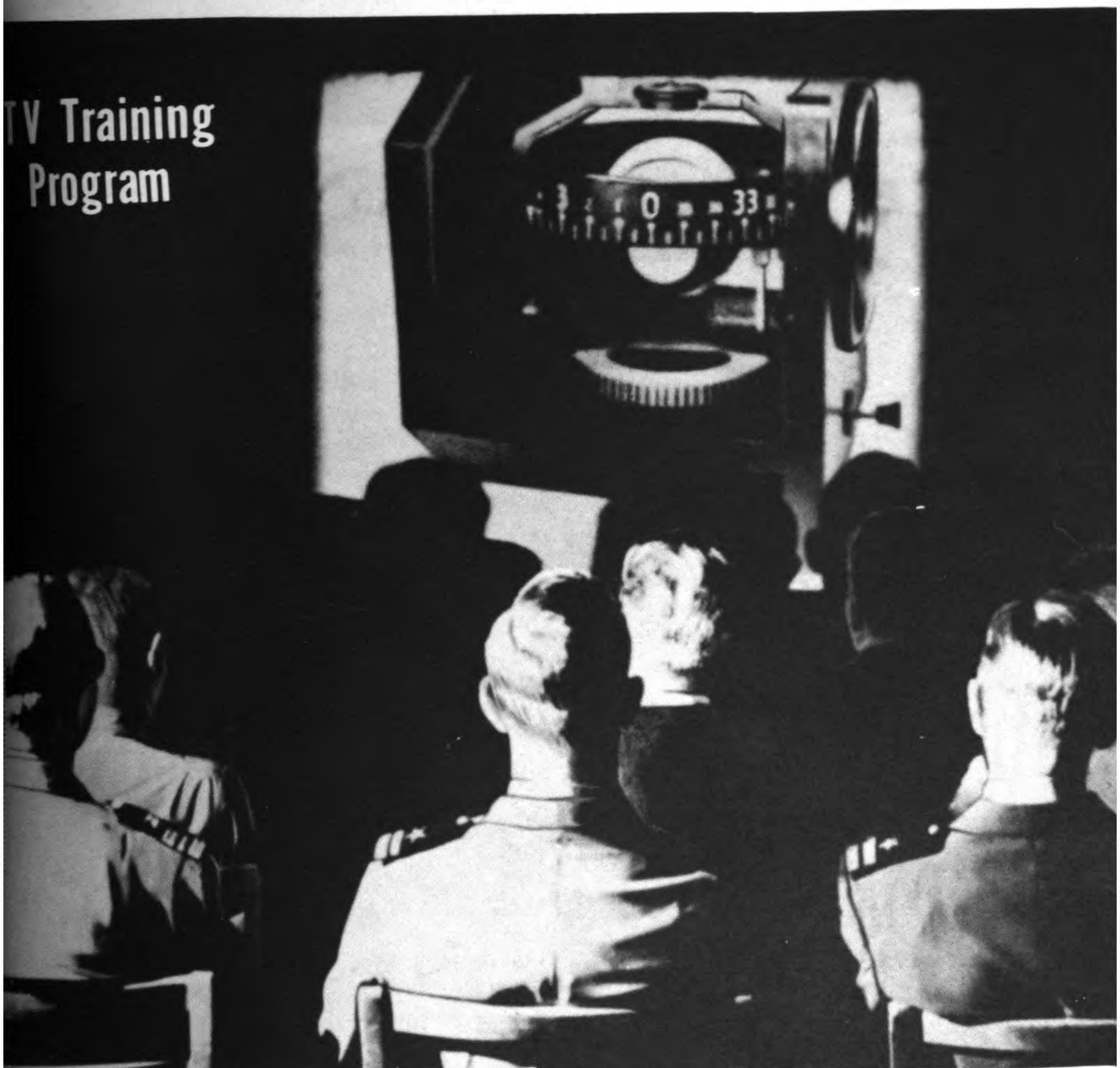
OFFICE OF NAVAL RESEARCH SEPTEMBER 1951

RESEARCH REVIEWS



NAVEXOS P-510

DEPARTMENT OF THE NAVY
WASHINGTON, D. C.

COVER PHOTO: Most of us have seen movies on television, but few have seen what these officers are watching--motion pictures of television shows. The "show" in this case is not entertainment, but an experimental training session designed to test the effectiveness of "canned" TV instruction in Navy training. For more about such experiments see "Training by Television", pp. 7-12.

Approved by Bureau of the Budget, 13 April 1948.

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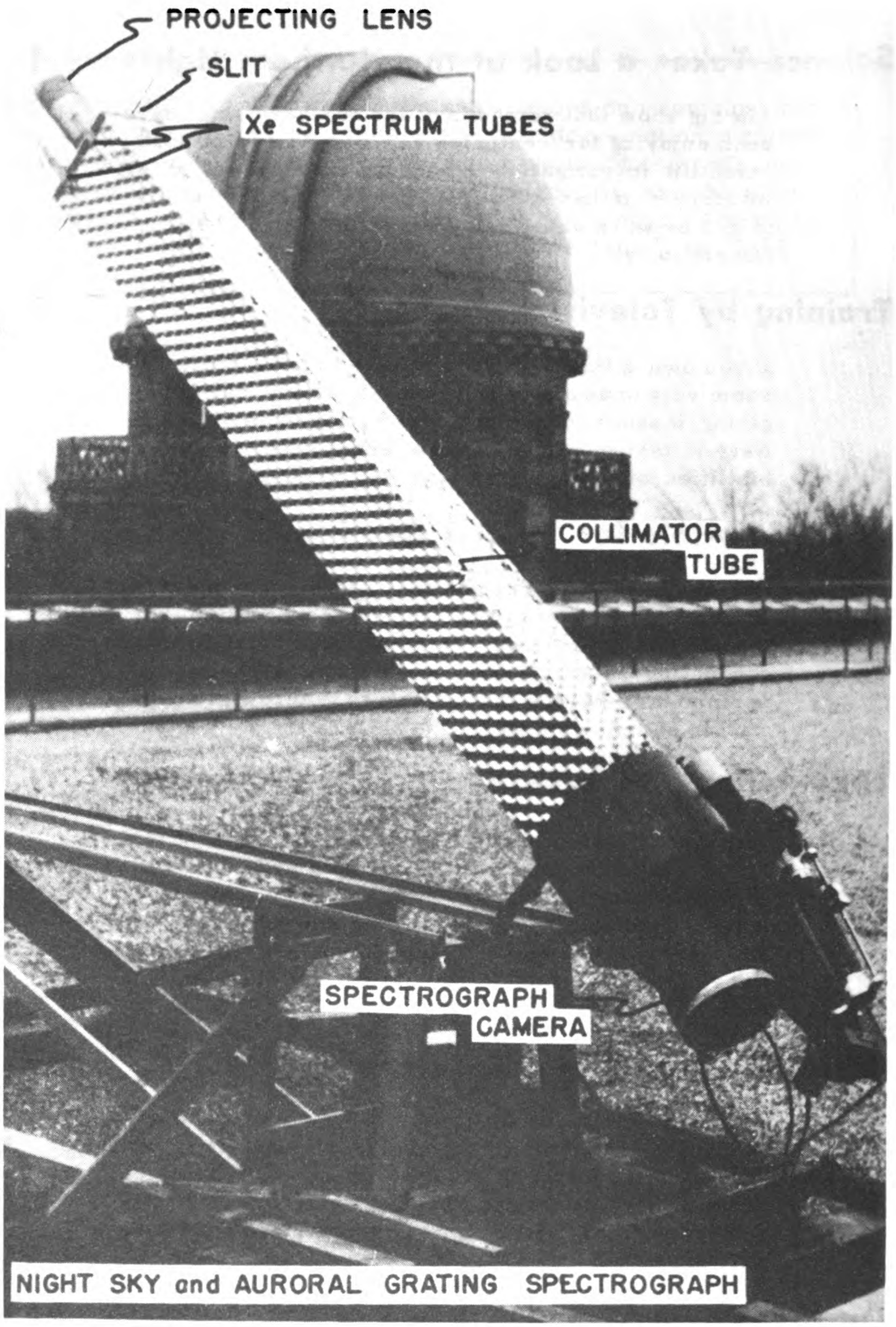

This is the instrument, called a spectrograph, which scientists working at the Yerkes Observatory in Williams Bay, Wis. are using to probe the secrets of the upper atmosphere in an effort to discover more about the Northern Lights. The tube, which is made of stressed aluminum, contains a long-focus collimator at the upper end. The instrument is shown atop the Observatory.

Science Takes A Look At The Northern Lights

by

Aden B. Meinel
Yerkes Observatory

The dancing and flaming fingers of the Northern Lights have left their mark upon man's history extending far back into Nordic antiquity. Before the advent of modern science they were fancifully interpreted in superstition and mythology. Even today it is an eerie sight to watch the flaming Valkyrie ride across the black expanse of the northern winter night.

Though the aurora borealis, as this phenomenon is commonly termed, is frequently visible in the northern United States, readers who have never seen it may appreciate a more detailed description. After twilight in certain latitudes the northern sky near the horizon is illuminated with a light like the dawn. This light is the most frequent form of the aurora, and is in the form of a broad arch, highest near the magnetic north and reaching the horizon in the northeast and northwest directions. Presently beams of light stream across the sky, quivering, flickering and fading to give way to others. Occasionally many hues may be visible, but soft yellow-greens and reds usually predominate.

Scientists have disputed for years about what causes these beautiful displays. It was clear that there was some connection between the Northern Lights and the sun, since aurorae frequently occurred shortly after the outburst of unusual activity on the sun. Moreover there appeared to be some connection between the Northern Lights and the earth's magnetic field, since all of the streamers of light are parallel, as near as we can tell, with the lines of the earth's magnetic force. And during very intense displays (auroral storms) marked disturbances of compasses are noticed.

These observational effects led to the theory that the aurora was caused by electrons ejected from the sun. When these electrons entered the earth's atmosphere it was thought that they caused the air to shine, much in the same way that the electrons from an electric current light up the flashing "neon" signs of Broadway at night. This simple theory was soon found to be unsatisfactory since the extremely light-weight electrons did not have enough penetrating power to reach very far into the atmosphere. Scientists then were faced with the problem of finding the correct explanation.

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About twelve years ago a Norwegian scientist, Lars Vegard noticed occasional weak hydrogen emissions from the aurora. This clue led him and others to the hypothesis that the particles exciting the Northern Lights were not electrons but the more massive hydrogen atoms. This explanation, though difficult to prove at that time, was immediately interesting since the sun's atmosphere is known to consist of almost pure hydrogen.

This particular theory was hard to confirm. Studying the Northern Lights had been systematically pursued only for a comparatively few years and many difficulties had been encountered. The most severe handicap was the continual fading and changing of the aurorae, which makes it very difficult to study any features in detail.

Recently, however, advances in the branch of physics known as spectroscopy have permitted studies which have greatly revised the present status of atmospheric physics. As most readers are probably aware, the spectroscope is an instrument which analyzes light emitted from and absorbed by matter. The way this instrument works will be clear to anyone who has ever seen how an ordinary prism breaks sunlight down into the varied colors of the spectrum. The spectroscope, although far more complicated, works on the same principle. In other words, it breaks visible and invisible light into the different wavelengths of which it is composed. When the spectroscope has a camera attachment to record

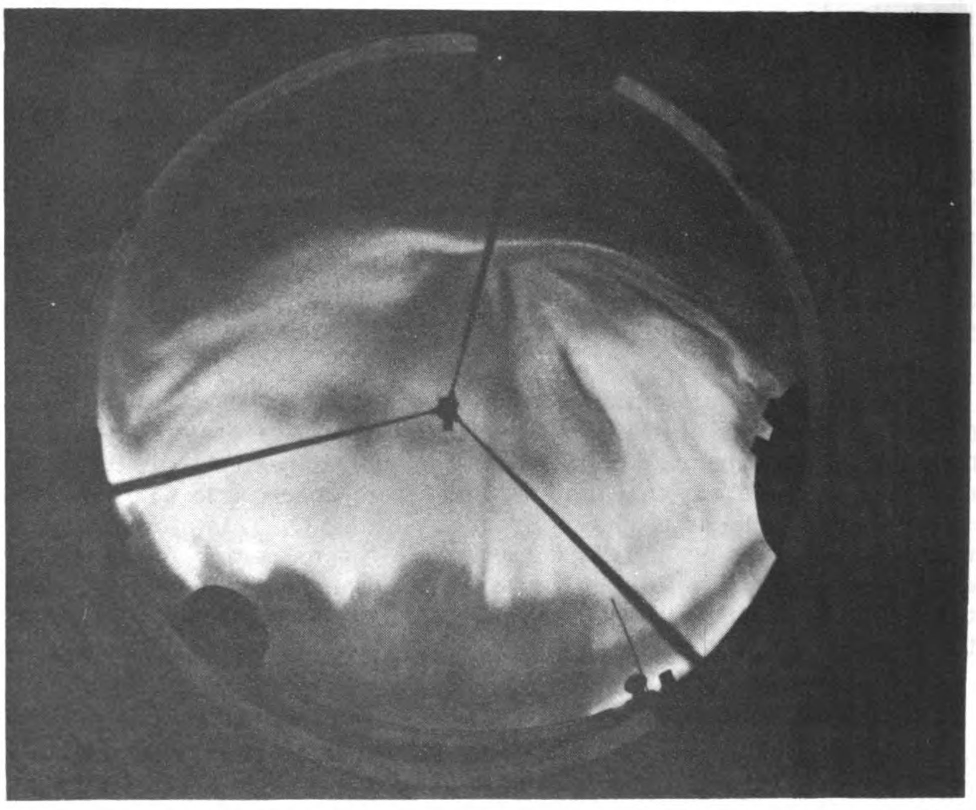

Figure 1. Here is the great auroral storm of August 18-20 when the spectra described in this article were obtained. This unusual photograph was taken with a 140-degree F-12 camera by Steward Sharpless and Donald Osterbrock, two graduate students working on the project.

