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RESEARCH REVIEWS

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NAVEXOS P-510

Aboard the Stratus

The sea-going cosmic-ray observatory described in the December 1957 issue of Research Reviews has been transferred from the Swedish merchant vessel LOMMAREN (Sweden to South Africa) to the STRATUS (Sweden to Australia via South Africa).

In the photograph below, taken aboard the STRATUS, Dr. Martin A. Pomerantz, author of "Sea-Going Cosmic-Ray Observatory," is using his Research Reviews article to explain features of the observatory's neutron-monitor pile to the skipper of the STRATUS, Captain Landing. Looking on are Mr. Ginstrup of Lund University, scientific observer, and Dr. Sandström, who is directing the investigation.

The neutron-monitor pile was designed to measure cosmic-ray intensities in many parts of the world and thereby provide data for compiling a cosmic-ray map of the world. It was built by the Bartol Research Foundation with funds provided by the Office of Naval Research.

The Coast Guard cutter PONTCHARTRAIN wallows through a storm in the North Atlantic.

Cyclogenesis: The Birth of Storms

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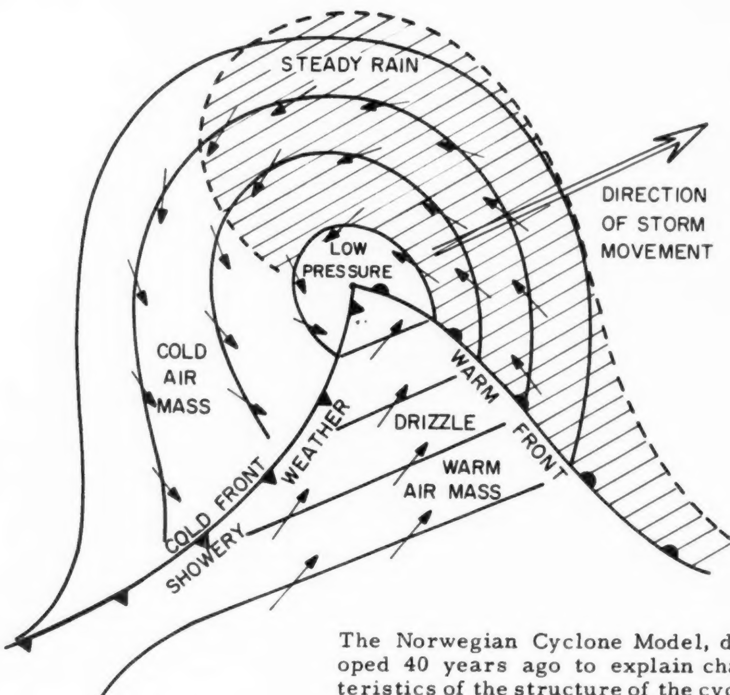
To weather forecasters, the central problem of meteorology for more than a century has been the cyclone. As seen on a weather map, a cyclone is a region of low atmospheric pressure about which the air circulates in a rotary, in-spiralling whirl. In the Northern Hemisphere the air circulates in a counterclockwise direction about the cyclone (low pressure) center, while in the Southern Hemisphere the direction of the wind is reversed, and the circulation is clockwise.

Cyclones (which are also called "lows" or "depressions") are usually accompanied by foul weather. However, the clouds and rain or snow are distributed asymmetrically about the low pressure center. The circulation around the low, as well as the pattern of pressure itself, are also generally not symmetrical. Cyclones are rarely circular. Distortions of the field of wind and pressure in the form of "troughs" (lines of low pressure) and convergence lines (where the winds clash, causing masses of air to accumulate and rise) occur commonly. Outside the tropics, these asymmetries in the cloudiness, the weather, the wind, and the pressure are associated with an asymmetrical pattern of temperature.

Almost 40 years ago meteorologists at the Geophysical Institute in Bergen, Norway, succeeded in explaining the relationships between the various asymmetries in the structure of the extra-tropical (middle latitude) cyclone through a synthesis known as the Norwegian Cyclone Model, or Polar Front Theory.* It was shown that the two troughs (which were also found to be convergence lines) radiating from the low pressure center are really fronts, or boundaries between cold and warm air masses. The asymmetrical weather pattern was explained by the interaction of the air masses at the fronts. Thus by a bold and imaginative use of a conceptual model, the Norwegians succeeded in explaining many of the characteristics of the cyclone structure.

On the basis of their model, the Norwegian meteorologists were able to propose a hypothesis regarding the complete life history of a cyclone, from its birth (cyclogenesis) through its death. This hypothesis, known as the wave theory of cyclones, states that cyclones in middle latitudes form as waves on the polar front. (The polar front is the primary boundary between cold air masses from the arctic regions and warm air masses from the tropics.) The waves, which are in the form of corrugations of the front, travel along the front and grow in amplitude,



The Norwegian Cyclone Model, developed 40 years ago to explain characteristics of the structure of the cyclone. Unbroken lines are isobars; arrows denote wind directions.

*A Scandinavian-American meteorological meeting has been scheduled in Bergen, Norway, for June 19 to 25, 1958, to commemorate the fortieth anniversary of the Polar Front Theory. The American Meteorological Society has been invited by the Norwegian Geophysical Society to participate.

while the pressure at the "crest" of the wave falls. As the pressure falls, the circulation around the cyclone increases, bringing the two branches of the corrugated front together. This process, known as occlusion, was suggested as the mechanism for the intensification and the increase in the kinetic energy of the cyclone. The completion of the occlusion process, leading ultimately to the disintegration of the frontal boundary, represents the end of the cyclone's development and the beginning of its dying stage.

The Norwegian Cyclone Model proved to be an invaluable guide in weather analysis and forecasting. But it was not without its limitations. The presence of a front, for example, is neither a necessary nor a sufficient condition for cyclogenesis. (Tropical cyclones are characteristically non-frontal, and, even in middle latitudes, cyclones are often observed to develop in the absence of fronts.) The development of the front sometimes follows the appearance of the cyclone, rather than vice versa. Furthermore, cyclones are frequently observed to intensify before the occlusion process begins. The pattern of weather around the cyclone center is almost invariably more complex than the model would suggest.

More serious was the failure of the wave theory itself to provide a useful technique for predicting cyclogenesis and the growth of storms. According to the wave theory (which was never completed mathematically) some frontal waves may be unstable and will grow, if certain conditions of wind and density exist near the front. Unfortunately, this instability theory of cyclogenesis was never verified by observation, nor could it ever be applied in practical weather forecasting. Thus, lacking a firm physical basis for forecasting the development of cyclones, weather forecasters could do little more than continue to use experience and the early recognition of signs of cyclogenesis as a basis for forecasting the phenomenon. The development of networks of upper air sounding (radiosonde) stations after 1935, provided new insight into the structure and behavior of cyclones. But it did not alter the fact that a basic weakness of weather forecasting was the lack of a reliable technique for predicting the birth of new storms and their subsequent development.

About 10 years ago meteorological research and weather forecasting entered a new era with the establishment at the Institute for Advanced Study of a project on numerical weather prediction (NWP). At that time a group of meteorologists and mathematicians under Dr. J. G. Charney and the late Dr. J. von Neumann demonstrated that forecasts of the atmospheric circulation could be accomplished by solving the meteorological equations on a high-speed electronic computer. Since then, proceeding to more and more realistic (and complex) mathematical models of the atmosphere, and seeking always for greater detail and higher accuracy, meteorologists have succeeded in achieving with machine-made forecasts a skill equal to that of experienced weather forecasters.

