OFFICE OF NAVAL RESEARCH OCTOBER 1953

RESEARCH REVIEWS

NAVEXOS P-510

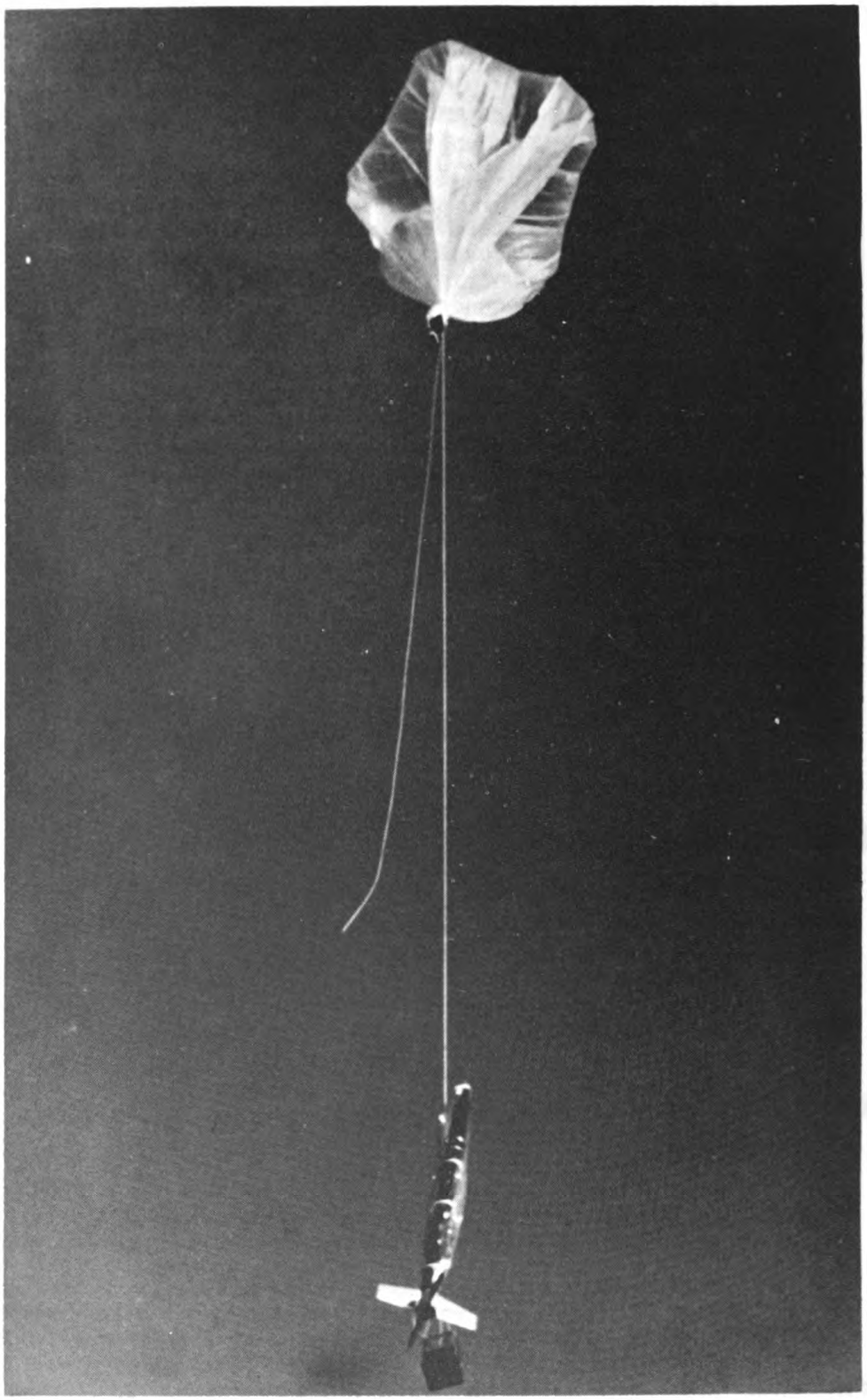
DEPARTMENT OF THE NAVY
WASHINGTON, D. C.

COVER PHOTO: A vital part of ONR's Project MUSHRAT, the USS STATEN ISLAND AGB 5 carried scientists and equipment to western Greenland, where the flight deck of the ship was used as the base of operations for sending up balloon-launched rockets. The experimental group—representing government, the universities, and industry—had a two-fold purpose: To study cosmic radiation at the Geomagnetic North Pole and to gain information about weather conditions miles above the earth in extreme northern latitudes. For more about this, see "Upper Atmosphere Research" on pages 1 to 6.

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

Approved by Bureau of the Budget, 14 February 1952

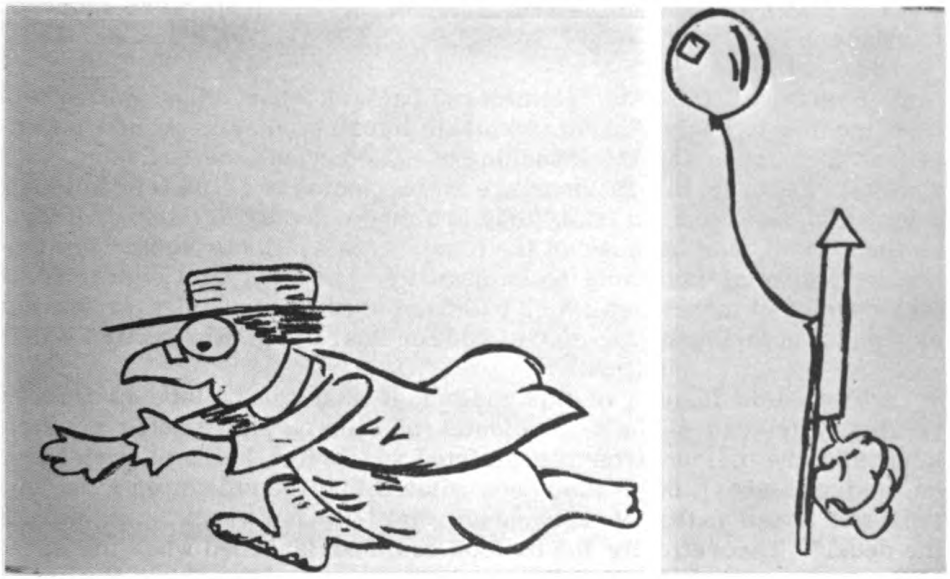
In This Issue



Launched from the small flight deck of the USS STATEN ISLAND, a SKYHOOK balloon trailed by a Deacon rocket soars into the air. This rocket, carrying scientific instruments in the nose cone, rose to a record height of 66 miles.

Upper Atmosphere Research

Rockets fired from balloons aid the ONR-AEC joint program of basic research in nuclear physics and NRL's research on the physics of the upper atmosphere.



Balloons rose into the cold skies above western Greenland during July and August, as ONR's high altitude research expedition—with the assistance of BuAer, BuOrd, and MSTS—gathered information on cosmic rays and the physics of the upper atmosphere. Far from the Washington summer, the group probed into phenomena which can be observed only in the vicinity of the geomagnetic pole. At this point, near Smith Sound (78.5°N, 69.0°W), cosmic rays "get through" with less interference than at any other spot on the earth. Here the earth's magnetic field causes a minimum of deviation in the path of an incoming cosmic ray particle. Therefore it is possible to measure the energy and charge spectrum down to much lower energies than at any other place. A glance at the diagram on page 2 is the easiest way to see why this is true.

Project MUSHRAT, named after Deacon Mushrat (above) of Pogo comic strip fame, included one group from the State University of Iowa who set out to measure cosmic-ray intensity above the earth's atmosphere by means of geiger counters and ionization chambers carried in instrumented rockets which were launched from balloons at altitudes of about 70,000 feet. It included another group from the Naval Research Laboratory who measured atmospheric pressure, density, and temperature at altitudes above 100,000 feet—also by means of balloon-launched rockets. The third group, from General Mills, Inc., had primary responsibility for furnishing and launching the high-altitude balloons.

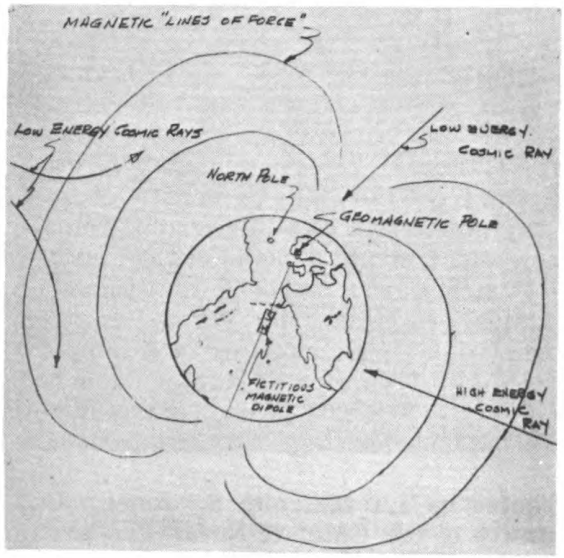
The whole project was directed by LT Malcolm S. Jones, Jr., CEC, USN, designated representative of the Chief of Naval Research. Other members of the expedition were: Dr. Melvin B. Gottlieb, Leslie Meredith, and Raymond B. Ellis (State University of Iowa); Herman

Legow, Karl Medrow, and Raymond Newell (Naval Research Laboratory); David Church and Raymond Krieg (General Mills Inc.).

The expedition started out on the USS STATEN ISLAND AGB 5 (formerly the NORTHWIND), from which fifteen balloons were launched. Then, well past the midpoint of operations, the ship received a hurry-up call to go farther north to break ice. So a transfer was made to the USCGC EASTWIND, and the remainder of the 24 flights were launched from there.

Besides all the data telemetered back to these ships, which will take months to analyze, other valuable information was gained on improved techniques for the launching of balloons and the balloon-rocket system. Because the balloons are so big (some are 105 feet in length when uninflated) and so frail (they are made of polyethylene 1/1000 of an inch thick), and because of the small area available aboard an icebreaker, special launching techniques are necessary. General Mills Inc. developed techniques which had been used successfully in similar experiments during the summer of 1952 on board the USCGC EASTWIND.

The basic feature of this method is that the balloon is inflated vertically instead of in a horizontal position. This makes possible launching the balloon from a restricted space (the helicopter platform on the icebreaker), but it also necessitates that the ship be moving with the same speed as that of the wind in order to provide "zero wind across the deck." Theoretically the balloon could be launched when the speed of the surface wind equalled the maximum speed of the ship. But speed changes while the ship is operating at maximum power take appreciable periods of time to accomplish, and it is therefore difficult to adjust to minor fluctuations in wind velocity. For this reason, balloon launchings are usually not started until the surface wind is below a velocity of 10 knots and there is some assurance that it will remain below this velocity for at least two hours. (From a larger deck space, say that of an aircraft carrier, different launching methods can be used and "zero wind" is not required.)



