

## THE U. S. COAST GUARD IN THE ARCTIC AND SUB ARCTIC

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The operations of the ice protective service to North Atlantic shipping, and war time service in Greenland, have brought the U. S. Coast Guard into regions and affairs both Arctic and sub-Arctic. The two factors which have largely contributed to the Coast Guard's participation in northern operations are: (a) the duties and experience gained by long service in Alaskan waters, and (b) the sturdy, single-screw type of cutters adaptable to navigating in regions of floating ice.

The Coast Guard's sub-Arctic duty in the Atlantic originated as a direct result of the British White Star liner TITANIC colliding with an iceberg in the North Atlantic, April 14, 1912. The sinking of this huge ship, and the loss of 1517 lives (one of the worst marine disasters of modern times) shocked the world. Although countless miles of sea-ice and icebergs had drifted out of the Arctic and menaced the courses of trans-Atlantic ships from the earliest voyages, the TITANIC disaster culminated all preceding tragedies. It precipitated an important conference of nations on sea safety which established among other provisions a patrol of the ice regions off Newfoundland during the dangerous part of the year.

A member of the United States' delegation to the International Conference of Safety of Life at Sea, 1913-14, was the Commandant of the U. S. Revenue Cutter Service (Captain E. P. Bertholf), a man of ice experience and strong convictions. As a young officer he had been a member of the famous Arctic relief party which in 1897 had traversed on foot several thousand miles across Alaska to drive a herd of reindeer to the American whaling fleet beset in the dangerous ice fields of the Beaufort Sea. Undoubtedly Bertholf's arduous experiences in northern ice navigation was an important influence at the London safety conference leading to the permanent establishment of an ice observation and ice patrol service in the North Atlantic. For the past 35 years the Coast Guard has been carrying out the work, the cost of which is divided among the principal maritime nations of the world.

The complete official title of the then newly created organization is: International Ice Observation, Ice Patrol, and Derelict Destruction Service. The destruction of derelicts, however, has become obsolete due to the disappearance of the once large number of wooden vessels, many of which abandoned after severe storms, drifted out into the North Atlantic as menaces to navigation"

In order to obtain a comprehensive insight of the Coast Guard's administration of the Ice Observation and Ice Patrol, one should review the long list of casualties which had befallen trans-Atlantic vessels during the

preceding half-century. Where the cold northern currents carry ice on to the North Atlantic lanes of commerce, there it becomes a distinct menace to life and property, The early records of ice accidents are replete with the foundering[sic] of ships and the loss of crews, Thus in the year 1777 the entire Dutch whaling fleet was unexpectedly caught in the heavy floes off East Greenland where 12 ships were swept away and sunk in the treacherous waters of Denmark Strait. The tragic loss of the famous DeLong Expedition ship, JEANETTE, and practically all of her helpless crew, occurred in the relentless grip of the heavy polar pack off the coast of Siberia. Chasing the bow-head whale in the polar pack, far to the east of Point Barrow, Alaska, caught the American whaling fleet on four memorable "freezes", 1871, 1876, 1888, and 1896, with a total loss of some 50 ships.

The movement and force of the ice in the polar sea, where fields miles in extent close vice-like with tremendous pressure, differs markedly from conditions of the drift-ice of more temperate latitudes. The pressure ridges of ice fields tumbled high in chaotic mass, of the far north, become in the Atlantic much looser and lighter, yet fields which may ensnare vessels and damage bow plates, rudders, and propellers. The most serious ice danger of the Atlantic sub-Arctic, in the hours of darkness or dense fog, is the possible sudden impact of disastrous collision with an iceberg. Modern attainments in the art of shipbuilding have placed in trans-Atlantic trade huge ships as large as 50,000 tons, costing many millions, and capable of speeds of 25 knots or more per hour. Several of the larger passenger liners today carry a thousand or two (a fair sized village on shore) at each passage by the Newfoundland ice regions~ Considering the frequency of the trips it is obvious that the number of lives and the total of the value of property which comes within the shadow of the ice menace, is extremely impressive.