In 1953, Charney achieved what he has termed "...perhaps the first instance of a purely mathematical prediction of cyclogenesis...". This remarkable accomplishment, which has been followed by countless others, indicated that the mathematics employed did indeed express the

Operator console of the NWPU computing facility.

basic dynamics of the process of cyclone development. Of course, not all forecasts of cyclogenesis by NWP (the method is in operational use by the Joint Numerical Weather Prediction Unit in Suitland, Md.) were equally successful. It would have been most surprising had they been, for the physical model employed is really a greatly simplified version of the atmosphere. For example, the models used do not contain any thermal energy sources, such as the latent heat released by condensation of water vapor or the heat added to cold air when it moves over warm land or warm ocean surfaces. Many meteorologists believe that such energy sources play an important role in cyclogenesis, although Charney's work would indicate that it is a secondary role. Certain phenomena, such as the rapid intensification of cyclones often observed over the ocean off the east coast of North America, appear to be associated with the transfer of thermal energy to the air.

In research being done for the Office of Naval Research by a group at New York University and in work being carried out elsewhere, attempts are being made to incorporate into the NWP models the effects of heat transfer from the sea and latent heat of condensation. Adding these effects results in a great increase in the complexity of the mathematics and in the running time of the programs on the electronic computers. The atmospheric humidity must be included as one of the meteorological variables, and a by-product of the predictions is a forecast of precipitation. The heat transfer from the sea is computed empirically on the basis of special studies that have been carried out for this purpose.

How these added complexities will affect the predictions of cyclogenesis is still not known. (The computer program for the author's model is just being written.) But the least we can expect to accomplish is a greater understanding of the role of heat sources in the development of storms.

Balloon Astronomy*

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Since the time man first became curious enough about the heavenly bodies to attempt to magnify them for study, he has become more and more frustrated by the distortion and fuzziness imparted to their images by the earth's atmosphere. Efforts to reduce the effects of this vapor barrier were made by moving the telescopes to mountain tops. But even from the highest observatories, more than 70 percent of the atmosphere still lay between the telescopes and the stars. Of course, the ideal solution was to raise the telescopes completely above the veil so the heavens would lie fully exposed to view. Some day, of course, this will be done by means of powerful rockets and satellites. But while we wait for the happy event to occur, we are not just standing still. For a number of years now we have been in the process of making the hurdle by other means—through the marriage of telescopes and modern plastic balloons. In so doing, we have been making what might well be one of the most significant contributions to optical astronomy since Galileo made his first discoveries with the telescope.

Admittedly, a small portion of the earth's atmosphere will remain between the balloon observatory and the planets or other bodies to be investigated—about three percent at an altitude of 80,000 feet. But the image distortion this will cause is insignificant when weighed against the vast improvement in seeing that will be realized. To the astronomer, this improvement is comparable to that of near-perfect vision over near blindness. When it is considered, further, that this remarkable capability can be provided at relatively small expense—the balloons cost only a few thousand dollars each, and the instruments and gondolas are retrievable—it is easy to understand why astronomers have suggested a number of investigations by means of the technique. Clearly, the launching of balloon observatories is the next logical step toward achieving the ultimate in space astronomy.

THE EARLY ASTRONOMER-BALLOONISTS

Although we have only recently been able to send balloons high enough above the earth and keep them there long enough to enable scientists to make significant advances in astronomy and astrophysics, pioneer balloonists began working toward the goal decades ago. In fact, one of the earliest uses of balloons for astrophysical observations was made as long ago as 1863. At that time, the English physicist James Glaisher made a series of 10 ascents with instruments for meteorological research. On one, instruments for making solar spectroscopy measurements were carried. But the English trail-blazer's lead was not followed by other investigators until about 90 years later. This does not mean that scientific balloonists did not exist during the interval,

*Condensed from a talk presented at the Fourth Annual Meeting of the American Astronautical Society, January 31, 1958, New York, N.Y.

but rather that they were busy with other research. From 1931 to 1935, these men were unusually active, making a series of 10 manned flights to the stratosphere. However, they did not send telescopes aloft.

The Soviets, after their first successful flight in the stratosphere on September 30, 1933, became keenly aware of the importance of the manned "stratostat" for scientific research. But the Soviet All Union Conference, held early in 1934 to consider the scientific opportunities afforded by balloons, did not give serious consideration to balloon astronomy, although it did reveal some advanced thinking in other fields.

The most forward-looking balloon researcher of the thirties was that dreamer, inventor, and true pioneer, Auguste Piccard. In his book Between Earth and Sky, a recount of his own stratospheric adventures and a summary of the others made during the 1931 to 1935 period, he contemplates the possible future use of manned balloons for research. One of the suggestions he makes is that balloons be used to lift telescope and spectrograph combinations high above the earth. The object of such flights, he explains, would be to study the atmosphere of other planets. Another proponent of such studies is J. Gordon Vaeth of the Navy Training Device Center. In his book 200 Miles Up, Mr. Vaeth suggests using a manned balloon system for conducting exploratory research of the Martian atmosphere. As will be shown later in this article, such thinking has not gone unnoticed. Thus, to Piccard and Vaeth, and to the handful of other scientists who were among the first to recognize the advantages of telescopic balloon flights, must go a large measure of the credit for making possible the big forward strides we are realizing today in optical astronomy.

In Europe, the balloon-telescope combination has been utilized recently by Audouin Dollfus, a French astronomer-balloonist, son of veteran aeronaut, Charles Dollfus. In 1954, the Dollfus father-son team made an ascent to an altitude of about 20,000 feet to measure the water vapor in the atmosphere of Mars. However, their data indicate that a much higher altitude will have to be reached to minimize the screening effect of the water vapor in the earth's atmosphere. The Frenchman plans to continue his Martian studies, but for his next vehicle he will use a cluster of balloons, a technique first proposed by Jean Piccard and successfully demonstrated by him (he called the technique PLEIADES) in 1937. Dollfus has also made solar observations from balloons, particularly of the surface granulation. These were made in collaboration with the British astronomers Dewhirst and Blackwell on flights launched in 1956 and 1957. An 11-inch telescope was carried aloft for this purpose.

THEN CAME PLASTICS

Until the last decade, balloons were made primarily of rubberized silk or cotton. This material was strong enough to withstand the strains of flight, but too heavy to lift large payloads to high altitudes. Although lighter weight materials, particularly plastics, had been tested on a few flights (the first of these was made from Swarthmore, Pa., by Professor Jean Piccard, with a ballon made of cellophane) highly reliable plastic films were not developed until 1947. The improved vehicles are direct descendants of those used by Piccard, but are of much larger size, and most of them, instead of being made of cellophane, are made of polyethylene, a far tougher material (see article beginning on page 13).

As a result of further refinements of plastic film and of other advances in balloon technology made during the past decade, the entire concept of very high altitude balloon research has changed. Now, balloons are vital research tools and are being used in large numbers for many applications. It is not surprising, therefore, that the Office of Naval Research, pioneering agency in supporting balloon research, is planning to use the improved vehicles for making extraterrestrial observations. In so doing, it is catalyzing the efforts of many scientists who seek a fresh, unobstructed look at the heavens.