The geomagnetic effect on cosmic radiation

Once there is assurance of continued light winds, the balloon is taken out of its box and laid on the deck in a circular pattern. Helium is then introduced into a tube which runs from the open appendix of the balloon up through the inside of the crown. The outside is held by a plastic "reefing" tube which protects the balloon from damage while being handled, and which prevents it from billowing out in the form of a sail in light winds. The helium, introduced into the crown by the inflation tube, forms a bubble which starts to rise into the air. As the bubble grows

A 55-foot SKYHOOK balloon is carefully laid out on the flight deck of the USS STATEN ISLAND, and helium is slowly pumped into the upper portion through an inner sleeve. At takeoff the balloon is inflated only enough to lift its cargo; the helium then expands as the balloon rises. In an upright position in the center of the deck is the Deacon rocket to be carried aloft by the SKYHOOK.

larger it has more lift and rises higher, carrying with it more of the balloon until it is all in a vertical position. Inflation is continued until the gas bubble is able to lift a weight which is equal to the load to be flown plus a predetermined amount of free lift. This operation is known as "weighing-off."

When the balloon lifts the weigh-off weight, the flow of helium is stopped and the helium inflation tube is removed. The reefing tube on the outside is also removed and the balloon is ready for the attachment of the scientific equipment and the take-off. (For the balloon-rocket flights, the balloon is let up about 100 feet in the air on a line from a winch before the rocket is attached.) The balloon is inflated to only about 10 percent of its full volume at take-off. As it rises, the helium expands, filling out the balloon until it reaches ceiling altitude, where it is completely distended. Any excess helium pressure is valved out the open appendix at the bottom, and the balloon floats in static equilibrium.

The altitude of the balloon is ascertained from information transmitted by a standard 403-megacycle radiosonde. The flight is normally terminated by the firing of the rocket. However, in case the rocket does not fire by a prescribed time, or if the balloon descends below 30,000

feet in altitude, the flight is terminated by electrical switches. The radiosonde also provides information on the position of the balloon.

The total operation required about 800 cylinders of helium. Approximately 35 cylinders are needed per flight. In order to provide for the safe and orderly stowage of these cylinders aboard ship, the U. S. Naval Shipyard, Boston, fabricated a series of racks which could be mounted on the stern of any of the fleet icebreakers. These racks fit on the main deck near the towing equipment under the flight deck.

The balloon-rocket method, commonly referred to as Balloon Assisted Take-off (BATO) or Rockoon, was developed by Dr. James A. Van Allen at the State University of Iowa. (In the Naval Research Laboratory tests a new-type nose cone designed by NRL scientists was used.) In this method, a small rocket is lifted to altitudes of about 50,000 feet or higher by a 55-foot diameter SKYHOOK balloon. At a fixed altitude or time, the rocket is fired in an almost vertical direction. With the aerodynamic drag of the lower altitudes eliminated, the rocket achieves an almost perfect vacuum ballistic trajectory and attains altitudes greatly in excess of those which can be reached from a sea-level firing of the same rocket.

A small FM transmitter (300 milliwatts), located in the nose cone together with the batteries for all the electronics instrumentation, telemeters signals from a geiger counter, ionization chamber, or pressure and temperature instruments. The transmitter is modulated by a subcarrier whose frequency shift is proportioned to the size of the output signal from the measuring instruments. The rocket has an insulated disc section at the end of the nose cone which effectively divides the rocket electrically into two sections. The transmitter feeds each half of the rocket, which then radiates as a dipole. By this method, the whole rocket is used as an antenna whose physical size is compatible with good propagation at the frequency being used for telemetering. Therefore, no external antennas are needed.

The radio signal is received at the ground station where the detector signal is unscrambled from the FM carrier. This signal is then amplified and recorded by a Brush recorder on a moving strip of paper. This makes it possible to determine the cosmic-ray intensity or temperature, pressure, and density at any time during the flight. Because of the dipole radiation pattern from the rocket, it is also possible to determine if the rocket is "tumbling" by noting variations in signal strength. The antenna used at the ground station can also be moved in azimuth and elevation angle to follow the flight of the rocket.

The rocket consists essentially of the motor, tail fins, lifting hooks, and nose cone. The motor unit is the Deacon, which is produced by the Allegany Ballistics Laboratory, Cumberland, Maryland. It burns for approximately 2 seconds, and during this period the rocket attains enough momentum to coast up to an altitude of about 250,000 feet if there were no air resistance. The motors are shipped in an inert form and can be stored on deck if necessary. The only requirement is that the motor should be gradually warmed to about 70° F before firing.

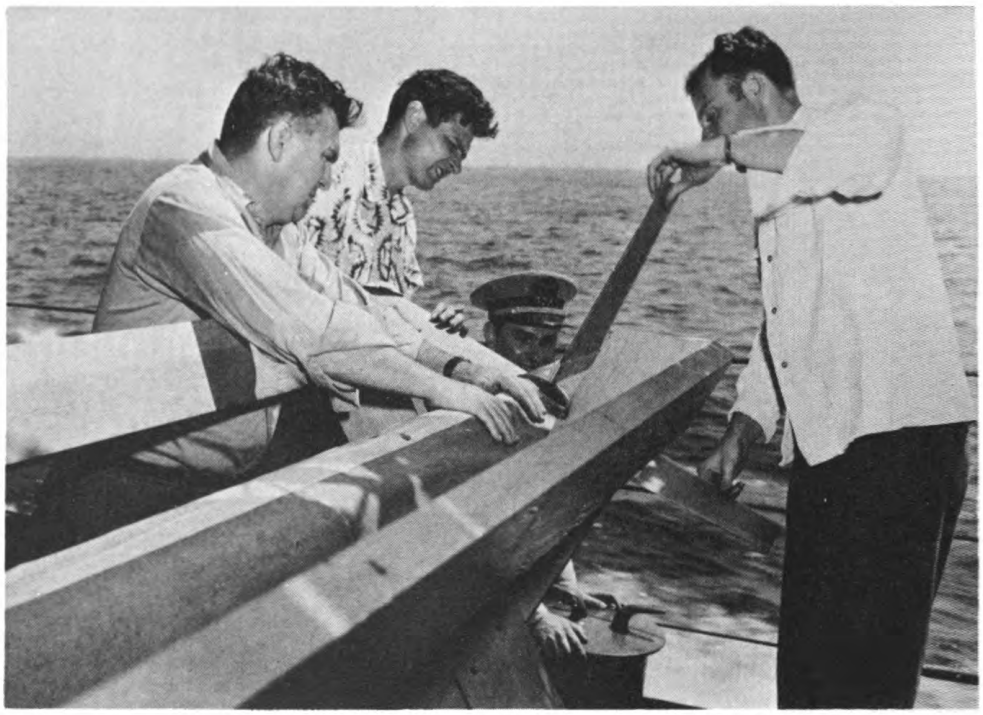
After the motor has been warmed it is taken out of its shipping box and the assembly is started. The first step is to screw on the tail fins.

At right, the sleeve is being removed from the partially inflated balloon. At left, the rocket is being raised and covered with a plastic "Greenhouse" to keep it warm. Below the rocket is the automatic timing device.

Then the igniter is installed and connected up to the firing gondola which is suspended under the tail. The firing gondola has previously been checked and adjusted so that it will fire the rocket at a desired altitude. If this altitude is not reached, a clock mechanism will fire the rocket at a set time after take-off. The firing circuit is shorted out so that it cannot fire the rocket accidentally before take-off. After the firing gondola is attached, the transmitter in the nose cone is turned on and all instruments receive their last check-out. The nose cone and lifting hooks are then installed. Since the temperature at high altitudes is about -40°C, the batteries for the instruments and the radio transmitter might freeze. In order to prevent this, the rocket body is painted a dull black so as to absorb solar radiation when above the clouds. The last step in assembly is to cover the whole rocket with a transparent plastic "Greenhouse," which helps to keep it warm.

Once the rocket is fully assembled and the final instrument checks are completed, the balloon is let up about 100 feet in the air on a line. The load line from the balloon, which has the altitude telemetering radiosonde and cut-down switches on it, is attached to a lifting hook on the side of the rocket by means of a simple steel ring. The hold-down line is then slacked off and the balloon picks up the rocket. The last act before letting the flight go is to remove the short circuit from the firing gondola.

The balloon lifts the rocket at a speed of about 800 feet per minute. At an altitude of about 70,000 feet, a pressure switch in the firing gondola



Tail fins are being fitted on a Deacon rocket by (left to right) Mr. Karl Medrow and Mr. Herman Le Gow of the Naval Research Laboratory; LT M. S. Jones, Jr., CEC, USN, Office of Naval Research; and Dr. Melvin Gottlieb, State University of Iowa.

closes, setting off the igniter inside the rocket, which then takes off, slipping out of the ring on the load line. Because of the large acceleration of the rocket, approximately 35 g's, the firing gondola and the "Greenhouse" will fall off. The rocket hangs on the load line at an angle of about 7° and therefore should miss the balloon. However, because of the thinness of the balloon material and the high speed of the rocket, it is doubted that any damage would occur to the rocket if it did hit the balloon.

After the rocket stops burning, it coasts the rest of the way up to an altitude of about 300,000 feet, taking measurements continuously on the way up and on the way down. For cosmic ray purposes, the maximum altitude achieved is not an important quantity, but it is representative of the length of time that the rocket is above the appreciable atmosphere, and therefore the length of time that cosmic-ray data can be taken. On its downward flight the rocket gains speed. When it returns to the dense lower atmosphere it will be going about four times the speed of sound. However, the drag of the atmosphere soon slows the rocket down to its terminal velocity.

Operation of the balloon-rocket system was highly successful, and new techniques developed since last year's expedition proved valuable. As for information on cosmic radiation and the physical characteristics of the upper atmosphere, results of the expedition must be carefully analyzed and studied. But expectations are that the yield will be high in scientific information that can be used as a basis for much future research.

The Geography of Human Disease

Jacques M. May

. . .heads a program of research in medical geography at the American Geographical Society. He is now publishing an Atlas of Diseases under ONR contract.

Disease is not just an inconvenience or a tragedy in human life. It can also be viewed as a phenomenon arising from the great conflict which the fact of living among other organized living things brings about. It is, therefore, a part of life and should be studied in its proper perspective and without anthropomorphic bias. Thus we can conceive of disease as a phenomenon inherent to the world we live in and as natural and inevitable as the ebb and flow of the tide or the succession of day and night. In this way we can shift the focus of our attention from the personal unpleasantness of disease to the innumerable factors, with deep roots in the universe, which bring it about.

It is the basic assumption of medical geography—or the ecology of disease—that by trying to unravel these causes and by studying the pathological phenomenon as part of the process of living, much will be gained toward the understanding of disease and, eventually, toward its control. Naturally the first grasp we have of this phenomenon is superficial. A man is sick in a certain place. Another man is sick in a different way at a different place. The correlation between the different types of sickness and the different "habitats" is the purpose of our work.

The forces that operated millions of years ago to shape the physical environment as we know it govern the pattern of diseases as we discover it now to exist. The medical ecologist observing disease from his superficial prima-facie knowledge has to find his way back to these primeval forces for there is a continuous chain of events, a definite cause and effect relationship, from the genesis of landforms, climates, flora, and fauna to the present mapping of diseases being undertaken at the American Geographical Society under the sponsorship of the Office of Naval Research.