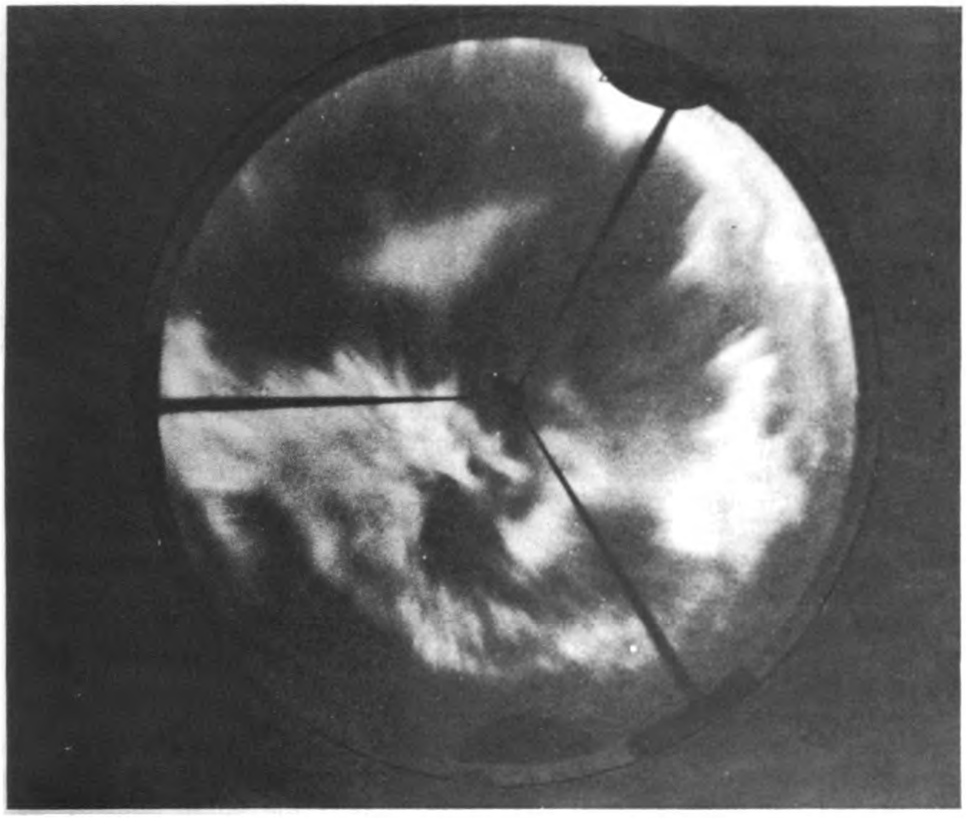

Figure 2. The formation of a corona. In this picture we are looking up through the thin edge of some auroral protons. Because the spectrograph is pointed at the center of the corona, the protons that were creating these curtains were moving directly at the spectrograph.

these different wavelengths, or spectra, as they are called, on photographic material, the whole apparatus is called a spectrograph. This, then, is the instrument which we used to study the aurora.

Since different molecules and atoms give off light of definite wavelengths (colors) when struck by protons or other electrically charged particles, a study of the radiations from the Northern Lights was expected to tell us a great deal about the forces that produce them.

Our research was centered not only on the radiations which produce the beautiful pale colors seen in the aurora but on a part of the spectrum which is invisible to our eyes. This is the so-called "near-infrared" region, made up of light waves which are just a bit too long for us to see. They could, however, be "seen" and recorded by the spectrograph.

At the time this ONR-sponsored work was started, the near-infrared was largely unexplored. This was because research in this region presented serious difficulties. First of all, since the aurora is not very bright, special equipment was needed to photograph it. Obviously a fast optical system--i.e., a camera that admitted a maximum amount of light quickly--had to be used. And a "low dispersion" spectrograph was necessary; that is, one which did not scatter the various wavelengths of light too diffusely. This was essential because enough light had to be concentrated within a certain area of film to get a clear image. This low dispersion, however, made the spectra of the various elements hard to distinguish from each other. An additional difficulty existed because film sensitive to infrared radiations is slow, and must be exposed a long time in order to get a satisfactory picture. Obviously a lengthy exposure is not very satisfactory to record the constantly changing patterns of the Northern Lights.

Three technical advances made it possible for us to extend observations into the infrared in spite of all these difficulties. The first was the development by the author of a F/0.8 flat-field Schmidt type camera. Though this device is only six inches in diameter it is so fast that it can photograph, in only 60 seconds, stars 50,000 times fainter than the eye can see. The second improvement was the use of a large high-efficiency transmission grating. This grating, supplied to the author by Prof. R. W. Wood of Johns Hopkins University, enabled the design of a very compact and simple spectrograph. The third important development was the great improvement in the speeds of infrared-sensitive emulsions by the Eastman Kodak Company.

Our spectrograph was mounted on the body and yoke of a Navy signal searchlight so that it could be pointed at any portion of the sky. Figure 1 shows it atop the Yerkes Observatory at Williams Bay, Wis. Because of the difficulties involved in working in the open during bad winter weather the instrument was later moved into the transit room.

An exciting incident arose as a consequence of this move. The transit room is equipped with three sets of shutters to permit access to the sky. In most auroral observations only the north shutter was opened. On the night of August 19, 1950, however, a strong auroral display appeared south of the zenith. Since an observation of this arc was badly needed to test the hypothesis that particles from the sun were precipitating into the atmosphere along lines of magnetic force, attempts were made to open the top shutter. To our complete surprise, we found that it had been sealed down as a protection against bad weather, since the room had not been used for some 20 years. In desperation we put all the strength we could muster on the old shutter winches. Just as we were about to give up for fear of breaking them, the roof shutters ripped open with a bang that must have been heard for miles.

The spectra we obtained were well worth all these strenuous efforts, for they provided us with one of the most far-reaching consequences of the project. They have confirmed the often-disputed hypothesis that the aurora is caused by the entry of energetic particles into the upper atmosphere. The spectra of the aurora taken near the northern horizon showed a familiar pattern. The spectra taken from the aurora just south of the zenith, however, showed one spectrum line out of place. This was the H-alpha emission line of hydrogen, which was violently distorted toward the violet end of the spectrum. This effect could only be produced if the radiating hydrogen atoms were moving with great velocity down the lines of magnetic force toward the spectrograph. The speed of the protons responsible for the H-alpha emission was measured at 7,500,000 miles per hour.[1] This is greater than what was calculated from indirect correlations between occurrences on the sun and the later appearance

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[1] A. B. Meinel, Astrophys. J. 113, 50, 1951.

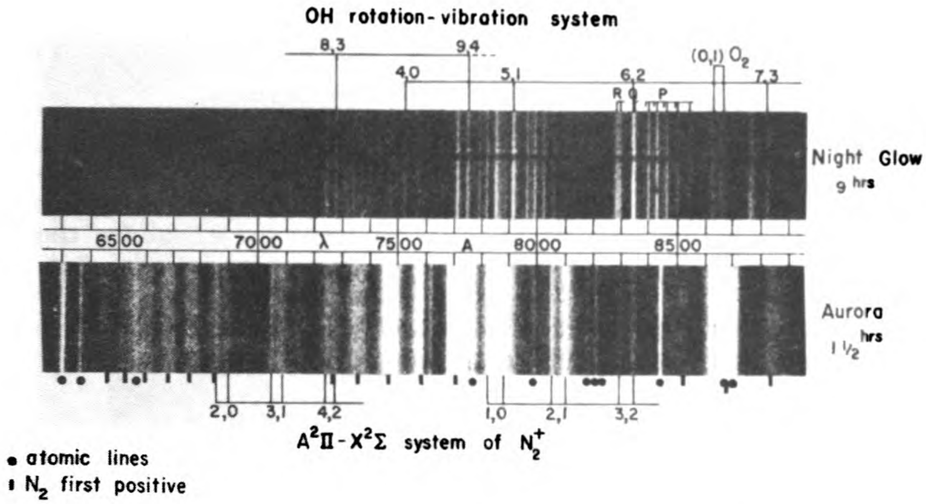


Figure 3. The spectrum showing the OH bands.

of an aurora. We do not know the reason for this discrepancy. It appears, however, to be connected with electromagnetic interactions between the magnetic field of the earth and the high-velocity stream of particles from the sun.

Another important result of observations made on this occasion (and also on the previous night, when there was another strong auroral storm) was the identification of a new band system from the ionized nitrogen molecule. In other words, some nitrogen in the upper atmosphere exists in a form which scientists had predicted from theoretical calculations but which they had never been able to produce in the laboratory.

Actually the main emphasis of the program was supposed to have been on observations of aurorae. The winter of 1949-50, however, was very cloudy and the two auroral storms described were among the few that occurred during those months. As a result, most of our studies were of the airglow. These produced one particularly interesting result.

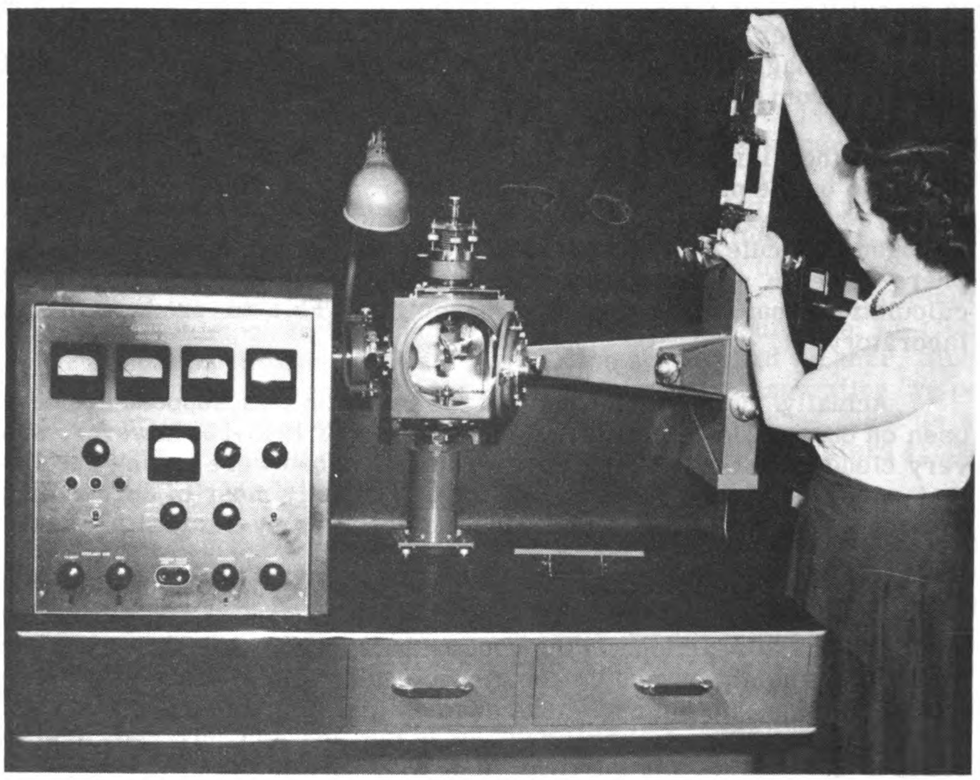
Contrary to the aurora, the airglow is a faint, constant glow that is spread more or less uniformly over the entire earth. It is apparently due to chemical reactions in the upper atmosphere. During the day the ultraviolet sunlight breaks up certain molecules into atoms. When these atoms re-form into molecules during the night, minute amounts of light are given off. The strong emissions in the red and infrared airglow regions were shown for the first time to be due to the OH molecule.[2] This result, now confirmed by many persons,[3] was at the time very surprising, since the amount of the parent molecule, H_2O (water) makes up only a very small fraction of the substances present at heights of around 45 miles. Studies by others (D.R. Bates and M. Nicolet[4]) under ONR

[2] A. B. Meinel, Astrophys. J. 111, 555, 1950.
[3] J. Geophys. Res. 55, 183, 1950.
[4] J. Geophys. Res. 55, 301, 1950.

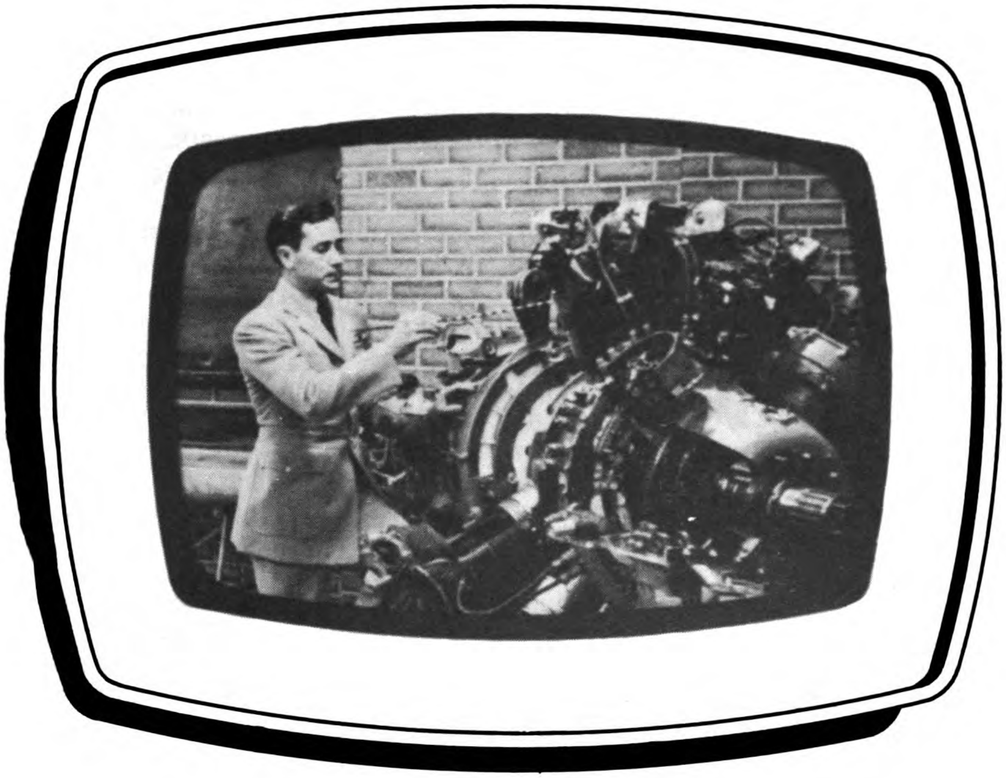
sponsorship showed that a chemical reaction productive of light was taking place between ozone, a very active form of oxygen, and atomic hydrogen.