Few realize the responsibilities of the North Atlantic navigator regarding the annual invasion of ice. Its variation in time and place presents an elusive problem which denies easy solution and tends from its nature to lull one into security, possibly just at a time when vigilance is vital. In the year 1929, for example, a total of 1350 icebergs drifted into the North Atlantic to plague the shipmasters; in 1940, none" Icebergs have been sighted as far south as the tropical islands of the Azores and Bermuda. Protective measures taken during the ice season each spring are: (a) a system of prescribed routes south of the normal ice zone, and (b) a ship patrol to warn vessels of the position of the most dangerous ice. The operations of the Coast Guard cutters may be better understood by reviewing a few of the ice accidents that have damaged ships in the past, and the course of events which have led to the patrol's establishment.

Icebergs off Newfoundland hundreds of years ago were more dreaded then than they probably are today. John Cabot describes vividly sailing past these towering monsters on his voyages to America in the early 16th century. Pioneer voyagers learned to determine their longitude approaching western shores by the sharp line of Arctic waters thrust southward along longitude 47 west. Benjamin Franklin pointed out the Gulf Stream and the path to follow to avoid most of the Newfoundland fog and ice.

The fact that the sea off Newfoundland, embracing the greatest number of icebergs, is also that which is enveloped in fog a large percentage of the ice-season, greatly accentuates the hazards, not only as to ice but also collisions between vessels. In fact the latter risk was the one to elicit first attention, when early in the nineteenth century an usually appalling disaster off Cape Race, Newfoundland, and the loss of 300 lives, brought the acute realization that remedial measures must be taken. The first step was to establish traffic routes; the westbound lane to run diagonally across the Grand Bank, just south of Cape Race, while the eastbound tracks to lie 100 miles southward. Although this arrangement materially reduced the frequency of collisions, the casualties due to ice continued. The Cunard Steamship Company in 1875 took the first really constructive step, when they directed their shipmasters to follow routes across the Atlantic laid south of the normal ice limits. A few of the other large passenger companies followed, and although ice accidents showed an encouraging decrease, they continued to be too frequent viz., during the decade 1880-1890, there were no less than 14 vessels lost and 40 seriously damaged. The majority of the Trans-Atlantic traffic, however, persisted in following courses through the ice area despite the added safety which it had brought to the Cunard and a few others navigating farther south. The increased distance of the safer routes of about 100 miles has always been the incentive to cut the corner. Further efforts, however, in 1898 resulted in the formation of an association of shipping lines called the Trans-Atlantic Track Conference, - all members of which agreed to abide by a system of prescribed tracks south of the normal ice zone, and shifted in time and place based upon the varying ice limits. The system has also the advantage of avoiding the fog enshrouded waters of the Grand Banks where a fleet of fishing vessels presents a vulnerable target. Shipping on the routes between Canada and Europe, however, find it impossible of course to avoid the ice-belt and consequently they run a greater risk of colliding with ice than do the others on the more southerly tracks.

Within hours following the terrible accident of April 14, 1912, our country clamped a ship guard on the icebergs. In 1913 the naval cruisers were replaced by Coast Guard cutters, and in 1914 the permanent international organization, as we have known it over the years, began to function. The Coast Guard's duty has been interrupted only by the two World Wars, when the active ship patrol had to be curtailed or abandoned on account of military operations. The continuous guard is inaugurated each year with the appearance of the first icebergs (or sea-ice) south of Newfoundland, usually in early spring, and the patrol is discontinued after the danger disappears often in early July. Those icebergs which actually drift down on the shipping lanes receive the closest attention of the Coast Guard cutters which stand by them until they have disintegrated to the degree that they are no longer a navigational danger. In order to maintain ship patrol, it was the practice of the Coast Guard to assign two cutters, each relieving the other at periodic intervals, from a base at Halifax, N.S., or Boston, Mass. Following World War II and the introduction of aerial ice observation, new practices have been adopted which are mentioned later.

