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INTERNATIONAL GEOPHYSICAL YEAR
THE ARCTIC
ANTARCTICA

REPORT

OF THE

COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE
HOUSE OF REPRESENTATIVES

Pursuant to Section 136 of the Legislative Reorganization Act of 1946, Public Law 601, 79th Congress, and House Resolution 99, as Amended, 85th Congress

SUBMITTED BY MR. HARRIS, CHAIRMAN

FEBRUARY 17, 1958.—Committed to the Committee of the Whole House on the State of the Union and ordered to be printed

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85TH CONGRESS } HOUSE OF REPRESENTATIVES { REPORT
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INTERNATIONAL GEOPHYSICAL YEAR

THE ARCTIC AND ANTARCTICA

FEBRUARY 17, 1958.—Committed to the Committee of the Whole House on the State of the Union and ordered to be printed

Mr. HARRIS, from the Committee on Interstate and Foreign Commerce, submitted the following

REPORT

[Pursuant to sec. 136 of the Legislative Reorganization Act of 1946, Public Law 601, 79th Cong., and H. Res. 99, as amended, 85th Cong.][1]

Your Committee on Interstate and Foreign Commerce reports herewith on certain of its activities following the adjournment of the 1st session of the 85th Congress.

For many years, your committee has exercised legislative jurisdiction, among other things, over matters pertaining to civil aviation,

[1] The resolution is as follows:

[H. Res. 99, as amended by H. Res. 197 and H. Res. 316]

RESOLUTION

Resolved, That effective from January 4, 1957, the Committee on Interstate and Foreign Commerce may make investigations and studies into matters within its jurisdiction, including the following:

(1) Policies with respect to competition among the various modes of transportation, whether rail, air, motor, water, or pipeline; measures for increased safety; and adequacy of the national transportation system for defense and the needs of an expanding economy;

(2) Policies with respect to the promotion of the development of civil aviation; measures for increased safety; restrictions on American air carriers which impede the free flow of commerce; rates, accounts, and continuance of subsidy payments; airport construction, hazards of adjacency to airports, and condemnation of airspace; aircraft and airline liability; aircraft research and development, and market for American aircraft; and air navigational aids and traffic control;

(3) Availability of channels for allocation for radio and television; and divestment of international radio and cable facilities;

(4) Adequacy of the protection to investors afforded by the disclosures and regulatory provisions of the various Securities Acts;

(5) Adequacy of petroleum, natural gas, and electric energy resources for defense and the needs of an expanding economy; adequacy, promotion, regulation, and safety of the facilities for extraction or generation, transmission and distribution of such resources; development of synthetic liquid fuel processes; and regulation of security issues of and control of natural gas pipeline companies;

(6) Advertising, fair competition, and labeling;

(7) Research in weather, including air pollution and smog, and artificially induced weather; research into the basic sciences; and standards and weights and measures;

(8) Effects of inflation upon benefits provided under railroad retirement and railroad unemployment programs; and inequities in provisions of statutes relating thereto, with comparison of benefits under the social system;

(9) Adequacy of medical facilities, medical personnel, and medical teaching and training facilities; research into human diseases; provisions for medical care; efficient and effective quarantine; protection to

communications, weather, and science.[2] In such connection, the committee has been ever conscious of its responsibilities in assuring that our communications and weather knowledge, and our air navigational routes and systems, be adequate for the needs of our Nation's defense and for the demands of our expanding civilian economy. We have been equally conscious of our responsibilities in assessing and developing the Government's proper role in the coordination and advancement of scientific knowledge, and have been justifiably proud of the creation of the National Science Foundation under the committee's legislative jurisdiction.

Your committee has been keenly aware of the great contribution to our scientific knowledge and to the geophysical discipline that was contemplated would be developed from the International Geophysical Year (IGY). We have attentively followed the United States participation in the IGY under the guidance of the National Academy of Sciences, working in conjunction with such Federal agencies as the National Science Foundation, the National Bureau of Standards, and the Weather Bureau.