Needless to say, our project has led to many new problems. We are still a long way from complete understanding of the aurora and it appears that a clearer understanding can only be obtained from some intensive laboratory work using protons produced by a low-energy nuclear accelerator. Such studies could form the basis for explaining the way in which the molecules of heavy gases are excited by protons. But even though our work still has a long way to go, we now know a good deal more than we did about the mysterious and beautiful Northern Lights which have puzzled and fascinated men for centuries.

Lubrication Research at NRL



Mrs. Elaine G. Shafrin, a chemist in NRL's Lubrication Branch, is operating an instrument called an electron diffraction unit which is helping to solve some of the many complex problems connected with improving lubricants. Work in this branch has resulted in some important developments, among them the well-known "hydrolubes" which have proved so effective in extreme-temperature uses. Work is also underway to develop protective coatings for equipment subject to corrosion. All these projects have important Naval applications.



Training by Television

Until recently the power of television to get a message across to a lot of people at the same time has been used mainly by advertisers. The channels have been flooded with images of people smoking cigarettes, shampooing their hair or using other products on whose virtues manufacturers felt that the public needed visual instruction.

Though it was probably natural for commercialism to make the quickest grab at the practical aspects of telecasting, this did not mean that educators had been ignoring its possibilities. In particular, military teachers were quick to grasp the fact that here might be one way of solving a serious problem that exists in times of emergency: that of training huge numbers of people quickly to do certain tasks. Shortages of instructors and training equipment, of course, present the main difficulty in times of emergency. But if instruction could be televised, scores or even hundreds of students could learn a lesson given by a single instructor. Better still, if a movie could be made of the televised lesson it could be used again and again and thousands of students might eventually benefit from it.

But putting such ideas to work was not quite as simple as it sounds. No one knew just how well people would be able to learn from televised instruction, compared to the amount they could learn from real, live instructors. Possibly "televised" facts just would not get across to the trainees; possibly they simply would not like such a method of teaching. Or the unlimited opportunity to ask the instructor questions which students have in a classroom might prove to be an important lack in televised instruction. There were a score of other important questions on the use of this method of teaching to which no one had the answers.

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ONR's Special Devices Center, which for years had been solving similar problems, set out to find at least some of these answers. Aided by the Fordham University Psychology Department they set out to discover the effectiveness of television teaching compared to other types of instruction among one important group--naval air reservists.

Nine naval air stations were chosen for the experiments. Both enlisted men (all at the same stage of basic training) and officers (all on active flying status) participated. At Willow Grove, Floyd Bennet and Anacostia stations, naval air reservists watched live shows telecast from SDC over a special network arranged through the National Broadcasting Company. Groups of trainees at Dallas, Olathe and Glenview, on the other hand, saw the same programs as sound motion pictures. Ordinary instruction in classrooms -- based on the same lesson plans -- was given to trainees at Akron, Minneapolis and Grosse Ile.

To test how much each group learned it was necessary for each to have equal chances to ask questions. This was easy enough for those seeing the television movies or being taught by actual instructors; the local training officer answered the queries. But a special arrangement had to be made for those seeing the "live" telecasts; a talk-back microphone, connected by telephone circuits, to SDC, was installed in each classroom, making it possible for the trainees to ask questions of the television instructor during question periods.

A lot of careful preparation was put into the two series of lessons given the reservists. One of these series was a refresher course for pilots, the other a basic training course for enlisted airmen. Each contained eight lessons, dealing with such topics as civil air regulations, aerology, and navigation (for officer pilots) and theory of flight, gunnery, jet engines and nuclear physics (for enlisted men).

An equal amount of care was given to testing the men on what they had learned. Before each lesson approximately 30 multiple-choice questions of the following type were given to each man:

ENLISTED AIRMEN'S LESSON 7. JET ENGINES

12. Preflighting a plane means

    (1) a quick check of fuel and engine, (2) a routine check before each flight, (3) a detailed check on each plane, (4) loading the plane for flight.

OFFICERS' LESSON 8. CROSS-COUNTRY FLIGHT

49. Normally, upon closing a VFR flight plan for a non-military base, a new flight plan may be filed at the same time only if the pilot (1) intends to depart within the hour, (2) plans to clear for a military base, (3) intends to continue under VFR, (4) notifies CAA.

Immediately after the lesson, the same 30 questions, plus 30 more, were given to the trainees. Since speed was not important, enough time was allowed for practically all the men to complete the tests. The uncompleted

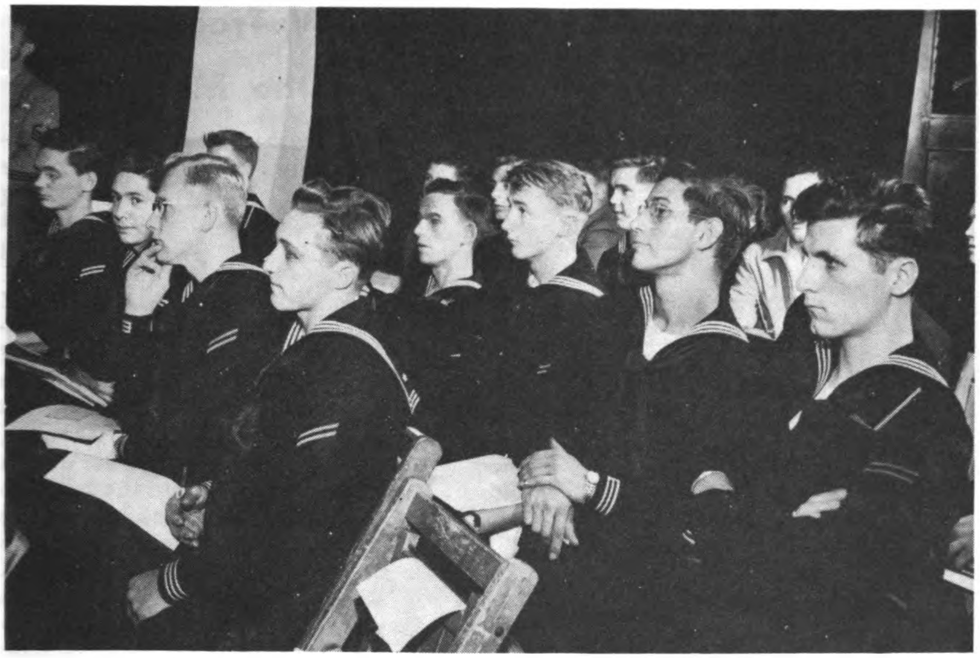


Figure 1. Enlisted naval air reservists watch television training show. Sixteen persons were assigned to each set.

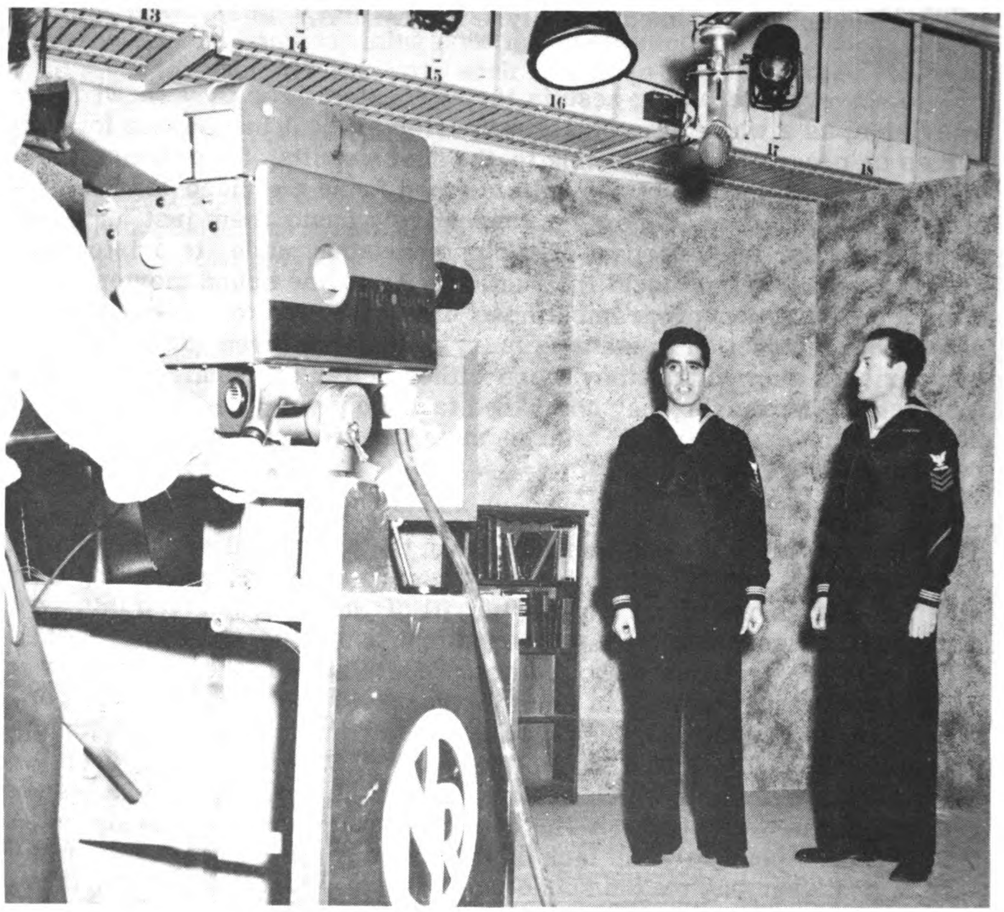
examinations, which were very few, were discarded. Conventional statistical methods were used to analyze the results.

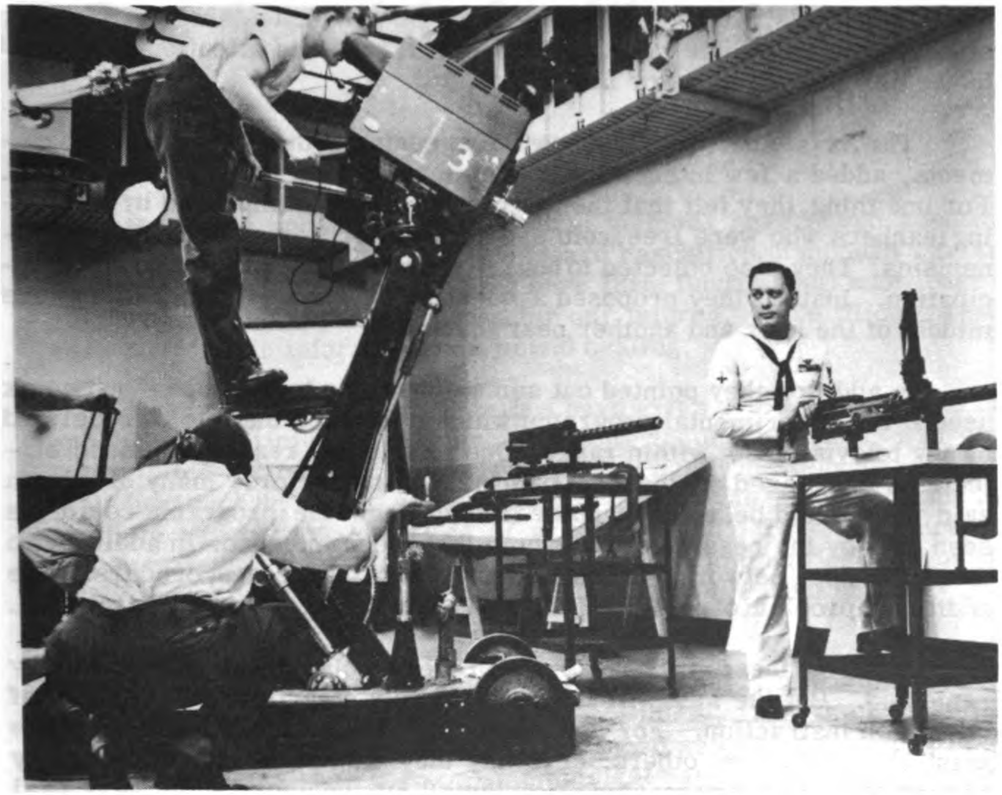
And very interesting results they were, too. For they showed that television, as a whole, was clearly superior to local instruction for this series of programs. According to the test results, 50 percent of the officers and 53 percent of the enlisted men found the video lessons superior, while 38 and 20 percent respectively found them just as good. In other words, in 80 percent of the comparisons made, television was as good or better than local instruction. As to the sound movies made from the television programs, these did not prove to be superior to classroom instruction in quite as many cases, but three quarters of the comparisons showed that they were either better or equal to the local instruction. Moreover, they compared favorably with the live television shows, to the extent that in a large majority of cases (84 percent) the recordings were just as good.

But more interesting, perhaps, than the bald results is finding out what made some of the television shows more effective in teaching than others. For as we might expect, not all of the lessons given this way were equally successful. It was found that when the instructor talked directly to the trainees without any dramatic action, the program was usually more successful than local instruction. The same thing was observed in programs that contained animated motion pictures with the narrative on the film sound track. The poorest television lessons, on the other hand, were those which spent a lot of time dramatizing the lesson material while the instructor who described the action was not shown on the screen. Apparently the lack of connection between what was on the screen and what was on the sound track was a great handicap to those trying to learn.

TV Training in the Making

A lot of hard work and careful preparation went into the making of suitable training films. The Center's expert staff of human engineering experts aided in the job. These pictures show TV cameras trained on instructors lecturing on a variety of subjects. Since instructors were aware that their work was experimental in nature, it was believed that the extra effort they put into the preparation of the lessons made them a bit above the average of most training sessions. Likewise, the lessons which were not televised were believed to have been more carefully prepared than usual. Instructors preferred that TV sessions be on closed circuits.