TWO BALLOON SYSTEMS

Plastic balloons can be utilized in support of astronomical and astrophysical observations in two basically different ways—either as manned or unmanned vehicles.

Unmanned flights.—One of the first known attempts to carry out an astrophysical measurement from an unmanned plastic balloon was made during the solar eclipse of June 30, 1954, as part of ONR's SKYHOOK balloon program (Research Reviews, November 1957). The objective was to photograph the entire eclipse from a high altitude. To do this, two balloons carrying cameras employing simple orienting systems were launched by the program contractor, Winzen Research. The photographic equipment utilized was developed by the Aviation Photographic Equipment Laboratory, Johnsville, Pa. Although the attempt was not fully successful—one of the balloons not having achieved the desired altitude and the other still rising (and therefore rotating) when the black-out occurred—the effort did provide valuable background experience that has helped make more refined measurements possible.

At a meeting of the American Astronomical Society in Ann Arbor, Mich., on June 23, 1954, Dr. Martin Schwarzschild (Figure 1) of Princeton University proposed a completely automatic system for studying the granular structure of the solar surface at high altitudes from balloon platforms. It was inevitable that he met later with ONR representatives, who first assisted him and then arranged for ONR support for his program, called Project STRATOSCOPE (Research Reviews, October 1957).

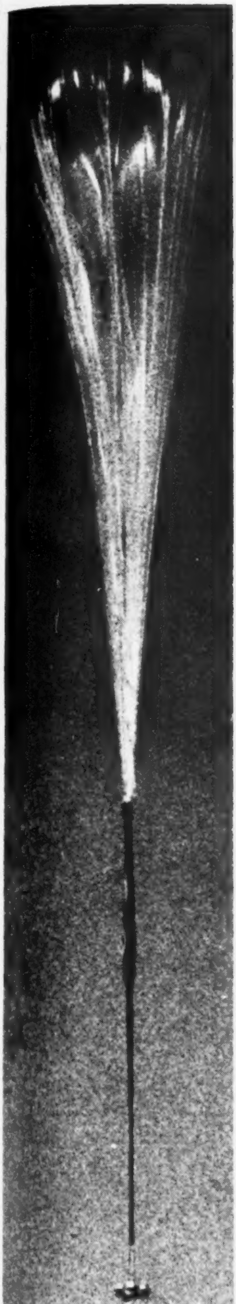
The STRATOSCOPE system includes a 12-inch telescope developed by the Perkin-Elmer Corporation. Figure 2 shows the special tube constructed for the telescope. A precise, light-sensitive system was developed by the Research Service Laboratories of the University of Colorado to orient the telescope while airborne. These components were designed for balloon use by engineers of General Mills, Inc., Minneapolis. In Figure 3 the complete system, mounted on a launching truck, is shown with the balloon that carried it aloft on its first flight. Figure 4 shows the balloon and telescope system floating skyward.

Figure 1 -- Dr. Martin Schwarzschild.

Figure 2 -- The solar telescope.

Figure 3 -- The solar-telescope system, mounted on truck, awaits launching. Stretched between balloon and cargo is a large parachute which will return payload safely to earth.

Figure 4 -- As it is lifted skyward, the telescope system is dwarfed by its balloon vehicle.



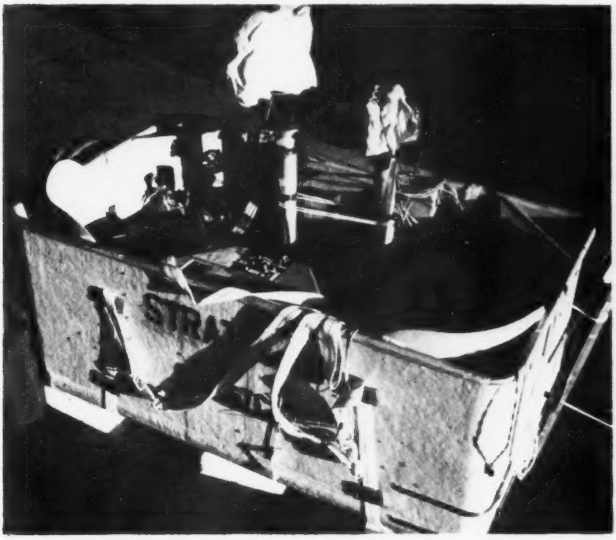


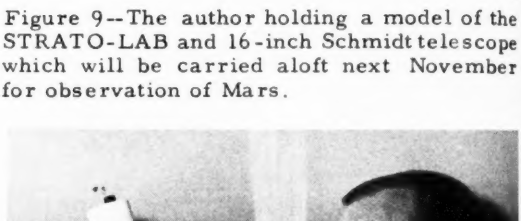
Figure 5 -- The open-basket gondola.

Figure 6 -- The sealed cabin being readied for a stratospheric flight.

Figure 7-- The STRATO-LAB gondola rises above its launching site near Rapid City, S. Dak., on its flight of November 8, 1956. Only part of the balloon to which it is attached is visible.

Figure 8--Professor Strong.

Figure 9--The author holding a model of the STRATO-LAB and 16-inch Schmidt telescope which will be carried aloft next November for observation of Mars.



Two flights were made last year, on September 25 and October 17. By sheer coincidence, the former was launched on the 10th anniversary of the first successful flight of a SKYHOOK balloon. The results were indeed gratifying, for the pictures obtained have permitted the best quantitative solar-surface measurements to be made to date. Thus it appears that in the future a vigorous pursuit of research employing the STRATOSCOPE technique will be made. One plan calls for the 12-inch system to be modified so as to include television-scanning equipment; and another, to hoist a 36-inch telescope into the stratosphere.

Manned flights.—A few weeks after the solar eclipse flights in 1954, ONR began planning a manned plastic-balloon research system capable of reaching great heights in the stratosphere. Named STRATO-LAB, it was intended to provide a means of carrying out certain types of researches which required people aboard (Research Reviews, November 1957). One of the first objectives envisioned was to obtain views of the celestial bodies from beyond our atmosphere.

Two types of STRATO-LABS have been developed—one utilizing an open-basket gondola (Figure 5) and the other, a sealed cabin (Figure 6). The former, which requires that its crew be equipped with oxygen masks, is intended for flights into the lower stratosphere, whereas the latter, which provides a completely artificial atmosphere, is designed for very high altitude operation. Major astronomical studies have not yet been made from these platforms, but several are being planned.

By the time this issue of Research Reviews is distributed, it is likely that star-scintillation measurements will have been made from the open basket at altitudes up to about 40,000 feet. Equipment developed under the direction of Dr. John Hall and Mr. A. H. Mikesell of the Naval Observatory is being utilized for this purpose. The measurements should yield important information in an area of astronomy where little data have been obtained previously.

Another open-basket investigation—this one of the solar aureole—has been proposed by Dr. Walter O. Roberts and Dr. Gordon Newkirk of the High Altitude Observatory of the University of Colorado. For this, a special photographic sky photometer and portable coronagraph will be used. The coronagraph is designed to occult the solar disc so as to allow investigation of the aureole in the immediate vicinity of the sun. In previous work, Newkirk has used the photometer and coronagraph to study the aureole from the solar limb to a point three degrees beyond, but only from relatively low altitudes. By carrying the instruments aloft in the open basket, the investigators hope to obtain data from altitudes up to about 40,000 feet.

