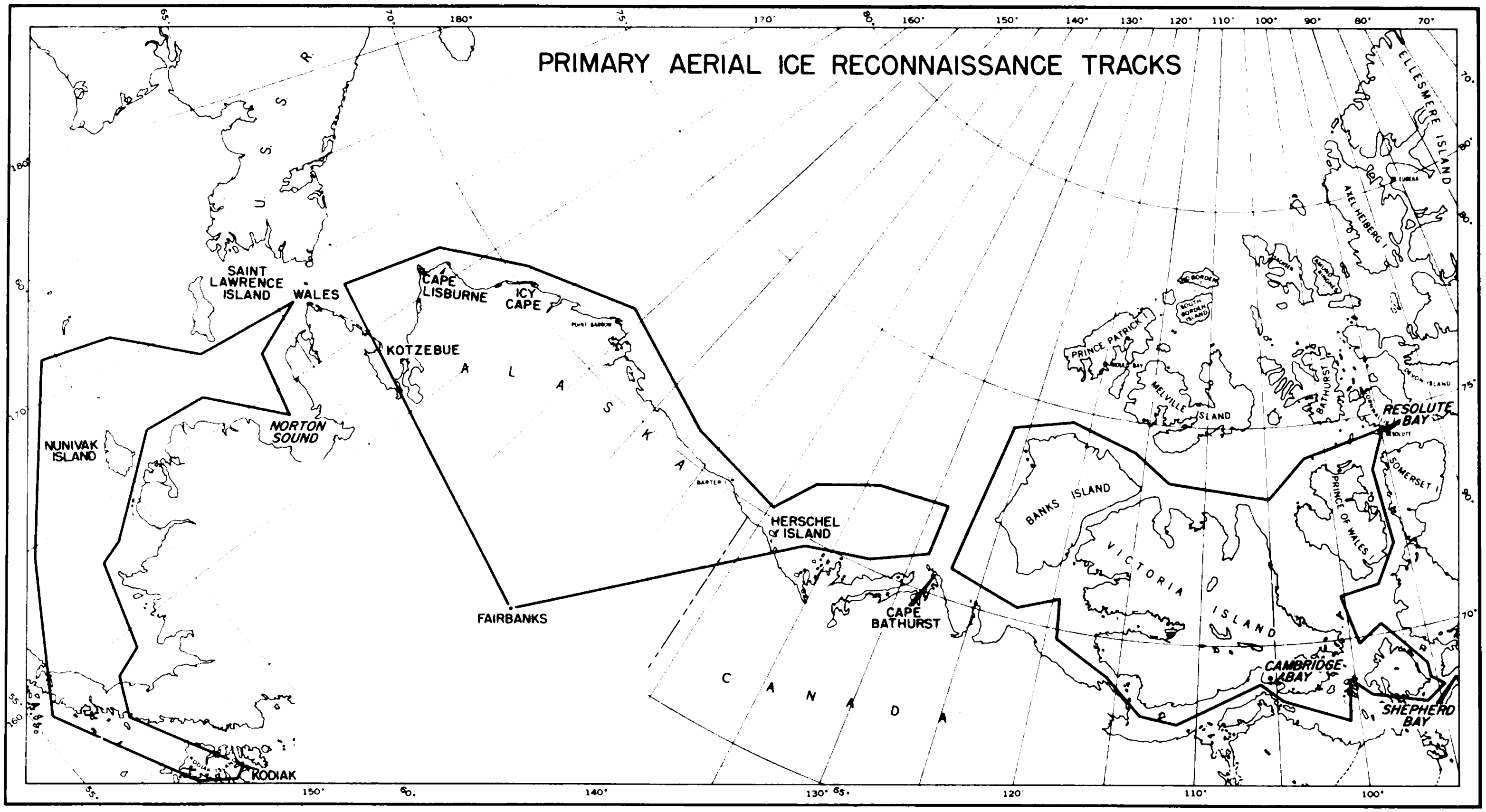
OFFICE OF NAVAL RESEARCH **MAY 1956**

RESEARCH REVIEWS

NAVEXOS P-510

DEPARTMENT OF THE NAVY
WASHINGTON, D. C.


PRIMARY AERIAL ICE RECONNAISSANCE TRACKS
U S S R
SAINT LAWRENCE ISLAND
WALES
CAPE LISBURNE
ICY CAPE
KOTZEBUE
NORTON SOUND
NUNIVAK ISLAND
A L A S K A
FAIRBANKS
HERSCHEL ISLAND
CAPE BATHURST
C A N A D A
KODIAK
BANKS ISLAND
VICTORIA ISLAND
CAMBRIDGE BAY
SHEPHERD BAY
RESOLUTE BAY
PRINCE OF WALES I
SOMERSET I
PRINCE PATRICK
MELVILLE ISLAND
BATHURST I
AXEL HEIBERG I
ELLESMERE ISLAND

Sea Ice Forecasting Program in Support of Military Operations

Applied Oceanography Branch
U.S. Navy Hydrographic Office

The strategic importance of the Arctic regions has been widely acknowledged in recent years and emphasized in innumerable articles appearing in popular magazines. It appears inconceivable at the present time that any large-scale operation in the Arctic can be conducted without major support from shipping. In order that the safety and efficiency of these shipping operations be at an optimum, sea-ice conditions must be considered in planning and effecting the operation. Consequently, the Hydrographic Office has focused much attention (Frontispiece) on the vast, seasonally-frozen, channel waters and seas of the North American Arctic.

With the establishment of the remote Arctic weather stations in cooperation with the Canadian and Danish Governments during the years 1946-1949, the construction of Thule Air Base in 1951, and the establishment of a network of Arctic radar stations in 1955, the Hydrographic Office has concentrated on providing vital ice information and predictions of ice conditions to the planners and participants of these operations. The magnitude of these operations can be realized by the number of ships involved and the tonnage transported during 1955. Considerably more than 100 vessels of various types and sizes transported more than three and one-half million barrels of fuel oil and a half-million tons of other cargo to Arctic bases.

One of the aims of the Hydrographic Office in support of these operations has been to gather ice information and develop scientific forecasting techniques in order to give operational planners an early estimate of ice conditions. This information aids the planners in determining when ships might first reach a given Arctic site and how severe the ice conditions will be during the operation. This permits maximum utilization of the short navigational season and avoids costly delays in reaching the destined site. In addition, during the operation, forecasts are made to give both planners and participants in the operations advanced intelligence on ice conditions to be encountered enroute and at the destined site. Operations units are also forewarned of the date when the freeze-up recommences and closes shipping routes to navigation.

The type of ice encountered by Arctic shipping varies greatly. Smooth "fast" ice develops in most of the protected harbors and approaches, forming a useful landing area for aircraft during the winter season. The thickness of such ice generally varies from 3 ft along the Labrador coast to more than 6 ft at Thule and 8 ft or more at the joint U.S.-Canadian weather stations north of 74° latitude. However, pressure ridges and hummocks usually increase ice thickness, often considerably. At Frobisher Bay, for example, tremendous tides toss large cakes of ice around like toy blocks, resulting in huge pressure ridges and even upended "ropaks." "Storis," peculiar to the southern tip of Greenland, is another type of ice encountered in the Arctic. This drift ice is the remains of the thickest fused pressure ridges of polar ice which drift southward along the east coast of Greenland, round Cape Farewell, and tend to accumulate near the mouth of the fjord on which Bluie West-1 Air Base was built.

Supply ships approaching Bluie West-1 are often hampered by this heavy "Storis" during the spring and summer. Ships sailing to Thule Air Base in July (Figure 1) frequently encounter the Baffin Bay pack which is composed of ice of one winter's growth as well as many icebergs. Ships supplying the joint U.S.-Canadian Arctic weather station at Resolute Bay, N.W.T., meet belts and patches of "polar" ice which is old ice that is stronger and more resistant to melting. From its source in the polar basin this ice drifts southward out of Kane Basin and eastward out of Barrow Strait in August and early September. Transit of heavy concentrations of polar ice in Kane Basin or in Norwegian Bay makes it possible for icebreakers to navigate and resupply the joint weather stations of Alert (Figure 2) and Eureka on Ellesmere Island.

Icebreaker reconnaissance of Foxe Basin was accomplished in July of last year through heavy concentrations of rough pressure ice with dirt-stained ridges, apparently the combined result of wind and tidal currents. This ice was almost completely melted by early September except for troublesome local concentrations of grounded ice

Figure 1 - APA 31 safely in North Star Bay on 18 July 1951 during establishment of Thule Air Base.