Did the trainees like this method of learning? The answer is an emphatic yes. Comments were obtained from all the men. More than half of these were favorable and the best-liked programs were praised in more than 90 percent of the cases. Very few said that any lesson as a whole was poor or dull or that they objected to television as such, or to its physical limitations. Such criticisms as were made were directed against specific parts of programs and these varied greatly from program to program.

One frequent criticism made by officers (15 percent) was that certain of their lessons were too theoretical and insufficiently practical. A like number of enlisted men objected to one program that they said was too long. Other adverse comments involved the meagre use of visual aids and the insufficient opportunity to ask questions.

The television evaluation staff supported these comments and criticisms. The staff members remarked on the sustained interest of the trainees in the programs, but agreed that more visual emphasis was needed. For example, the television picture of a speaker is more interesting than his voice alone. But it is undoubtedly better, when the speaker is talking about a certain device, to have the device or a model of it shown instead of the teacher's face. Unfortunately this presents some difficulties, for the black and white of television images does not show clearly the details that would be displayed in color.

The production staff came in for some criticism from these evaluators, who did not like the continual concentration on "interesting camera angles". They felt that expert or fancy photography should be subordinated to more emphasis on getting the meat of the lesson across. For example, they pointed out that angle shots frequently distorted charts and blackboards, while models stayed on the screen too short a time for students to grasp their meaning. Moreover, too little attention was paid to the difficulty of ideas or new words.

The Naval Advisory Group, while agreeing with many of these comments, added a few interesting criticisms and comments of their own. For one thing, they felt that the instruction could be improved by selecting teachers who were free from speech peculiarities and annoying mannerisms. They also objected to hour-long lessons with no student participation. Instead they proposed a question or discussion period in the middle of the hour and another near the end.

In addition they pointed out some objections to the "open" network used in the experimental programs which permitted them to be received by any television set within range. One interesting reason for these objections was based on the comment of the instructors, many of whom said they would be much happier if they knew the programs could be seen only by the reservists for whom they were intended. In addition to the strain open networks put on the instructors, there was, of course, the additional problem of public relations that such telecasting would involve.

Most of these drawbacks which were pointed out can be easily remedied. But the way still is not absolutely clear for the easy use of television instruction. For one thing, the results found by these tests must be verified by others; certainly they cannot be indiscriminately applied to all military teaching problems. Furthermore some very real and difficult problems must be solved before satisfactory shows can be produced.

Getting qualified people to plan, write, direct and deliver the television lessons is of paramount importance. At present few military instructors have had any experience in teaching before cameras; men must be found who can express themselves clearly and who can use visual aids skillfully. The same scarcity exists among writers and directors for educational television. Here the problem involves a realization of how this type of program differs from commercial entertainment. Putting on a "good show" is much less important than making the lesson clear and direct. Of course psychologists and educational experts will be needed to help in applying sound principles to the preparation of the programs, and also in assessing the effectiveness of television training sessions.

Besides these personnel needs, there will be the problems of obtaining the proper equipment and men to service it, both of which are scarce in times of emergency. Gear for television studios and classrooms must be procured and distribution facilities must be acquired or built.

In spite of the difficulties that still lie ahead, these experiments have shown decisively that television is an excellent training medium which can easily be made better than good classroom instruction. More studies will be made on the best and cheapest way for using it in large-scale training programs. This will be time well spent, for the future of this type of training may be closely bound up with the future of a successful national defense program.

Raw Materials for Wound Healing

by

Martin B. Williamson
Loyola University

Research and up-to-date medical methods have saved countless lives among the battlefield and shipboard casualties of modern warfare. In spite of this fine record, we still have little fundamental knowledge on a very important aspect of caring for our injured. We still do not have very much basic information on wound healing.

Even the most primitive tribes have given a lot of thought to this problem. The injured warrior, returning from hostilities, was often subjected to a ritual which was supposed to purify his wounds and speed their healing. In fact it seems likely that since the earliest times this problem has been a subject of great concern. This, of course, is not surprising, for even in highly civilized communities wounds are fairly common. Accidental injuries or purposeful wounds made by surgeons are everyday occurrences.

In spite of all this, very little is known about the basic processes of wound healing. The approach to the problem, from the incantations and potions of primitive times, to the more scientific therapeutics of modern medicine, has been on an empirical basis. If a remedy worked it was used; if it did not seem to succeed it was discarded. The application of medicines to the wound or the inclusion of certain foods in the diet were the main lines of attack. But no really systematic attempt was made for many years to find out exactly why some of these were effective and others failed.

Moreover, there was not even any sure way of finding out just how effective remedies actually were, except in very crude terms. This was because until recently accurate methods had not been developed to measure the rate of wound healing.

Everyone who has ever had a cut or incision has had the opportunity to observe how the body, often with great speed and efficiency, seals the wound over with firm new tissue. Just how does this interesting process take place? What are the conditions under which it happens and what does the body require in order to accomplish it? This was what we wanted to find out, for it was clear that if we could determine, for example, that a certain element in the diet promoted healing, such knowledge would help greatly in treatment of wounds.

Martin B. Williamson (B. S. Brooklyn College, A. M. and Ph.D., University of Missouri) is a biochemist whose principal interests have been in studying proteins and the way the body uses them. The present research which he is conducting in this field under ONR contract is being done at Loyola, where he is Associate Professor of Biochemistry at the School of Medicine. He was also on the faculty of the Harvard Medical School and before that served as Senior Research Biochemist at the Wyeth Institute.

We knew, of course, that by some special process the wound puts together certain substances to form protein--the main constituent of skin and muscle. We also knew that the substances which it uses to do this are called "amino acids". These are chemicals, all containing nitrogen, which have sometimes been referred to as "body building blocks". They are found in ordinary foods such as eggs, meat and cheese, and are essential raw materials for the building of tissue.

In mature animals body tissue is built up (catabolizes) at the same rate that it is broken down (anabolizes). If this were not true we would be gaining or losing weight constantly instead of remaining about the same, as do most normal people. When wounding occurs, however, there is a change in the body metabolism which causes tissue to be broken down at a faster rate than it is being built up; consequently the patient loses weight. This condition is called a "negative nitrogen balance", since body proteins all contain nitrogen, and the body mechanism which produces it is called a "stress-reaction". In young growing people there may not be an actual loss of weight, but growth is reduced instead.

Immediately a possible explanation for the "stress-reaction" can be suggested. It seems likely that the body may break down some of its tissue proteins so that the amino acids of which they are composed will be available for building new tissue at the site of the wound.

After the wound has healed somewhat, the tissue protein which had been lost is built up again--i.e., the patient regains his normal weight. It seems likely that the process that caused him to lose it was brought about by some hormone-like substance produced at the site of the wound. This chemical may either stimulate the breaking down of body tissue or slow the building-up process; either action would make the amino acids available for building new tissue to heal the wound.

In order for us to study the basic aspects of these processes, two important standards had to be developed: a wound that could be duplicated again and again and a way to measure quantitatively the rate of healing. It was found that a fairly "standard" wound could be made repeatedly in the skin of rats on the back of the neck, where the animals could not disturb the injury. In addition an apparatus (Figure 1) was developed which appears to give a fairly good measure of the rate of healing.

Repeated experiments using this apparatus showed that an appreciably greater "healing index" can be achieved when wounded animals are fed a high-protein diet than when they are fed a low-protein diet. Of course hospitals for years have been feeding patients recuperating from operations plenty of proteins, but knowledge on the actual effect of this regime had not been systematically compiled.

The good results obtained by the high-protein diet seem readily explainable. It appears probable that the extra amino acids available from such food would aid in building protein for new tissue. But we felt that this explanation might be oversimplified. It seemed possible that only one particular substance needed for wound healing might be in short supply in a normal or low-protein diet.

Further observations indicated that this was indeed the case. The addition of a certain sulfur-containing amino acid found in eggs and other common foods to a low-protein diet resulted in speeding up the rate of

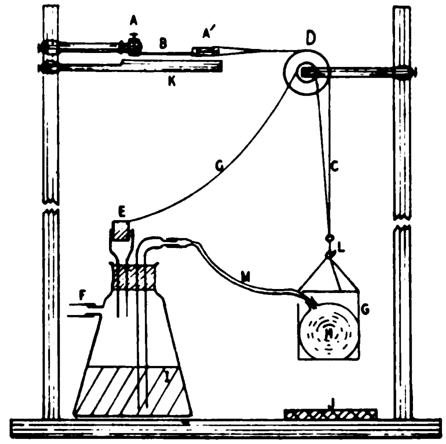


Figure 1. The basic design of the apparatus used to determine the tensile strength of healing skin wounds in rats. A section of wounded skin is held by clamps A and A'. Then mercury is pumped into the balloon H. When the healing skin tissue tears under the weight of the mercury the valve E opens so that no further mercury can enter the balloon. The weight of the mercury is taken as a measure of the tensile strength of the wound, which is indicative of the amount of healing that has occurred.

healing markedly. In fact the addition of this particular "body building block", which is called methionine, to a diet that otherwise contained little protein, produced a rate of healing that was just about as fast as that obtained with a diet that supplied all the amino acids in large quantities. This meant that methionine and not just an indiscriminate assortment of amino acids was a key substance in promoting rapid healing.

This led to further speculation. Methionine is not the only sulfur-containing amino acid, so we decided to test the others to see if they also had a marked effect on the rate of wound healing. Cysteine, for example, is a naturally occurring amino acid which can be produced in the body from methionine. When wound-healing experiments were repeated using cysteine, the rate of healing was just as fast as when methionine was employed. Thus it seems probable that the total supply of sulfur amino acids rather than only methionine is critical for the healing of wounds.

Other experiments tended to confirm this. For example it was noted that when no protein at all is fed, healing does progress, but at a very slow rate; apparently in this case the tissues of the body are supplying the substances necessary to build up new tissue over the wound. But when only sulfur-containing amino acids are added, there is a marked increase in healing.

A further indication of the importance of sulfur amino acids has been found by studying the sulfur balance of the body. This was found to be positive at all times in wounded animals, even though the nitrogen balance was negative. In other words, although the tissue proteins were being broken down (negative nitrogen balance) the sulfur-containing constituents of such proteins were being conserved. This indicates that during the "stress reaction" to wounding, tissue protein is being sacrificed in order to make a greater proportion of the sulfur compounds available for healing.

Our experiments, then, have established that, of all the raw materials required for healing wounds, the sulfur-containing amino acids are the most important in regulating the rate of mending. This is useful information which may help to put on a sounder basis the dietary requirements for people convalescing from injuries and operations. At any rate, it brings us closer to an understanding of what the body needs to patch itself up after injury--knowledge that may prove valuable in solving the medical problems of either peace or war.

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Engineering the Weathe

When steam power became a practical reality for ships, mariners were able to accomplish what had previously been only a dream - the navigation of a great circle course regardless of wind belts. Deviations from the course occurred only wherein land areas, certain storm areas, or icebergs and growlers were known to exist. Steam has brought many other changes. Ship size and speed have increased and more passengers and cargo are moved from one port to another in less time. Paralleling the increase in size and speed of ships, have come improvements in design and construction, in navigational instruments, and in seamanship. All of these advances have emboldened steamship captains to hold to their courses regardless of weather, sometimes with tragic results.

In spite of our apparent mastery of the sea we still read of tankers being twisted in half, of a cruiser losing its bow, of men being swept overboard, of ships capsizing - all victims of uncompromising storms. An air chief marshal of the RAF recalls that "... in one month in 1943 there were one million tons of shipping laid up under repair in various (English) ports, entirely owing to the appalling weather conditions ...".

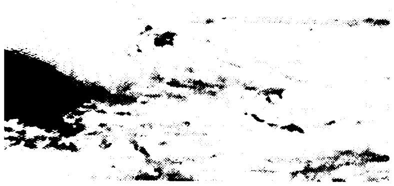
Ships are finer and faster than ever before, yet danger lurks at sea. What has been overlooked?

Perhaps what we have overlooked is the sea itself! To illustrate: a derelict sunk near New York harbor endangered navigation in that vicinity. All efforts made to raise it failed until an engineer attached floats at low tide. Then the force of the ocean lifted the "immovable".

by

Louis P. Allen,
Staff Oceanographer
Undersea Warfare Branch
Office of Naval Research

Mr. Allen is well acquainted with problems of navigating under adverse conditions. Before coming to ONR he was with the Navy's Hydrographic Office, where the problems of adapting operating procedures to environment were under study. Previously he was a meteorologist for an airline company, for the Weather Bureau and for a broadcasting concern.



or Better Navigation

Moreover, this force causes even 1000-foot superliners to roll and pitch. And these are but two of the lesser capabilities of the sea!

The testimony is overwhelming that too little appreciation has been given to the power of the sea, and too little is actually known about the forces which create it. Shipping routes are planned according to great circle courses, with scant thought given to selection on the basis of safety or favorable use of the elements. To improve the art and science of sea navigation, more thorough studies of the power of wind and waves, the variability of this power, and the forces responsible for it, are in order.

Some progress, however, has already been made. During World War II the Hydrographic Office, the Bureau of Ships, the Scripps Institution of Oceanography, and others set about to study the effect of wind in creating sea and swell. Forecasts of sea and swell--made from weather charts--were essential to the landing operations at Normandy, Iwo Jima, and Okinawa. Previously, little knowledge had been available, but this work showed that sea conditions can be forecast with amazing accuracy if the weather is known. It is illogical that such an accomplishment should be allowed to fall into disuse now that the war is over.

Areas of hazardous sea have, in fact, been blocked out, but the basis for the selection of boundaries between areas is inadequate. Now that the sea can be predicted, these boundaries should be reconsidered, revised, and redrawn. At best this will be only a partial solution, for weather and sea do not respect any such boundaries. Dangerous storms can occur almost anywhere. "Normal" weather conditions do obtain, however, in most regions of the ocean, and the navigator who sets his course to avoid storms and other detrimental conditions can have more than reasonable expectancy of favoring winds and seas.