The feasibility of conducting astronomical exploration from the sealed cabin has been demonstrated several times, most notably on the ONR flights of November 8, 1956 (Figure 7), to 76,000 feet, and on October 18, 1957, to 85,700 feet. Preliminary stability measurements made on the second of these flights indicate that the motion of the manned gondola will not be great enough to prohibit making precise measurements.

The first attempt to view our solar system from the sealed cabin will be made next November by Professor John Strong (Figure 8) of Johns Hopkins University and the author. Professor Strong's plan calls for a Schmidt telescope to be mounted on the sealed cabin (Figure 9). The Schmidt will be used with a 16-inch primary mirror, a special spectrograph, an automatic star tracker, and a manual control system which will enable the observer to orient the telescope from within the gondola. The observer will also be able to "trim" the image as needed.

Immediate plans for the Strong system are to obtain spectra of the Martian atmosphere. Two flights have been scheduled. The first will be in November, a time when Mars will be in a favorable position for investigating the water vapor in its atmosphere. A later flight will be made to determine the oxygen content. Also, on one or both of the flights the solar spectrum will be examined during the daytime.

THE FUTURE IS BRIGHT

Informal discussions with Dr. Strong, Dr. Schwarzschild, Dr. Roberts, and other investigators reveal that in addition to the studies for which definite plans have already been made, a number of others are being considered as part of the long-range STRATO-LAB and STRATOSCOPE programs. These are—

- Observations of the center of the Andromeda galaxy.
- Investigations of the gaseous nebula of Orion.
- Photographic observations of the aurorae on Venus.
- Measurements of the diameters of some of the planets.
- Photographic study of Mercury.
- Photographic study of the infrared spectra of all the planets.
- Spectroscopic observations of some of the stars.

Eventually, plastic balloons may also be utilized to facilitate making radio-astronomy observations. If so, the list of proposed investigations will be lengthened considerably. As a matter of fact, studies of virtually all major astronomical problems could be advantageously included, for their reinvestigation from the vantage point of the balloon aloft is sure to yield much more reliable information than has been obtained by conventional observatories. Thus it appears that over the next decade or so the plastic balloon will serve not only as a stepping stone to satellite and/or true space observatories, but will also make its own very positive contributions to a more complete understanding of the universe.

Polyethylene Balloon Film

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In recent months, we have all read many accounts of record-breaking manned balloon flights, of balloon launchings of rockets, of balloon-supported telescopic surveys of the sun, and other equally remarkable achievements of this International Geophysical Year (see article beginning on Page 5). In most of these reports, there was casual mention that the balloons were made of plastic film, and in some, that the material was polyethylene film. Actually, most of these balloons were made of polyethylene film. But, if the reader assumed, as he probably did, that the film was the same as that used for commercial packaging, which he sees every day in the grocery store or on the dry goods counter, he was mistaken.

Balloon film has to be much stronger and tougher than packaging film, particularly when used at very low temperatures. It also has to be absolutely free of manufacturing flaws, such as pin-holes, fish-eyes, gels, and out-of-standard gauge variations. Producing film of this quality has required not only that a special resin be used and that special manufacturing processes be applied, but also that a much more intensive inspection and quality-control program be effected than that normally required for commercial packaging films.

The story of the achievements mentioned above really started about 11 years ago when project personnel of the Office of Naval Research, working with the balloon producers, established the feasibility of polyethylene film for the construction of balloons for flights into the stratosphere. Since then, a large number of people working in a variety of groups have contributed to the development of the film.

Many failures made in the early years led to further projects in which the cooperation established between research teams of the balloon producers and film-and-resin manufacturers was highly important. These projects resulted in the production of many special films from a variety of polyethylene resins—commercially available ones as well as developmental ones—involving a wide range of extrusion conditions and production know-how. The special films had to be made in sufficient width and quantity and at adequately low gauge to permit fabrication of full-size balloons for hundreds of trial flights.

A very important part of this whole effort was the selection and development of physical test methods which would serve to define the film requirements as demonstrated by the test-flight failures and successes. This was not a simple task, because of the severe conditions under which the balloons were to be used. Thus, in addition to the routine film dimensional requirements which had to be met, were special property requirements critical to successful balloon performance. For

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example, on many flights the film had to be strong enough to support the load of the gondola or instruments without benefit of tapes or other reinforcing structures. Also, it had to be able to take severe punishment by the wind (whipping and repeated flexing), particularly at the time of launching, when the balloon is only partly inflated. Furthermore, it had to be designed to stand these stresses at very low temperatures (the mercury may go down to -90° F before the balloon reaches its ceiling). Because of these facts, the film had to have very high tensile and impact strength and unusual ductility.

By the summer of 1954, the project had progressed to the point where a very large amount of film had to be produced. Through a series of conferences, decisions were made as to which tests were essential to establish control and which could also be run in the film-producer's plant on a practical production basis to insure the required quality in all lots of film. By early 1955, the details of a contract for a specific polyethylene film type and gauge for heavy load use had been worked out, and the contract was let. This film was called Visqueen "A".

Visqueen "A" was produced on unique equipment and with special techniques, designed and developed by Visking Company, to impart to it those physical properties which would enable it to withstand the stresses and strains mentioned above. The resin selected as a result of the tests was produced by Bakelite Company. Film was supplied, at the option of the balloon fabricator, in either tubular or sheet form, .002 inches thick and 54 inches in flat width.

To be acceptable, this film had to pass, at specified levels, the following tests:

Melt index—This is an established test in the polyethylene-resin field for flow characteristics, or viscosity, of the molten resin. For a given resin the viscosity and molecular weight are correlative. The test served to monitor the resin used for uniformity and type.

Flat width—This simple dimensional measurement was made to insure cutting of the proper balloon gore width with a minimum of waste.

Thickness—This measurement was made with a dial-type thickness gauge at many points across the width of the tube to hold the average thickness and extreme highs and lows within tolerances. Obviously, if thin spots occur in the film, they will be sources of weakness. On the other hand, if the average thickness is greater than necessary, the load-carrying capacity of the balloon will be reduced accordingly.

Impact strength, or toughness—This test consists of dropping a heavy steel ball on a sheet of film, properly supported in a holder, and measuring the decrease in its velocity as it passes through it, using a photoelectric technique. By this means, the basic toughness of the body of the film is checked, and, if weak folds occur in the tube, they are detected. Folds have to be practically as strong as the film itself.

polyethylene balloon being readied to haul scientific instruments to the stratosphere.

Tensile strength and elongation—This test is run by a conventional method on strips of film cut both lengthwise and crosswise from the tube. It is a measure of load-carrying capacity of the film and, of course, uniformity in this property from lot to lot.

Cold brittleness—In this test, conducted in a chamber whose temperature is maintained at -68° C, or -90.4° F, a heavy steel ball is allowed to roll down a "ski slide" and through the film sample, which is mounted at the bottom. To pass the test, the film must show a ductile-type or single-line break, rather than a fingered or shatter-type break.

Visual inspection—This is done to insure the greatest possible freedom from blemishes and faults, such as holes, fish-eyes, gels, and weak lines.