Climate in general has evolved into regional climates which climatologists have taught us to group according to common characteristics. These regional climates can themselves be broken down into smaller and smaller units. Thus climates vary not only between the poles and the equator, between the level of the sea and the tops of the mountains, but between the bottom of a little depression as big as the palm of one's hand in a field, and a similar depression two feet away. All these variations occur according to natural laws, some of which man has discovered and learned to understand, some of which remain mysterious and represent the field of research for tomorrow.

In this wide range of microclimates life at one time appeared. It is a difficult thing to define. For the present we can only say tentatively that life is a perceptible dynamism in a perceptible thing. This dynamism expresses itself through adaptation to the environment and through multiplication of the original living form. If adaptation fails, death of the original living form unavoidably occurs. If multiplication were not checked, there would be no limit to the expansion of the same form; but other forms and inner limitations see to it that multiplication is checked.

Life multiplied and adapted itself in numerous forms in the various habitats which regional and microclimates provided for it. It progressed from the vegetable kingdom through the animal kingdom to the advent of man. This new form was remarkable by its most versatile adaptability, enabling man to withstand most of the climates of the world and to multiply in them.

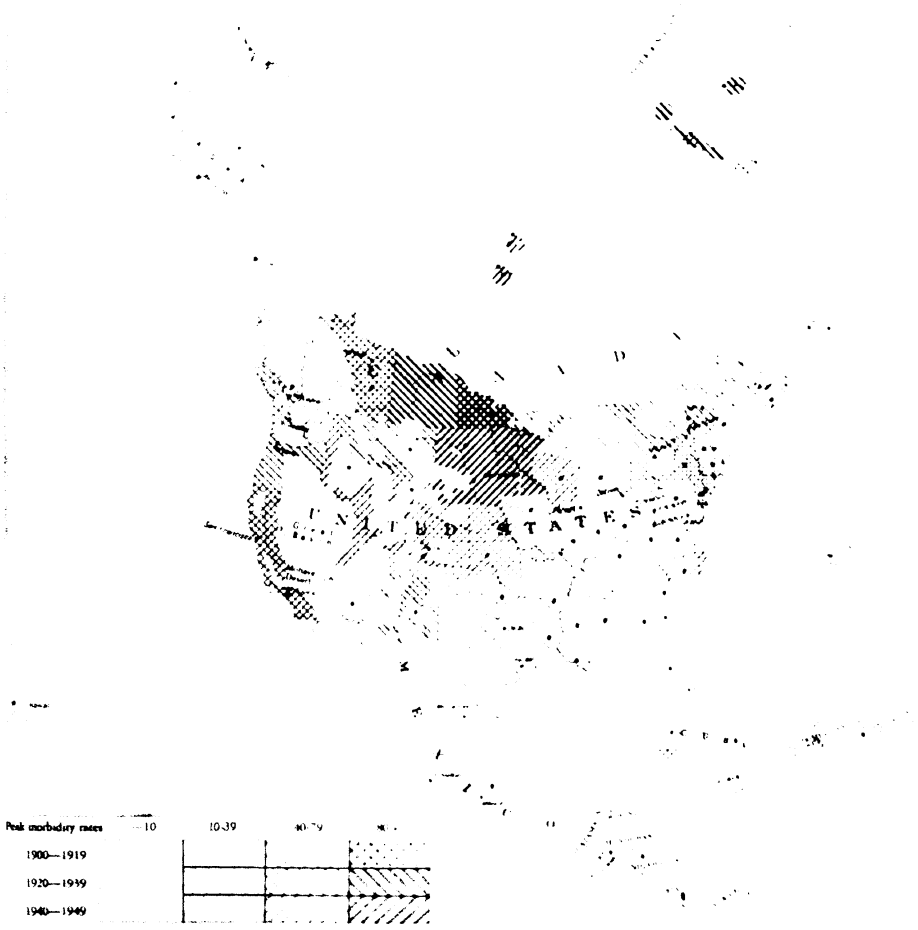
Man seems first to have established himself in high places so that he would be protected against attack from his fellows. In so doing he increased his feeding difficulties; eventually, however, he developed means of protection, housing, and communication which enabled him to adapt himself to the fertile plains and to resist aggression and destruction from other living forms and other men. He was not always successful, and the battles fought by his own versatile physiology to adapt itself to climate and by his specialized living cells to resist infection represent what we call "pathology"—that is, disease.

Thus we can conveniently divide diseases into two groups: (1) those that represent the temporary (reversible) or permanent (irreversible) alterations sustained by man's physiology in the battle of adaptation, and (2) those sustained by the battle against viral, bacterial, and animal aggressors. In modern parlance the former are the degenerative diseases, the latter the transmissible.

It would be convenient at this point to list the environmental factors which we can recognize, and perhaps to measure their influences upon the occurrence of disease. However, this is not yet possible. Furthermore, it is hard to know which of these factors are instrumental in fostering the phenomenon, as they often coexist. They are of three kinds: physical, cultural, and biological. Physical factors comprise the elements of the physical environment, such as soil, water and air. Cultural factors include religion, diet, and housing—in short, the standard of living. They are the result of the reciprocal actions of man and his environment in his fight for adaptation, and have been transmitted from man to man and from generation to generation. Biological factors include the other forms of aggressive life, still in competitive or subservient relationship with man. Such are the bacteria, the viruses, the disease-bearing arthropods, the disease-fostering parasites, as well as plants and edible animals with their life-sustaining proteins.

It is not possible in the scope of this article to give more than a few examples to illustrate the relationship between these physical, cultural, and biological factors and the occurrence of degenerative diseases. In the physical group the waters for instance, because of their chemical composition, seem to have an action on certain glands (goiters) or on human teeth (dental caries). In the second group one may mention the relationship between foods and the nutritional diseases of man. These food habits, which reflect cultural tastes and taboos, methods of cooking, and so on, the origin of which is often difficult to detect, govern a number of nutritional diseases and possibly also the physical types, the way of thinking, and the behavior of entire populations.

In the third group the relationship between biological life and the occurrence of human disease is best illustrated if we note more specifically the transmissible diseases. These should be viewed as a complex. In its simplest form an agent of disease (germ) attacks a victim (man).



The distribution of poliomyelitis in North America from 1900 to 1950. The legend refers to the number of cases per year per 100,000 inhabitants. This is one of a series of maps showing world distribution of polio.

This is what happens, so far as we know now, when cholera or poliomyelitis occurs. Although cholera can explode in epidemics in almost every corner of the world, it soon disappears from these places, but there are a small number of localized districts in India where cholera is permanent, where it has found its home and whence it erupts under certain circumstances, some of which are well defined and some not. Poliomyelitis is found to exist in various forms practically all over the inhabited world. But in one place it may take the form of severe, periodical summer outbreaks, hitting selectively certain age groups of human beings; in another it may occur in a mild, practically unrecognizable form at almost any season, striking a different age group. There is reason to believe that geographical factors have something to do with this pattern of occurrence, but so far this has not been demonstrated.

In a second type of transmissible disease the germ is not usually conveyed to the victim directly; the intercession of a third party, the vector, is needed. This vector carries the agent from one man to another by breaking the skin of both men to suck from one and to inject into the other the lethal living organism. A good example of this is malaria. However, malaria occurs in different seasons in different

places. The world has been, malaria-wise, divided into zones of permanent transmission, zones of twice yearly transmission, zones of yearly transmission, and zones that are free from malaria, even though at least two elements of the malaria complex—man and mosquito—are present. Thus geographical factors govern the pattern of occurrence of this disease, which reveals itself only when the ecology of man, germ, and mosquito coincide.

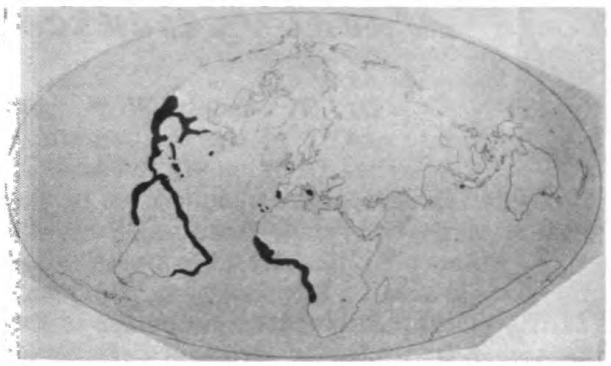
In certain cases, still other factors are involved, namely, an intermediate host or reservoir. The intermediate host is a living form which is needed to allow the agent of disease to complete its own life cycle outside man's body. The reservoir is a living form, usually a mammal, which sustains in its tissues or fluids the agent of a human disease. If a vector connects the ecology of the mammal with the ecology of man by bringing the agent from one to the other, then human disease is possible.

A good example of this is plague. Here the map of disease will be the sum total of the localities where the ecologies of mammal, agent, vector, and man coincide. However, this will only show the places where the disease can occur. Other circumstances come into play to make it actually exist—for example, variations in temperature and humidity and in the susceptibility to infection of at least two factors involved in the complex. We could prolong the description and give examples of more complicated pathological complexes where several cycles interlock; for instance, yellow fever. But the dominant point is that temperature, soil, water, and air combine endlessly to create an infinite variety of propitious circumstances in which the adaptability of man is challenged to resist or to succumb to disease.

Having defined the ecology of human diseases, the question arises, how does one study it? The difficult aspect of the problem, as noted above, is that our grasp of the subject is limited to what we can observe on the surface. What we see is only the sick man, and the first thing to do is to recognize the symptoms of his disease: physically (by microscopic and macroscopic examinations), functionally (by devising more and more searching methods of studying physiology), and biochemically (by penetrating deeper and deeper into the intimate mechanism of tissues). This is the clinical aspect of medicine, and since Hippocrates' day physicians have done a pretty good job of working at it. Hippocrates, indeed, saw further than that and, to guide man's mind towards the understanding of the causes of disease, suggested that the "airs," "waters," and "places" surrounding disease should also be studied. Enriched by the clinical, bacteriological, and biochemical knowledge acquired by his predecessors, the medical ecologist of today is now prepared to follow Hippocrates' advice.

The first step is to make a census of what is known—to discover the actual occurrence of disease and to plot it on maps. Then we can study the ecological factors prevailing in the region, and see whether these factors are common to the various places of occurrence. This method has, unconsciously if not explicitly, governed the great epidemiological discoveries of the modern era, such as the role of mosquitoes in malaria transmission and the relationship between certain soil, temperature, and humidity factors and the occurrence of hookworm diseases. But it has not yet been used in a systematic manner for the avowed

purpose of penetrating deeper into the mystery of pathology. The advantages of the method seem obvious when we look back upon solved problems, but the method itself seems somewhat irrelevant when we project it into the future against unsolved problems. Thus the importance of ecological factors in malaria is clear, almost obvious. In poliomyelitis it is strongly suspected, but in cancer it is completely rejected by many.

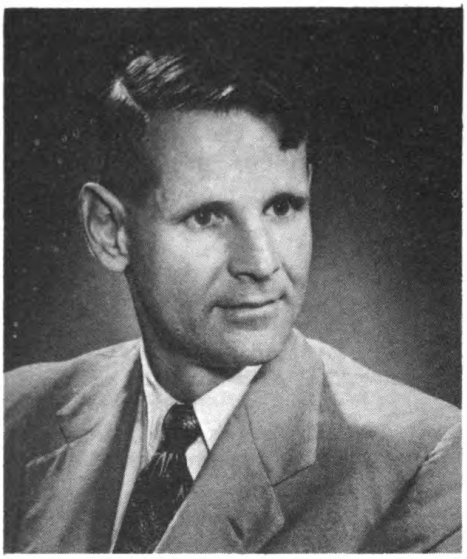


The recorded occurrence of yellow fever from 1600 to 1930 was limited to the shores of the Atlantic and Pacific. Dr. May has other maps showing the distribution of yellow fever all over South America and Africa, as revealed by the mouse protection tests started in 1930.