While studies of the power of the sea will lead to increased safety, studies of wind power will lead to increased economy of ship operation.

Because the mariner is no longer required to depend upon the wind systems, the tendency is to ignore this source of energy. Yet if wind is the force that makes the mighty sea a brutal bludgeon its importance cannot be casually dismissed. What are its effects upon ships? In considering this question we must remember that the power of the wind varies as the cube of its speed; i.e., doubling the wind velocity increases its power eightfold. For example, when a 4-knot wind rises to 16 knots, the wind power increases 64 times. This is not a far-fetched instance, for a true wind of 4 knots can easily become a 16-knot headwind along the deck of a moving ship. And if a 30-knot headwind sweeps along the deck, ship performance is materially reduced, and operating economy is seriously impaired. Clearly more respect should be given to the power of the wind, not only as it creates the sea, but also as it affects ship operation.

For years the German Hydrographic Institute has been studying the effect of wind upon moving ships. The graph in Figure 1 is taken from "Annalen der Hydrographie und Maritimen Meteorologie" for 1905. Nine well-known German vessels making trans-Atlantic crossings participated in the collection of these data with an average of 300 observations per ship.

Under conditions of a high sea, data contained in the graph probably embody the effect of the sea itself as well as the wind. But under normal conditions the effect is due to wind alone. (According to the graph, "normal" defines the wind from calm to 22 knots.) Wind over the stern increases the speed about 1 percent, but headwind decreases the speed approximately as follows:

3 percent for fast passenger vessels;
4 percent for slow passenger vessels;
13 percent for lightly laden freighters;
10 percent for heavily laden freighters.

Although the wind was only normal, navigating with it rather than against it produced, without increasing fuel consumption, an increase in daily mileage from 21 to 38 miles, depending upon the type of ship. A much greater saving was accomplished under the stronger wind conditions typical of winter weather.

Consider a ship that makes good 18 knots under normal headwind conditions, and in adverse weather makes but 13. If, along a route that ordinarily requires seven days to accomplish, a strong headwind and high sea exist, the captain could deviate from his course a total of 850 miles to gain normal weather, and yet make the trip in the same time that the original course would have required! Other advantages would be easier handling of the ship with less strain on the crew, and a vessel reaching port free from damage.

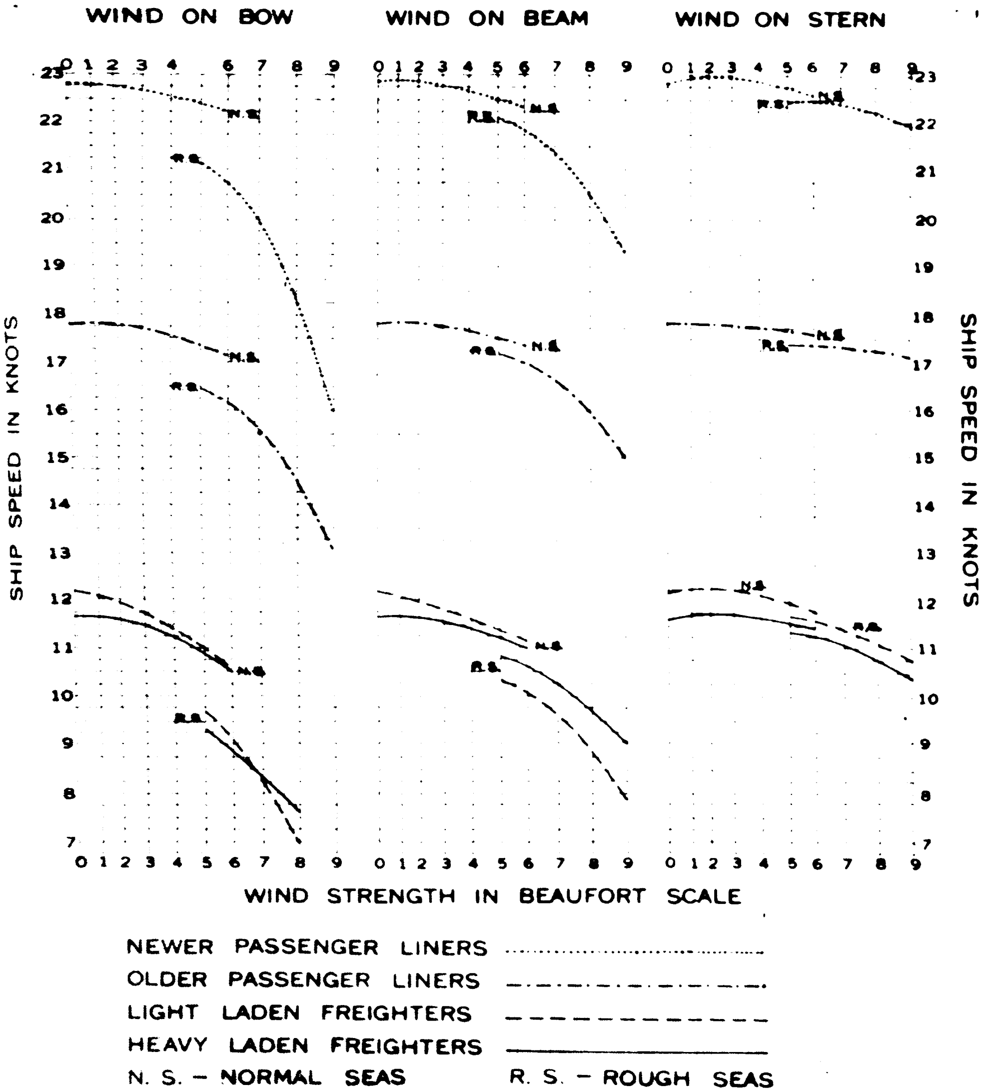


Figure 1. Effect of relative wind upon speed of ship

Mariners, of course, have long been aware that wind does affect even ships propelled by steam. Consequently many individual attempts to reckon with the wind have been made. Anton Flettner, for example, designed a "rotor ship" in 1922 to use the power of the wind. This ship failed, not because Flettner had overestimated the power of the wind, but because the wind was too unreliable for profitable voyages. Other wary mariners anticipate areas of high wind and sea, and attempt to circumnavigate them when possible, or wait a chance to navigate with the wind, keeping it on the quarter. Many a master has learned to be his own meteorologist.

Sometimes these individual systems of coping with the wind have been very successful. In 1940 a Norwegian motorship left Noumea, New Caledonia for Panama. The master decided not to follow a great circle route, but to follow the equatorial countercurrent and go north of the southeast trades and any swell that may have resulted from them. The combined effect of unopposing winds and favorable current caused the ship to exceed continually the dead-reckoning position based upon shaft-log readings.

The approximate location of trade-wind belts and belts of equatorial calm are well known to mariners, and the purposeful use of them in shipping can be easily made, since little change takes place from season to season. But greater skill is required to make use of the shifting storm areas in the belts of the westerlies. Winter Aleutian storms, for example, are well known, but they do not remain in one area throughout a season. Moreover they are subject to accelerating and decelerating forces, strengthening and weakening processes.

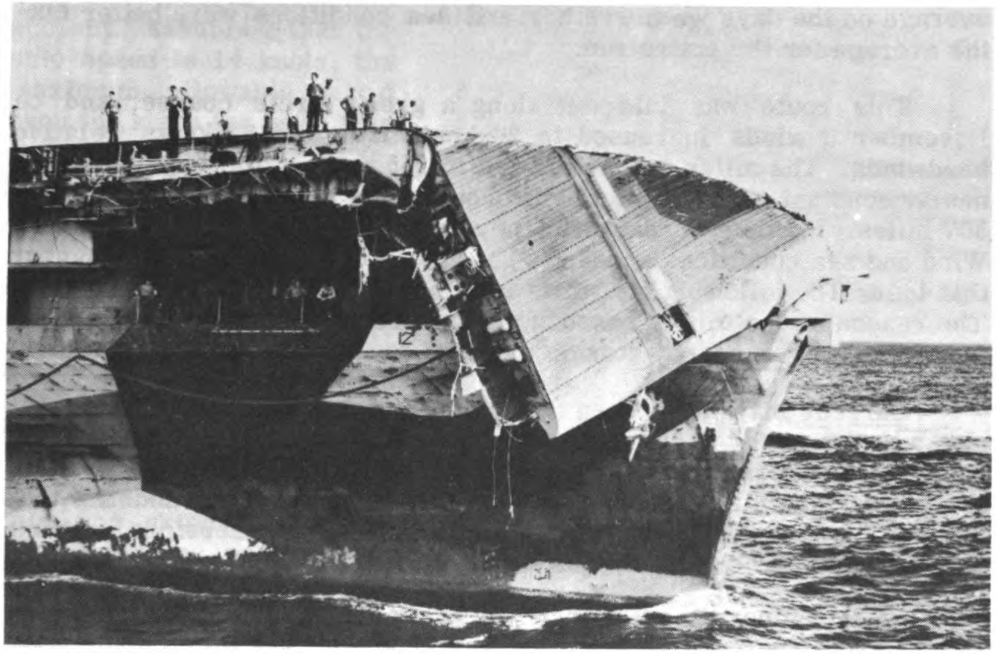
Meteorology has made tremendous strides within the last decade and weather forecasting has become a science. The requirements of air navigation have made up-to-the-hour weather reports available along most sea lanes. Modern navigation must recognize that today's meteorology and climatology deal not with mere tabulations and records; that, on the contrary, weather is a dynamic process, and that it must be applied specifically before the full value can be realized.

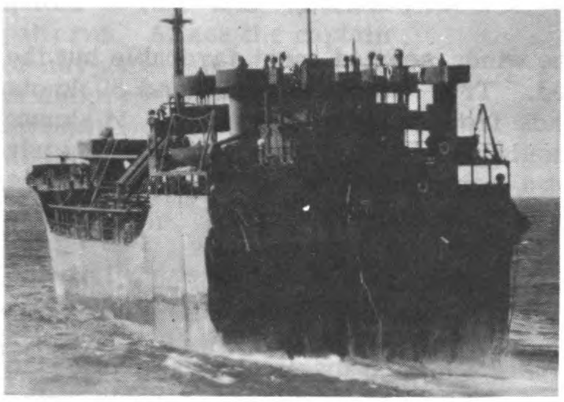
Instead of rigidly setting a course, taking the weather as it comes, and on many occasions fighting it, it certainly seems wiser to plan each trip in relation to existing and expected weather rather than depend upon climatic averages. For example, a delay in departure because of anticipated bad weather may result in a smoother, faster, more economical trip. Or following a more circuitous route, though it means more miles traveled, can also mean greater economy with less time at sea; it certainly means better weather for the trip.

An experience that demonstrates this is that of the commanding officer of the USS BECKHAM who became tired of bucking storms, headwinds, and rough sea on "Magic Carpet" runs between the West Coast and the Orient. On several crossings he kept a complete account of the weather and ship performance. After correlating the ship performance with the conditions encountered, he decided that weather is an important factor to the economy of ship operation.

Figure 5 contains graphs based on daily observations of a crossing made by the BECKHAM from Manila to San Francisco. The top line represents the average 24-hour wind speed based upon hourly observations. The second line represents wind speeds relative to the moving ship, or more specifically, the wind along or across the deck. A positive value indicates relative winds from astern. The third line represents a deviation of the ship's efficiency, or performance, from the trip average. This was obtained by the actual miles made good per 24 hours with respect to the shaft-miles turned. For example, on November 7 the deviation of performance from the trip average was 5 percent, or 105 percent of the average. This means that the ship made good more miles than indicated by the shaft log. The heavy line in the bottom grid indicates the shaft-miles per 24 hours. On the day in question the shaft miles were 304; navigational miles were 105 percent or 319 miles. This is represented by the light line. Also on November 7 the true wind speed was about 6 knots, giving a relative headwind of 16 knots.

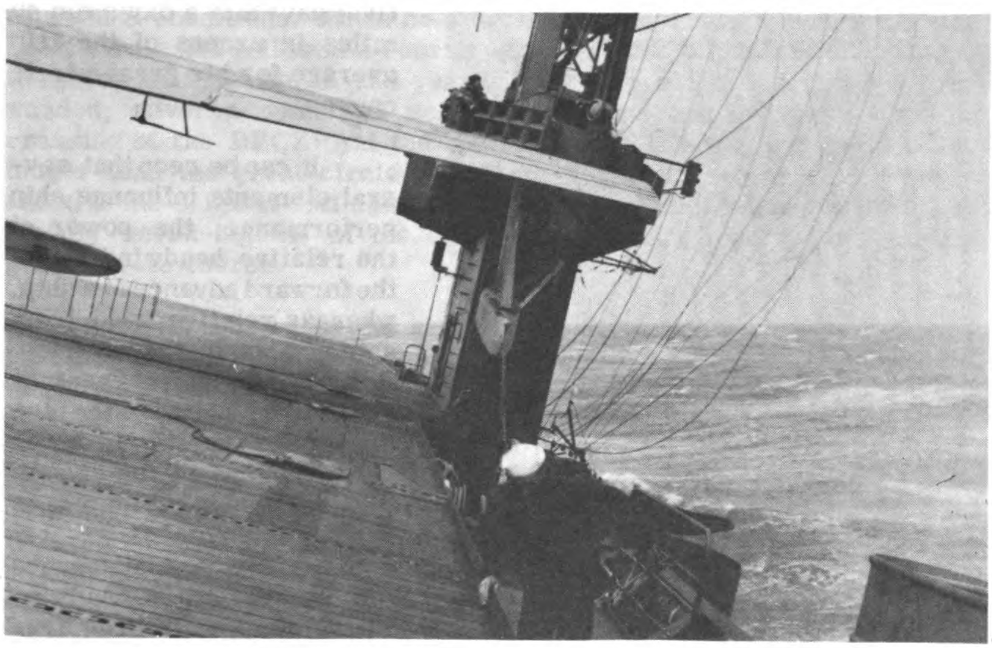
All figures are based upon trip averages. If the entire voyage had been made in foul weather, performance could still be above the trip





Danger at Sea

If you doubt the power of storm and sea, look at these pictures. Figure 2 (above) shows the famous Hornet, which in 1945, had damaged thousands of tons of Jap shipping without being hit by a single bullet. But a typhoon did all this damage. Figure 3 (left) shows a tanker twisted in half by a storm. Below (Figure 4) we see the heavy rolling which caused a man to be lost overboard from the USS SARGENT BAY.



average on the days when weather and sea conditions were better than the average for the entire run.