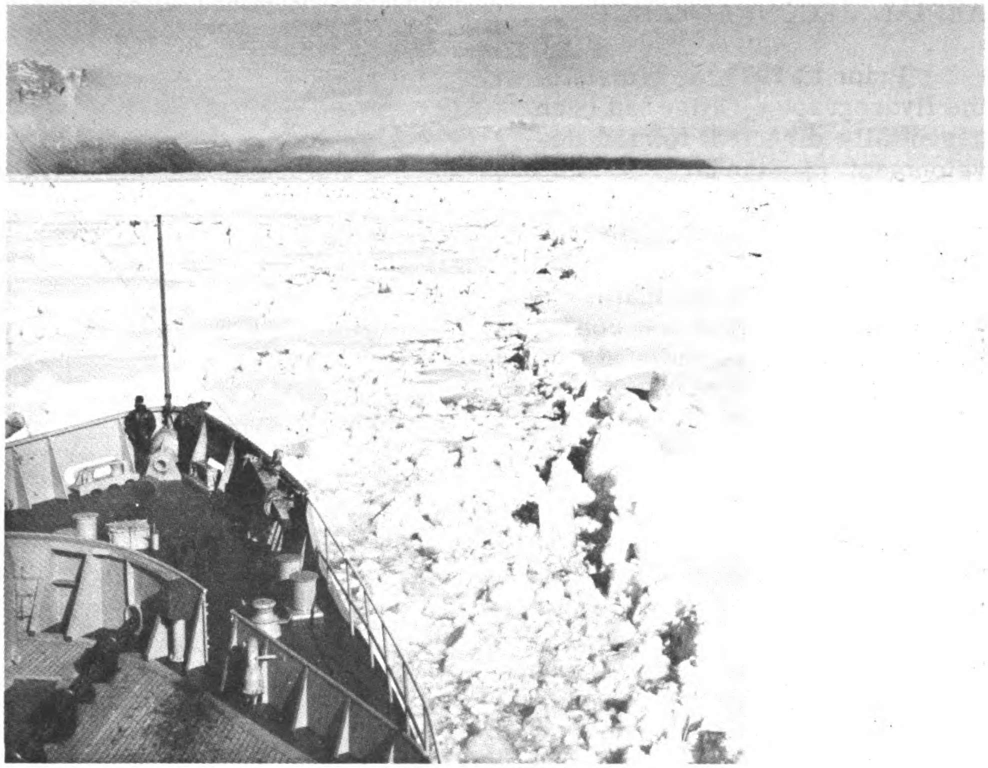


Figure 2 - Navy Icebreaker EDISTO on resupply run to arctic weather station ALERT in August.

along the beaches which hindered unloading operations. This grounded ice, eroded by tidal action, produced one of the most picturesque ice formations, the atomic cloud-like "Stamukhi." In the southern gulfs of the Canadian Arctic Archipelago ice consists generally of relatively smooth fields and giant floes separated by cracks, ridges, and occasional lakes or "polynyas." This ice melts rapidly in early July and by August disappears southward and westward of Victoria Island. However, patches of "polar" ice drifting southward from Victoria Strait, as well as grounded ice on the shores of the islands, continue the ice hazard to navigation in eastern Queen Maud Gulf throughout the remainder of the summer.

Most baffling of all the Arctic shipping routes is that along the northern Alaskan coast. The "polar" pack of the Arctic Ocean is seldom far from this coast and in many years is piled directly on the beach of the outer islands. Even during years when a "lead" develops between the beach and the southern edge of the "polar" pack, the transit is difficult as late as August since ice concentrations persist. As much as three to seven tenths of the "lead" may be ice. Usually, by September concentrations in the lead decrease and the width increases, facilitating passage for a short period. However, about the middle of September, thin, young ice begins to form north of the Alaskan coast and the brief shipping season is over. Strangely, the disintegration and freezeup processes here have approximately a month's overlap; that is, the inner part of older sea ice is still disintegrating at the same time that new ice is forming and superficial portions of the older ice are refreezing.

AERIAL RECONNAISSANCE

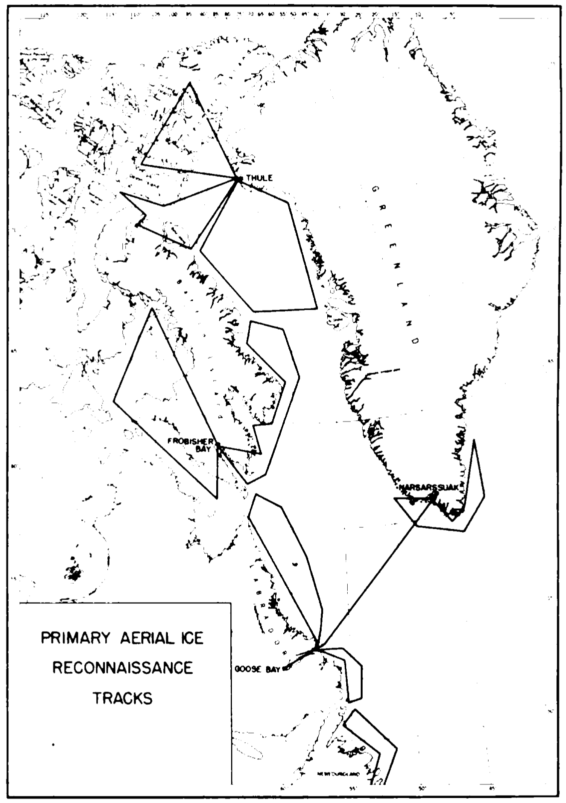


Figure 3 - These tracks are the major ones flown by planes on air ice reconnaissance during the operational season.

Prior to 1951 the efforts of the Hydrographic Office had been essentially directed toward development of standardized ship and shore ice terminology and reporting procedures. An ice atlas had been compiled which gave Arctic-bound navigators a general idea of what ice conditions would be encountered and what seasonal changes would take place as the ice cover receded and/or disintegrated. Ice information prior to 1951 was based largely on sporadic ship reports which were strongly biased on the basis of individual ships' experiences. Most of these ships were small whalers and fishing vessels whose activities were confined to the outer ice boundaries.

Although steps had been taken to establish recording and reporting procedures for aerial ice reconnaissance as early as 1946 during the establishment of Resolute Bay, it was not until 1953 that the first regularly scheduled, systematically conducted program of aerial ice reconnaissance was established. The program encompassed the entire North American Arctic sea-ice region from the waters adjacent to Greenland westward to those fringing Alaska.

The mission of ice reconnaissance may be considered threefold. First, it furnishes a comprehensive and thorough concept of existing ocer-all ice conditions prior to the operation. Thus, each year an early survey of the entire North American Arctic reveals information of current ice conditions which can be compared with past years and with normal concepts such as those provided by the ice atlas. Second, while icebreakers or convoys are transiting ice, direct or tactical support can be furnished to such shipping in seeking out the best approaches or transit routes through the ice. Third, this reconnaissance supplies synoptic or instantaneous comprehensive ice information, which is used as a basis for ice forecasting, a service which the U.S. Navy Hydrographic Office has been providing to Arctic shipping since 1952 and which is becoming more significant to shipping operations each year.

The mission of ice reconnaissance is an extremely difficult one. Ice-observational flights (Figure 3) are long, tedious, and extremely hazardous. The few navigation aids available over the Arctic are in many cases rendered completely useless by the rugged mountains and

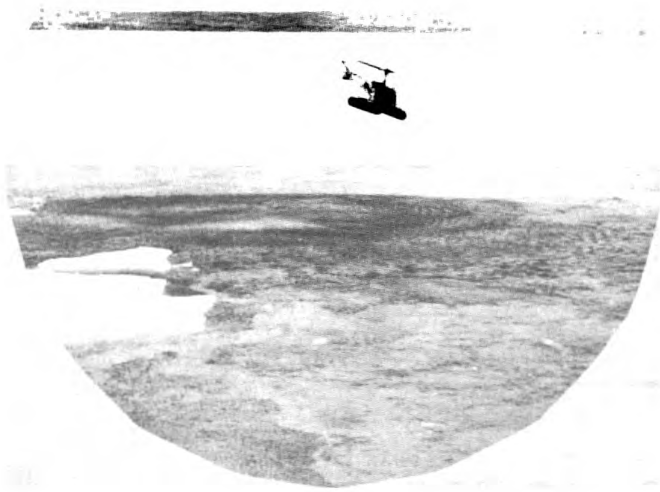


Figure 4 - Helicopter from Navy Icebreaker BURTON ISLAND on ice reconnaissance flight in Arctic Ocean near Banks Island in August.

glacial terrain bordering the ice-filled seas. Emergency landing strips are few and difficult to find because of the inaccuracies and inadequacies of mapping. Landing on sea ice, because of the hummocks and ridges (Figure 4) during most of the year and melt puddles during the short summer, is virtually impossible.

The vagaries of Arctic weather are famous. The extreme winds and snow of the long winter yield to the equally deterent rain, sleet, fog, and heavy cloudiness in the brief summer. Despite such obstacles, U.S. Navy Patrol Squadrons and Royal Canadian Air Force Squadrons are able to obtain valuable ice information each season and to furnish direct support to shipping. P-2-V type icecraft (Figure 5), which have taken the lead since 1954 when they replaced the PB-4-Y2, are the primary reconnaissance aircraft utilized in fulfilling the U.S. ice-reconnaissance commitments. Canadian squadrons have conducted a successful reconnaissance program utilizing Lancaster type aircraft. In both the U.S. and Canadian experience, the crews assigned this

Figure 5 - Forecaster of the Navy Hydrographic Office (extreme right) and crew of Navy P2V at Thule, Greenland before ice reconnaissance flight.