Yardage per roll—Recording the exact yardage of rolls of film earmarked for balloon manufacture is especially important because of the great length of the balloon gores cut from the rolls. If the total number of yards per roll is not slightly more than an even multiple of the gore length, a large amount of film will be wasted.

Some of the tests had to be conducted on a roll-by-roll basis, others less often. Tests for impact strength and cold brittleness required special equipment designed and built by a balloon manufacturer. Detailed records had to be kept of all test results on a roll-by-roll basis to meet inspection requirements.

To carry out this program, it was necessary to hire and train a staff of nine tester-inspectors on very short notice. Some of the test equipment was not available until five days before the deadline for shipment of the first truckload of film. However, the first truckload did go out on schedule, and the project continued without delay until the contract was completed about nine months later.

The detailed early planning, combined with the closest cooperation of the resin supplier, our production people—right down to the individual operators—the shipping department, our inspectors, the military inspectors, and the balloon manufacturer allowed the whole operation to proceed very smoothly and satisfactorily. The work done on this contract helped materially in improving and refining the balloon film specifications.

It is significant that the experience gained in developing Visqueen "A", plus improved know-how, has made possible the production of satisfactory balloon film in thicknesses of .0015 inch, .001 inch, and experimentally, even .00075 inch. It has been a long pull, but a very rewarding one, for the front pages of today's newspapers clearly tell the story of the practical results of the work done 10 years ago.

International Sea-Ice Conference

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Office of Naval Research

At the request of the Office of Naval Research and the Navy Hydrographic Office, the National Academy of Sciences—National Research Council sponsored an international conference on sea-ice problems. The meeting was held at the Tidewater Inn, Easton, Maryland, from February 24 to 27. Of the 80 scientists who attended, 24 represented eight foreign countries—Canada, Denmark, England, Finland, Germany, Japan, Sweden, and the USSR—and the remainder were from the United States. These men are the leaders in sea-ice research and forecasting throughout the world.

DISTRIBUTION AND CHARACTER OF SEA ICE

The first session, on distribution and character of sea ice, was convened by Dr. T. E. Armstrong of the Scott Polar Institute of Great Britain. He is the author of a new atlas of sea-ice conditions in the Arctic of Eurasia. Papers presented during this session were by Franz Nusser, Deutsches Hydrographischer Institut, Hamburg, on the types of sea ice and their distribution in the European Arctic; Professor G. A. Avsyuk, Doctor of Geographical Sciences, USSR, on the distribution of glaciers in Arctic Siberia; C. W. M. Swithinbank, Scott Polar Institute, Great Britain, on the sea-ice atlas for the Canadian Arctic, now in production; and A. A. Kirilov, Arctic Research Institute, USSR, on the Soviet system of sea-ice classification (read by title only).

ICE OBSERVATION

The second session was chaired by Helge Thomsen, Meteorological Institute, Denmark. Five papers were read. Kou Kusunoki, Institute of Low Temperature Science, Hokkaido University, Japan, described the Japanese system of ice observation and recording. A paper by A. F. Laktionov (read by M. A. Ryazanov), Arctic Research Institute, USSR, presented the Soviet methods of ice observation from vessels, shore stations, and planes. Dr. Bertil Rodhe, Swedish Meteorological and Hydrological Institute, discussed ice observation methods used in the Baltic Sea and explained the Baltic Ice Code. H. V. French of the U. S. Navy Hydrographic Office described aerial ice-reconnaissance techniques. And Professor Geza Teleki of George Washington University discussed his research in development of photographic and electronics scanning techniques for extending and improving sea-ice observation.

An evening lecture by Dr. Ilmo Hela of the Institute of Marine Research, Helsinki, Finland, entitled "The Baltic Sea as an Objective of Ice Studies, with the Arctic Sea as a Reference," concluded the first day of the Conference.

PHYSICS AND MECHANICS OF SEA ICE

The third session, chaired by E. R. Pounder of McGill University, Montreal, dealt with physics and mechanics of sea ice. Dr. Norbert Untersteiner of the University of Washington, Seattle, and Senior Scientist of the U. S. Drifting Station A, presented some preliminary results of the thermal-budget studies at Station A. Dr. Wilford Weeks of Washington University, St. Louis, gave a progress report on his research on the crystallographic structure of sea ice. Next, a paper by Dr. I. S. Peschansky of the USSR Arctic Research Institute on the physico-mechanical properties of Arctic ice and methods of study was read by the interpreter. This paper evoked considerable discussion, especially by Dr. Pounder, Dr. Andrew Assur, and LT Don Anderson. Unfortunately, Dr. Peschansky was not present to answer the many questions raised. It was explained that he was preparing to return to the Arctic for further field work. Dr. Kolesnikov attempted to answer some of the questions and agreed to have the paper checked before publication.

Dr. Assur of the U. S. Army Snow, Ice, and Permafrost Research Establishment presented a provocative paper on composition of sea ice and its tensile strength. Although this study was commented on at length by LT Anderson, Dr. Weeks, and Dr. Untersteiner, time did not permit adequate discussion of it. Dr. Tadashi Tabata of Hokkaido University submitted a paper on visco-elastic properties of sea ice, and LT Anderson submitted one on a model for determining sea-ice properties. These two papers were read by title only but will be published in the proceedings of the meeting.

SEA-ICE FORMATION, GROWTH, AND DISINTEGRATION

The fourth session was convened by Dr. G. A. Avsyuk, the head of the Russian delegation, and dealt with sea-ice formation, growth, and disintegration. Dr. A. G. Kolesnikov submitted a paper on rate of sea-ice accumulation, which was read by the interpreter. Next, Mr. L. S. Simpson described the ice potential method used by the U. S. Hydrographic Office to calculate the probable ice thickness on Baffin Bay. Dr. Tadashi Tabata presented a theoretical solution to estimation of maximum ice thickness in the Sea of Okhotsk; his formula neglected snow cover and heat flow from the water. M. A. Ryazanov then read a paper by G. N. Yakovlev on solar radiation as the chief component of the heat balance of the Arctic ice. During the discussion period which followed, Dr. Rodhe compared his equations derived in the Baltic Sea with Tabata's formulae, and LT Anderson presented an empirical ice-growth curve based on observations in Baffin Bay and Labrador.

On Wednesday evening the practical problems of operating ships in ice were discussed by RADM Charles W. Thomas, USCG (ret.) and CAPT O. A. Peterson, USCG.

DRIFT AND DEFORMATION OF SEA ICE

The fifth session of the conference, chaired by Colonel Joseph O. Fletcher, USAF, was on drift and deformation of sea ice. Dr. P. A. Gordienko reviewed the history of drift studies in the Arctic Ocean and the present-day concepts of Soviet students of this problem. He prefaced his paper by stating that the problem of ice drift in the Arctic is one of the most important scientific and practical problems of our day. Miss Irene Browne read a paper by herself and A. P. Crary on the drift of Ice Island T-3, and finally, Dr. Thurston read a condensation of the paper of Takaharu Fukutomi of Japan on "A Theory on the Steady Drift of Sea Ice due to Wind on a Frozen Sea." Lively discussion followed, particularly on the significance of the increased east-west pulsations of T-3 as it drifted southward.