This route was laid out along a great circle course, and on November 9 winds increased to 24 knots true and 37 knots relative headwinds. The miles made good fell to 265 and yet the engines held a nearly constant shaft speed which should have made good a distance of 307 miles. In other words, efficiency fell to 14 percent below normal. Wind and sea conditions appear to have been the principal reasons for this loss. The following day winds lessened, yet efficiency remained low. The reasoning for this is based upon the presence of high sea that was generated from a nearby storm; the wind had abated but sea remained.

Current may have been responsible for some of the loss, but absolute values for current are unknown. Studies of ship's set for the purpose of determining current assume that all navigational errors, wind effect, and miscellaneous factors are corrected. It is doubtful that many of these corrections are made in practice, and therefore current charts contain true current plus these errors.

On November 21, efficiency was at its height. While the true wind was 14 knots, the relative headwind was 11 knots. The miles made good in excess of miles turned up on the shaft were 27.

On November 22 and 23 the winds seemed most favorable but the performance of the ship lagged. True winds were 28 and 30 knots respectively, and relative winds from astern were 5 and 11 knots respectively. Ship efficiency should have been at its peak. Closer study of the circumstances shows that a high sea was created by the 28-knot wind, and headway was reduced by pitching.

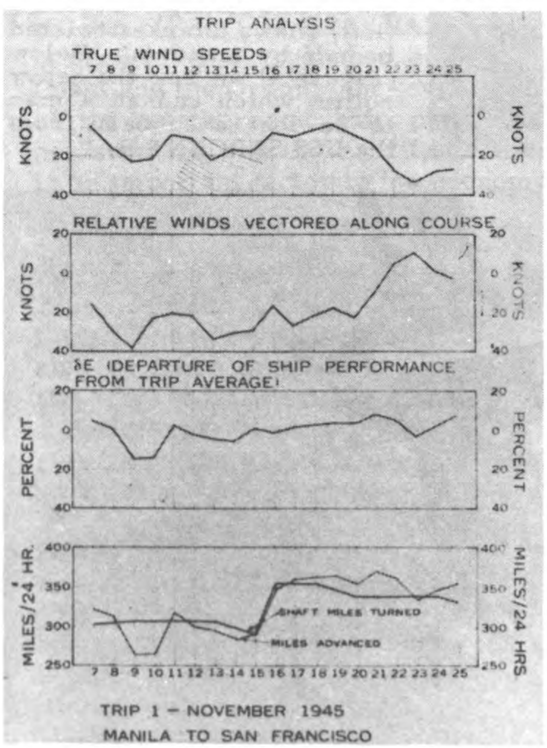


Figure 5. Analysis of trip 1--from Manila to San Francisco

On the return trip the BECKHAM's captain obtained corroborative records. On one particular day a following 23-knot wind (8 knots relative) gave him a day's run 40 miles in excess of the trip average for his great-circle course.

It can be seen that several elements influence ship performance; the power of the relative headwind slows the forward advance of a ship, whereas relative wind from astern aids in the advance. But a third element requires consideration: the sea created by true wind. It can be shown that in the case of this particular ship a true wind of 25 knots or greater created a sea that caused this vessel to lose headway. Thus, an upper limit of true wind force must be taken into account. Assuming that the ship speed is 14 knots, the maximum allowable wind over the stern for peak ship performance is 10 knots. This means that the true wind would be 24 knots, and it would not create a sea that affects materially the headway of the ship. These, in part, are optimum conditions for the greatest headway possible for this type ship.

A meteorologist in the port operations office could help the skipper plan the basic route, pointing out areas where course deviations might be necessary because of existing and anticipated wind and weather patterns. At sea the captain or navigator should be able to make changes in the route indicated by unforeseen weather. If this is not feasible, the ship should be able to radio the operations office for advice when predicted weather begins to appear questionable. This is essentially what is done in airline travel.

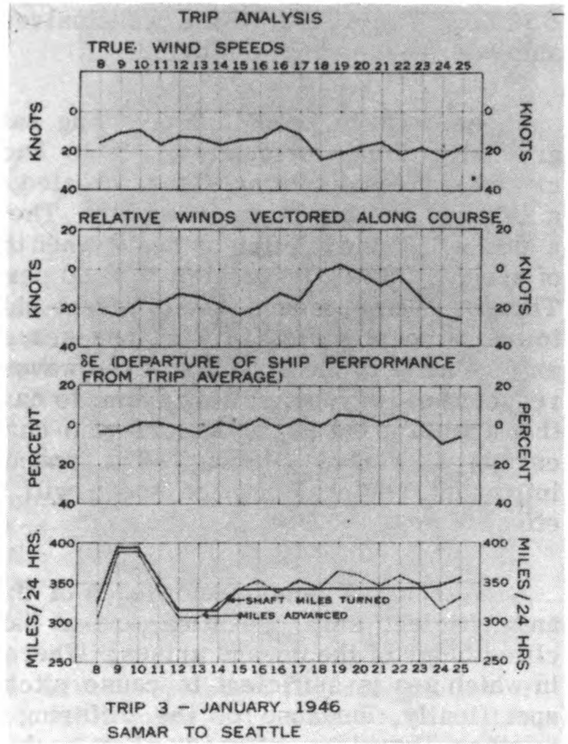


Figure 6. Analysis of trip 3--from Samar to Seattle

With an idea of what constituted good and bad conditions for the operation of his ship, the captain of the BECKHAM decided, on his next voyage, to lay his course through regions of favorable weather. Before leaving Samar (in the Philippines) for Seattle on January 8, 1946, he spent considerable time with the aerographer's mate studying meteorological conditions. When he weighed anchor he deliberately left the great circle and followed a course patterned on general weather conditions for that season of the year. The canny skipper was amply rewarded; adverse wind and sea were virtually nonexistent. On this crossing of the BECKHAM the distance traveled was over 600 miles longer than the great-circle route, but the arrival time was 24 hours ahead of the original estimated time of arrival. Fuel consumed amounted to only seven-eighths of the estimated consumption for the original great-circle course.

Note (in Figure 6) the smoothness of the ship's operation; departures from normal were small, except for January 24, when weather maps show that a high swell entered the operating area from the Gulf of Alaska. It should be remembered that the figures for these crossings represent departures from EACH TRIP AVERAGE; they are relative and apply specifically to this ship and the particular set of data in question. They cannot be used as definite indices for other ships making crossings under differing circumstances. In time actual figures may be available for each type of ship, and economy of ship performance can then be computed for each trip based upon expected weather. The

BECKHAM's record shows conclusively, however, that efficiency of ship operation can be improved.

Answers to problems involving safety and efficiency at sea are gradually being formulated. It is known conditionally under what circumstances disabling sea is created, and under what circumstances a ship can operate more efficiently. The studies made to date show that a ship will begin to pitch or heave when the distance from crest to crest of a wave is a little greater than 50 percent of the length of the ship. This, of course, means that different ships react in a different manner to the same elements in wind and sea. Moreover, the heading of the ship relative to the direction of the waves must be considered. Pitching reduces headway, but rolling seems to have little retarding effect - facts that are borne out by navigators who change course in a heavy sea to escape excessive pitching. The speed of advance of a ship is also important, and changing the speed will frequently alter somewhat the effect of sea.

Although a general knowledge of the elements necessary for safe and efficient ship operation are at hand, a question concerning the climatology of the oceans arises: Where are located geographic areas in which sea is sufficient to cause pitching? This cannot be answered specifically, because of the differing characteristics of ships and weather already mentioned. For each class of ship, however, some generalities may be made.

Consider a 500-foot ship heading into the wind. A series of waves measuring 250 feet from crest to crest will cause pitching to begin. The meteorologist can show that a 28-knot wind blowing for 18 hours creates such a sea. This leads to the problem of locating areas where such winds exist. This cognate problem cannot be solved with certainty either, for existing climatic studies are merely average weather conditions. The requirements concern existing and expected weather conditions regardless of any deviations from the average.

Obviously the oceans can never be blocked out into specific regions of definite wind and sea conditions, for these elements change with daily and seasonal weather patterns. However, answers can be computed on a percentage basis, and a probability can be stated for an Aleutian storm to be weak or displaced, and in what areas excessive wind may occur for any time in any season. Though conclusive results may never be realized, much can be learned and utilized to the advantage of those closely associated with ships navigating the seas.

In time climatic and oceanographic studies should be available. When direction and persistency of unfavorable wind and high sea along each route have been blocked out on a percentage basis, mariners will be able to select the best route in accordance with the seasonal pattern. In addition, a meteorologist should be consulted about the existing and expected weather and the course altered accordingly. Smoother, safer, and more efficient crossings would then be an accomplished fact.

(A somewhat fuller account of this work can be found in this month's issue of the Bulletin of the American Meteorological Society, under the title, "Navigating with the Weather".)

Who's Who in Naval Research

CAPT Samuel M. Tucker, Assistant Chief for Research, would much rather talk about the aims and accomplishments of ONR than about his own part in them. In spite of this unassuming attitude (which incidentally is typical of the Captain) his job of running the contract research program is one which requires not only scientific comprehension and technical experience, but also the ability to weld many diverse personalities and opinions into one smoothly functioning organization.

Around ONR CAPT Tucker has a reputation for doing a lot of careful listening. Small in stature, soft-spoken and courteous, he seems never to waste a word or a gesture. But when he does express himself it is usually with great effect. Frequently in conferences he listens quietly to a maze of conflicting recommendations, then when everyone has had his "say", makes a few remarks that straighten things out quickly and neatly.

As for CAPT Tucker's Navy career, his record speaks for itself. After graduation from the Naval Academy and a short postgraduate course in aviation, he saw service aboard the USS COLORADO and the USS UTAH. Submarine training in New London, Conn. followed and subsequent service on USS S-32, USS R-5 and USS R-13.

After these assignments CAPT Tucker began the training that was to enable him to render distinguished service during World War II: radio engineering courses at the Postgraduate School in Annapolis, at the Submarine Base in New London, and at Harvard University (from which he received his M.S. in 1936). He then reported as tactical and communication officer aboard the USS CHICAGO, flagship of the Commander Cruisers, Scouting Force, and Cruiser Division FIVE. Detached from that cruiser in 1938, he joined the staff of Commander Battle Force as Radio Officer.

Back in the States again in 1939, he began work that was to prove influential in determining the course of the war. He became Officer in Charge of a section in the Navy Department which was directing development of a new, highly secret type of radio detecting equipment. When discussion of the work in busy crowded rooms began to present a security hazard, CAPT Tucker and CAPT Frederick R. Furth (Director of NRL) decided a code word was needed to designate it -- and forthwith "radar" was coined to mean the equipment eventually familiar to all of us as a potent weapon in the victory over the Axis. For his part in this development CAPT Tucker received a letter of commendation which stated that "his early work in construction design can be traced in all subsequent, skillfully utilized radar equipment."

From here on the commendations came thick and fast. Some of them follow, in part.

For services as Communication Officer on the staff of Commander Amphibious Force, U. S. Pacific Fleet:

Legion of Merit--"For exceptionally meritorious conduct ... as Communication Officer of a Joint Army-Navy staff during the planning phases of the Attu-Kiska operations and later as Communication Officer on the staff of the Commander Assault Force during the seizure and occupation of Kiska Island in August 1943 ... (he) was responsible for the extremely successful functioning of the communication system during the progress of the amphibious landings on these strategic islands."

Navy Unit Commendation--".. Imperilled by perpetual fog (the USS PENNSYLVANIA) served as flagship of the task force commander during the Aleutians campaign and navigated in poorly charted waters to deliver her accurate broadsides on predetermined but invisible targets..."

For services as Radio Maintenance Officer, South Pacific, on the staff of Commander Service Squadrons:

Citation accompanying award of the Gold Star--"Persistent in the accomplishment of his duties, (he) rendered valuable service in the planning, installation, maintenance and repair of radio, radar and sonar equipment, and organized and put into the field advance communication components and Argus units".

A second letter of commendation from the Secretary of the Navy with authorization to wear the Bronze Star on his Commendation Ribbon was awarded him in 1945 for outstanding services in the Electronics Division of the Office of the Chief of Naval Operations. After this he assumed command of the USS PICKAWAY until September 1948 and then served as Executive Member of the Air Defense Board (also in the CNO's office). It was ONR's good fortune to get him in July 1950 as Assistant Chief of Research.

Red Blood Cell Counter Developed

Quick estimates of damage done by hemorrhage, shock, burn and radiation will be available through use of a new red blood cell counter recently developed at Cornell University. The instrument, which permits a few technicians to make some 40 to 60 counts per hour, represents a valuable clinical advance, for counting red cells has been a slow process.

Though counting red blood corpuscles is a valuable tool in the practice of clinical medicine and is required in routine hospital examinations, it is believed that use of the new device will not be practical under such conditions. Only when massive numbers of casualties must be treated will the method really come into its own. It will be particularly useful under war conditions, when the need for treatment increases a thousandfold.

The counter is based upon a relationship between the red cell count and the conductivity of whole blood. Errors involved in visual methods are of course, eliminated with the new instrument. It does, however, have its own sources of error, which averages about 9 percent per count.

The development of the blood counter is only one part of a project involving a study of the electrostatic forces in the blood, being carried out at Cornell under Navy funds. The relationship of these forces to blood clotting is another aspect of the program. The principal investigators are Drs. I.S. Wright, Erwin Sheppard and C.W. Ballard.

On the Naval Research Reserve

Research Reservists on ISL Can Easily be Reinstated

If you have received the unpleasant news from the Navy that your name has been placed on the inactive-status list, don't be too disturbed. It will be simple enough to correct if you have been active in your research reserve unit.