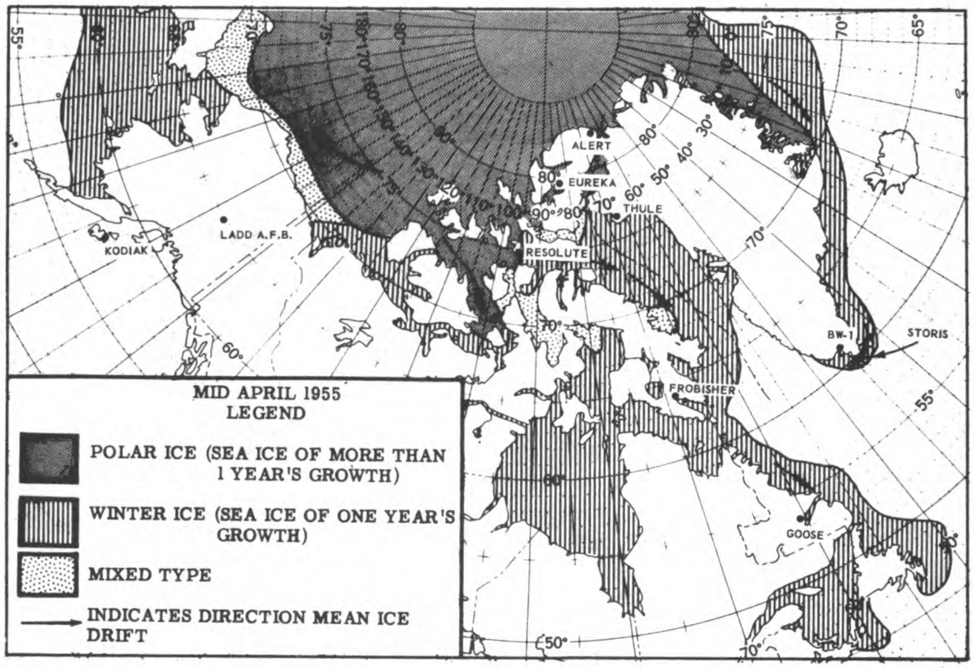


Figure 6

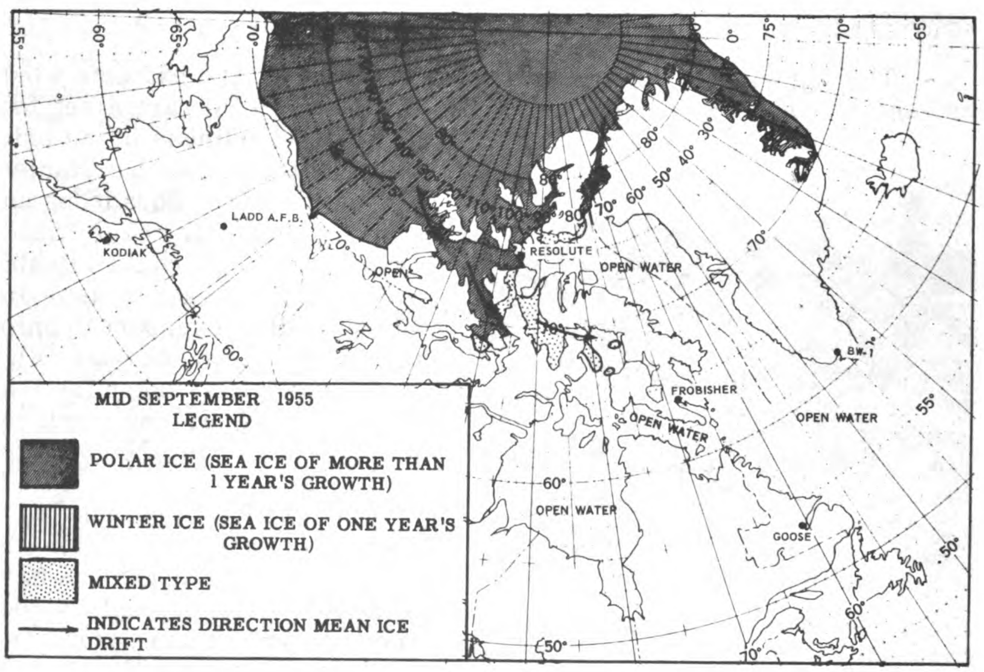


Figure 7

responsibility have shown remarkable adaptability and ingenuity in carrying out their novel assignments.

ICE OBSERVERS

The U.S. Navy Hydrographic Office first assisted in providing aerial ice-reconnaissance support to Arctic shipping in 1950 when two civilians, one provided by the Canadian Government, the other by the Hydrographic Office, were assigned to the resupply of Resolute Bay, N.W.T., in Barrow Strait of the celebrated Northwest Passage. The RCAF provided the necessary aircraft in order to investigate the potential of aerial ice reconnaissance.

In 1951 Messrs. Kaminski and Parker of the Hydrographic Office were assigned to study and provide aerial ice-observational support to the massive shipping involved in the establishment of Thule Air Base as well as for continuing support to shipping traffic to Resolute Bay. No specific U.S. aircraft was assigned a definite, regular responsibility to Arctic shipping operations until 1952. At this time Henry S. Kaminski, who had applied a great deal of personal effort since 1951 in developing and expanding the U.S. Navy's program of ice reconnaissance and ice forecasting, thoroughly instructed and briefed the U.S. Navy's VP-24 Squadron in the use of the reconnaissance methods and techniques developed at the Hydrographic Office. By 1953 regular schedules of ice reconnaissance were devised and a complete program of ice reconnaissance conducted under the guidance of the Hydrographic Office prior to, throughout, and following the navigational season of that year.

On 16 April 1954, a USN ice-reconnaissance aircraft commanded by Lt. Walter C. Kuerten crashed at Paget Point on bleak Ellesmere Island, Canada. All aboard were lost, including Henry Kaminski of the Hydrographic Office. Another fatality was Lester L. Martin, AG-1, who had graduated at the head of the first class of naval aerographers mates trained specially for ice reconnaissance by the Hydrographic Office during February of 1954. The work of these men in pioneering ice-reconnaissance support to Arctic shipping served as an important contribution toward the brilliant success attained in the mammoth "DEW-Line" shipping operations which took place in 1955 under the command of VADM Denebrink, Commander, Military Sea Transportation service. A highly specialized body of aerographers mates exists today; its control and highly specialized training in ice reconnaissance is provided by the Naval Aerology Branch of the U.S. Navy's Flight Services Division.

ICE FORECASTING

Although now well established and of extreme importance, ice reconnaissance left unfulfilled certain requirements of necessary support to Arctic shipping. A preconception of the incipient ice season was needed by planners of operations; the operational need existed for knowledge of ice conditions at time of arrival along transit routes rather than at the time of observation; and a desire existed for continuing flow of ice information uninterrupted by negative reports as a consequence of poor flying weather over reconnaissance and ship-transit routes. These limitations are being overcome by the developing and improving ice-forecasting service (Figures 6 and 7) provided by the Hydrographic Office.

Prior to the onset of operations, the Hydrographic Office issues Long Range Outlooks giving approximately 150- to 180-day predictions of the general ice conditions and trends to be expected in specific areas of operations. The outlooks are based on oceanographic, climatic, and historical ice information. In addition, the Hydrographic Office issues twice-monthly 30-Day Ice Forecasts, providing advanced indications of the general features of ice conditions. For example, a forecast may cover the amount of northward recession to be expected in the pack ice boundary along the coast of Labrador or the average concentration to be expected in the "lead" between the polar pack and the Alaskan mainland.

The 30-day forecasts are developed by coordinating the long-range meteorological information issued by the Extended Weather Section of the U.S. Weather Bureau with oceanographic information. To give more detailed and specific predictions, 5-Day Forecasts are issued by the Hydrographic Office in Washington by radio dispatch and by graphic, prognostic ice charts disseminated by radio facsimile. These forecasts give the expected ice conditions for specific areas or task groups operating in portions of the ice-filled Arctic seas.

Corresponding to the "tactical support" mission provided by aerial ice reconnaissance, the Hydrographic Office sends skilled ice forecasters into the field to issue, by radio dispatch, 48-Hour Forecasts of ice conditions to the tactical operational units at particular locales. The field forecasters are based at stations from which the reconnaissance aircraft operate to insure prompt and complete familiarity with the latest local ice information and to provide the advantage of being in close proximity to the operational units. The ice forecaster occasionally participates in the reconnaissance flights and communicates directly with the commander of the icebreaker or task group which he is supporting. For example, during the 1954 entry into Thule, when the USCGC WESTWIND lost her helicopter, the naval VP squadron detachment maintained 24-hour coverage to guide the ship through the ice until she reached North Star Bay. A Hydro ice forecaster accompanied each flight. Field locations at which both ice reconnaissance detachments and Hydrographic Office field forecasting facilities are installed are Goose Bay, Labrador; Frobisher Bay, N.W.T.; Thule, Greenland; Resolute Bay, N.W.T.; Ladd Field, Alaska; and Kodiak, Alaska.

DEVELOPMENT WORK

In establishing the first ice-forecasting service in the Western Hemisphere, it has been necessary for the Hydrographic Office to carry on developmental work concurrently with operations. All the scientific literature on sea-ice physics was examined and in many cases found to be inadequate. Accordingly, the Hydrographic Office has extended the work of Defant and Zubov* in order to devise a system of "Ice

*Two reknowned oceanographers who worked independently in the field of sea-ice physics. Zubov is a contemporary Russian.

Potential" forecasting. This method involves the examination of oceanographic data from stations occupied by icebreakers during the fall months in order to predict the date when ice will first form in the ensuing season and its consequent rate of growth or thickness at various dates when operations are scheduled. Because laborious calculations were required, the Hydrographic Office developed a method of ice-potential computation suitable for adaptation to high-speed electronic computers.

Further studies have been made and are in progress on such novel scientific problems as sea-ice drift, sea-ice distortion and sea-ice disintegration. Constant and increasing knowledge of sea-ice forecasting is being realized in the program conducted by the Hydrographic Office. Certain limitations should be noted, however, and corrected if possible. First and foremost is the lack of basic research that is needed in order to increase further the accuracy and scope of ice forecasts. A large part of the theory upon which Hydrographic Office procedures are based is available from translations of obscure but recent work published by Russian and Japanese scientists whose urgent needs for ice forecasting have existed for a much longer time than those of North American nations. It is felt that additional research is needed in theoretical studies of sea-ice movement and disintegration.

Secondly, it is believed that entirely too little emphasis has been placed on extended Arctic weather forecasting. A considerable part of ice forecasting involves the application of meteorological predictions and synoptic information to oceanographic data with which it is closely interrelated.

A third and final impediment to the ice programs has been the scarcity of oceanographic data over Arctic regions. All too little information has been gathered in past years' operations. An extensive data collection program is planned for this coming year which should prove very valuable to ice forecasting and related sciences.

In conclusion, a great deal has been accomplished toward destroying the gloomy and fatalistic notion that "Ice Is Where You Find It." A great deal remains to be done.

Floating Automatic Weather Station

During the hurricane season of 1955, a pioneering effort was carried out to determine the problems and potential value associated with the use of floating automatic weather stations strategically placed in the ocean to give data on the development and movement of hurricanes. Naval Research Laboratory worked with the National Bureau of Standards under BuAer support to develop and build five stations to test the system. These five were launched from a ship in the western Atlantic. From their locations at sea, the five stations broadcast by radio the barometric pressure, direction of the wind, and wind speed.