Although the immediate and practical need following the TITANIC disaster was a patrol of the dangerous ice, the London Convention had full appreciation also of the importance of scientific investigations to learn more of the causes of the Arctic ice invasions, and of other related factors, a solution of the problems of which promise to raise the standards of safety of life at sea. This is the significance of the ice observation feature which was authorized to be carried on throughout the year, as deemed desirable, by one vessel of the Coast Guard. Much interest at the time focused on the Grand Banks area near the scene of the ice accident, the British Board of Trade sponsoring an investigation by the auxiliary bark SCOTIA, whose scientific staff carried out an oceanographic survey the summer of 1913.

The ice observation and scientific field investigations of the Coast Guard have varied in time and place yet always the objectives have been the increase of safety. Ice observation cruises based on the reports of ice sightings in the early season, northward of the regular steamship tracks, have been a practice, - the continuous ice patrol being inaugurated on the recommendation of the ice observation cutter, Ice observation cruises have been carried out at other times of the year, often at the expiration of the patrol season, an ice observation cruise (or as it is often called, a "post season" cruise) is made up-stream, toward the Arctic birth-place of the ice"

The directive program of the International Ice Observation and Ice Patrol Service for many years was vested in a federal inter-departmental board, the chairman of which was the Commandant, US, Coast Guard. Other members included the Hydrographer, U. S. Navy, the Director, Bureau of Standards, the Chief, U. S., Weather Bureau, and the Director, Bureau of Fisheries and Wild Life A scientific advisor to the board who served for many years with distinction, was Professor Henry B. Bigelow of Harvard University,

In the pursuit of the scientific work of the ice observation and ice patrol service, several Coast Guard officers have shown exemplary interest and contributed valuable studies and information on the ice problem, The Coast Guard has during practically all of its administration of the service employed civilian scientists composed of a small staff the researchers of which are devoted primarily to the field of physical oceanography and specialized glaciology. During the early years the value of marine biology was tested as the drift of plankton in the ocean currents revealed information on the movement of the icebergs. Meteorological investigations have also been undertaken as the winds affect the ice drift.

A Coast Guard officer of unusual scientific and practical ability, and one who early envisaged the importance of the ice problem, was Captain Charles B. Johnson, USCG, the first Commander of the International Ice Patrol. As Commanding Officer of the Coast Guard cutter SENECA he has the distinction of initiating the first ice observation cruise of the Coast Guard toward the Arctic in July, 1914, "to observe the origin of the ice

Which annually appears on the banks of Newfoundland, and to investigate the agencies by which it is transported from the North."

The scientific program, however, which throughout the years of the patrol has attained the most success, has centered on physical oceanography and the determination of the currents which transport the ice southward on to the steamship tracks. A method of dynamically determining the circulation, which was introduced on ice patrol in 1926 by a Coast Guard officer (Lieutenant Commander Ed. H. Smith) furnishes a map of the currents by which the ice patrol cutter is able to trace the probable drift of the ice and therefore more effectively than otherwise safeguard passing traffic.

The new methods of current mapping (which subsequently has become an adopted program of the international ice patrol) and the consequent information revealed in the Grand Banks area, stimulated Coast Guard interest in carrying' out an expedition the summer of 1928 to learn more regarding the behavior of the ice from the time the icebergs are calved in Greenland until they drift south of Newfoundland. The cutter MARION, in command of Lieutenant Commander Smith, was fitted out and spent two months in the Labrador Sea and Davis Strait visiting iceberg glaciers in the Disko Bay region on the first known visit of a U. S. Coast Guard vessel to the Greenland continent ... The MARION Expedition is of interest also as it marked the first systematic survey of the pathway of the ice, and furthermore, it stimulated interest and inaugurated subsequent ice and oceanographic investigations by the Coast Guard into Arctic regions and adjacent to the North Atlantic.