One of the main difficulties in taking the first step is that we do not know "who" has "what" and "where." Most of the pathological phenomena are not observed; if observed, they are not reported; if reported, they are erroneously interpreted. Thus, our geographical knowledge of the occurrence of disease is, to say the least, fragmentary. A good example here is the status of yellow fever prior to the mouse protection tests started in 1930. Up to that time yellow fever, as revealed by crude clinical observation, was limited to the shores of the Atlantic and the Pacific. As soon as subclinical and mild forms, or perhaps sometimes merely exposures, became detectable by the mouse protection tests, the occurrence of yellow fever, and hence of an ecology favorable to yellow fever, was detected all over South America and all over Africa. Another discovery was made, fascinating but mysterious—yellow fever was found not to exist in Asia and Oceania in spite of the presence of the mosquito vector and of an enormous susceptible human population.

If we are successful in completing the first step and an Atlas of Disease is compiled to show the pattern of distribution of human diseases throughout the world, the second step will be to list the geographical correlations common to the different areas of occurrence. It is conceivable that some striking common factor would then reveal itself in such a comparative study, perhaps leading eventually to a practical method of control.

A third step might even be envisioned; this would be the study of the correlation that exists between the agents of disease themselves. It is already apparent that certain agents attenuate or reinforce each other from the point of view of their aggressiveness toward man. Interferences between one disease and another could thus be brought to light. This study has just begun in the laboratory, but nothing is known as to what occurs in the limitless experiment that is going on in nature. If these facts could be revealed and interpreted, an important aspect of man's adaptation to his habitat would be discovered.



Dr. F. J. Weyl

Who's Who in Naval Research

Dr. F. Joachim Weyl, new Director of the Mathematical Sciences Division—in place of Dr. Mina Rees, now Dean of the Faculty of Hunter College—is almost literally a born mathematician. His father, Hermann Weyl, Professor Emeritus of the Institute for Advanced Study at Princeton, is one of the top men in the field and his mother shared her husband's mathematical interests. By the time young Joe, in his teens, left his home city of Zurich, Switzerland, he had already been met by most of the leading mathematicians of Europe and America.

Dr. Weyl began his higher education at Gottingen, then switched to Swarthmore where he graduated in 1935. Joining his family in Princeton for graduate study at the University, he received his Ph.D. in 1939. Part of his work was done at Illinois where he held a teaching fellowship from 1937 to 1939. Next he settled down to what he believed would be a quiet academic career at the University of Indiana. But in 1944 came a wartime interruption, and he was called to Washington to do high explosives research for the Navy's Bureau of Ordnance.

After the war Dr. Weyl planned to go back to teaching. He was persuaded, however, to stay with the Navy—the immediate lure was the Bikini operation on which he did much of the theoretical computing for the Bureau of Ordnance Instrumentation Group. Bikini passed, for formation of a promising new organization—ONR—aroused his interest. He was offered and accepted responsibility for the applied mathematics program. He has been with ONR ever since, though 18 months of the time (1951 to 1952) were spent at ONR, London. Dr. Weyl, still on the near side of 40, looks even younger. A slender man whose accent oddly suggests Britain, his keen interest in his work is immediately apparent. Here is a man, it is clear, easily capable of encompassing all the fields—logistics, statistics, mechanics, applied mathematics—that are included in his division.

Married while teaching at Indiana, Dr. Weyl has two charming daughters—nearly old enough now to start asking for expert help with their algebra.

Evaluating Research Personnel

John C. Flanagan

Director of Research at the American Institute for Research

James W. Altman

Research Associate at the American Institute for Research

In any organized work activity, among the most important decisions made are those concerning selection, placement, and promotion of employees. The smooth running of the organization, as well as the proper development of personnel, depends upon adequate assessment of their past performance and potentialities for the future. Some type of evaluation—either subjective and implicit or objective and explicit—must be made.

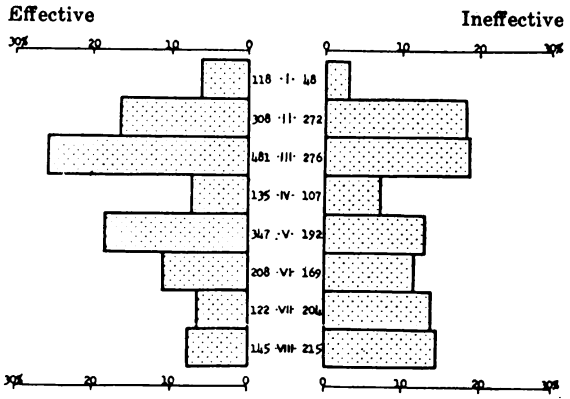
To solve some of the special problems involved in evaluating research personnel, a program aimed at the development of objective procedures was undertaken by the American Institute for Research in 1948 under contract with the Office of Naval Research. The first step was to define successful and unsuccessful performance of research work. Almost 500 senior scientists were interviewed in 17 naval and three civilian research laboratories. From these scientists, 2573 critical incidents—reports of observed on-the-job behavior which was judged either especially effective or especially ineffective—were obtained. Critical behaviors—that part of the incident describing the especially effective or ineffective performance—were then abstracted from the noncritical descriptive portions of the incident. A total of 3347 critical behaviors were thus obtained. These behaviors were then inductively classified into nonoverlapping categories. Eight main areas and 36 sub-areas resulted from the classification. The percent of total effective and ineffective behaviors falling within each area is shown in the graph on the next page. Below the graph are shown the main areas of classification with the sub-areas they include.

The classification of critical behaviors was developed into a checklist of critical requirements. Each behavior in the classification was described in a short objective statement. Homogeneous areas of performance were defined to aid in locating behaviors on the list of critical requirements.

From these critical requirements, two forms were developed for evaluating research personnel with a record of critical incidents observed on the job. A long form lists main areas and sub-areas of performance with items describing individual behaviors shown under each sub-area. A shorter form lists only main and sub-areas of performance with spaces under each sub-area for entering the date on which a critical behavior in that area occurs. These forms were then tried out, with the cooperation of supervisors, at three government laboratories. The supervisors for four weeks recorded the outstanding and the unsatisfactory behaviors of their immediate subordinates. During the test certain

variables were studied including: (1) the long versus the short evaluation form; (2) comprehensive versus abbreviated training in the use of the critical incident procedure; (3) recording of incidents daily, weekly, or monthly.

Participating supervisors returned the completed forms together with their comments and answers to questions about the test. The graph opposite shows the average number of incidents reported for each experimental variable.



Percent of total effective and ineffective behaviors falling within each of eight classifications. Roman numerals represent area groupings. Arabic numerals indicate the number of behaviors represented by the graphed percents.

I. Formulating problems and hypotheses, including: identifying and exploring problems; defining the problems; and setting up hypotheses.

II. Planning and designing the investigation, including: collecting background information; setting up assumptions; identifying and controlling important variables; developing systematic and inclusive plans; developing plans for the use of equipment, materials, or techniques; anticipating difficulties; determining the number of observations.

III. Conducting the investigation, including: developing methods, materials, or equipment; applying methods and techniques; modifying planned procedures; applying theory; attending to and checking details; analyzing the data.

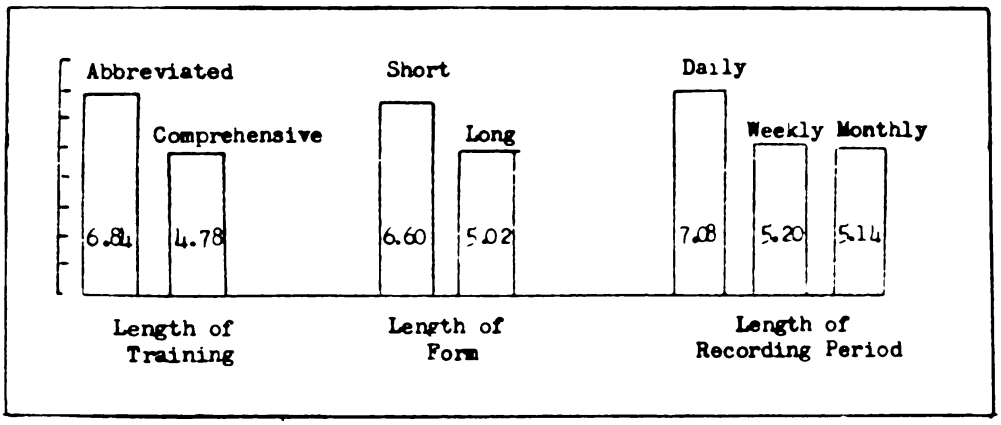
IV. Interpreting research results, including: evaluating findings, and pointing out implications of data.

V. Preparing reports, including: describing and illustrating work; substantiating procedures and findings; organizing the report; using appropriate style in presenting report.

VI. Administering research projects, including: selecting and training personnel; dealing with subordinates; planning and coordinating the work of groups; making administrative decisions; working with other groups.

VII. Accepting organizational responsibility, including: performing own work; assisting in the work of others; subordinating personal interests; accepting regulations and supervision.

VIII. Accepting personal responsibility, including: adapting to associates; adapting to job demands; meeting personal commitments; being fair and ethical; showing interest in work.



Average number of incidents reported for each experimental variable. It may be noted that participants with abbreviated training in the use of the critical incident procedure reported more incidents than participants with comprehensive training. This may be due to the development of a more restricted concept of what is critical by the supervisors with comprehensive training.

Results of the field study indicated, in part, that: (1) Participants considered the critical incident technique useful in evaluating research personnel. (2) The basic list of critical requirements is applicable to a variety of scientific and engineering positions.

In order to make the procedure more convenient and more readily available for research supervisors, a manual was developed on the critical incident type of evaluation with various reporting forms. The first part discusses general problems of employee evaluation and their relation to the critical incident technique. The rest of the booklet presents the 36 sub-areas and job elements, of critical requirements with examples and pictorial illustrations. One page of the manual dealing with the element, "Modifying Planned Procedures," is reproduced on the next page.

In addition to the evaluation of research workers through direct observation of job behaviors, measurement of another type of performance is useful for many purposes. This is performance on standardized tests. We can distinguish two general types of standard tests. The first is an aptitude test which is intended to show the individual's potentiality for becoming proficient in a certain activity. The second is a proficiency test which is intended to show whether the individual has the specific knowledges and skills necessary for performing job activities at the present time. These two types of test were developed for the evaluation of potential and working research personnel. An aptitude test was constructed which was aimed at approximately the college senior—beginning graduate level of training. A sample item is shown at the top of page 17. This test is applicable to persons trained in physics, chemistry, and the various fields of engineering. A proficiency test in chemistry (see sample item on page 17) and one in physics were also constructed. These tests are intended for persons with the Ph.D. level of academic training or its equivalent in job experience.