The system as tested yielded information on radio propagation factors, launching techniques and design considerations. Such data will guide further development work now in progress, and contribute to a more effective system for future operational use.

The Role of Plastic Materials in Building a Better Navy

Although it is often said we are living in "the plastic age," there are many who believe that we are just getting into the period in which plastics are demonstrating their worth as useful materials. Certainly in the Navy there is widespread belief that plastic materials can and will contribute in larger amounts to the construction of a Navy surely able to maintain its leadership among the sea powers of the world.

For more than 30 years, plastics in a variety of forms, especially molded shapes and laminated sheets, have been used in the marine field as electrical insulation. As far back as 1947, tests were being conducted on glass-reinforced plastic pipe for use on shipboard. Nowadays all sorts of plastics are being developed with some of them already proven satisfactory for such things as windshields and transparent covers, for small-boat hulls, mine-sweep floats, and survival equipment. Improvements are expected on materials already introduced and tested by the Bureau of Ships. An active research and development program under the Materials Development Division of the Bureau has 28 subtasks in the field of nonelectrical plastics alone. These tasks cover a wide range of materials: for structural parts of ships, for propellor-shaft insulation, for plastic pipe on submarines, etc.

In developing a program on plastic materials such as this one, the Materials Development Division has for some time been investigating the nature of plastics. Considerable data have been amassed on structural plastics which are usually defined as glass-reinforced resinous products which may readily be shaped or molded—frequently heat or pressure may be applied in the process.

What research and development people do, their approach to a problem such as that posed by structural plastics, is brought out by a short summary of what has been taking place. Take, for example, the fibrous-glass reinforcement. How good the final product, the structural plastic, will be depends on how effectively the reinforcement material is used. These fibers are only 0.0004 inches in diameter, but are very strong, 300,000 psi, and have a tensile modulus of 10,000,000 psi. It is practical to make use of these fibers in several ways:

- As a random mat,
- As bidirectionally oriented cloth,
- As a yarn or roving,
- As unidirectional cloth,
- As combinations of two or more of the above.

In the case of the random mat of fibers (Figure 1), the fibers have no more orientation than straw in a hay stack. Unidirectional

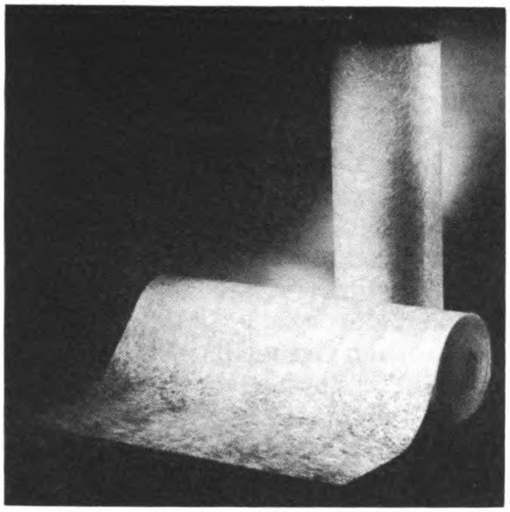


Figure 1 - Random distributed glass mat.

cloth, when combined with synthetic resin to form a structural plastic, gives a high tensile strength in one direction, and very little at right angles. In the combinations, it has been convenient to use mat and cloth together in a plastic material easily employed to construct boat hulls in thicknesses from 3/16 to 1/2 inch.

Because it was necessary to know the comparative strength of various plastic materials, and especially the reinforced structural materials, comprehensive tests were undertaken. To cite just one example, tests were conducted on a promising material that was essentially a fabric polyester laminate formed from parallel, laid-up cloth. The results of tests to bring out flexural strength are shown in Figure 2.

Other investigations have been carried out to compare the tensile and compressive yield strengths of the more promising structural plastics with other commonly used materials:

TABLE I

Material	Specific Gravity	Yield Strength (psi x 10^{-3})	
		Tensile	Compressive
Aircraft-grade spruce	0.4	10	5
Random glass mat plus polyester resin	1.55	24	25
Magnesium alloy AZ61X	1.8	30	30
181 glass cloth plus polyester resin	1.87	41	34
Aluminum alloy 24S-T4	2.77	42.5	42.5
SAE 1050 steel	7.9	47.5	47.5
Parallel glass fibers plus polyester resin	1.9	120	70
Titanium alloy RC-130A 7% manganese	4.5	135	135

ADVANTAGES OF STRUCTURAL PLASTICS

As progress was made in establishing the engineering merits of certain reinforced polyester plastic materials, attention was directed to other advantages. The Navy, of course, has a keen interest in any materials that are resistant to salt-water corrosion. Although good quality structural plastics have been made for only about ten years, it is estimated that they have indefinite life. They are durable under continuous exposure to sea water and under widely varied environmental conditions. Not only do they resist salt water corrosion, but they also resist dry rot, borer attack, and other vulnerabilities of wood when exposed to conditions common to naval operations.

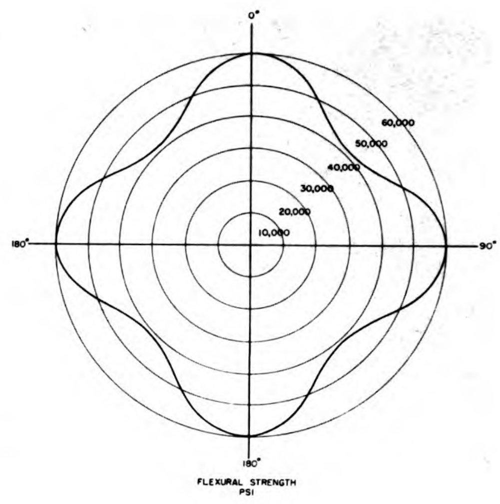


Figure 2 - Directional properties of 181-114 fabric polyester.

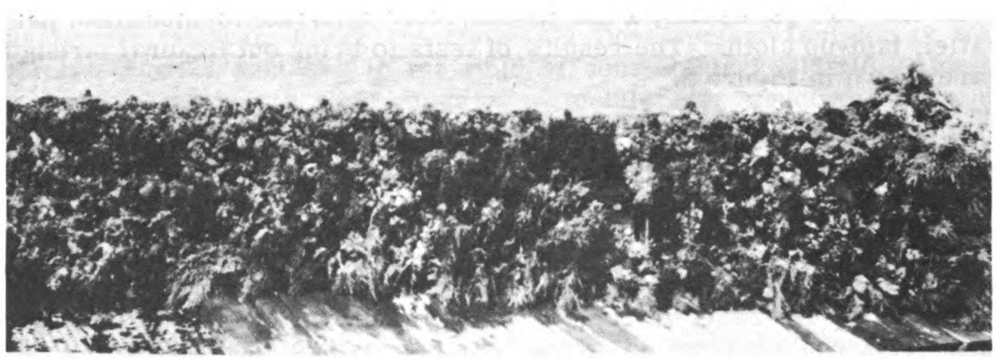


Figure 3 - Marine fouling of test panels after 416 days.

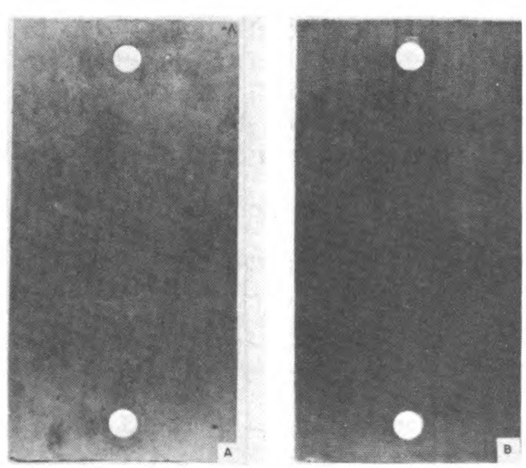


Figure 4 - Test panels after fouling is scraped off.

In a series of tests, it was found that although barnacles attach themselves to panels of reinforced plastic (Figure 3), the fouling may be removed with no damage (Figure 4) to the structural material. In some cases plastic test panels showed the original smooth, polished finish as soon as they were cleaned of fouling. Such a smooth finish, so readily restored, piles up comparative advantage, as it saves the Navy many man-hours of time and contributes to other economies. Take, for instance, the surface of a boat that comes in contact with the water while underway—the smooth, polished surface obviously makes for better performance.

When structural plastics are fabricated, the job is much easier than in the case of most other materials in common use by the Navy. Complex forms which might take skilled workmen many hours to shape in the case of some materials, are easily formed by craftsmen in a plastics shop. Close tolerances can be held and reproduced easily. Furthermore, identical units can be turned out easily with relatively few man-hours required. Through the use of plastic material, fastenings are kept to a minimum; it is not difficult to fabricate monolithic structures with no fastenings at all. The engineering designer, as a consequence, gains much in freedom and latitude for his structural specifications.

Weight-strength ratios in the case of structural plastics are high as compared with other structural material. Should sandwich construction (Figure 5) be used, the weight-stiffness ratios are favorable. As compared with steel, structural-plastic materials can be utilized to advantage in producing marine items ranging from highly stressed gas cylinders to submarine superstructures. In some cases there are definite advantages over aluminum. This is illustrated by a British commercial development on reinforced-plastic bus panels which were produced at a weight saving of 20 to 25 percent and a cost saving up to 50 percent on complex parts.

The ready availability of raw materials for structural plastics adds to advantages already described. The glass fibers are produced from silica or sand. Expensive facilities are required to take this raw material and produce satisfactory glass fibers, but such facilities can be built in a relatively short time. The resins are a product of the rapidly growing chemical industry, and as for the raw chemicals, they are available in very large quantities. The basic chemicals are applied for many other end-uses, so a chemical plant can divert these materials, in case of dire need, from products less urgently needed, and make resin for plastics on a high-priority basis.