Another significant advance in the Coast Guard is ice service to mariners was made in 1931 when a third vessel was authorized, and a civilian scientific staff was appointed. The third cutter was for the purpose of taking over the entire oceanographic program, and also the ice observation cruises when the services of a larger cutter, or a continuous patrol was unnecessary. This arrangement has permitted the ice patrol cutter to devote its entire time on the important and arduous schedule of ice scouting and patrol of the more dangerous icebergs. The civilian scientific staff which has been in charge of Senior Principal Oceanographer Floyd M. Soule since 1932 (with little interruption) has contributed much of practical and scientific value to enhance the service of the Coast Guard. The field investigations and study by the Coast Guard's scientific staff are devoted to many aspects of the ice problem, A phenomenon of Arctic significance, for example, is the wide fluctuations in the annual ice invasions. The value to the ice patrol (and to shipping) of a forecast of the number of icebergs to guard against is obvious. The termination of the ice season in the Atlantic signifies no cessation in the activities of the scientific staff which is actively engaged throughout the year. It has been the practice since 1931 (except during the war) to conduct post-season ice and oceanographic observations, the results of which are prepared for publication. The office of the scientific staff is at the Woods Hole Oceanographic Institution except during the periods at sea or in Newfoundland.

An epoch in Coast Guard annals is that Service's Arctic operations during World War II, Reference has already been made to the Arctic-Alaskan duty of the U. S. Revenue-Cutter Service (merged with the Life Saving Service in 1915 and renamed the U. S. Coast Guard) and the probable influence of that environment on the philosophy and development of a doctrine among service personnel. The Coast Guard then began to be regarded as the naval service in our federal government which had considerable experience in the North, An excellent article on the history of the Revenue-Cutter Service in the development of coastal Alaska and the Bering Sea area, is contained in another section of the Encyclopedia Arctica. The Coast Guard's International Ice Patrol and expeditions such as the MARION's, and the ice observation cruises to the Labrador Sea, Davis Strait, and Greenland, allover a period of years, have also assisted to endow the Coast Guard with an Arctic reputation. As a matter of fact the Coast Guard's operations have been far more sub-Arctic than Arctic. Since this is, however, a factual account, mention should be made of a Coast Guard officer's participation in the Aero-Arctic Society's north polar expedition of 1931, when as a member of the scientific party, Lieutenant Commander Smith represented the Ice Patrol and the U., S. Coast Guard, in a flight of the dirigible GRAF ZEPPELIN to the vicinity of Franz Josef Land and the Siberian Arctic. Another factor conferring polar associations upon the Coast Guard is its duty in connection with the enforcement of this country's obligations in connection with the International Whaling Treaty. Several Coast Guard officers have served as official observers on board whaling vessels in the Antarctic. Coast Guard personnel, fortunately, as the result of several ice observation visits to West Greenland, were not strangers there when the service was called upon to answer the first call for northern missions on the approach of World War II.

The cutters, where speed was not a critical requirement, were the least liable of all our naval craft to be crippled in areas of floating ice. At the time of which we speak, (early 1940) neither the Navy nor the Coast Guard had a single modern ice-breaker to compare with those which had been developed by the Russians. The best that we could muster were the two Arctic veterans (the old cutter BEAR which had been purchased by our government from Britain following the rescue of the Greely Expedition in 1884) and the cutter NORTHLAND which had replaced the BEAR in 1924 on the Coast Guard's annual visits to Point Barrow. Later the U. S. Office of Indian Affairs' supply ship NORTH STAR was added to the collection of antiques. In areas less liable to contain heavy drift-ice, the Coast Guard employed semi ice-protected 165-foot cutters of the COMANCHE class, and 110-foot class ice-breaking tugs of the RARITAN class~ The former were handicapped by a short fuel range, but the latter proved to be quite useful in the fjords and coastal waters of West Greenland. When, therefore, in April, 1940, Greenland became isolated by the Nazi invasion of Denmark, Coast Guard cutters were dispatched to Greenland for the purpose of displaying the stars and stripes there, as a sign to belligerent nations that the United States regarded Greenland to be in the American hemisphere of defense.