The tests are composed of items designed to sample the critical requirements for the job. As a preliminary step before actually writing

the items, we prepared an explicit definition and analysis of each critical behavior in the form of a comprehensive "rationale." Each rationale included specifications for a test item intended to measure the behavior. Each test item was designed to present a situation similar to that in which the critical behavior was observed and reported. This provides a close correspondence between the critical behaviors and test problems. A sample rationale for an item is given on page 18.

13. Modifying Planned Procedures

Making modifications of standards, plans, or procedures to fit changing conditions, and adapting to unforeseen changes in the situation.

UNSATISFACTORY

1. Failed to modify standards, methods, or work schedule to meet deadline.
2. Omitted an essential step or precaution for accuracy in order to meet deadline.
3. Continued to follow old method or approach without change when evidence showed it had failed.
4. Began work on a phase of project without waiting for results of earlier phase.
5. Refused to accept partial results or temporary solution to an urgent problem.
6. Ordered a change causing damage, incorrect performance, or inaccuracy.
7. Abandoned or modified a method or device before sufficient evidence had been gathered.
8. Modified only a part of the materials or procedures giving trouble.
9. Started and abandoned several methods without following any far enough to justify rejection.

INCIDENT

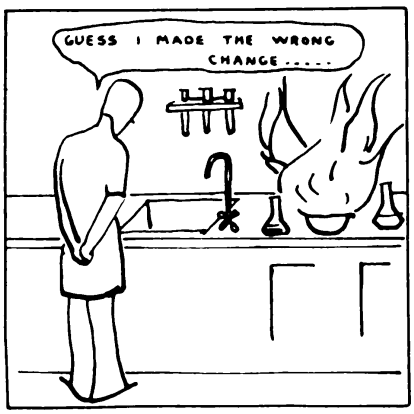
A chemist assigned to the analysis of a certain non-ferrous alloy could not obtain one of the chemicals needed for the routine analysis. He made a substitution without thinking carefully about the properties of all the reactants. An explosion resulted, causing considerable damage to the laboratory and equipment.

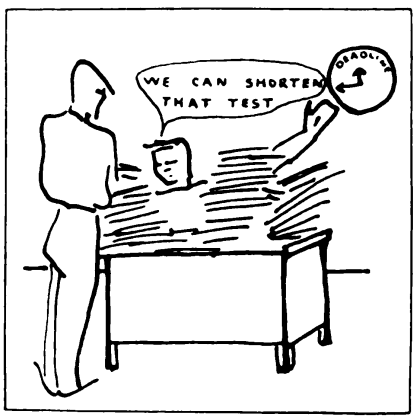
OUTSTANDING

1. Modified standards, methods, or work schedule to meet deadline without reducing essential value of results.
2. Modified work to incorporate latest research findings.
3. Adopted alternate procedures as soon as unforeseen negative conditions or difficulties were encountered.
4. Held up phases of work until results of earlier phase were available.
5. Accepted partial results or temporary solution to an urgent problem.
6. Anticipated the probable effect of a defect or difficulty and took appropriate action.
7. Took emergency action which prevented damage or injury.

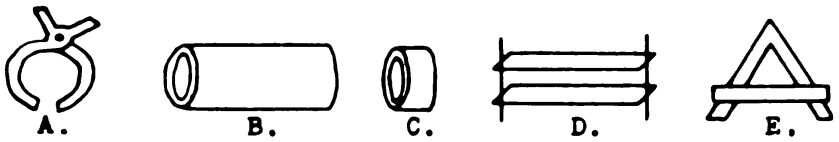
INCIDENT

A man was asked to conduct comparison tests of several types of very high frequency radio equipment on a transport. The facilities were available for a limited time only. The man took effective short cut methods so that the tests were completed during the time allowed. He was able to shorten the tests without affecting the value of the results.





APTITUDE TEST ITEM



Aptitude test item. Specifications for power transmission wire state that no diameter may be greater than 1.00 inch. The prescribed inspection procedure requires that the diameter of the wire, which is produced in 1000-foot lengths, be checked at one point selected at random in each 10 feet of wire. In designing an instrument for accomplishing this purpose, which of the basic designs pictured would provide, with appropriate modifications and refinements, the most adequate instrument? Intended answer: A

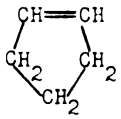
The aptitude test has been given to 921 graduate and undergraduate students in twelve universities and to 780 relatively new employees in eight industrial and eight governmental laboratories. Grade records are being obtained for the students, and supervisors' records of critical incidents over an eighteen-month period are being obtained for the employed group. To estimate the value of the aptitude test in predicting success in scholastic and on-the-job performance, the relationship between grade records and test scores and between critical incident reports and test scores will be determined.

The chemistry and physics proficiency tests are currently being given to many of the students and employees previously given the aptitude test. It is planned to give alternate forms of the proficiency tests to the same group a year later. In this way, we can study

1. $CH_2=CH-CH=CH-CH_3$

2. $H-C\equiv C-CH_2CH_2CH_3$

3. $CH_2=CH-CH_2-CH=CH_2$

4. 

5. $CH_3-CH\equiv C-CH_2CH_3$

You have a sample which can be one of the five compounds listed above. What step would you select to determine whether the sample is compound 2?

A. Determine the boiling point and molecular formula.
B. Treat the sample with a solution of bromine in carbon tetrachloride.
C. Add an ether solution of methylmagnesium bromide.
D. Determine the amount of unsaturation by a quantitative hydrogenation.
E. Hydrate and determine whether the product is an alcohol or a ketone.

Intended answer: C

Rationale for Chemistry Proficiency Item

Behavior to be Sampled

AREA II. Planning and designing the investigation
Subarea D. Developing systematic and inclusive plans
Behavior 3. POINTED OUT THE BASIC FACTORS IN A MASS OF INFORMATION ABOUT THE PROBLEM.

Description of Behavior

An effective performance of this behavior is exhibited by a scientist who can separate the more basic factors from irrelevant or less fundamental information concerning a problem. This requires that he have a clear formulation of the problem under consideration. This behavior differs from those in II-A (Collecting background information) since the information has already been collected.

Identification of Behavioral Components

(Specific) 1. Formulating clearly the problem for which information is needed
(Specific) 2. Judging the relevance of available information to the problem and identifying the basic factors

Item Specifications

1. Objective, five-choice item
2. This item requires subject matter specific to the field of specialization.
3. Description of Proposed item
   Describe a problem in general terms, without formulating specifically the basic variables or technical factors involved. Ask the examinee a question about the solution of this problem and present five choices. The correct choice should be such that an examinee would select it only if he had identified the basic factors involved. The wrong choice should appear attractive to examinees who define the basic factors incompletely or incorrectly. This is intended to sample components (1) and (2).

proficiency differences associated with different amounts of time on the job as compared with similar amounts of time in graduate school. It is also planned to study the relation between aptitude and proficiency test scores. For students, it is planned to compare proficiency test scores and graduate grades. For employees, proficiency test scores will be compared with the critical incident evaluations being obtained. These comparisons should provide an estimate of the value of the proficiency tests as a measure for evaluating the performance of research personnel.

It is believed that these aptitude and proficiency tests will provide relevant information about new or potential research workers. Each item in the tests was written to predict a specific behavior found to be critical to effective performance in research work. Scores on these tests are therefore expected to provide information not covered by academic records or tests of subject matter content.

Drug Resistance and Related Problems

M. G. Sevag

. . . Associate Professor at the School of Medicine, Univ. of Pa., and author of a textbook on Immuno-Catalysis, is Principal Investigator of an ONR contract on drug resistance in microorganisms.

Man has come a long way in combatting infectious diseases since the discovery of cinchona bark in curing malaria, of ipecac in treating amebic dysentery, and of mercury in the treatment of syphilis. With the researches of Paul Ehrlich, eminent German scientist and Nobel Prize winner at the beginning of the century, the foundation of scientific chemotherapy was laid. But soon Paul Ehrlich and his collaborators encountered the phenomenon of drug-fastness. They made valuable contributions towards the understanding of this phenomenon.

Today we have numerous potent weapons discovered by the concerted efforts of the medical profession and allied sciences to combat infectious diseases. However, as in Ehrlich's time, the so-called miracle drugs—sulfonamides, penicillin, streptomycin, aureomycin, terramycin, chloromycetin, to name a few—are being met with an inadequately explained resistance acquired by the infectious agents after contact with these drugs. The phenomenon of microbial drug-resistance is not an isolated one. Development of resistance to narcotic, for example, during general medical practice, resistance to insecticides, herbicides and anti-tumor agents makes the drug-resistance phenomenon a challenging and alarming problem.

Many specific cases can be cited. Since the clinical application of sulfonamides, an increase in the percentage of sulfonamide-resistant cases of disease has been reported. In World War II, at certain U. S. naval centers, large numbers of men were given prophylactic doses of sulfadiazine to reduce the incidence of scarlet fever and other diseases. After a few months of apparently successful prophylaxis, there was reported a rapid increase in infection from sulfonamide-resistant strains of bacteria. Among 40 strains isolated at one of these stations before trial was initiated, no resistant strains were encountered.

Just as conclusive are reports on penicillin. The incidence of infection from penicillin-resistant bacteria was 12 percent in 1942, 50 percent in 1949, and 60 percent in 1952. A study is also reported on tubercle bacilli isolated from 12 tuberculous patients before and after treatment with streptomycin. The majority of them were 500 to 1000 times more resistant than they were before initiation of the treatment. Inoculated into animals these resistant cells were likewise resistant to the antibiotic. This shows that if the resistant bacilli from treated patients are disseminated, the disease set up in new victims will be streptomycin-resistant from the start. In fact, the generally held view, as expressed by L. P. Garrod, is that "for streptomycin there can be no ultimate future: extensive use of this drug can only have the effect of producing universal resistance to its action."

Fortunately, new antibiotics have replaced sulfonamides in the treatment of certain infections; for example, penicillin has taken over the treatment of gonorrhea from the sulfonamides. Similarly, aureomycin is now used instead of penicillin to treat the resistant staphylococcal infection, and other antibiotics are used to supplement streptomycin in the treatment of tuberculosis.

The question of how often threatening situations born of drug resistance can thus be circumvented cannot at present be answered. It must here be emphasized that the basis of the ever existing threat to the continued usefulness of any one of the drugs is not abolished but by-passed by the use of new drugs. These "successes" therefore cannot be regarded as continuing safeguards against drug resistance unless our resourcefulness produces an array of new drugs from which to select the most desirable one. Very recently, Dr. James S. Jeffrey of Edinburg and Dr. Ronald W. Fairbrother of Manchester reported alarmingly that some of their patients had developed strains of bacterial infections that were resistant to all supplies of antibiotics available there. These included penicillin, streptomycin, chloromycetin, aureomycin, and terramycin.

The belief has been entertained for nearly half a century that an organism is less likely to become resistant to two or more antimicrobial agents of different nature administered simultaneously than to a single agent. In test-tube experiments with 7 strains of gonococci, Dr. C.M. Carpenter and his associates found that acquired resistance to sulfathiazole was 700-fold; rivanol lactate, 80; poromine, 9; and penicillin, 182. When resistance was acquired in a mixture of the first three drugs, there was only an 8-fold increase to each of the three drugs, and when all four were used there was no increase of resistance to any of the four drugs. However, such combinations of four drugs might not find practical application because of undesirable side reactions. Nevertheless, results show that the emergence of resistance can be prevented by such combinations.

