prime contractor--Stanford Research Institute—and will be "on the air" by mid-spring.

The antenna will be used principally for tracking missiles and satellites and for studies involving space physics and electromagnetic propagation. When free time is available, the big dish can be employed as a telescope for research in radar astronomy.

The antenna, supported on four wheels, rotates on a single circular rail, and can be elevated from the horizon to the zenith. Both drives are accomplished hydraulically by means of modified surplus Navy gun mounts. Both motions are fast enough to track a high-velocity missile or satellite.

IN THIS ISSUE

NAVAL RESEARCH reports highlights of technical progress in research by Navy laboratories and contractors and the development of important naval research facilities. The magazine is listed for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. Subscription price: $1.50 per year in U. S. and Canada; $2.00 per year, foreign; $0.15 per individual copy. Changes of address should be sent to Code 740, Office of Naval Research, Washington, D. C. The issuance of this publication approved by the Secretary of the Navy on 1 March 1961.



Last trip of a ferry. Completion of the bridge in the background cancelled the need for the converted Navy launch which, for twenty-five years, ferried Naval Research Laboratory commuters to and from Alexandria. (Photo Courtesy Washington Evening Star)