From the arrival of the first cutter in May, 1940, until the present writing, there has been practically no absence of some form of Coast Guard activity in Greenland. During the height of war-time operations there were as many as fifty armed vessels; a squadron of patrol planes; and a few scattered, shore units, all manned and operated by Coast Guard personnel. As war activities spread to other parts of the Arctic, convoys were escorted to military installations in the Hudson Bay region where small liaison units served and assisted during two summers with the movement of vessels in and out of the Canadian Arctic. A small Coast Guard detachment spent the winter of 1941-42 at an isolated camp on one of the inner arms of Scoresby Sound, East Greenland. Another detachment served for more than a year on the tiny island of Jan Mayen in the Greenland Sea.

Greenland's needs were immediate when the Coast Guard was called upon to make its first visit there. All supplies which formerly had come from Denmark, had to be purchased in the States, and the shipping and delivery had to be completed during open navigation. Trade commissions were transported by cutters to establish economic and political relations. After a few months, however, it was quite obvious that long range plans should be laid to give an insight of naval problems and a prosecution of the war. The coastal charts of Greenland, for example, required revision in order to meet the needs of the military and merchant vessels piloting in hitherto unfrequented fjords.

One of the first tasks curiously enough was an Army job. The only commercial cryolite mine in the world, located at Ivigtut, Greenland, required immediate protection against the possibilities of enemy attack. Arrangements were made with the mining company to hire Coast Guardsmen as civilian guards, and the crew of the cutter NORTHLAND after Herculean efforts succeeded in mounting a 3-inch gun on a mountain side commanding seaward approach to the fjord. High premiums were placed on the ingenuity of service personnel - the tasks in the Arctic frontier taxing the hardihood of muscles and the resourcefulness of practical minds. The cutter COMANCHE which had earlier arrived with the first American consular representatives, was loaded to the scuppers with all sorts of emergency equipment, including a complete radio station to be assembled on shore for the handling of United States traffic.

Coast Guard cutters ran lines of soundings into the principal fjords to provide early cargo and troop ships with a semblance of piloting safeguards. In this manner several of the more important fjords were sounded out for the deeper draft vessels, and places such as Kungnat Bay, in the outer reaches of Arsuk Fjord, became recognized as a desirable and useful harbor for naval craft. The fact that several of the cutters cruised along the Greenland coast, assisted to familiarize them with the country which the United States had been called upon to defend. During October, 1940, the cutter NORTHLAND made a reconnaissance survey of the 100-mile long Sondrestrom Fjord, West Greenland, and landing parties tramped the inner end of the fjord for favorable air field sites. This mission was followed by a visit to the principal iceberg glaciers of West Greenland (some 20 or more), and an 1800 mile circuit of Baffin Bay in which more than 3000 icebergs were recorded. During the cruise new oceanographic data were obtained on the west side of Baffin Bay, and the circulatory system of the

water masses was reviewed. A report on West Greenland coastal waters, for the practical use of visiting ships, was issued under the heading, - GREENLAND PILOT.

Beginning in 1942 the Greenland Patrol, which operated as a group of the U. S. Atlantic Fleet, kept one or two of its units engaged in hydrographical surveys of Coastal and fjord waters. Where possible fixed points were coordinated with aerial photographs. Accompanying the program of field surveying, and often in advance of it, aids to navigation were being established which in turn required several construction parties, transported and landed from small cutters. A loran station was established in southern Greenland at an unusually isolated and little accessible site. From 1941 to 1943 there were erected on the west coast of Greenland four radio beacons, three major light stations, 30 minor lights, and 16 day marks. This construction was carried out under the handicaps of storms, bitter cold, icy waves, rocky skerries, and slippery precipices. More than 400 miles of desolate coastline was marked in this manner in order that the ships loaded with war supplies and troops might safely navigate the treacherous waters of West Greenland.

In order to assist the transit of military aircraft through Greenland, Coast Guard cutters were stationed as plane-guard and weather-ships in Davis Strait and Denmark Strait. To maintain stations throughout an Arctic winter called for the highest type of seamanship and determination in line of duty.