In some cases the drugs antagonize each other, and the favorable effects are usually not of great magnitude, in fact are probably of minor therapeutic significance. In others, however, the antibiotics act synergistically; that is, they reinforce each other in such a way that the effect is greater than a simple additive one. But so far no scientific logical basis has been found for predicting how a given pair of antibiotics will generally act. They may act favorably on one organism and not on another.

The first step in attacking the problem is to determine the enzyme systems of a bacterium upon which any one of the antibiotics acts most strongly. Principal and alternate pathways which a microorganism uses for the metabolism of a given substrate must also be known. It is reasonable to assume that if the principal pathway is blocked by a drug the organism can often use an alternate route to bypass the inhibition. The utilization of such secondary pathways will be associated with the emergence of resistance. Thus, to prevent the emergence of resistance, these important pathways must be blocked simultaneously by a combination of drugs which experiments have shown to be capable of effecting such simultaneous blockage.

Another possible clue for a most effective synergistic combination might lie in the proper choice of two drugs, one capable of suppressing the oxidative enzyme systems, and the other, capable of suppressing the protein-synthesizing enzymes of a given species of bacteria. The two simultaneously effective drugs might act from the start to suppress two very important metabolic processes and thus prevent the chance of survival. Investigations are in progress in our laboratory to test the value of these approaches to the problem of synergism.

It has been reported by Dr. A. Voureka and others that penicillin sensitivity can be restored to certain penicillin-resistant bacteria by association with other bacteria or their products. It is possible that genetic combinations can occur between drug-resistant and drug-sensitive strains of a given species. The central problem here would be to effect such combinations exclusively in one direction producing completely resistant cells from a highly sensitive strain and, conversely, highly sensitive cells from completely resistant cells. Experiments are in progress with this thought in mind. The claims by Dr. Voureka and others do not appear to have involved such genetic combinations. In our laboratory, experimenting with streptomycin-dependent Escherichia coli, it was found to be possible to abolish drug-dependence without affecting drug-resistance by restoring the ability to utilize pyruvate for growth in place of glucose. In another streptomycin-dependent strain of Escherichia coli, both drug-dependence and drug-resistance were abolished by growing the cells in the presence of a factor extractable from various bacteria and serum. This factor is heat-stable and appears to be non-protein in nature.

The proposal that the emergence of resistant cells may be experimentally blocked is open to criticism by those who would explain all drug resistance as arising by spontaneous mutation. Their theory states that resistant cells emerge spontaneously in a population of sensitive individuals. The latter are killed by the drug and the few resistant ones survive and multiply. On this basis, one may rationalize that there is nothing that one can possibly do to prevent the spontaneous emergence of a few resistant individuals. On the other hand, if we consider the alternate theory that the emergence of resistance may be due to a direct action by a drug on the sensitive individuals (induction, adaptation), we can investigate the nature of various underlying biochemical factors and thus, possibly, be able to control the emergence of the resistant cells.

We have tested this possibility experimentally. Using Micrococcus pyogenes var. aureus as test organism, the results of experiments showed that glucose and amino acids play key roles in the emergence of resistant cells. Attempts to obtain resistance in the absence of glucose failed. This was not due to the inability of the resistant cells to grow in a glucose-free medium since cells which have acquired resistance multiplied freely in 1000 milligrams of streptomycin/ml of glucose-free amino acid medium. On the other hand, in an amino acid medium which was deficient in phenylalanine and aspartic acid but contained streptomycin and glucose, resistant cells failed to emerge even when these media were seeded with as many as 200 million sensitive cocci as inoculum. Under these conditions, one resistant cell added to a sensitive population survived the sensitive cells, showing that if there had been one resistant cell among 200 million sensitive cells it would have multiplied in the amino acid deficient medium. These results would

lead us to conclude that the emergence of resistance to drugs, under appropriate growth conditions, may be prevented by omitting carbohydrates or, in their presence, certain critical amino acids from the medium. In what manner these observations can be put to practical use remains to be investigated.

Further experiments have shown that the nutritional environments exercised a controlling role on the degree and speed of the emergence of resistance. Using Escherichia coli as test organism, resistance to 1500 milligrams of sulfathiazole/ml casein hydrolysate medium was produced after from 5 to 6 transfers. In contrast, in salt-glucose medium it required from 15 to 20 transfers to produce resistance to only one-tenth the above amount or 125 to 150 milligrams of this drug /ml. Development of resistance to 2000 milligrams of streptomycin in Escherichia coli in casein hydrolysate medium required only 3 transfers. In contrast, in salt-glucose medium, this degree of resistance required 36 transfers. Resistance to 1000 milligrams of polymyxin B in Pseudomonas aeruginosa was obtained within 72 hours in one transfer. In contrast, in broth medium, this organism was killed within 3 to 5 hours by only from 3 to 5 milligrams of antibiotic. In fact, all efforts to develop resistance in rich medium met with complete failure. The cells which acquired resistance in salt-glucose medium are just as sensitive to drug in the broth medium as the original parent cells.

In general, the same pattern of behavior operates in Aerobacter aerogenes. However, while this organism acquires resistance to 4000 milligrams of polymyxin B after a few transfers in salt-glucose medium, it takes at least 15 transfers for acquiring the same degree of resistance in a complex medium. Cells which have acquired the highest degree of resistance in salt-glucose medium show no greater resistance in the complex medium than the parent sensitive cells. On the other hand, resistance gained in the complex medium is exercised also in the salt-glucose medium. It must be emphasized here that the addition of any one of certain pairs of amino acids—leucine + serine, methionine + serine, or methionine + leucine—to the salt-glucose medium renders this antibiotic bactericidal. That is, the complex medium in which this phenomenon was first observed can be replaced with a simple salt-glucose medium containing any one of the above pairs in the development of resistance by Aerobacter aerogenes. These facts are strong indications that no drug-resistant cells could have been present in a normal population capable of exercising resistance in a complex medium or in salt-glucose medium containing one of these pairs of amino acids. Also the fact that the high degree of drug-resistance acquired in salt-glucose medium is wholly ineffective in a complex medium supports this conclusion and emphasizes the determinant role of the nutritional environment in these processes. These observations strongly suggest that the drug-resistant populations arise in direct response to the action of drugs when the nutritional environment is optimal for the cells to undergo stable or inheritable drug-insensitive metabolic adjustments.

Cells which undergo metabolic adjustments for the acquisition of drug-resistance would of necessity emerge with changed biochemical properties. The changes which are pertinent to our subject are: (a) increased synthesis of an antagonist to drug action by an occasional strain of a microbial species; (b) destruction or detoxication of a drug by the bacterial enzymes such as penicillinase which might be synthesized

in an increased amount in the presence of penicillin by certain strains of staphylococcal species; (c) changes in the permeability of cell-wall (frequently postulated but difficult to prove experimentally. Even if such changes can occur, the question must be asked as to what are the basic or primary new factors which cause changes in permeability); (d) changes in enzymatic activities (loss of certain enzymatic activities with the concomitant appearance of alternate drug-insensitive metabolic pathways); and (e) dependence on certain growth factors, amino acids, purines, carbohydrates, etc. (and even dependence on the presence of the specific drug) for multiplication.

It is tempting to consider the possibility that there exist common denominators in all living cells from the standpoint of resistance to drugs and infectious agents. A collation of the experimental data obtained in metabolic studies would bring out certain striking similarities between microbial and mammalian tolerance to drugs. "Streptomycin-dependence" and "dependence on narcotics" may, perhaps, have comparable metabolic basis. What the basic nature of these apparent similarities may be must be left for future discussion and investigation. However, one might see a practical and theoretical importance in the fact that if measures can be employed to prevent the acquisition of drug-tolerance in microbes, one might attempt similarly to prevent the acquisition of addiction to narcotics. Or one might even devise the means of reversing the addiction process as preliminary findings with microbes make it a possibility.

Challenging also is the applicability of the information from the field of microbial drug-resistance to cancer chemotherapy. Unlike the treatment of bacterial infections, chemotherapy of cancer would require a prolonged period during which the tumor cells could acquire resistance against even the most effective anti-tumor drug. Would the information gained in microbial drug-resistance studies be of use in planning cancer chemotherapy which so far has met practically with failure?

Another phenomenon which should be considered here is drug-allergy or drug-sensitivity. In anti-infectious chemotherapy the drug acts by suppressing the normal physiology of the infectious agents. Host cells are not insensitive to this action. The sensitivity of the host tissue enzymes to a drug may differ only in degree from that of the parasite which the host harbors. This effect can no doubt produce in the host manifestations of abnormal physiology depending on the degree of the sensitivity of the tissue cells or the amount of the drug employed.

The drugs give rise to idiosyncracies which in the past have been identified with clinical allergy. It is interesting that some of these cases have been reported to undergo improvement or recovery with intake of nicotinic acid, ascorbic acid, vitamin B complex, etc. These improvements may have a bearing on the fact that various manifestations following treatments with sulfonamides and antibiotics may be related to their action on certain tissue enzymes.

It may well be that these drugs on first contact initiate abnormal metabolism and precipitate a potentially existing condition or a deficiency state in the sensitive cells. These manifestations may have a common denominator with the problem of drug sensitivity and resistance discussed above. Approaching these problems from such new viewpoints might prove highly fruitful.

On The Naval Research Research

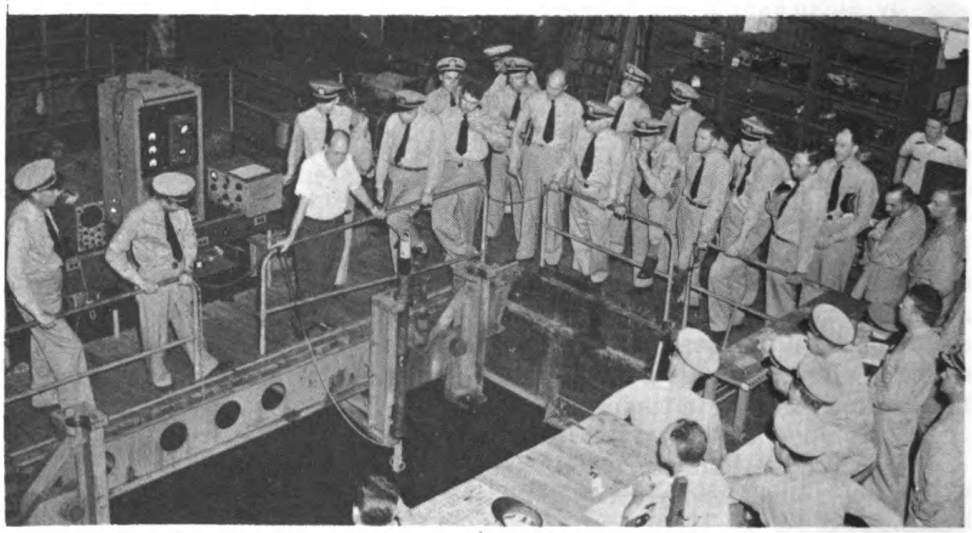
Company 9-2 Completes Training Program

In August Naval Reserve Research Company 9-2, Urbana, Illinois (Captain C. M. Louttit, USNR, Commanding Officer) completed its 1952-53 refresher training course consisting of 23 scheduled drill programs conducted by Company members. The Training and other Specialist Officers attached to the local NROTC acted as specialty advisors, and the NROTC Commanding Officer and his whole staff gave their enthusiastic cooperation.