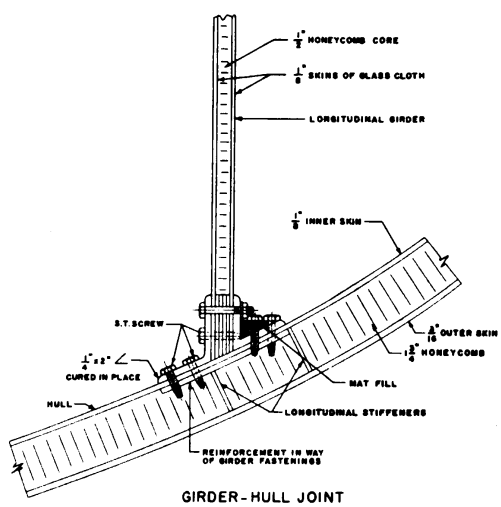


Figure 5 - Honeycomb core-sandwich construction in a boat.

FABRICATING PROBLEMS

As plastics began to gain wide usefulness, fabricators with little or no experience got into business. Little capital investment was required, and prospects seemed rosy. But there were pitfalls and problems that soon began to weed out the inept. Some of the problems of fabricators stemmed from the fact that they had no equipment or technical personnel to check the quality of raw materials. Likewise they were unable to perform similar checks on the finished product. The resultant lack of uniformity and deviation from prescribed tolerance was disastrous for the venturous who could not develop practical manufacturing methods.

NEW APPLICATIONS

The development work of the Bureau of Ships and the Materials Development Division has been aided by the cooperative efforts of the various naval shipyards. For example, some 200 plastic boats of the 12-foot wherry type were built by the Puget Sound Naval Shipyard between 1951 and 1953 (Research Reviews, June 1955). As a result, the Materials Development Division has been able to get a good line on the suitability of these boats for Navy service. The Shipyard is now cooperating in related developments set up by a subtask of the project on nonelectrical plastic materials. Work is in progress on:

- Glass-reinforced coatings for wooden boat hulls,
- Glass-reinforced coatings for metals,
- Effect of long-term exposure to sea water on the properties of sandwich panels having reinforced skins with honeycomb and other low-density cores.

As a preliminary to this investigation, a 38-foot picket boat in 1953 was coated on the bottom with glass cloth and polyester resin. Based on this experience, a tentative set of instructions for such a coating operation was issued. Currently, on the basis of later experience, a revised set of these instructions is being prepared.

Another development effort at the Puget Sound Naval Shipyard is directed at the building of a plastic 36-foot LCVP which will perform satisfactorily and be capable of mass production. To do this, a strong, lightweight sandwich construction is needed. As an approach, tests are being conducted on several low-density cores to determine if they stand up well when exposed to salt water.

The possibilities of carrying plastic boat construction up to a size as large as 80 feet long is among the newer potential developments of the Bureau of Ships. A preliminary design study is proceeding with a contractor, W. R. Chance, Inc., doing the work.

The development of plastic sonar domes is the objective of a task located at the David Taylor Model Basin. The material being investigated is glass-reinforced plastic. This laboratory also has the task of determining the approximate hydrodynamic loading on a JT hydrophone blister. A full-scale blister could not be tested at the Model Basin, so a 1:6 wooden model was built, and as a result the scientists conducting the test will be able to get data on ideal pressure distribution in an electrolytic tank.

The Portsmouth Naval Shipyard has been assigned the task of compiling data on plastic pipe for submarines. This work will include shock tests, storage-battery-water compatibility, and a determination of the best methods to connect metal with plastic, and to connect plastic with plastic. The material being tested currently is confined to high-impact plastic pipe and fittings.

Several interesting end-use items of plastic are being made and tested at the Norfolk Naval Shipyard. One is a sea-water scoop which has been installed on a PT boat. Test results have been satisfactory. Sunshields for ready-service ammunition lockers have not been shown to offer any advantage over metal ones. Reinforced-plastic propellor-shaft fairwaters and ropeguards have been installed on the USS DYESS (DDR 880) for service evaluation. Various methods of bonding and installing Styrofoam buoyancy blocks in small boats are being investigated.

Improvements are being sought on repair kits for plastic boats and damage-control kits for emergency repair of metal pipe. These kits already have a record of satisfactory service use. The New York Naval Shipyard has been assigned the job of prolonging the shelf life of the repair kits by making them from epoxy resins rather than polyester resins. A limited number of these new kits are being procured for service evaluation.

The Forest Products Laboratory of Madison, Wis., is conducting long-term tests on the load that can be carried by glass-reinforced laminates. Such a determination on load is essential before plastics can be safely used for such items as storage tanks and high-pressure cylinders. Laminates included in the program are: polyester #181 cloth, polyester #1000 cloth, polyester-mat, epoxy #1000 cloth, and a unidirectional reinforced laminate. Some samples have been under test for as long as 10,000 hours.

Inevitably, designers and engineers working in the field of plastics need an authoritative handbook. Consequently the Materials Development Division has sponsored a task which has as its purpose the compilation of such a handbook. The Fairchild Kinetics Division has been selected to do the job. They will, as a preliminary, analyze present research and development programs. The completed handbook should be highly useful to contractors, engineers, and designers working on Navy problems.

Phases of the plastics program described here are but an indication of the over-all effort of the Bureau of Ships and the Materials Development Division. The current planning for the future encompasses some 28 major objectives that have been put into writing for the information of the Office of the Assistant Secretary of Defense for Research and Development. As time passes, more and more reinforced plastics are going to find their way into the marine field. Through the cooperation of the marine engineer, the naval architect, the materials engineer, and the shipbuilder, reinforced plastics can be made to serve the marine industry as a full partner of the older materials of construction.

Scientists Are Learning More About the Arctic

Dr. Louis O. Quam
Head, Geography Branch
Office of Naval Research

In the years since World War II, scientific effort has become a symbol of our times. The probe for systematic knowledge through the use of science has been felt in many a neglected research area and has reached out to remote sections of the earth largely inhospitable to man and his activities. An outstanding example of accelerated research in regions which have been given but slight scientific attention is afforded by developments in the frozen lands of the Arctic. A half-dozen nations have land areas--either the homeland or possessions--that extend into the Arctic. Most, if not all, of these nations have stepped up their scientific studies in the frozen North, and there is a pronounced tendency for the weight of research effort to increase year by year.

A general appraisal of what has been happening in the Arctic reveals that the two main reasons why activity and research have been accelerated are: (1) This once remote and inhospitable area has become relatively accessible and habitable through the rapid development of air transport, and airplanes are now being used to carry out all sorts of missions where other means of transport would be difficult if not impossible, and (2) the American and Canadian people have become increasingly aware of the strategic significance of the Arctic as well as the relative advantage enjoyed by the people of northern Eurasia in their more detailed and intimate knowledge of that environment.

It is understandable that the Russians and the Scandinavians should have probed the North scientifically at a much earlier date than peoples of the United States and Canada, as the Eurasian nations have long had important economic activities in the Arctic. As early as 1850 a Russian merchant, M. K. Sidorov, who owned gold mines in regions tapped by the Yenisey River in northern Siberia, promoted the opening of a sea route which later became known as the Northeast Passage, linking the Kara Sea coast to the more accessible maritime centers of Europe. This merchant not only arranged international exhibits and offered prizes to advance his cherished project, but went so far as personally to attempt a ship expedition which failed to overcome the difficulties of frozen seas and unfavorable weather.

Other efforts to accomplish the Northeast Passage were made by Russians, Scandinavians and British, but it remained for a Swedish scientist, Baron A. E. Nordenskíold, to accomplish the feat in 1874. His ship was a 70-ton vessel normally used to hunt seals. Four years later he managed in another ship, the VEGA, to complete a voyage, with a forced interruption to wait out the winter, from the Atlantic to the Pacific. Thus the Northern Sea Route was opened, and as years went by it became of increasing importance to the development of northern Eurasian areas.

Much commercial and scientific activity was carried out in these waters until 1917, when the Bolshevik Revolution disrupted commercial activity. It was not until 1932 that O. Yu. Schmidt, with a party of scientists aboard the SIBIRYAKOY, succeeded in making the entire voyage in one season. This voyage had far-reaching results for it launched the Soviet Government on an extensive program of Arctic development. Furthermore, it was appreciated that Schmidt's success was in large measure due to radio and airplane support as well as to weather and ice forecasts from coastal stations that had been established during the First and Second International Polar Years - 1882 and 1932 respectively. Eleven stations were established in 1882 of which five existed at the time of the Revolution; a total of 19 were in operation in 1932. Some of these were discontinued after 1933 but others were established, and in 1938 there were 64 stations in operation.

The same year that Schmidt made his successful passage of the Northern Sea Route, the Soviet Government established an organization to improve and develop the seaway. This is known as Chief Administration of the Northern Sea Route (Glavnoye Upravleniye Severnogo Morskogo Puti, abbreviated to Glavsevmorput' or GUSMP). The route is now in regular use during the navigation season of 2 to 2-1/2 months. Traffic is greatest between the White Sea ports and the mouth of the Yenisey River, but several ships make the entire trip from Murmansk to Vladivostok.

For two decades the Glavsevmorput' has been carrying out a continuous program of research, particularly as regards ice, weather, and hydrography. These observations are obtained by research vessels cruising around the borders of the ice cap or frozen into and drifting with the pack, air reconnaissance, landings by aircraft on sea ice, establishment of research stations on the coasts, and drifting stations on the sea ice. After several preliminary ice-breaker expeditions in the Kara and Laptev Seas and a reconnaissance landing on he sea ice, the Russians' first effort to penetrate the Arctic Basin was made in 1937 by the four-man expedition under Papanin which was landed by plane on unprepared sea ice near the North Pole. After drifting almost due south for 274 days, the men were taken off the ice by ship at about 71° N just northeast of Scoresbysund in East Greenland. In the same year, the icebreaker SEDOV was ice bound in the Laptev Sea and drifted roughly parallel to the track of the Norwegian FRAM in 1902.