The Greenland Patrol provided escort cutters for the convoys of transport and cargo ships, and maintained communications of the sea lanes between Greenland and the United States" When the merchant ships reached the sea-ice belt off the Greenland coast, the cutters assisted to clear a channel, through which they could follow. In the fjords, Coast Guard icebreakers kept lanes open to the southern air base and to the cryolite mine at Ivigtut. Sondrestrom fjord leading to the northern air base normally freezes, its upper reaches being inaccessible from late December to June. The east coast air site at Ikatek, near Angmagassalik, is usually ice bound, or ice hampered, much of the year. Navigation and the transportation of supplies by sea were possible only in the summer season, and then usually with the assistance of a Coast Guard icebreaker.

Throughout the war there were air detachments based in Greenland, and since no land transportation exists, and travel by sea is often circuitous and handicapped by ice, many uses were found for aircraft. One of their first employments was in the search and rescue of airmen stranded on the ice-cap, and after several thrilling rescues the worth of air-rescue units continued throughout the war. Army and Navy-manned airplanes operated during the major portion of hostilities until relieved by Coast Guard" In addition to the rescue-task units were other missions, one of the most important of which was anti-submarine coverage, not only for Greenland convoys, but of trans-Atlantic convoys often routed within air radius of Cape Farewell. Coast Guard aviators, therefore, received tough experience in Arctic flying conditions.



The Greenland Administration, under the provisions of the Defense Agreement with the United States, stipulated that no native Greenlanders should be employed in military or construction activities, and that no such installations where possible to avoid, should be located near a native settlements, In this manner the Greenland government endeavored to continue the excellent system of colonization which has prevailed for Generations.

The east coast of Greenland was visited repeatedly by Coast Guard vessels, mostly as they carried out missions in support of small Army weather stations, several of which were located at indentations along the ice-bound, rocky, forbidding coastline. The type of ship employed on this work was small converted trawlers, manned by a crew of 20 or 30, and armed with a bow gun and bridge machine guns. A total of ten of these little ships were hurriedly requisitioned from the Boston fish piers in 1942. They were strengthened against ice by doubling their bow plates, and while having few comforts, they performed very well in carrying out their missions in the ice infested waters. A tragic accident occurred to the trawler NATSEK when she was lost near the Strait of Belle Isle, with all hands, in late December, 1942, as the result of what is believed to have been the effects of severe icing. The duty which these little cutters performed was both arduous and hazardous.

Every summer during World War II, one or more Coast Guard cutters visited the fjords of northeast Greenland from Scoresby Sound to Dove Bay. On at least one occasion a cutter cruised as far north as the Ile de France in latitude 77-40. It was stated by those who had visited northeast Greenland that it was wise to depart from the coast and get outside of the ice belt not later than early September. The summer of 1941 proved unusually favorable for navigation and the cutters were quite active in visiting practically all of the camps in the fjord region, and evacuating the trappers and their dogs, and other valuable possessions. Every opportunity was taken to add to the knowledge of the fjords and the navigation of the ice, The fact that no supply ships from Europe could be anticipated for the remainder of the war, required the removal of the score or more of hunters from the sparsely scattered cabins along some 400 miles of coast" Later the men and dogs trained in winter sledge travel, and having an intimate knowledge of northeast Greenland, were organized into groups, where throughout the winter they performed reconnaissance patrols to report the presence of any unauthorized persons found in the territory.

During the few brief weeks of summer when the fjord region of northeast Greenland was reached through the seaward barrier of ice-fields, Coast Guard cutters conducted searches for enemy radio stations. Several of these were found and destroyed. In these missions it was necessary for the cutters to buck their way through fields of heavy polar ice as early in the navigational season as possible, and to remain on the coast as late as possible without becoming beset in the ice. On two occasions during the latter part of the war enemy vessels were captured late in the season as they attempted to escape by the freezing and the thickening of the

fields. Working in the ice subjected our cutters to severe tests in which it was not always possible to avoid damage. In some cases the crippled ships were able to effect jury repairs, and there were other cases in which they had to be towed to points of safety. It was not until the latter part of hostilities that new, powerful icebreakers began to arrive in Arctic waters, and provide us with adequate ships to penetrate farther into polar fringes than ever before. The operations in northeast Greenland probably exceeded any that the Coast Guard had experienced up until that time not excepting the early Alaskan duty. Coast Guard personnel handling the so-called wind-class icebreakers during the war gained valuable experience which proved of practical use later in both the Arctic and Antarctic. These operations first revealed the future potentialities of ships constructed of high tensile steel and installed with powerful propulsion. From the success of the Wind-class ships in Greenland, and subsequently, it is felt that further development of this type will result in a ship capable of navigating through any ice normally met in the Arctic.