SEA-ICE PREDICTION TECHNIQUES

The final session appropriately concerned sea-ice prediction techniques. The program lists three speakers. However, owing to illness, Dr. V. V. Frolov of the USSR was unable to attend the conference or prepare a paper. Erkki Palosuo of Finland described the methods used in ice forecasting for the Baltic, and Walter I. Wittman of the Hydrographic Office reported on continuity aids in short-range ice forecasting as used in the United States. After a long discussion of these subjects, the chairman of the Russian delegation, G. A. Avsyuk, took the floor and spoke as follows:

"Mr. Chairman, ladies and gentlemen, the conference is drawing to a close, and I think that I speak on behalf of all the participants here if I mention that in my opinion this conference has been a very great success, indeed, and that it has exceeded in that respect all our hopes. I must emphasize in this connection the very pleasant and business-like atmosphere that has prevailed at our meetings, and I think that the results of this conference will be of very great import to further the development of the science of ice, and thus promote the progress of science in general. Such exchanges of information as we have just had here are extremely useful for the study of ice and, in fact, they are in conformity with that spirit of international cooperation which is needed when we embark on the study of such a large area as the Arctic Ocean. The fact that this work was made possible is due to the initiative of the United States Academy of Sciences, which has provided such excellent organization and facilities for our conference. I think I shall express your feelings and be speaking on your behalf if I now extend our warmest gratitude to the Academy of Sciences of the United States, especially to Mr. Thurston and to all those who have made this conference possible. Thank you."

To the truth of this statement all participants in the conference will attest. It is to be hoped that "the spirit of international cooperation" of which he spoke is as genuine as it appeared to be.

NTDC Has New Executive Officer

CDR Dred Walker Poole, USNR, has relieved CDR W. D. Hudgins, USN, as Executive Officer at the Naval Training Device Center. Formerly, CDR Poole was with the Supreme Allied Commander, Atlantic, as Director of Communications for Communications-Electronic Materials Requirements.

Research Notes

Research on Noise

As reported in articles appearing in Research Reviews for February 1954 and January 1956, noises generated by jet aircraft operating aboard aircraft carriers have become so intense, the Office of Naval Research has undertaken several studies of their effects on humans. The Laboratory research on this project is now nearing completion, but extensive field research, utilizing the equipment and techniques developed under the contract, yet remains to be done. This phase of the program will be carried out by the School of Aviation Medicine.

Through this work, Navy investigators hope to determine the critical limits of intensity, spectrum, and duration of exposure commensurate with the well being of Naval personnel working in high-intensity noise fields. The results are expected to include information concerning (1) the temporary auditory threshold shifts accompanying noise exposure; (2) the relative effect of cumulative or long-term exposure; (3) the value of various ear protective devices that will attenuate sound stimuli and yet permit verbal communication; and (4) the effect of varying degrees of noise intensity upon such non-auditory functions as motor performance, reasoning ability, personality factors, fatigue, and various indices of physiological activity, such as blood pressure and heart rate. This knowledge will have application to numerous military problems.

Physiological Psychologists Meet at Pensacola

The Office of Naval Research, which provides funds for hundreds of different research projects, must constantly be arranging for the exchange of information between its investigators. In the field of physiological psychology such an exchange is being effected, in part, through symposia. Specifically, the purpose of these meetings is to acquaint the ONR contractors with Naval operations and military laboratory research, and to give them an opportunity to exchange information concerning their individual studies. To promote unbridled discussion, impromptu presentations, rather than formal papers, are requested of the participants.

The second Symposium on Physiological Psychology was held at the Naval School of Aviation Medicine, Pensacola, Florida, March 19 to 21. It was attended by 30 contractors and 21 other interested investigators. Twenty-two discussions, concerning as many research projects, were programmed. These dealt with sensory mechanisms, the central nervous system, perception, and higher thought processes.

Both this meeting and the previous one, held in 1955, proved to be of great benefit, not only to the individual participants in exchanging information about their roles in the Navy research program, but also to those individuals responsible for research administration and programming for the other Services.

Symposium on Guided-Missile Training Equipment

On March 18 and 19 an inter-Service and industry symposium on Guided-Missile Training Equipment was held at the Naval Ordnance Laboratory, White Oak, Md. The meeting, the first of its kind ever held in the missile field, was sponsored by the Office of the Chief of Naval Operations and coordinated by the Naval Training Device Center.

Before the symposium, synthetic training equipment had been considered a little known and highly specialized field. But when it was over, it was apparent that interest in the subject runs high among many individuals and firms. Forty papers were volunteered for the meeting and about 1,200 persons requested permission to attend. Since the number of seats available totaled only 550, strict quotas had to be imposed. As a result, more than 30 companies, including leaders in the missile field, were refused admittance. Nevertheless, the meeting was attended by representatives of some 200 firms comprising the missile, electronics, and training-equipment industries. The Army, Navy, and Air Force actively participated, too.

Mr. Frank Pace, Jr., President of General Dynamics, set the keynote of the meeting with his statement that operational capability in missiles depends upon the timely availability of properly designed training equipment, and that such equipment, by use of simulation and synthesis, can reduce the demand for and consumption of costly operational missiles for exercise and practice purposes.

Navy Lays Groundwork for First Atom-Powered Seaplane

Solutions to many of the problems involved in building the Navy's first atom-powered seaplane are now being sought by a Philadelphia Navy laboratory. The research is aimed at developing materials capable of withstanding the heat and radiation effects which will exist in the new aircraft and determining the potential of a nuclear seaplane as applied to Navy missions, considering both military effectiveness and cost. Materials studies are vital to the A-plane effort because weight limitations prohibit use of conventional heavily shielded nuclear reactors, as used in atomic submarines.

The studies will provide the basis for development of a fleet operational nuclear seaplane system in 1964 or 1965.

Refueling will be no problem for the Navy's atom-powered seaplane, as its endurance will be limited only by crew needs and maintenance requirements. The plane's turbo-prop engines will be more efficient and will require a smaller nuclear power plant than jet engines. Its ability to land and take off on water will eliminate the need for long runways and land-based facilities and will permit independent operations over wide areas.

Anorganic Bone

In cooperation with the Naval Medical Research Institute, the Office of Naval Research is sponsoring research on the use of anorganic bone—animal bone that is chemically treated to remove more than 99 percent of the protein, fat, and other organic material—for bone grafts. Cow bone appears to be particularly well suited for this application. Unlike human bone, anorganic bone is inert for all practical purposes and simply helps the normal forces of the patient's bone bring about natural repair. Also, it does not need to be stored under sterile conditions, as human bone does, but can be made sterile by boiling. Furthermore, it can be made readily accessible in large quantities, whereas human bone cannot, because only a limited number of healthy humans are available to supply it.

R&D Program Reported on Film

A new series of 16-millimeter color film reports on the current Navy research and development program is now being prepared by the Office of Naval Research for distribution quarterly to high-level Navy and Department of Defense audiences. Most of the films cover six or seven subjects, such as new aircraft, missiles, submarines, ships, and Marine Corps weapons. These are arranged in newsreel fashion, which enables individual projects to be shown at various stages of development and to be repeated later to indicate progress. By means of the films, research and development information can be presented more clearly and concisely than is possible through the conventional written technical report.

POLARIS and the Human Engineer

The development of the POLARIS missile system is being supported by a major human-engineering program at the Missile Systems Division of the Lockheed Aircraft Corporation. The program includes a job task analysis, human-engineering support in the design and development of POLARIS, and the plan and conduct of an on-the-job training procedure.