In 1938 the Glavsevmorput' was reorganized and expanded. It now has about 100 polar stations north of 68°N., operates 18 ice breakers, a polar aviation unit, and several training schools for Arctic technicians. In 1941 a project to investigate the polar basin was set up in which the famous polar pilot Cherevichnyy made three landings on sea ice north of Wrangel Island, but apparently little other than operational experience was gained from this project.

Although less spectacular, the pre-war work of the Scandinavians furnished the principal scientific basis for understanding the Arctic and its environment. The work of Nordenskiold, Nansen, Amundsen, Sverdrup, Alhamann, and Bjerkness is too well known to require repeating here.

Ski Jump Plane (R4D) on the Polar Ice.

Pre-World War II scientific research in the North American Arctic was sporadic. The greatest stimulus to geographic exploration was the search for the ill-fated Franklin Expedition during which M'Clure completed the discovery of the northwest passage. The establishment of circumpolar stations during the International Polar Year 1882-83 stimulated a second period of exploration with the object of reaching the North Pole, a feat accomplished by Peary in 1909 and claimed also by Cook a year earlier. Scientific work in the Arctic engaged the attention of Sverdrup, Leffingwell, Stefansson, MacMillan and others. In 1926-28, three flights were made to the North Pole by Byrd, Amundsen and Wilkins, inaugurating the modern era of arctic exploration. Although these and many other expeditions were accomplished at a cost of great expense of time, effort, and hardship, little knowledge of the Arctic Ocean and its shores was available. When in World War II military requirements necessitated data on the Arctic, we were forced to extrapolate from knowledge of the Antarctic and Alpine environments, supplemented by ship logs of the Coast Guard Ice Patrol. By and large such operations as the CANOL Project, the Aleutian Campaign and the Navy PET-4 were conducted by trial-and-error engineering.

The need for scientific research was at once apparent and a few facilities were provided during the early post-war period. Thus were established the Joint Arctic Weather Stations and the Churchill Arctic Test Station by Canada and the United States; the Arctic Research Laboratory at Point Barrow, Alaska; the Aero-Medical Laboratory at Fairbanks; and the Quartermaster Test Station at Big Delta, Alaska—establishments of the Navy, Air Force, and Army, respectively.

Daily flights from Fairbanks to the North Pole for weather and sea-ice reconnaissance, transportation research at Thule, and the Ice Island T-3 station were major field activities.

One ONR project was similar to that of Cherevichnyy. We refer to it as Operation SKI JUMP. By means of the Navy's R4D laboratory plane mothered by a P2V, eight landings were made on sea ice. At each station a hole was cut through the sea ice and temperature and salinity soundings were made to the sea floor. Guided by these data, Worthington of Woods Hole Oceanographic Institute concluded that the theory of clockwise circulation of Arctic waters advanced by Nansen on basis of the FRAM observations, did not apply to the whole Arctic Basin. The SKI JUMP observations indicated an independent circulation in the Beaufort Sea north of Alaska and that the Beaufort Sea bottom temperatures are appreciably warmer than those observed by Nansen to the north of Siberia and Europe.

Worthington suggested two possible explanations:

(1) The deep water entering the basin from the Norwegian Sea had been warmer in recent years than it was in Nansen's time; or

(2) there is a submarine ridge, running roughly from Ellesmere to the New Siberia Islands, which separates the deepest water of the Beaufort Sea from the remainder of the basin.

We shall see that the Russians came to this same conclusion.

The occupation of Ice Island T-3 by Air Force scientists is an activity similar to the Russian drift stations. T-3 is an oval mass of ice which has an area of 30 square miles and stands 30 to 40 feet above the surrounding pack ice, indicating a thickness of 150 to 200 feet. Its surface is corrugated with ribs thousands of feet long, 10 to 20 feet high and 100 to 500 feet apart. It is now known that these ice islands are shore ice from the coast of northern Ellesmere Island. Their probable mode of origin was described by Debenham in the October, 1954, issue of The Geographical Review.

The first camp established on Ice Island T-3 by Col. Joe Fletcher consisted of tents, but later prefabricated buildings—including a power plant and equipment such as a power winch—were flown in. Research has consisted of a study of the island's composition and structure as well as meteorological, hydrobiological, and oceanographic observations. During its occupancy T-3 drifted across the North Pole and southward to the north coast of Ellesmere Island.

Attention will now be directed to the post-war activities of the Russians. It is interesting to note that very little was known of the Russian activities until 1954. Apparently goaded by the world-wide publicity we were receiving in regard to discovery and scientific work on the Ice Island, the Soviet press began to point out that the T-1 was first discovered by Soviet airman I. S. Kotov in March, 1946, in the region of Wrangel Island; T-3 by I. P. Mazuruk in April, 1948, and T-2 by V. M. Perov in March, 1950. Later, popular articles were written by members of the USSR Academy of Sciences, such as D. I. Shchebbakov, who visited the drift stations. These articles give considerable information on the organization and accomplishments of the Soviet Arctic program.

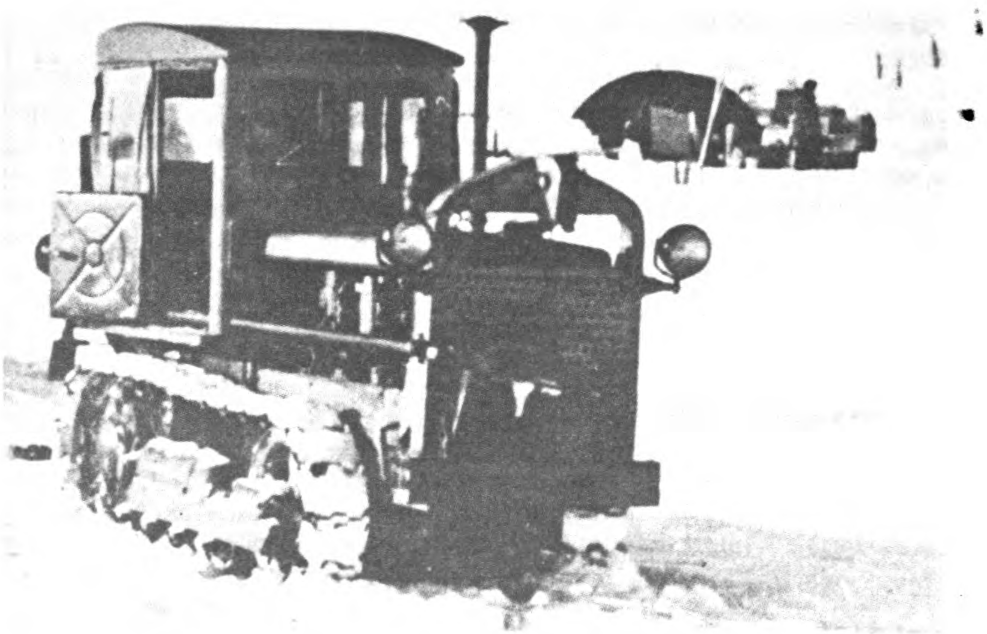
Research work on the Arctic basin similar to that of Papanin in 1938 and Cherevichnyy in 1941 was resumed in 1947. In April of that year, three SKI JUMP-type stations were established north of the New Siberian Islands from which it is reported that scientists under Professor Ya. Ya. Gakkel' worked from more than 200 observation sites in 1948-49 and discovered a submarine ridge, extending across the Arctic basin from the New Siberian Islands to northwest Greenland, which they named the Lomonosov Ridge.

Starting in April, 1950, an expedition of 16 men, led by M. M. Somov, drifted in Arctic waters until evacuated on 9 April 1951. It covered about 2,500 kilometers and reached a point 600 kilometers north of the starting point. Twenty tons of supplies were air freighted to this expedition. Somov reported two significant discoveries which required modification of the then held concepts of Arctic oceanography and meteorology: (1) A warm-water layer exists at a depth of 75 to 100 meters, and (2) warm Pacific air occasionally enters this section of the Arctic and cyclonic storms develop. The 1938 Papanin expedition is now known as Scientific Station North Pole 1 and the Somov Station is designated North Pole 2.

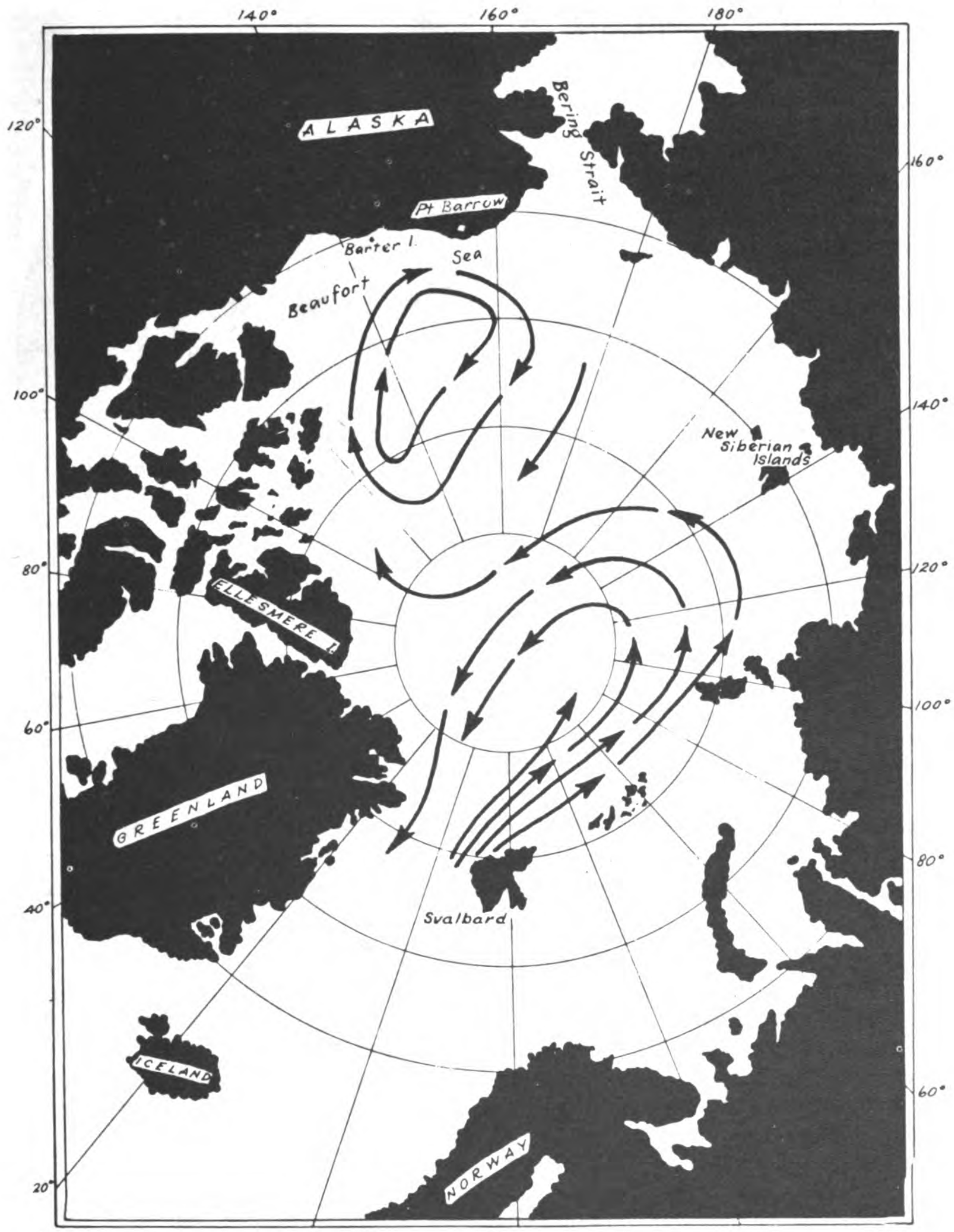
In 1954 the Soviet research program in the Arctic basin was again expanded. The plan called for joint operations by the Glavsevmorput' and the USSR Academy of Sciences. The plan involved four operations:

- A drift station near the North Pole under A. F. Treshnikov to be staged from Cape Dikson and Cape Chelyuskin

- A drift station under Y. I. Tolstikov in the area north of Cape Schmidt.



Russian Equipment at North Pole, August 1954.



The North Polar Basin - showing circulation of sea currents.

- High Latitude Air Expeditions under M. Y. Ostrekin to be closely coordinated with the two drift stations, one to land at the North Pole and the other to work the outer edge of the Continental Shelf in the northern Chuckchi Sea.

Soviet meteorologist taking observations at North Pole Station 3.

"Regular flights" by one or more "flying laboratories" along the whole periphery of the area of the expeditions, to take meteorological and ice observations. The two drift stations were designated North Pole 3 and North Pole 4.

It is reported that in July, 1954, a delegation of top scientists from the USSR Academy of sciences spent two weeks at each of the drift stations. The purpose was to discuss enlargement of the scientific program in fields of submarine geology, geomorphology, and hydrobiology.

The "High Latitudes Air Expedition" under Ostrekin was given the task of determining the precise location of the Lomonosov Ridge in the vicinity of the North Pole and to repeat some of the magnetic observations made by Papanin in 1937. The "Flying Laboratories" are apparently well-equipped reconnaissance planes for ice and meteorological observations. It is reported that they conduct "weather and ice research during non-stop flights from the coastal stations to the North Pole and back."

It is interesting to note that the conclusions reached by Worthington on the basis of the SKI JUMP operation are substantiated by the Russian discoveries, and T-3 soundings agree. The Arctic Basin is indeed separated into two distinct parts. The pack ice circulates in clockwise direction in the western portion and in counter-clockwise direction in the northern eastern hemisphere.

In summary it may be said that the American and Canadian effort in the Arctic is similar to that of the Russians but much less intensive and less regimented.

A large part of the effort on this side of the pole is carried out by individual scientists sponsored by their universities, private organizations, or by government agencies such as the Office of Naval Research and the National Science Foundation.

Through cooperative effort of the Weather Bureaus and Defense Departments of the United States and Canada, several new weather stations have been established in the Canadian Arctic and, with the cooperation of Denmark, also in Greenland. These stations may be used by scientists as bases for the conduct of field research.

To extend meteorological and sea-ice observations over the Arctic Ocean the United States Air Force conducts daily flights from Fairbanks, Alaska, to the North Pole. Canadian and U. S. Navy fliers make similar ice-reconnaissance flights in northeastern Canada, Baffin Bay and the Bering Sea. These reports are collated by the U.S. Hydrographic Office into short- and long-range ice forecasts.

To supply the Air base at Thule, the weather stations, and the newly constructed DEW line stations, the United States and Canadian ice breakers escort fleets of supply ships into Baffin Bay, through the waters of the Canadian Arctic Archipelago and the Arctic Coast of Alaska. The Northwest Passage is witnessing an increasing traffic each year.

To keep apace with over-ice construction and transportation requirements the U.S. Army is carrying out an extensive program of snow and ice research and engineering tests in Greenland as well as at the Snow Ice and Permafrost Research Establishment in Illinois.

Naval engineers and Seabees have carried out extensive construction experiments and equipment tests at Point Barrow, Churchill, and in Greenland. In one such experiment they built an air strip on the Arctic Ocean by thickening the sea ice through a flood-and-freeze process.

Research on the problems of cold-weather-clothing protection of personnel is conducted by the Army Quartermaster Corps at Natick, Massachusetts, Big Delta, Alaska, and in cooperation with Canada at Churchill. Special laboratory facilities for research on health and physiological and psychological effects of cold have been established by the Public Health Service at Anchorage, Alaska, and by the Air Force at Fairbanks, Alaska.

During 1957-58 there will be unfolded the greatest program of international cooperation in science ever attempted. This is, of course, the International Geophysical Year beginning July, 1957, and ending in December, 1958. The projects planned for the Arctic will include at least one American drift station on the pack ice as well as increased activity at all the Arctic stations.

The Russians have agreed to cooperate fully with the international program, and if they do, our knowledge of the Arctic basin should increase many fold.

With accurate experiment and observation to work upon, imagination becomes the architect of physical theory.—John Tyndall

Research Notes

Change of Command at NRL

CAPT Peter Harry Horn, USN, will relieve CAPT Samuel M. Tucker, USN, as Director of the Naval Research Laboratory about the middle of May.

In naval circles, if you mention that CAPT Horn was a destroyer skipper in the Battle of the Komandorskis,* you have said enough. If you want to embellish the record, you might add that he also sank a submarine off the Aleutians, and that he earned the Silver Star, the Bronze Star, and the Legion of Merit.

Of interest to technical people is the fact that CAPT Horn has spent more time in engineering than in the line. On his climb upward to Captain—he was Class of 1930 at USNA—he served in the black gang of a battleship (WEST VIRGINIA), as Engineer of a destroyer (PORTER), took the engineering design course at the Naval Postgraduate School and at the Naval Boiler Laboratory, and collected an M.S. degree from the University of California. Throughout World War II he was a destroyer officer, as Exec (PORTER) and Captain (CHEW, MONAGHAN, and SMALLEY), but after the fighting was over he became an "Engineering Duty Only" designee, as Assistant Head and, later, Officer in Charge of the Interior Communication and Fire Control Section of BuShips. He became a Captain in 1948. In that rank he was successively Repair Superintendent at Long Beach Naval Shipyard and at Philadelphia Naval Shipyard, and Assistant US Naval Attache in London. When appointed to the directorship of NRL he was serving as Director of the Ship Technical Division of BuShips.

Research Scientists Pinch-Hit for Science Teachers

Last March 15 and 16, the National Science Teachers Association held its annual meeting in Washington. Most of the science teachers in the area naturally wanted to attend, but that would mean that scores of science classes would be left without instructors.

*27 March, 1943, halfway between Kamchatka and the Aleutians, two U. S. cruisers and four destroyers met a much heavier Japanese force escorting an eastbound convoy. Extremely gallant action by the U. S. destroyers saved the cruiser SALT LAKE CITY from almost certain destruction and turned back the Japanese attacking force.

The Joint Board on Science Education of the Washington Academy of Science and the D. C. Council of Engineering and Architectural Societies came forward and offered to recruit, from among the thousands of research scientists in and around Washington, men and women who would take over the classes during the two-day sessions.

The idea worked beautifully. There were enough volunteers so that no "special substitute" had to serve more than one day. No attempt was made to follow the class curricula, although chemists were chosen to instruct chemistry classes, etc. The sponsors of the program saw this, rather, as an opportunity for working scientists to arouse the interest of youngsters in science as a profession, by telling the kids about their work and demonstrating the fascinating opportunities that were open to those who would major in science in high school and college.

Both ONR and NRL responded, each providing twice as many applicants as could be used. ONR also set up, in the lobby of the convention hall, an Earth-satellite exhibit entitled "Man Steps Into Space," which attracted the interest of the science teachers themselves. NRL opened its doors to the conventioners, and several bus-loads took the opportunity to visit the station.

Operation "NORPAC"

Scientists from Japan, Canada, New Caledonia, and the U. S. met in Honolulu, T. H., recently to discuss the results of the largest cooperative oceanographic coverage ever attempted. During July, August and September of 1955, twenty ships from Japan, Canada and the U. S. were actively engaged in obtaining oceanographic information from over 1,000 separate locations in the North Pacific Ocean north of 20 N latitude. The wealth of information thus obtained will, for the first time, make possible the study of synoptic oceanographic phenomena over the whole northern half of an ocean.

The various scientific institutions represented are now engaged in a task no less monumental, that of collecting, analyzing, and preparing presentations of the vast amount of data collected during NORPAC. Complete publication of all these data including a narrative account of the survey and a separate volume of charts of currents, distribution of plankton, temperature, salinity, oxygen, phosphate, etc., is planned for 1 March 1957, less than two years after collection of the data.