Greenland was not the only Arctic sector in which the Coast Guard was called upon to operate during World War II. During the navigational season of 1942, and subsequent years until the end of the conflict, Coast Guard vessels and personnel, as units of the U. S. Atlantic Fleet, were busily engaged in assisting the Army in wide scale construction of air bases in the Canadian Arctic. Largely because ice conditions, and the limited navigational season for the delivery of construction materials, personnel, and other equipment, it was essential that all cargo ships be moved to their destinations and out again with a minimum of delay. The open season amounted to something like ninety days. The Coast Guard cutters acted as escorts and ice pilots, providing the merchant vessels with charts and local information for voyages to diverse points as Frobisher Bay, Baffin Island, Southampton Island, Port Churchill, and Port Chimo, Quebec. Coast Guard officers were assigned to each of these places as port directors" Coast Guard air patrols guided the courses of the ships in order that they escape the heavier ice and follow leads where possible.

The Coast Guardsman was often required to adapt himself to a strange and often completely isolated Arctic environment. The demands of his resourcefulness and self-buoyancy of spirits called forth the best efforts and determination to see it through. In most cases those men who kept themselves occupied and industrious on a planned program suffered least from isolation and the depressing effect of long periods of darkness and stormy weather.

Another Arctic land which has witnessed Coast Guard personnel is the small island of Jan Mayen lying in 71 north and 8 west, on the border of the ice-fields in the Greenland Sea. Here a dozen men served for the remainder of the war in one of the most northerly of Arctic outposts~ The nearest support was Iceland from which mail was dropped occasionally and sea-borne supplies brought less often.

The Coast Guard resumed its peacetime protective service to shipping (the International Ice Observation and Ice Patrol) with the season of 1946 •. The manner in which the present service is conducted is based upon practical experience and scientific development. The war years were especially productive in the application of new methods of scouting and detecting the ice; one of the most important of which is the use of aircraft for ice observation. Aircraft based in Newfoundland are now employed to cover the area from the Nova Scotian banks, over the Newfoundland banks, and north along the east coasts of Newfoundland and Labrador. Airplanes possess an advantage over surface craft of covering large sea areas more quickly. On the other hand ice areas not navigable by ship can be scouted by airplanes to obtain an estimate of the total amount of ice up-stream which is liable to drift down on the paths of commerce, The state of the ice in closed areas, furthermore, can be watched for the date of break-up, and the forming of new ice can be followed, Airplanes are also a valuable aid in ice piloting, scouting out the leads, through or around large fields. Ship-board helicopters have been used very effectively to pilot vessels through the more extensive, heavy fields of the Arctic and the Antarctic Surface ships, on the other hand, are less handicapped by adverse weather, and possess the advantage of determining their position more accurately, and that of the drifting ice.

The Coast Guard has adopted the best employment of both; - its long distance service airplanes and its cutters on the International Ice Patrol. The Commander of the patrol coordinates operations from an office at the U. S. Naval Operating Base, Argentia, Newfoundland, where also are based the cutters and the aircraft. The Ice Patrol shore office receives the ice and obstruction reports from the cutter at sea, and this information is combined with that from other sources, and then condensed in a twice daily radio ice broadcast to shipping. The U. S. Hydrographic Office also issues ice broadcasts from naval shore radio stations and includes ice reports in publications to mariners. The cutter on patrol carries an ice observation officer;-the representative of the Commander International Ice Patrol, to assist the commanding officer of the cutter. He keeps a plot of the ice; the ships transiting the area; and the sea-water temperatures. He receives from the oceanographic vessel the latest current map, and based on the above data, replies to requests for special ice information, and warns those ships which appear to be standing into danger. The cost of the ice patrol service approximates one-half a million annually.