The human-engineering activity consists almost exclusively of applied support to engineering design groups. This enables required information to be supplied to the hardware designers in the pre-blueprint and blueprint phases. Early attention to human factors insures that required modifications will be made economically and that the human-engineering group will be able to operate efficiently within the design schedule.

In the development of the POLARIS missile system, human engineers are assigned to work directly with design engineers. This approach is relatively unique within human-engineering activities.

On The Naval Research Reserve

Research Reserve Assistants Meet in Omaha

The annual conference of Reserve Assistants of ONR branch offices was held at the Naval Reserve Training Command, Omaha, Nebraska, on March 18 and 19. The selection of this location made possible presentations by, and active participation of, officers of the Command. Of course, these discussions added materially to the success of the conference.

CAPT J. P. Aymond, USN, Special Assistant to the Chief of Naval Research (Research Reserve) was the seminar chairman. The conference was attended by all Reserve Assistants from the branch offices of ONR; by CDR John K. Hicks, USNR, Training Officer; Miss Eleanor Kehoe, Training Specialist; and CDR L. W. Rash, USN, Director, Special Programs Division, Eighth Naval District.

Participants in the Research Reserve conference at the Naval Reserve Training command. First row (left to right)--CDR J. K. Hicks, USNR; CAPT J. P. Aymond, USN; LCDR E. F. Kehoe, USNR; CAPT C. H. Fuller, Jr., USN. Second row--CDR L. W. Rash, USN; CDR H. B. Joslin, USNR; CDR R. S. Downes, USNR; CDR W. C. Avery, USN. Third row--CDR F. G. West, USNR; LCDR T. V. Kelly, USN; LCDR G. F. Cronin, USN; LCDR N. L. Fish, USN; and LCDR L. H. Rich, SC, USNR.

The seminar was opened by RADM E. H. von Heimburg, USN, Commander, Naval Reserve Training Command. Informative talks were given by staff members of the Command: CAPT H. G. Corey, USN, Chief of Staff; CAPT H. C. Duff, USNR, Senior Member, National Inspection Board; CAPT C. H. Fuller, Jr., USN, Director, Schools and Special Programs; and LCDR L. H. Rich, SC, USNR, Assistant to the Director, Schools and Special Programs. The agenda for the first day also included a discussion on the "Functions of ROPRA," by CDR F. G. West, USNR, Officer in Charge, U. S. Naval Reserve Officers Performance Recording Activity; "Mobilization Operations, Utilization of Officer Qualifications, Designation of Officers, and Assignment of Officer Designator Codes," by CDR R. S. Harlan, USN, Head, Officers Classification and Mobilization Branch, Bureau of Naval Personnel; and the reading of a paper prepared for the conference by LCDR F. B. Guest, Jr., USNR, Head, Naval Reserve Training Section, Bureau of Naval Personnel, on "Active Duty for Training for Remainder of Fiscal Year 1958 and Plans for Reserve Training for Fiscal Year 1959."

Other subjects discussed at the conference included mobilization procedures, recruiting activities, and administrative matters in connection with the Program.

The Naval Reserve Training Command

The Naval Reserve Training Command in Omaha, Nebraska, was recently host to members of the Research Reserve Program attending the annual conference. The two-day meeting was held at the Command's headquarters at Omaha's 91-year-old "Fort Omaha."

A touch of American history. . . Fort Omaha's near century old officers' quarters overlook the parade ground where blue-coated soldiers once trained to fight the Indian wars.

The 82-acre tract, now officially called the U. S. Naval Personnel Center, is still called "Fort Omaha" by the Omahans. From 1867 to 1947, from blue-coated cavalrymen to khaki-clad veterans of World War II, the North Omaha landmark stood as an Army installation... a reminder of the West's Indian wars. But in 1947 the Navy dropped anchor.

Now the Naval Reserve Training Command is but one of several activities sprinkled throughout the tree-dotted fort... ranging from the Air Force's Radar Bomb Scoring Unit to the Marine Corps Recruiting Station. On the fort's walks the uniforms of every service meet.

Here, in sharp contrast to its historic surroundings, the Naval Reserve Training Command keeps tabs on the training of the most modern, powerful Reserve force the Navy has ever known. Here, the Commander, Naval Reserve Training—RADM E. H. von Heimburg, USN—his Chief of Staff, CAPT H. G. Corey, USN, and a staff of 52 officers and men supervise the training of 35 Surface Reserve pay and non-pay programs in 319 training centers across the nation and in scores of training ships moored and at sea.

MISSION

The Command, established on July 1, 1956, has several basic missions to accomplish. With four departments and an inspection board, the Command 1) administers, through the Commandants of the Naval Districts in which the Reserve units and training facilities are located, the Naval Reserve training program—except Air Reserve activities, 2) directs the employment of all ships assigned to the District Commandants for Reserve training purposes, 3) supervises the administration of all Naval Reserve training matters through the District Commandants, 4) inspects and evaluates Reserve training activities in the field and submits an annual report to the Chief of Naval Operations, and 5) supervises and administers the Naval Reserve Competition. A big job... affecting over 400,000 Reservists.

ORGANIZATION

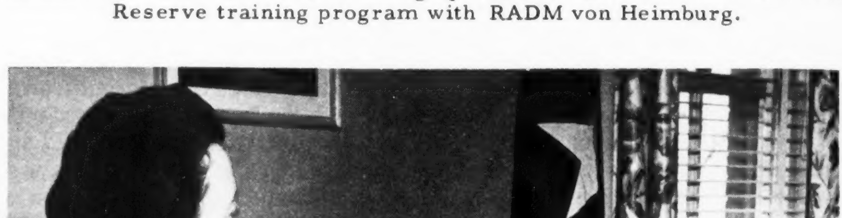
The Commander, Naval Reserve Training, reports to CNO (Personnel and Reserve Forces); in turn, the Commandants report to Omaha directly for all Naval Reserve matters.

Omaha's Naval Reserve Training Command has four departments: Fleet Programs, Fleet Support Activities, Shore Establishment and Schools, and Special Programs. In addition to these, there is the "will travel" National Naval Reserve Inspection Board.

Fleet Programs Department.—CAPT T. P. Lowndes, USN, its Director, heads the Fleet Programs Department. This eight-man section, the Command's largest, personnel-wise, is responsible for the overall employment of Naval Reserve training ships assigned to the Commandants. This job includes the training given Reservists aboard some 30 APD and DE types, 10 PCE's and 23 submarines—in addition to the small surface craft used for dockside training. Statistics say that

Building 22, once Fort Omaha's commissary, now houses the Commander and staff of the Naval Reserve Training Command.

LCDR Kehoe, USNR, ONR training specialist, discusses the Research Reserve training program with RADM von Heimburg.



since the centralized Omaha command took over the control of the Reserve Training Fleet in January 1957, participation in Reserve cruises has jumped 7 percent for enlisted men and 25 percent for officers.

The Fleet Programs Department also administers the training of the Surface, Submarine, Electronics, and Amphibious Beach Group Programs.

Fleet Support Activities Department.—CAPT N. E. Fryer, USN, heads this four-man team. Its responsibilities lie in the training procedures of seven Reserve programs: Advance Base, Harbor Defense, Construction Battalion, Civil Engineer Corps, Ship Activation Team, MSTS, and Merchant Marine.