Simply write a letter to the Chief of Naval Personnel stating the date that you joined the unit and telling how many drills you have attended since that time. Express your desire to continue your affiliation with the unit and request return to the active-status list. Anyone who has been active in a research reserve unit since January 1951 will be considered to have shown sufficient interest in the reserve program to be retained on the active rolls.

Retention of active status is important to reservists who want to keep their privileges. Eligibility for promotion will, of course, be lost by transfer to inactive status, as will the ability to earn credits for retirement. Moreover, such reservists will not be permitted to take any officers' correspondence courses.

Information on Retirement

The information of Naval Reserve Non-Disability retirement is contained in NRMAL 27-49. It applies to both officers and enlisted. Briefly it provides retired pay upon reaching age 60 to those who have performed a minimum of 20 years of "satisfactory Federal service." The amount of pay is based on the number of retirement points earned.

Prior to 1 July 1949, each year of Reserve service is considered a year of "satisfactory Federal service." Subsequent to that date a reservist must accrue a minimum of 50 retirement points. Retirement points may be earned by members of drilling units in any of the following ways:

a. One retirement point for each authorized drill period in an organized or volunteer unit.

b. One retirement point for each period of appropriate duty, equivalent instruction, or equivalent duty.

c. One retirement point for each day of training duty, served with or without pay.

d. One retirement point for each day of active duty.

e. A varying number of retirement points for correspondence courses.

f. Fifteen retirement points per year gratis to all Reservists not on active duty.

No more than 60 retirement points earned by items a, b, e, or f above will be credited in any anniversary year. Points earned by training or active duty are added on to those earned by items a, b, e, or f without limitation.

Officially Activated

Volunteer Research Reserve Units

Designation	Time and Place of Meeting	Commanding Officer and Mail Address
1-1	1930, 1st & 3rd Mon. Rm. 4-370, M.I.T. 77 Mass. Ave. Cambridge, Mass.	CAPT L. M. SMITH, USNR 34 Parkland Ave. Lynn, Mass.
1-2	1930, 2nd & 4th Tues. USNROTC Bldg. Brown University Providence, R.I.	CDR Carl PFAFFMAN, USNR (O in C) 16 Cabot St. Providence, R.I.
1-2 Sub-Unit	1600, 1st & 3rd Tues. Rm. 305, Ranger Hall, Rhode Island State College Kingston, R.I.	CDR Charles J. FISH, USNR (O in C) Narragansett Marine Lab. Kingston, R.I.
1-2 Sub-Unit	2000, 1st & 3rd Tues. Oceanographic Institute Woods Hole, Mass.	LCDR Mary SEARS, USNR Glendon Rd. Woods Hole, Mass.
1-3	1900, 1st & 3rd Tues. University of Mass. Amherst, Mass.	LCDR E. D. EMERSON, USNR Dept. of Mech. Eng. University of Mass. Amherst, Mass.
1-4	2000, 1st & 3rd Tues. Coburn Hall University of Maine Orono, Me.	LT Francis J. SULLIVAN, USNR Dept. of Mech. Eng. University of Maine Orono, Me.
1-5	2000, 1st & 3rd Mon. Stratton Hall Worcester Poly. Institute Worcester, Mass.	CDR Emerson A. WIGGIN, USNR 25 Bay State Rd. Worcester 6, Mass.
1-7	2000, 1st & 3rd Tues. Wentworth Hall Dartmouth College Hanover, N. H.	LT Richard C. DUNHAM, USNR River Ridge Hanover, N.H.
3-1	1915, Alt. Thurs. Auditorium, Med. College Cornell University New York 21, N. Y.	CAPT Robert H. GRIFFIN, USNR 105 Pennsylvania Ave. Tuckahoe 7, N. Y.
3-2	1930, 2nd & 4th Mon. Special Devices Center Eng. Bldg. Port Washington Long Island, N.Y.	LCDR A. A. CHESTER, USNR Navigation Training Section Special Devices Center Port Washington Long Island, N.Y.
3-3	2000, 1st & 3rd Mon. USNRTC & MCRTC 3 Porter Ave. Buffalo, N.Y.	CDR Morris BEERMAN, USNR 479 Eggert Rd. Buffalo, N.Y.
3-4	1930, 1st & 3rd Tues. Harkness Hall University of Rochester Rochester, N.Y.	CDR Henry C. SHEVE, USNR USNRTC & MCRTC 900 East Main St. Rochester 7, N.Y.

Designation	Time and Place of Meeting	Commanding Officer and Mail Address
3-5	1930, 2nd & 4th Thurs. USNRTC Fort Nathan Hale Park New Haven, Conn.	CDR D. S. ROWELL, USNR USNRTC Fort Nathan Hale Park New Haven, Conn.
3-6	2000, 2nd & 4th Mon. USNRTC Syracuse (Liverpool), N.Y.	LCDR Leslie R. PARKINSON, USNR 117 Harrington Rd. Syracuse, N.Y.
3-7	2000, 2nd & 4th Thurs. USNRTC Scotia, N.Y.	LCDR Harold L. SHAMBACH, USNR 1826 Nott St. Schenectady 8, N.Y.
3-8	1930, 2nd & 4th Tues. 7th Floor Conf. Rm. General Foods Personnel Offices New York, N.Y.	CDR Alfred WEEKS, USNR Rm. 1205, 247 Park Ave. New York, N.Y.
3-9	2000, 1st & 3rd Wed. Brookhaven National Lab. Upton, Long Island, N.Y.	CDR John S. MEDD, USNR Brookhaven National Lab. Upton, Long Island, N.Y.
4-1	2000, 1st & 3rd Wed. Nassau Tavern Princeton, N.J.	CDR Harry C. HART, USNR 21 Lilac Lane Princeton, N.J.
4-2	1930, Alt. Thurs. Franklin Institute 20th St. & Parkway Philadelphia, Pa.	CDR John H. NEHER, USNR Philadelphia Electric Co. 1000 Chestnut St. Philadelphia, Pa.
4-3	2000, 2nd & 4th Thurs. Rm. 232, Cathedral of Learning University of Pittsburgh Pittsburgh, Pa.	CDR Neil D. COLE, USNR University of Pittsburgh Rm. 303, Thaw Hall Pittsburgh, Pa.
4-4	1900, 1st & 3rd Wed. Rm. 200, Engineering "E" Pennsylvania State College College Station, Pa.	LT Paul F. NORTON, USNR Box 274 State College, Pa.
4-5	2000, Alt. Mon. USNRTC Foot of Madison St. Wilmington, Del.	LCDR Donald MacCREARY, USNR USNRTC Foot of Madison St. Wilmington, Del.
4-6	1930, 2nd and 4th Wed. USNRTC Bethlehem, Pa.	LCDR John O. CHELLEVOLD, USNR USNRTC Bethlehem, Pa.
4-7	1930, 2nd & 4th Tues. Rm. 107, Old Armory Ohio State University Columbus, Ohio	LCDR Karl E. KRILL, USNR Engineering Exp. Station Ohio State University Columbus, Ohio
4-8	2000, 1st & 3rd Mon. USNRTC 1089 E. Ninth St. Cleveland, Ohio	LCDR Viktor SCHRECKENGOST, USNR 2366 Noble Rd. Cleveland 21, Ohio
4-9	1930, 2nd & 4th Mon. USNRTC Dayton, Ohio	LT Nathan L. WENER, USNR 1007 Amherst Pl. Dayton 6, Ohio

Designation	Time and Place of Meeting	Commanding Officer and Mail Address
W. Battalion	2000, 3rd Thurs. Auditorium, Interior Dept. Washington, D.C.	CAPT Fred C. WIESNER, USNR ONR, LI 5-6700, X-65755 Rm. 2714, Bldg. T-3, ONR Washington, D.C.
W-1	2000, 1st Thurs. Lecture Room Material Testing Laboratory National Bureau of Standards Washington, D.C.	CDR Urner LIDDEL 9511 Lindale Dr. Bethesda 14, Md.
W-2	1900, 1st Thurs. Auditorium, Bldg. 8, NRL Washington, D.C.	LCDR H. A. TANNER, USNR NRL, JO 3-6600, X-561 Rm. 152, Bldg. 8, Naval Res. Lab. Washington, D.C.
W-4	2000, 2nd & 4th Tues. Rm. 6618, Interior Dept. Washington, D.C.	Herbert B. CHANDLER, ET 1/c, USNR RR #2, Silver Spring, Md. National Institute of Health Bethesda, Md.
W-5	2000, 2nd & 4th Tues. Conference Room, NMRI Bethesda, Md.	CDR Barry G. KING, USNR 5617 Wood Way Circle Sumner, Washington 16, Md.
5-1	1930, 1st & 3rd Wed. Rouse Physics Lab. University of Virginia Charlottesville, Va.	LTJG Harold S. MORTON, USNR P.O. Box 1716 Univ. Station Charlottesville, Va.
5-2	1915, 1st & 3rd Fri. Bldg. 364, Virginia Poly. Inst. Blacksburg, Va.	LT Frank D. HANSING, USNR 402 Progress St. Apt. #8 Blacksburg, Va.
5-3	2000, each Tues. Camp Detrick Frederick, Md.	CAPT LeRoy D. FOTHERGILL, USNR Camp Detrick Frederick, Md.
5-4	2000, 1st & 3rd Thurs. Rm. 202, Maryland Hall Johns Hopkins University Baltimore, Md.	LT Alan T. OSSERMAN, USNR 1809 Chelsea Rd. Baltimore 16, Md.
5-5	1700-1900, 2nd & 4th Mon. Medical College of Virginia Richmond, Va.	CAPT Roscoe D. HUGHES, USNR Medical College of Virginia Richmond, Va.
6-1	2000, Alt. Thurs. Rm. 103, Physics Bldg. Ga. Inst. of Tech. Atlanta, Ga.	CDR J. E. BOYD, USNR Physics Bldg. Ga. Inst. of Tech. Atlanta, Ga.
6-2	1915, 1st & 3rd Mon. Rm. 204, Ross Lab. Alabama Poly. Inst. Auburn, Ala.	LTJG J. E. LAND, USNR Dept. of Chemistry Alabama Poly. Inst. Auburn, Ala.
6-3	2nd & 4th Wed. AEC Townsite Oak Ridge National Lab. Oak Ridge, Tenn.	LCDR Edward I. WYATT, USNR 138 Tabor Rd. Oak Ridge, Tenn.
6-4	1930, 1st & 3rd Tues. Engineering Bldg. University of Florida Gainesville, Fla.	LCDR Chester L. EGGERT, USNR College of Education University of Florida Gainesville, Fla.

Desig-nation	Time and Place of Meeting	Commanding Officer and Mail Address
6-5	2000, 1st & 3rd Thurs. USNRTC Gulfport, Miss.	LCDR Lynn T. MILLER, USNR 2433 Wildes Ave. Biloxi, Miss.
6-6	1945, 2nd & 3rd Wed. USNROTC Armory University of North Carolina Chapel Hill, N. C.	LT Robert F. SCHENKKAN, USNR Communications Center University of North Carolina Chapel Hill, N. C.
6-8	2000, 1st & 3rd Mon. Underwater Sound Reference Lab. Orlando, Fla.	LCDR D. T. HAWLEY, USNR 1027 Guernsey Ave. Orlando, Fla.
6-9	1930, 2nd and 4th Tues. Rm. 101, Baldwin Hall University of Georgia Athens, Ga.	LCDR A. R. ROBERTSON, USNR Baldwin Hall University of Georgia Athens, Ga.
6-10	2000, 1st & 3rd Wed. Rm. S-110, Memorial Classroom Bldg. University of Miami Coral Gables, Fla.	LT R. D. KRESKE, USNR Dept. of Geography University of Miami Coral Cables, Fla.
6-10 Sub-Unit	2000, 1st & 3rd Wed. 151 South County Rd. West Palm Beach, Fla.	LTJG John H. COLEMAN, USNR 121 Worth Ave. West Palm Beach, Fla.
8-1	1930, 1st & 3rd Tues. USNROTC Bldg. Tulane University New Orleans, La.	LCDR John M. SCOTT, USNR Dept. of Chemistry Tulane University New Orleans, La.
8-2	2000, 1st & 3rd Wed. Rm. 221, Coates Lab. Louisiana State University Baton Rouge, La.	LT John A. ALFORD, USNR Dept. of Bacteriology Louisiana State University Baton Rouge, La.
8-3	1930, 2nd & 4th Mon. PMA Bldg. or Bolton Hall Texas A & M College College Station, Tex.	LCDR Norman F. RODE, USNR Dept. of Elec. Eng. Texas A & M College College Station, Tex.
8-4	1930, Alt. Wed. USNROTC Bldg. The Rice Inst. Houston, Tex.	LCDR L. J. CASTELLANOS, USNR 6513 Rutgers St. Houston, Tex.
8-5	2000, Alt. Tues. & Wed. Rm. 15, Chemistry Bldg. University of Texas Austin, Tex.	LCDR G. H. AYRES, USNR Dept. of Chemistry University of Texas Austin, Tex.
8-6	1930, Last Mon. USNRTC Galveston, Tex.	LTJG C. N. SECHRIST, USNR 1235 3rd Ave., North Texas City, Tex.
8-7	2000, 1st & 3rd Wed. USNRTC 1805 S. Yale Ave. Albuquerque, N. M.	LCDR Howard V. MATHANY, USNR Office of the Dean of Men University of New Mexico Albuquerque, N. M.
8-8	2nd & 4th Wed. Senior High School Bartlesville, Okla.	LCDR Alvin R. GREGORY, USNR 915 Dewey Ave., Box 1102 Bartlesville, Okla.
8-8 Sub-Unit	1930, 2nd, 3rd & 4th Thurs. Oklahoma A & M College Stillwater, Okla.	LT Dariel E. HOWELL, USNR 1408 Lewis St. Stillwater, Okla.