It should be emphasized that the formal organization as described above is only a part of the more extensive program which embraces and depends for its success on the cooperation of trans-Atlantic ships of many nationalities. The ice patrol itself, cutters and airplanes, cannot alone follow accurately and completely the drift of all of the ice over such a wide expanse of the ocean in which it often scatters. The value of the ice patrol is greatly enhanced, therefore, by the reports of the passing ships.

In view of the increasing installation of radar equipment on ships,

the Coast Guard has conducted some experiments with radar and ice, and has compared these results with the degree of detection of other types of targets. Naturally information on this subject is of interest and useful where ever a ship may navigate in the proximity of floating ice. Practical experience in the effectiveness of shipboard radar, moreover, was the primary consideration of the Coast Guard's investigations, more emphasis being placed on the detection of icebergs than on ice-fields. Ice proved to be a relatively poor reflector of radar waves. A large iceberg (200 feet by 400 feet), for example, presented an image of the radar screen no clearer than a small ship the size of the ice patrol cutter (90-foot mast, length 240 feet). The reliability, however, of present-day radar equipment to detect the proximity of ice depends mostly on the state of the sea. The main problem is the clutter caused by the roughness of the sea surface. Small icebergs and growlers capable of causing serious damage, were often undetected in moderate sea conditions, and as the sea became rougher so increased the size of the iceberg which might escape detection, either due to being obscured by the ocean swell, or by the sea clutter on the radar screen. Ships equipped with a properly functioning radar, however, and manned by a competent operator, should be able to locate any large iceberg in sufficient time to avoid collision. In the Newfoundland ice regions where fog prevails during the period when icebergs are normally most numerous, the desirability of the use of radar by passing ships is obvious. In fog, radar ranges are somewhat less than in clear weather but this handicap is secondary to the sea roughness.

Ice fields have been detected a maximum distance of five miles by ship-board radar, the leads being navigable at night by radar conning. Leads and areas of open water within the fields can be identified even in heavy fog by aircraft radar at distances as great as ten miles. Icebergs from airplane radars have been sighted as far off as 50 miles, depending upon the size of the iceberg and the altitude of the observer. Parallel search courses by the ice patrol planes are usually laid 25 miles apart on the basis that 15 miles is the limit of reliable observation both visual and radar range. No similar problem of sea cluttering exists on the air-borne screen as met with on ship-board radars. It is concluded, therefore, that until radar equipment is more universally installed in trans-Atlantic ships, and until it provides greater detection reliability, the International Ice Patrol will necessarily continue its service.

For those who are interested in studying in more detail the Coast Guard's ice protective service to shipping, they are referred to the annual reports of the International Ice Observation and Ice Patrol Service in the North Atlantic Ocean, They are published as a series of bulletins of the U. S. Treasury Department (U. S. Coast Guard) and are obtainable from the U. S., Government Printing Office. In addition to the narrative to the particular ice season, the bulletins contain information on related subjects of weather, radio communications, oceanographic discussions, tables of ice sighted and reported, maps of the ice and sea-water temperatures. In those years when ice observation, or post season cruises, have occurred, a report of the results is included or printed as a separate

bulletin of the series. An instructive article, particularly useful for ships' officers, is published annually as a supplement to the North Atlantic Pilot Chart by the U. S. Hydrographic Office. For more detailed information on the war-time duty of the Coast Guard in the Arctic and sub-Arctic, one is referred to the published accounts in various naval histories.

The U. S. Coast Guard's participation in current Arctic activities (other than those connected with the International Ice Patrol, and the maintenance of a few loran stations) is confined to the assignments of its icebreakers to duty with Navy task groups. During the past few years Coast Guard ice-breakers so assigned worked northward in the Arctic a record distance to latitude in Kane Basin and Kennedy Channel.

The Coast Guard takes pride in the Arctic service with which, over the years, it has been associated, and particularly, the International Ice Patrol, the guardian against the invasions of the White Terror of the North.

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