Shore Establishment Department.—CAPT D. W. Davis, USNR, the Director, and his staff are responsible for the training of seven other Naval Reserve programs: Mobilization Team, Intelligence, Censorship, Selective Service, Naval Security Group, Law, and International Affairs.

Schools and Special Programs Department.—The Research Reserve Program is one of the 15 Naval Reserve programs administered by this department. Some of the others include NROS, Medical, Composite, Ordnance, Supply, and Bureau of Ships. The Schools and Special Programs Department is headed by CAPT C. H. Fuller, Jr., USN. Together with his officer assistants, CAPT Fuller has used several methods of making improvements in Reserve training in his department's programs. The department 1) reviews quarterly drill schedules for suitability to the particular Reserve program, 2) inspects non-pay companies, 3) reviews all Naval District inspection reports of non-pay units, and 4) maintains liaison with sponsoring bureaus of special programs by providing for conferences at least twice a year.

National Naval Reserve Inspection Board.—The Command's National Naval Reserve Inspection Board inspects Reserve activities throughout the United States and Hawaii. Traveling mostly by air, the board has covered 42,510 miles so far this fiscal year and has inspected approximately 75 units. Sub-boards have inspected 112 units in all the 10 Naval Districts in the United States. The main board, that is, National Naval Reserve Inspection Board, under the direction of the Senior Member, CAPT H. C. Duff, USNR, is charged with the following responsibilities: 1) to keep the Commander, Naval Reserve Training, informed on conditions found during Naval Reserve inspections in the field, 2) to make recommendations on plans and policies affecting the Naval Reserve, 3) to evaluate the state of training of the Naval Reserve, and 4) to supervise and administer the National Naval Reserve competition.

The task of inspecting Naval Reserve units is divided between the main board and the sub-boards. The five-man main board inspects the pay programs and all programs in national competition. The sub-boards, made up of members of the Command's other four departments, inspect the units in the programs under their department's administration.

A schedule of the Naval Districts to be inspected is promulgated annually for the forthcoming fiscal year by the Commander, Naval Reserve Training. About two weeks before the inspection party is due in the District, the Commandant is advised as to which activities are to be inspected. He, in turn, notifies the units concerned.

The inspection party usually starts out on a Monday for a week's inspection schedule. Upon arrival, the main board and the sub-boards go their separate ways, each inspecting its assigned unit. On Friday all members of the inspection party meet with members of the Commandant's staff who are concerned with the Reserve program for a critique. And after a discussion of the findings and a coverage of items of common interest to all Naval Reserve programs, the inspection is complete. But there remains one important function yet to be performed—the inspection report.

In the case of special programs, such as Research Reserve, the report is prepared by the inspecting officer of the Schools and Special Programs Department's sub-board. This report is forwarded via the main board to the Commander, Naval Reserve Training, for final approval. After approval, copies are forwarded to the Commandant of the Naval District concerned, to the sponsoring technical bureau or office, and to the Commanding Officer of the unit inspected.

EFFECTIVENESS

Omaha's Naval Reserve Training Command has made notable strides since its organization in 1956. Through the promotion of a more effective and vigorous Reserve program, the Naval Reserve is now better prepared to "provide trained units and qualified individuals to be available for active duty in time of war or national emergency."

Selections for Promotion in Staff Corps

Last month's issue of Research Reviews listed line officers of the Research Reserve who were selected for promotion to the grades of Captain and Commander. The Chief of Naval Personnel subsequently released the names of officers selected for the rank of Captain and Commander in the various staff corps. Congratulations are extended to these officers, who are listed below along with their respective companies:

PROMOTED TO CAPTAIN (MEDICAL SERVICE CORPS)

Arthur L. BENTON	9-19

PROMOTED TO COMMANDER (MEDICAL SERVICE CORPS)

Heber W. YOUNGKEN, Jr.	1-2
Robert Z. PAGE	5-8
John A. ALFORD	5-10
Frances A. HALLMAN	11-3
Charles W. McNEIL	13-3

PROMOTED TO COMMANDER (CIVIL ENGINEER CORPS)

Lucius M. HALE	3-10
Fred J. BENSON	8-3

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LAST MONTH WITH "VANGUARD"

• In a speech given to the American Society of Newspaper Editors in Washington, D. C., on the 19th of last month, Dr. John P. Hagen, Director of Project VANGUARD, had this to say regarding the length of time the six-inch test sphere, launched on March 17, will remain in orbit:

"We have been analyzing the motions of VANGUARD I to detect and measure the rate of change of its period so that we might estimate its life time and measure the density of the atmosphere at 400 miles [the approximate perigree]. The change has been so small that it is most difficult to measure. However, we know now that if Benjamin Franklin, whose science was most modern for his day, put VANGUARD [I] in orbit, it would still be circling the earth, and we today might be speculating on when it might return to the atmosphere. It will take long observation to make possible a more accurate prediction, but we know now that VANGUARD [I] will be with us for at least 200 years."

Dr. Hagen commented, also, that we "will be hard put to place a final evaluation upon the seemingly faltering steps which are leading us slowly but surely into the most stimulating era in which man has yet lived — The Space Age. VANGUARD, whose major components were still on the drawing board a scant 16 months ago, lends emphasis to this fact."

• On April 24 and 25, preparations were made to launch TV-5, the last VANGUARD test vehicle, from Cape Canaveral, Florida. But owing to minor technical difficulties which developed during the countdown, the attempts were postponed. At this writing, the vehicle is still on the ground. TV-5 includes some test instrumentation in its first and second stages and an earth satellite which weighs 21-1/2 pounds and is 20 inches in diameter. Scientific experiments to be conducted will produce data on the X-ray output of the sun and meteoric particles encountered at orbital altitudes.

The X-ray sensors in TV-5 are two ionization chambers equipped with beryllium windows to pass the soft X-rays. When X-rays penetrate the windows they ionize the argon gas inside the tube, and current flows between the cylindrical shell of the tube and an insulated wire projecting down the center of the cylinder. The ion chambers are coupled to a transistorized amplifier capable of measuring currents as small as a millionth of a microampere with a speed of 1/30th of a second.

Four types of measurements will be made of the meteoric particles bombarding the satellite. The first type will use erosion gauges consisting of evaporated metallic resistance films on glass strips attached to the outer surface of the satellite. By monitoring the resistance of each strip it will be possible to observe the wearing away of the metallized film by the steady blasting of micrometeorites. The second will be made by means of a cadmium sulphide photocell covered by an opaque film which will respond to sunlight if punctured. In a third experiment, the "ping" of particles hitting the surface will be picked up by sensitive microphones. Finally, two hermetically sealed belts around either side of the satellite equator will be equipped with pressure gauges to detect puncture of the satellite wall.

In This Issue

Cover PHOTO: Moments after its release, a giant polyethylene balloon rises above the morning mist at Minneapolis, Minn., on a flight to the stratosphere. Its scientific cargo, beyond right edge of photo, has not yet been hauled off the ground. See articles beginning on pages 5 and 13.

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. ... Research Reviews is listed for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. Subscription price: $1.50 per year in U. S. and Canada; $2.00 per year, foreign; $0.15 per individual copy. Use of funds for printing this publication was approved by the Director of the Bureau of the Budget, February 12, 1958.