The last five programs of the series were conducted by the Company instructor, Commander Charles H. Bowman of the University of Illinois College of Law teaching staff. These covered Military Jurisdiction and Procedures of Courts-Martial under The Uniform Code of Military Justice. Interest in this subject was so great that Composite Company 9-93 of Champaign, Illinois, requested and obtained permission to attend. In addition, a group of senior law students destined for early service in the Armed Forces and several reserve officers not attached to any reserve activity attended the drills. While it is alleged that no proselyting of Composite Company members occurred during the combined meetings, at least one inactive officer expressed the desire to return to active status and affiliate with the Research Company.

Informative NRL Seminar

Approximately 50 Research Reservists last month enjoyed an interesting two-week seminar at the Naval Research Laboratory, Washington, D. C. Officers learned about the work of the 12 scientific divisions, and of two administrative divisions, through talks and tours of the laboratories. Below officers are shown aboard NRL's sound barge. For more pictures see the inside back cover.



Officially Activated Naval Research Reserve Companies

Company, Commanding Officer, Time and Place of Meeting

1-1, CAPT L. M. Smith, USNR
1930, 1st & 3rd Mon.
Rm. 4-370, M.I.T.
77 Mass. Ave.
Cambridge, Mass.

1-2, LT Robert H. Owens, USNR
1930, 2nd & 4th Tues.
USNROTC Bldg.
Brown University
Providence, R. I.

1-2 Panel, LT Eugene C. Winslow, USNR
1600, 1st & 3rd Tues.
Rm. 305, Ranger Hall
Univ. of Rhode Island
Kingston, Rhode Island

1-2 Panel, CDR Mary Sears, USNR
2000, 1st & 3rd Tues.
Oceanographic Institution
Woods Hole, Mass.

1-3, LCDR G. R. Richason, USNR
1900, 1st & 3rd Tues.
University of Mass.
Amherst, Mass.

1-5, CDR E. A. Wiggin, USNR
2000, 1st & 3rd Mon.
Stratton Hall
Worcester Poly. Inst.
Worcester, Mass.

1-7, CDR George Z. Dimitroff, USNR
2000, 1st & 3rd Tues.
Wentworth Hall
Dartmouth College
Hanover, New Hampshire

3-1, CAPT Howard B. Stevens, USNR
1915 Alt. Thurs.
Auditorium
Cornell Univ. Med. College
1300 York Avenue
New York 21, New York

3-2, CAPT David Scott Little, USNR
1930, 2nd & 4th Mon.
Special Devices Center
Engineering Bldg.
Port Washington
Long Island, New York

Company, Commanding Officer, Time and Place of Meeting

3-3, CDR Morris Beerman, USNR
2000, 1st & 3rd Mon.
USNRTC & MCRTC
3 Porter Avenue
Buffalo, New York

3-4, CDR Henry C. Sheve, USNR
1930, 1st & 3rd Tues.
Harkness Hall
Univ. of Rochester
Rochester, New York

3-5, CDR David S. Rowell, USNR
1930, 2nd & 4th Thurs.
Naval Science Lab.
Hammond Laboratory
14 Mansfield St.
New Haven, Conn.

3-6, LCDR Henry W. Isleib, USNR
2000, 2nd & 4th Mon.
USNRTC
Syracuse (Liverpool),
New York

3-7, CDR Harold L. Shambach, USNR
2000, 2nd & 4th Thurs.
USNRTC
Scotia, New York

3-8, CDR Alfred Weeks, USNR
1930, 2nd & 4th Tues.
250 Park Avenue (46th St.)
Conference Room of General Foods Personnel Offices
16th Floor
New York City, N. Y.

3-9, CDR John S. Medd, USNR
2000, 1st & 3rd Wed.
Brookhaven Nat. Lab.,
Upton, Long Island, N. Y.

4-1, CDR Frederick J. Trost, USNR
2000, 1st & 3rd Wed.
Nassau Tavern
Princeton, New Jersey

4-2, CDR Francis Clyde Powell, USNR
1930, Alt. Thurs.
Franklin Institute
20th St. & Parkway
Philadelphia, Penna.

Company, Commanding Officer, Time and Place of Meeting

4-3, CDR Ellis D. Verink, Jr., USNR
2000, 2nd & 4th Thurs.
Rm 1112 Science Bldg.
Carnegie Inst. of Tech.
Pittsburgh, Penna.

4-4, LT Merton B. Purvis, USNR
1900, Alt. Mondays (1st & 3rd)
308 Burrowes Bldg.
State College, Penna.

4-5, CDR Donald MacCreary, USNR
2000, Alt. Mondays
USNRTC
Foot of Madison St.
Wilmington, Delaware

4-6, CDR Lynn S. Beedle, USNR
1930, 2nd & 4th Wed.
USNRTC
Spring Garden & Rodgers St.
Bethlehem, Penna.

4-7, LT Raymond H. Blackmore, USNR
1930, 2nd & 4th Thursday
Batelle Memorial Inst.
Columbus, Ohio

4-8, CDR Viktor Schreckengost, USNR
2000, 2nd & 4th Mon.
USNRTC
1089 E. Ninth St.
Cleveland, Ohio

4-9, LCDR Edward J. O'Toole, USNR
1930, 2nd & 4th Mon.
USNRTC
Dayton, Ohio

4-9 Panel, LT John B. Hart, USNR
1930, Alt. Mondays (1st & 3rd)
Xavier Univ.
Cincinnati, Ohio

W-Battalion, CAPT Fred C. Wiesner, USNR
2000, 3rd Thurs. last month of quarter
Auditorium, Interior
Dept. 18th & E St., N. W.
Washington, D. C.

W-1, CDR C. V. L. Smith, USNR
2000, 1st & 3rd Thurs.
Nat. Academy of Sciences
21st & Const. Ave., N. W.,
Washington, D. C.

Company, Commanding Officer, Time and Place of Meeting

W-2, LCDR Bruce G. Bingham, USNR
1900, 1st & 3rd Thurs.
NRL Auditorium, Bldg. 8
Washington, D. C.

W-5, LCDR Herbert N. Gardner, USNR
2000, 2nd & 4th Tues.
Conference Room, NMRI
Bethesda, Maryland

W-6, CAPT Frank G. Kear, USNR
1530 every 2nd Tues.
Room 1803 - Bldg. T-3
Navy Dept., Wash., D. C.

5-2, LT William H. Miller, USNR
2000, 1st & 3rd Monday
Virginia Poly. Inst.
Room 208, Price Hall
Blacksburg, Virginia

5-3, LT Riley D. Housewright, USNR
1930, 1st & 3rd Tuesday
Camp Detrick
Frederick, Maryland

5-4, LT Albert W. Tiedemann, USNR
2000, 1st & 3rd Thurs.
Room 206, Maryland Hall
Johns Hopkins Univ.
Baltimore, Maryland

5-5, CAPT Roscoe D. Hughes, USNR
1700-1900, 2nd & 4th Mon.
Medical College of Va.
Richmond, Va.

5-6, LCDR Bryan W. Stonestreet, USNR
U. S. Naval Training Center
South Charleston, West Va.

5-7, CAPT J. Love, M.D., USNR
1900, 1st & 3rd Wed.
Room 206, Navy Bldg.
University of Louisville
Louisville, Ky.

6-1, CDR J. E. Boyd, USNR
2000, Alt. Thurs.
103 Physics Bldg.
Georgia Inst. of Tech.
Atlanta, Georgia

Company, Commanding Officer, Time and Place of Meeting

6-2, LT J. E. Land, USNR
1915, 1st & 3rd Mon.
318 Ross Lab.
Alabama Poly. Inst.
Auburn, Ala.

6-3, CDR George B. King, USNR
2nd & 4th Wed.
O.R.I.N.S.
Medical Division
Oak Ridge, Tenn.

6-4, LCDR Charles Roy Hughes, USNR
1900, 1st & 3rd Tues.
P. K. Yonge Bldg.
Room 132
Univ. of Florida
Gainesville, Fla.

6-5, LT Royal M. Hodges, USNR
2000, 1st & 3rd Thurs.
USNRTC
Gulfport, Miss.

6-6, LCDR Marvin E. Woodard, USNR
1945, 2nd & 3rd Wed.
USNROTC Armory
University of North Car.
Chapel Hill, N. C.

6-8, CDR William D. Daniel, Jr., USNR
2000, 1st & 3rd Mon.
Underwater Sound Ref. Lab.
Orlando, Florida

6-9, LCDR A. R. Robertson, USNR
1930, 1st & 3rd Mon.
Rm. 101, Baldwin Hall
University of Georgia
Athens, Georgia

6-10, CDR Norman R. Buchan, USNR
2000, 1st & 3rd Wed.
Rm. S-110, Memorial Classroom
University of Miami
Coral Gables, Florida

6-10 Panel, LT John H. Coleman, USNR
2000, 1st & 3rd Wed.
151 South Country Road
West Palm Beach, Fla.

6-11, LCDR William G. Miller, USNR
2030-1st & 3rd Wed.
Physics Bldg.
Clemson College
Clemson, South Carolina

Company, Commanding Officer, Time and Place of Meeting

6-12, LCDR Burl Zimmerman, USNR
1930, 1st & 3rd Mon.
Adm. & Engr. Bldg.
Arnold Engr. Dev. Center
Tullahoma, Tennessee

8-1, LCDR John M. Scott, USNR
1930, 1st & 3rd Tues.
USNROTC Bldg.
Tulane University
New Orleans, La.

8-2, LT Helen M. Forsberg, USNR
2000, 1st & 3rd Wed.
Rm. 221, Coates Lab.
La. State University
Baton Rouge, La.

8-3, CDR Norman F. Rode, USNR
1930, 2nd & 4th Mon.
PMA Bldg. or Bolton Hall
Texas A&M College
College Station, Texas

8-4, LCDR L. J. Castellanos, USNR
1930, Alt. Wed.
USNROTC Bldg.
The Rice Institute
Houston, Texas

8-5, CDR Gilbert H. Ayres, USNR
2000, Alt. Tues. & Wed.
Chemistry Bldg., Room 15
University of Texas
Austin, Texas

8-6, LCDR Lauro Gutierrez-Vela, USNR
1930, Last Mon. of month
USNRTC
Galveston, Texas

8-7, LCDR Tom O. Meeks, USNR
2000, 1st & 3rd Wed.
USNRTC
1805 S. Yale Ave.
Albuquerque, N. Mex.

8-8, LTJG Cleveland R. Scott, USNR
2nd & 4th Wed.
Senior High School
Bartlesville, Okla.