New Book on Finland

A handbook, "Finland and Its Geography," has recently been prepared by the American Geographical Society. Other volumes are in progress on Egypt, Pakistan, India and Thailand. These are being produced as by-products of a research project, sponsored by the Geography Branch, Office of Naval Research, to determine the best format, content, and methods of producing this type of geographical reference book. ONR's primary interest is to improve the methods of providing geographical data in more suitable form for naval use.

The handbooks are being prepared by a group of well-qualified authors working under the guidance and editorship of Raye R. Platt.

They are very comprehensive, containing a wealth of basic information on natural environments, economy, history, and life of the people. The text, written for the "general intelligent reading public," is richly supplemented by 120 excellent photographs, 128 maps, and many tables.

Navy Standard Ejectable Cockpit

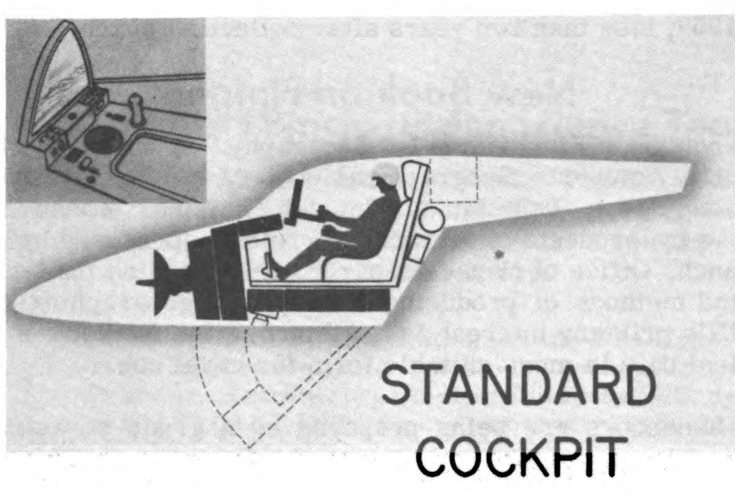
The Navy has announced that a standard ejectable cockpit capsule has reached the development stage. The product, a result of studies by Douglas Aircraft Company for the Office of Naval Research, was displayed at the Aeromedical Association Meeting at the Drake Hotel in Chicago, 18 April.

The cockpit capsule will standardize the modern aircraft cockpit to meet basic requirements for efficient operation, escape and survival, wide mission capabilities, and economy. The new standard unit, in addition to providing a recoverable escape device for the pilot and the plane's electronic equipment, will be interchangeable with other aircraft. The capsule will be produced in either one of two-place units, and will allow a variety of design combinations.

Standardization of the cockpit will utilize a larger number of identical parts, and as a result lower the basic cost of manufacture and repair. It will also reduce design time for the cockpit area of various types of new aircraft. For atomic powered aircraft, the cockpits may be removed and stored separately from the power plant to avoid contamination.

Jettisoning of the capsule will be by manual or automatic means. Stabilizing fins will extend as separation occurs and a drag chute employed. Upon reaching the proper speed the main parachute system will be activated by the drag chute. An altitude control will be used on the main chute system.

For ground fire escape or accidental firing the landing attitude will be controlled to provide a maximum energy absorption by the structure rather than the pilot upon contact with the ground. The capsule will float when landing on water and will be equipped with stabilizing and retrieving equipment.



On the Naval Research Reserve

Commanding Officers Conference

A Commanding Officers Conference has been scheduled for the week-end of 11-12 August 1956. At this conference the Research Reserve Office will review recent developments in the Naval Reserve Program with the Commanding Officers of the one hundred and eight Naval Research Reserve Companies, with particular emphasis on the Research Reserve. The nine panels of the program will also be represented at the conference.

The Commanding Officers Conference held on 7-8 May 1955 proved to be of great benefit to the program, as well as of great interest to the Commanding Officers present. Recent developments of vital importance to the Research Reserve make a Commanding Officers Conference this summer extremely desirable and the full representation indicated by responses to a questionnaire on the subject is most gratifying.

As a result of an expression of preference by the various Commanding Officers, and after some correspondence with the Chief of Naval Air Reserve Training, the Naval Air Station, Minneapolis, Minn., has been selected as the site for the conference this year. Arrangements for airlifts are in progress, and further details concerning the conference will be available at an early date.

Research Reserve Seminars for Fiscal Year 1957

The Research Reserve Seminar Program for Fiscal Year 1957 has been prepared and submitted to the Chief of Naval Personnel. Ten seminars have been scheduled, representing a number of generalized seminars as well as several programs in special areas. The seminars and convening dates are listed as follows for use in advance planning.

Nuclear Science, Idaho Falls, Idaho	23 July 1956
Naval Research Laboratory, Washington, D.C.	20 August 1956
West Coast, San Francisco, Calif.	20 August 1956
Great Lakes, Great Lakes, Illinois	15 October 1956
Nuclear Science, Oak Ridge, Tennessee	26 November 1956
Reserve Research Seminar, ONR, Washington, D.C.	28 January 1957
Special Devices Center, Port Washington, N.Y.	8 April 1957
Aviation Medicine, USN Sch. Avia. Med., Pensacola, Fla.	13 May 1957
Nuclear Science, Brookhaven Nat. Lab., Upton, N.Y.	3 June 1957
Research Methods, Columbus, Ohio	17 June 1957

Research Reservists Selected for Promotion

As reported in the last issue of Research Reviews, some twenty-two members of the Research Reserve were selected for Captain by the Fiscal Year 1956 Line Inactive Reserve Selection Board. In the past month selections for Captain have been made by this year's board in the various staff corps, and selection for Commander in both line and staff.

Promoted to Captain

JACOBZINER, Harold	3-8	SIMON, Julius	11-3
WILLIAMS, George Z.	W-5	SHATTUCK, Charles W.	11-7
BRINKER, Russell C.	5-2	BENNETT, Henry S.	13-1

Promoted to Commander

STOUGHTON, Roger K.	1-1	DURRENBERGER, John A.	6-15
MCLAUGHLIN, Thomas J.	1-1	MCLEAN, Lee V.	8-2
MAYNARD, Francis L.	1-1	LEWIS, Charles F.	8-3
DOWD, Thomas B.	1-1	CRUZAN, Charles G.	8-8
COOK, Everett L.	1-1	FOX, Homer M.	8-8
CHANCE, William G.	1-1	LANTER, Robert J.	8-9
TILDEN, Robert J.	1-2	JONES, Roy W.	8-13
RICHASON, JR., George R.	1-3	HOWELL, Dariel	8-13
MARSTON, George A.	1-3	JACOB, Walter C.	9-2
DAVENPORT, Warren H.	1-5	CHODAKOWSKI, Alexander S.	9-2
HATFIELD, Lester N.	3-2	SHAW, Robert H.	9-5
HERON, Leren E.	3-2	GREENLEE, John A.	9-5
MADAY, Albin T.	3-2	KNUDSEN, Orlando S.	9-5
HAVILAND, Robert P.	3-7	DODDS, John P.	9-6
HOUSEL, Webster H.	4-1	GILMORE, David S.	9-8
FELLOWS, Frank M.	4-3	PETERSON, JR., Dean F.	9-12
STEVENSON, Kenneth O.	4-3	LEWIS, John W.	9-12
BRAUN, Francis P.	4-6	GOLDEN, Harris M.	9-13
BOSS, Willis R.	W-1	BRUNNER, Jay R.	9-16
STERRETT, John K.	W-1	CASE, EUGENE H.	9-19
MCCULLOUGH, Timothy P.	W-2	KLOS, Warren W.	9-24
JOHNSON, Charles Y.	W-2	SPROUL, Hugo F.	11-2
HARMS, John	W-2	GODDARD, JR., Winfred R.	11-5
LARSON, James G.	W-2	KASLO, Max	11-6
CRECELIUS, Samuel B.	W-2	BRESWICK, William N.	11-6
BOURLAND, Langford T.	W-2	MORSE, Milton B.	11-6
DAVIDOFF, Melvin D.	W-5	TRIBOLET, Charles S.	11-7
IMUS, Henry A.	W-5	WOLFER, Donald P.	11-7
GARDNER, Herbert N.	W-5	KLEIN, Paul M.	12-1
VALLILLO, John M.	W-7	FROMAN, Jay	12-1
HERRMANN, Edward M.	W-7	ANDERSON, Otto E. E.	12-1
PENNINGTON, Winfie D.	W-7	MORRIS, Albert J.	12-3
MCCHESNEY, Lee D.	6-2	HAYES, John G.	12-3
WYATT, Edward I.	6-3	RIES, Harold C.	12-5
SMITH, Cecil N.	6-4	MITCHELL, Allen C.	12-8
WOODWARD, Marvin E.	6-6	WILSON, J. W.	12-8
BOBBER, Robert J.	6-8	WYMOND, F. C.	13-1
GORMSEN, Svend T.	6-8	KAWIN, Bergene	13-2
BELL, Marshall C.	6-11	BUSS, Irven O.	13-2
DELEHITE, Thomas H.	6-15	LOMAX, Claud C.	13-3
BLACK, John F.	6-15	KIRKHAM, William J.	13-5

In addition to the above, CDR Loren V. BURNS, USNR, who applied for orders to NRRC 9-20, Lawrence, Kan., in March 1956, is among the group of Naval Reserve Commanders who were recently selected for promotion to the rank of Captain.

U.S. GOVERNMENT PRINTING OFFICE : 1956 O - 384093

The United States Navy

Guardian of our Country

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends. The United States Navy exists to make it so.

We Serve with Honor

Tradition, valor and victory are the Navy's heritage from the past. To these may be added dedication, discipline and vigilance as the watchwords of the present and future.

At home or on distant stations, we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

The Future of the Navy

The Navy will always employ new weapons, new techniques and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war. Mobility, surprise, dispersal and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past. Never have our opportunities and our responsibilities been greater.

In This Issue

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; $.15 per individual copy.

Approved by Bureau of the Budget, 28 February 1955