Designation	Time and Place of Meeting	Commanding Officer and Mail Address
8-9	1705 1st & 3rd Tues. Rm. B-117 Los Alamos Scientific Lab. Los Alamos, N. M.	CDR Henry HEYMAN, USNR (Acting) 1072-48th St. Los Alamos, N. M.
8-10	1930, 1st & 3rd Thurs. Physical Science Lab. N. M. College of Agr. & Mech. Arts Las Cruces, N. M.	LT Calvin I. RICKETTS, USNR Box 548 State College, N. M.
8-11	1930, 2nd & 4th Thurs. USNRTC Orange, Tex.	LT Joseph L. SCHWEPPE, USNR 2229 Cross Lane Orange, Tex.
8-12	2000, 2nd & 4th Tues. Rm. 127, Fondren Science Bldg. Southern Methodist University Dallas, Tex.	LTJG Homer B. HIX, USNR 2516 So. Llewellyn Ave. Dallas, Tex.
9-1	1900, 2nd & 4th Tues. Navy Pier Campus University of Illinois Chicago, Ill.	LCDR Walter E. PETERSON, USNR 411 South 15th Ave. Maywood, Ill.
9-2	1930, 1st & 3rd Mon. Rm. 319, Gregory Hall University of Illinois Urbana, Ill.	CAPT Chauncy M. LOUTTIT, USNR Dept. of Psychology University of Illinois Urbana, Ill.
9-2 Sub-Unit	Peoria, Ill.	ENS R. G. DWORSCHACK, USNR 1503 N. Sheridan Road Peoria 5, Illinois
9-3	1930, Alt. Mon. Rm. 18, Angell Hall University of Michigan Ann Arbor, Mich.	LTJG Wm. C. TRUCKENMILLER, USNR 1303 W. Madison St. Ann Arbor, Mich.
9-3 Sub-Unit	Houghton, Mich.	LCDR Roy W. DRIER, USNR 715 Pine St. Calumet, Mich.
9-5	1930, 1st & 3rd Wed. USNROTC Bldg. Iowa State College Ames, Iowa	LCDR J. A. GREENLEE, USNR 307 Ash Ave. Ames, Iowa
9-6	1930, 1st & 3rd Mon. Rm. 4, Mech. Eng. Bldg. University of Minnesota Minneapolis, Minn.	LCDR J. A. WISE, USNR Rm. 222, Aeronautical Eng. Bldg. University of Minnesota Minneapolis, Minn.
9-6 Sub-Unit	2000, 2nd & 4th Wed. ROTC Armory Smith College Brookings, S. Dak.	LT Gerald B. SPAWN, USNR South Dakota State College Entomology - Zoology Dept. Brookings, S. Dak.
9-7	1930, 2nd & 4th Thurs. Rm. 111, Stanley Coulter Hall Purdue University Lafayette, Ind.	LT L. M. BAKER, USNR Dept. of Psychology Purdue University Lafayette, Ind.
9-8	2000, 1st & 3rd Thurs. Rm. 101, Crew Hall Washington University St. Louis, Mo.	LCDR John Hayes CARTER, USNR Rm. #1118 915 Olive St. St. Louis 1, Mo.
9-8 Sub-Unit	Louisiana, Mo.	LT Tracey P. MOORE, USNR Bureau of Mines Louisiana, Mo.
9-9	1930, 1st & 3rd Thurs. Rm. 204, Mechanics Hall Missouri School of Mines and Metallurgy Rolla, Mo.	CDR R. A. COOLEY, USNR Missouri School of Mines and Metallurgy Rolla, Mo.

Designation	Time and Place of Meeting	Commanding Officer and Mail Address
9-12	1930, 2nd & 4th Tues. Rm. 2, Botany Bldg. Annex Colorado A & M College Fort Collins, Colo.	LTJG W. D. THOMAS, USNR Dept. of Botany & Plant Pathology Colorado A & M College Fort Collins, Colo.
9-12 Sub-Unit	1900, 1st & 3rd Fri. Boulder, Colo.	LTJG John R. ZIMMERMAN, USNR 1080 7th Ave. Boulder, Colo.
9-13	1930, 1st & 3rd Thurs. USNRTC Des Moines Still College Des Moines, Iowa	LCDR J. R. MALONEY, USNR 2920 48th St. Des Moines, Iowa
9-14	1930, Wed. or Thurs. (2/mo) USNRTC University of Wisconsin Madison, Wis.	LT Richard M. SHACKELFORD, USNR Dept. of Genetics University of Wisconsin Madison, Wis.
9-14 Sub-Unit	1930, 1st & 3rd Tues. Inst. of Paper Chemistry Appleton, Wis.	LTJG Edward G. SNYDER, USNR Inst. of Paper Chemistry Appleton, Wis.
9-15	1900, 2nd & 4th Thurs. Conf. Rm. Pers. Bldg., Dow Chem. Co. Midland, Mich.	LTJG John L. SCHICK, USNR 1173 West Midland Rd. Auburn, Mich.
9-16	1900, 1st & 3rd Mon. USNRTC 1620 E. Saginaw St. Michigan State College East Lansing, Mich.	LCDR Ira B. BACCUS, USNR 407 Marshall St. East Lansing, Mich.
9-17	1930, 1st & 3rd Mon. Rm. 103, Eng. Bldg. University of Wyoming Laramie, Wyo.	LTJG Robert S. BRADFORD, USNR Dept. of Physics University of Wyoming Laramie, Wyo.
9-19	1945, 3rd Thurs. Senate Chamber, Old Capital State University of Iowa Iowa City, Iowa	LT John L. DAVIES, USNR East Hall Iowa City, Iowa
9-20	2000, 1st & 3rd Mon. Naval Science Bldg. University of Kansas Lawrence, Kans.	LTJG Russell C. MILLS, USNR Dept. of Biochemistry University of Kansas Lawrence, Kans.
9-21	1700, 2nd & 4th Wed. General Motors Research Lab. 485 W. Milwaukee St. Detroit, Mich.	LCDR Ralph A. RICHARDSON, USNR General Motors Corp. 485 W. Milwaukee St. Detroit, Mich.
9-22	1930, 1st & 3rd Wed. Military & Naval Sci. Bldg. University of Nebraska Lincoln, Neb.	LCDR Lloyd W. HURLBUT, USNR 2640 Colonial Dr. Lincoln 2, Neb.
9-23	1800, 2nd Thurs. Argonne Nat. Lab. Du Page County Site, Ill.	LT W. A. LAMBERTSON, USNR Argonne National Lab., Box 5207 Chicago 80, Ill.
11-1	2000, 1st & 3rd Tues. 1030 E. Green St. Pasadena 1, Calif.	LCDR Silas E. JOHNSON, USNR 48 Annandale Rd. Pasadena 2, Calif.
11-2	2000, Alt. Thurs. USNRTC Pasadena, Calif.	LCDR Albert Palm KELSO, USNR 1015 Cynthia Ave. Pasadena 8, Calif.
11-3	2000, 2nd & 4th Mon. USNRTC & MCRTC 851 Chavez Ravine Rd. Los Angeles, Calif.	CDR Louis J. CURRAN, USNR 758 North Orange Dr. Hollywood 38, Calif.

Designation	Time and Place of Meeting	Commanding Officer and Mail Address
11-4	2000, 1st & 3rd Wed. USNRTC San Pedro, Calif.	LCDR Philip B. WILSON, USNR 2633 E. 7th St. Long Beach 4, Calif.
11-5	1930, 2nd, 3rd & Last Tues. USNRTC San Diego, Calif.	LCDR Winfred R. GODDARD, JR., USNR 750 San Fernando St. San Diego 6, Calif.
11-6	2000, 1st & 3rd Wed. USNRTC Phoenix, Ariz.	LCDR Milton B. MORSE, USNR 522 West Virginia Ave. Phoenix, Ariz.
11-7	1st & 3rd Thursdays US Naval & Marine Corps Training Center 1100 S. Alvernon Way Tucson, Ariz.	LT John Warren STULL, USNR 1435 East 5th St. Tucscn, Ariz.
12-1	2000, 2nd & 4th Mon. 1000 Geary St. San Francisco, Calif.	Vacant ONR Branch Office 1000 Geary St. San Francisco, Calif.
12-2	1945, 2nd & 4th Mon. Rm. 201, Donner Lab. University of California Berkeley, Calif.	LCDR Nello PACE, USNR Rm. 2519, Life Science Bldg. University of California Berkeley, Calif.
12-3	2000, 2nd & 4th Wed. Rm. 208, Engineering Corner Stanford University Stanford, Calif.	CDR L. S. JACOBSEN, USNR Dept. of Mech. Eng. Stanford University Stanford, Calif.
12-4	2000, 2nd & 4th Thurs. Rm. M-103, McLane Hall Fresno, Calif.	CDR R. A. JACK, USNR Dept. of Physics Fresno State College Fresno 2, Calif.
12-5	1930, 2nd & 4th Wed. Rm. 208, LeConte Hall University of California Berkeley, Calif.	CDR John M. DUNDON, USNR 316 Pacific Ave. Piedmont, Calif.
12-6	2000, 1st Tues. 1200 & 1630 3rd Tues. Tower Rm., Animal Science Bldg. University of California Davis, Calif.	LCDR Lawrence L. CLAYPOOL, USNR 112 2nd St. Davis, Calif.
12-7	2000, 2nd & 4th Fri. USNRTC, Fort Douglas Salt Lake City, Utah	LCDR H. L. FOOT, JR., USNR 136 East South Temple St. Salt Lake City, Utah
13-1	1930, 2nd & 4th Mon. Rm. A-223, Health Science Bldg. University of Washington Seattle, Wash.	CDR H. S. BENNETT, USNR Dept. of Anatomy University of Washington Seattle, Wash.
13-2	1900, 2nd & 4th Tues. American Legion Hall Richland, Wash.	LCDR Donald R. GUSTAVSON, USNR 1510 Cottonwood Dr. Richland, Wash.
13-3	1930, 2nd & 4th Mon. Rm. 39, Holland Lib. Pullman, Wash.	LCDR W. G. GNAEDINGER, USNR 601 High St. Pullman, Wash.
13-4	2000, Tues. USNRTC & MCRTC, Swan Island Portland, Ore.	LCDR Danny C. MARQUEZ, USNR P. O. Box 696 Portland, Ore.
13-5	1930, 2nd & 4th Mon. Rm. 114, Chemistry Bldg. Oregon State College Corvallis, Ore.	LCDR Albert V. LOGAN, USNR Dept. of Chemistry Oregon State College Corvallis, Ore.

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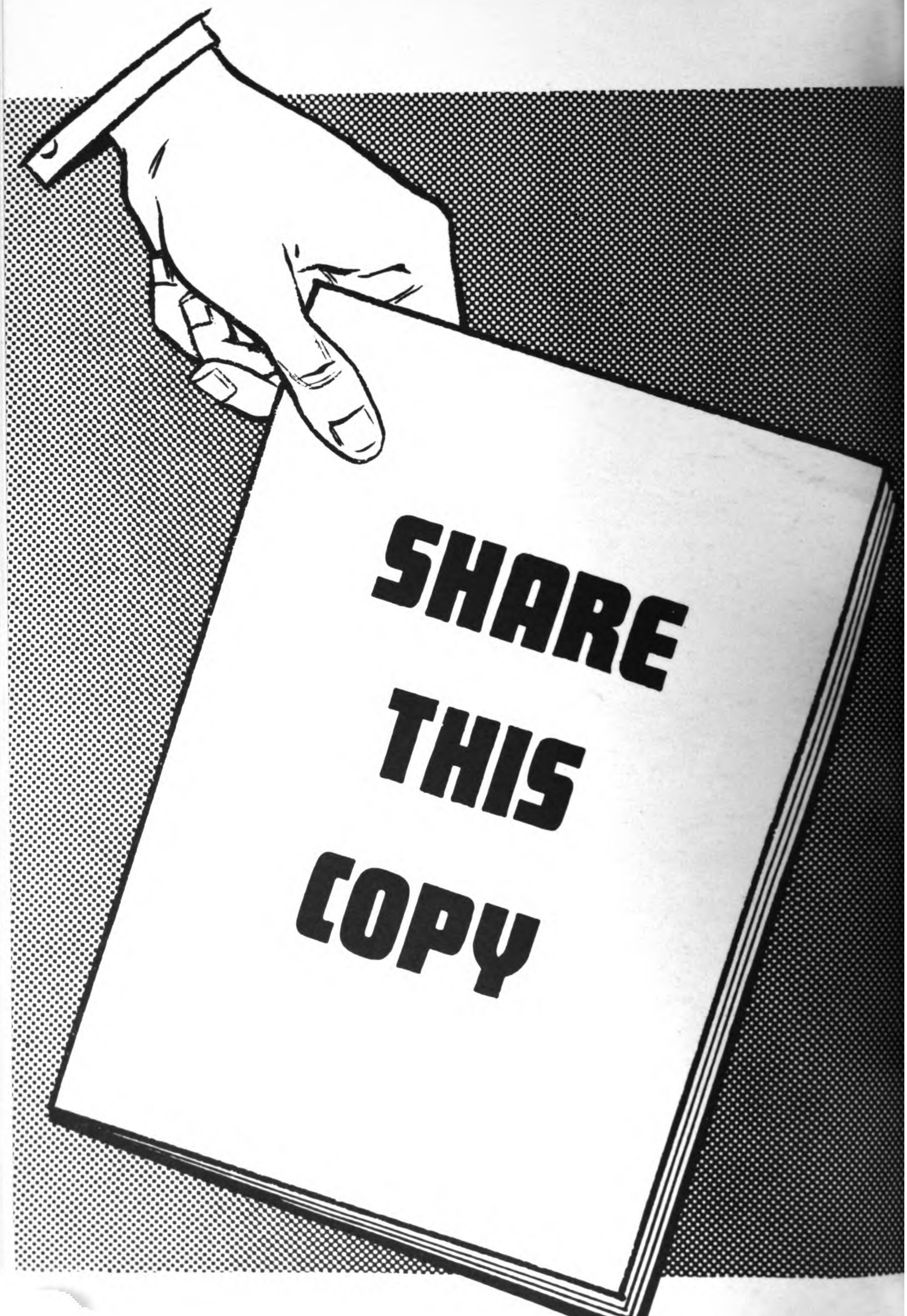
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