In the IGY, among other things, attention is being given to studies of auroral displays and the ionosphere leading to disruption of radio circuits, of methods for circumventing these disadvantages, and techniques for increasing the reliability of radio-communication circuits in polar and subpolar regions. IGY studies also are being made seeking a clearer understanding of atmospheric processes, in the air, at the air-ocean boundary surfaces, and in the effect of the oceans themselves, so as to enable more reliable weather data, predictions over longer intervals of time, and longer advance warning for preparing to meet such violent meteorological events as hurricanes, tornadoes, or droughts.

Such studies in the polar and subpolar regions, leading to greater reliability of radio communication, to better weather information,

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users against incorrectly labeled and deleterious foods, drugs, cosmetics, and devices; and other matters relating to public health;

(10) Disposition of funds arising from the operation of the Trading With the Enemy Act;

(11) Current and prospective consumption of newsprint and other papers used in the printing of newspapers, magazines, or such other publications as are admitted to second-class mailing privileges; current and prospective production and supply of such papers, factors affecting such supply; and possibilities of additional production through the use of alternative source materials;

(12) Increase in traffic accidents on the streets and highways of the United States during recent years; factors responsible for such increase, the resulting deaths, personal injuries, and economic losses; and measures for eliminating such accidents or reducing their frequency and severity; and

(13) The administration and enforcement by Departments and agencies of the Government of provisions of law relating to subjects which are within the jurisdiction of such committee.

For the purposes of such investigations and studies the committee, or any subcommittee thereof, may sit and act during the present Congress at such times and places within or outside the United States, its Territories and possessions, and the Commonwealth of Puerto Rico, whether the House has recessed, or has adjourned, to hold such hearings, and to require, by subpena or otherwise, the attendance and testimony of such witnesses and the production of such books, records, correspondence, memoranda, papers, and documents, as it deems necessary. Subpenas may be issued under the signature of the chairman of the committee or any member of the committee designated by him, and may be served by any person designated by such chairman or member.

The committee may report to the House at any time during the present Congress the results of any investigation or study made under authority of this resolution, together with such recommendations as it deems appropriate. Any such report shall be filed with the Clerk of the House if the House is not in session.

[2] Legislative jurisdiction of the Committee on Interstate and Foreign Commerce pursuant to the Legislative Reorganization Act of 1946:

1. Interstate and foreign commerce generally.
2. Regulation of interstate and foreign transportation, except transportation by water not subject to the jurisdiction of the Interstate Commerce Commission.
3. Regulation of interstate and foreign communications.
4. Civil aeronautics.
5. Weather Bureau.
6. Interstate oil compacts, and petroleum and natural gas, except on the public lands.
7. Securities and exchanges.
8. Regulation of interstate transmission of power, except the installation of connections between Government waterpower projects.
9. Railroad labor and railroad retirement and unemployment, except revenue measures relating thereto.
10. Public health and quarantine.
11. Inland waterways.
12. Bureau of Standards, standardization of weights and measures, and the metric system.

and to greater knowledge of how to cope with living conditions, all offer a significant contribution to the development and expansion of intercontinental air transportation via the shorter great-circle routes over both polar regions.

The importance of this scientific work, as well as the information and experience being gained through the accompanying logistic support, goes without saying. However, insofar as these observations and studies are being carried out under IGY, the program contemplates that they should cease at the end of 1958. The committee, therefore, has been concerned with the direction and magnitude that our post-IGY program should take, the probable IGY achievements in advancement of our general knowledge and of weather, ionosphere, and radio propagation, the continuing emphasis which properly should be placed upon the varying geophysical disciplines, and the legislation collaterally needed to accomplish the purposes of a post-IGY United States program.

With the adjournment of the House last fall, opportunity was afforded the committee for more intensive and informed consideration of these matters. Following is the report made to our committee by the members of a subcommittee concerned during the recess with these matters, which, because of the significance of the subject, is being transmitted to the House for the information of the Members and of the general public.

REPORT ON ARCTIC AND ANTARCTIC INTERNATIONAL GEOPHYSICAL YEAR PROGRAMS

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APPENDIXES

REPORT ON ARCTIC AND ANTARCTIC INTERNATIONAL GEOPHYSICAL YEAR PROGRAMS

Six members of the Subcommittee on Transportation and Communications of the House Committee on Interstate and Foreign Commerce engaged in a 5 weeks' study last November and December in the Arctic and Antarctic regions. The study embraced the general International Geophysical Year program with specific emphasis on the features of the program bearing on weather, communications and aviation. The study further covered aviation operations and routes in the Arctic and Antarctic. We submit herewith a report on our study, together with certain observations and recommendations.