8-8 Panel, LCDR Dariel E. Howell, USNR
1930, 2nd, 3rd, 4th Thurs.
Oklahoma A&M College
Union Building
Stillwater, Oklahoma

Company, Commanding Officer
Time and Place of Meeting

8-9, LCDR Daniel F. Seacord, Jr., USNR
1705, 1st & 3rd Tues.
Rm. B-117
Los Alamos Scientific Lab.
Los Alamos, New Mexico

8-11, LT Edmond S. Hastings, USNR
1930, 2nd & 4th Thurs.
USNRTC
Orange, Texas

8-12, LT Wilbur G. Teubner, USNR
2000, 2nd & 4th Tues.
Fondren Sc. Bldg. Rm. 127
Southern Methodist Univ.
Dallas, Texas

9-1, LCDR Walter E. Peterson, USNR
1900, 2nd & 4th Tues.
Navy Pier Campus
University of Ill.
Chicago, Illinois

9-2, CAPT Chauncy M. Louttit, USNR
1930, 2nd & 4th Tuesday
Room 149
Mechanical Engr. Bldg.
Univ. of Illinois
Urbana, Illinois

9-2 Panel, LT R. G. Dworschack, USNR
1930, 2nd & 4th Tues.
Library, Northern Regional Research Lab.
Peoria, Illinois

9-3, LT Edwin H. Young, USNR
1930, Alt. Mon.
Room 2084
East Engineering Bldg.
Univ. of Mich.
Ann Arbor, Mich.

9-3 Panel, LCDR Roy W. Drier, USNR
Houghton, Michigan

9-5, LCDR Arden F. Sherf, USNR
1930, 1st & 3rd Wed.
USNROTC Bldg.
Iowa State College
Ames, Iowa

Company, Commanding Officer
Time and Place of Meeting

9-6, CDR Joseph A. Wise, USNR
1930, 2nd & 4th Mon.
Room 18, Mech. Eng. Bldg.
University of Minnesota
Minneapolis, Minnesota

9-6 Panel, LT Gerald B. Spawn, USNR
2000, 2nd & 4th Wed.
ROTC Armory
South Dakota State College
Brookings, S. Dakota

9-7, LT L. N. Baker, USNR
1930, 2nd & 4th Thurs.
111 Stanley Coulter Hall
Purdue University
Lafayette, Indiana

9-8, CDR John H. Carter, USNR
2000, 2nd & 4th Wed.
101 Crow Hall
Washington University
St. Louis, Missouri

9-9, LCDR Robert Elgin, USNR
1930, 1st & 3rd Thurs.
204 Mechanics Hall
Missouri School of Mines and Metallurgy
Rolla, Missouri

9-12, LT W. D. Thomas, USNR
1900-2100, 2nd & 4th Thurs.
Room 220, Chemistry Bldg.
Colorado A&M College
Fort Collins, Colorado

9-12 Panel, LT William F. Utlaut, USNR
1900, 1st & 3rd Tues.
University of Colorado
Boulder, Colorado

9-13, LCDR J. R. Maloney, USNR
1930, every Thurs.
USNRTC
Des Moines, Iowa

9-14, LTJG Ralph R. Caldwell, USNR
1930, Alternate Wed.
USNRTC
University of Wisconsin
Madison, Wisconsin

9-14 Panel, LTJG Keith W. Hardacker, USNR
1930, 1st & 3rd Tues.
Lecture Room
The Institute of Paper Chemistry
Appleton, Wisconsin

Company, Commanding Officer
Time and Place of Meeting

9-15, LTJG T. E. Werkema, USNR
1900, 2nd & 4th Thurs.
Conference Room
Dow Chem. Co. Pers. Bldg.
Midland, Michigan

9-16, LCDR Ira B. Baccus, USNR
1930, 1st & 3rd Mon.
Room 306
Elec. Engr. Bldg.
Michigan State College
East Lansing, Michigan

9-19, LCDR Frank D. Sills, USNR
1945, 3rd Thurs.
Senate Chamber, Old Capitol
University of Iowa
Iowa City, Iowa

9-19 Panel, CDR John O. Chellevold, USNR
1930, 1st & 3rd Wed.
U. S. Naval Training Center
200 Riverside Drive
Waterloo, Iowa

9-20, LT Russell C. Mills, USNR
1930, 1st & 3rd Mon.
103 Haworth Hall
Univ. of Kansas
Lawrence, Kansas

9-21, LCDR Robert M. Van House, USNR
1900, 2nd & 4th Mon.
2792 E. Grand Blvd.
Detroit 11, Michigan

9-22, LCDR Loyd W. Hurlbut, USNR
1930, 1st & 3rd Wed.
Military & Naval Sci. Bldg.
University of Nebraska
Lincoln, Nebraska

9-22 Panel, LCDR Benedict J. Jaskoski, USNR
1930, Alternate Tues. (1st & 3rd)
Creighton Dental College
Room 7 - 26th & Calif.
Omaha 2, Nebraska

9-23, CDR Glen L. Hawks, USNR
1800, 2nd & 4th Wed.
Conference Room, Bldg. #2
Argonne Nat. Lab.
DuPage County Site, Ill.

11-1, LT Clarence E. Washburn, USNR
2000, 1st & 3rd Tues.
Thompson Lab.
125 S. Grand Ave.
Pasadena, Calif.

Company, Commanding Officer
Time and Place of Meeting

11-2, CDR George Van Schliestett, USNR
2000, 1st & 3rd Thurs.
USNRTC
Pasadena, Calif.

11-3, LT Don C. Atkins, USNR
2000, 1st & 3rd Mon.
Hancock Auditorium
Univ. of S. C., Room 109
Physics Biology Bldg. UCLA
Los Angeles, California

11-4, LT Robert Louis Eberhardt, USNR
1945, 1st & 3rd Wed.
USNRTC
San Pedro, California

11-5, LCDR Robert Halley, USNR
1930, 2nd, 3rd, 4th Tues.
Special Devices Center
2548 Kettner Blvd.
San Diego, California

11-6, LT James W. Stitt, USNR
2000, 1st & 4th Thurs.
USNRTC
Phoenix, Arizona

11-7, LT Willis R. Brewer, USNR
2000, 1st & 3rd Thurs.
USNRTC & MCRTC
1100 S. Alvernon Way
Tucson, Arizona

12-1, CDR R. M. Fincher, USNR
1930, 2nd & 4th Mon.
1000 Geary St.
San Francisco, Calif.

12-3, LCDR Albert J. Morris, USNR
2000, 2nd & 4th Wed.
Room 268, Engineering Bldg.
Stanford University
Stanford, California

12-4, CDR Ennis B. Womack, USNR
2000, 2nd & 4th Thurs.
Room 103, McLane Hall
Fresno State College
Fresno, California

12-5, LCDR George W. Schutz, USNR
1930, 2nd & 4th Wed.
Room 147, Cory Hall
University of Calif.
Berkeley, California

Company, Commanding Officer, Time and Place of Meeting	Company, Commanding Officer, Time and Place of Meeting
12-6, LT Perry T. Cupps, USNR 2000, 1st & 3rd Tues. Tower Room, Univ. of Calif. Animal Science Bldg. Davis, California	13-2, LCDR Donald R. Gustavson, USNR 1900, 2nd & 4th Tues. American Legion Hall Richland, Washington
12-7, LT Dean K. Fuhriman, USNR 2nd & 4th Thursdays of each month Utah State Agricultural College Logan, Utah	13-3, LCDR W. G. Gnaedinger, USNR 1930, 2nd & 4th Mon. Room 39, Ernest Holland Library Pullman, Washington
12-8, CAPT George J. Higgins, USNR Every other Wed. at 2000 Room 504, Bldg. 221 USN Postgraduate School Monterey, California	13-4, LCDR Danny C. Marquez, USNR 2000, 2nd & 4th Tues. USNRTC, Swan Island Portland, Oregon
13-1, CDR Blake D. Mills, Jr., USNR 1930, 2nd & 4th Monday Health Sciences Bldg. E-502 Univ. of Washington Seattle, Washington	13-5, CDR Albert V. Logan, USNR 1930, 2nd & 4th Mon. Rm. 104, Chemistry Bldg. Oregon State College Corvallis, Oregon
	13-6, LCDR David J. Mallon, USNR 1930, 1st & 3rd Thurs. City Hall Idaho Falls, Idaho

Prospective Companies

State College, Mississippi LT John A. Alford, USNR Dept. of Animal Diseases Agri. Experiment Station State College, Mississippi	Augusta, Georgia LT R. O. Hutchison, USNR U. S. Atomic Energy Commission Augusta, Georgia

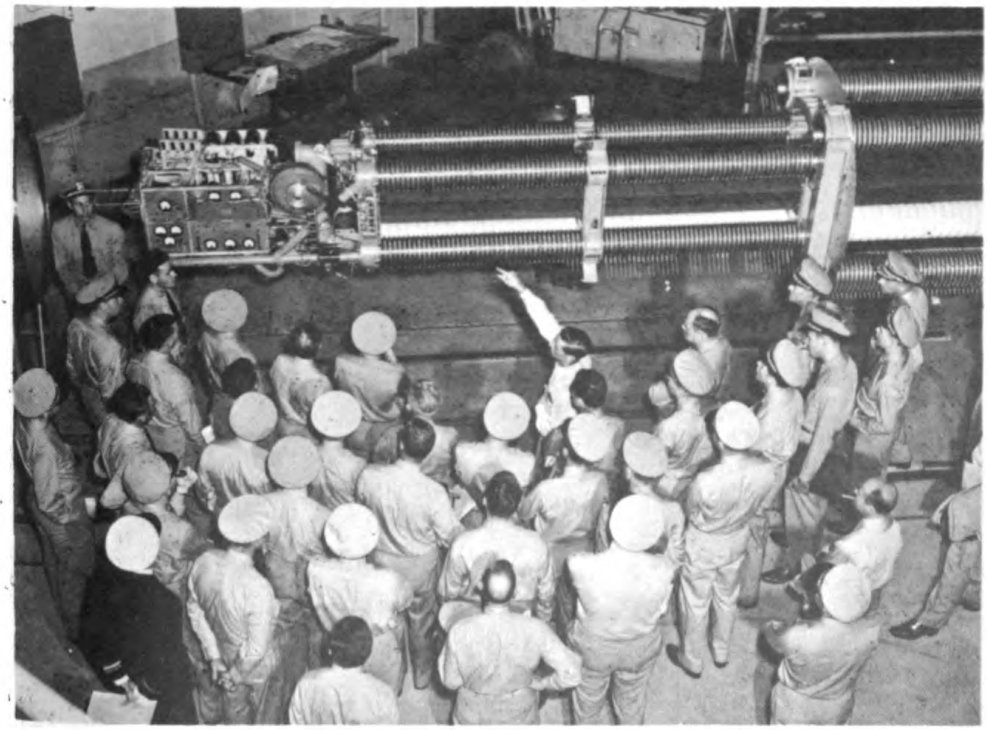
NOTE: Please advise promptly the Chief of Naval Research, Code 830, Washington, D. C., of any changes or corrections to be made to this roster.

Nuclear Science Seminar Coming Soon

Just a reminder that the time is almost here for the Reserve Research Nuclear Sciences Seminar in Oak Ridge, Tennessee. Beginning date is 30 November. The course will cover current developments in the nuclear sciences as well as field trips to testing and development activities and practical assignments.

☆U. S. GOVERNMENT PRINTING OFFICE: 1953 O - 277219

Members of NRL Research Reserve Seminar learn about the Metallurgy Division's research on crystals.



NRL's Van de Graaf machine is examined by Research Reserve Officers.