The members of the subcommittee making such study trip were: Chairman Oren Harris, Samuel N. Friedel, John J. Flynt, Jr., Torbert H. Macdonald, Robert Hale, and Steven B. Derounian. We were accompanied by Dr. Andrew Stevenson, of the committee staff; Dr. Laurence M. Gould, president of Carleton College and Chairman of the National Academy of Sciences USNC Committee on Antarctica; Dr. Harry Wexler, Director, Office of Meteorological Research, Weather Bureau, and chief scientist, USNC Committee on Antarctica; and Dr. James E. Mooney, assistant to the United States Antarctic Projects Officer.

The study was initiated by flight over the North Pole November 10 on the Scandinavian Airlines System regular route direct from Copenhagen to Tokyo, with an intervening stop at Anchorage, Alaska. Flight from Tokyo to New Zealand was made by commercial airlines, with brief stops also in Manila and Sydney for discussion of international aviation route proposals.

From New Zealand to Antarctica and return, and within Antarctica, flight was made with the Navy Air Development Squadron VI (VX-6), and between McMurdo and the South Pole, November 24, with the 53d Troop Carrier Squadron, USAF. The return from New Zealand was via Pan American World Airways.

In Antarctica, we visited at length the logistic support base at the Naval Air Facility on Ross Island in McMurdo Sound, the United States IGY scientific station at Little America, and the New Zealand IGY Ross Sea Scott Station, and participated in a USAF airdrop at the United States IGY Amundsen-Scott South Pole Station. We were privileged also to visit the old base established 50 years ago at Hut Point by Sir Robert Scott and Sir Ernest Shackleton.

From Adm. George Dufek, in his dual role as commander, Naval Support Forces, Antarctica (Task Force 43), providing logistic support for IGY, and as United States Antarctic Projects Officer, we received cordial and complete cooperation, not only in his appearance before the close of the first session at hearings conducted by the committee, but also in his provision of facilities and informed briefings during our sojourn and movement in Antarctica.

It would be appropriate at this juncture for us to express our appreciation of the helpfulness rendered to us by all of the other persons involved in making this survey so meaningful and comprehensive. It is impossible, however, here to list all of these persons, although we desire specifically to designate at least a few.

In arranging for and briefing us on the proposed trip to Antarctica, valuable and continuous assistance was received from Comdr. Paul Frazier, chief of staff, United States Antarctic projects officer, who had been chief of operations for Deep Freeze II. In the execution of these arrangements, full cooperation was given by: Capt. G. L. Ketchum, deputy commander, Naval Support Forces; Lt. Comdr. Scott W. Marshall and Lt. Comdr. Emmert E. Ludeman, in charge of the McMurdo base; and by Capt. W. M. Dickey and Capt. E. M. Maher, in charge of the Little America base. Weather and historical briefings by Comdr. John Mirabito, Navy meteorologist at McMurdo, were as stimulating as they were informative. The respective flights in Antarctica with Comdr. Henry Hanson, Lt. Comdr. C. S. Shinn, and Lt. Comdr. John A. Henning of the Navy, and Lt. Col. Dixon J. Arnold and Capt. Vincent J. Decesare of the 53d Troop Squadron, USAF, were as cordially as they were efficiently executed. Friendly and helpful assistance was also rendered by Comdr. Louis Darkowski, chaplain at McMurdo; Lt. William Cook, navigator and public relations officer, USAF; and Comdr. James Bofenkamp, aide to Admiral Dufek, who cheerfully discharged his tasks of liaison and aide to the subcommittee.

We are also appreciative of the assistance of Adm. Felix B. Stump, Commander in Chief, Pacific, and Lt. Col. Howard McGrath; and of Rear Adm. E. C. Stephan, Chief, and Capt. Theodore A. Torgerson, of the Office of Legislative Liaison, Department of the Navy.

In the scientific briefing, in addition to the informed companionship of those who accompanied us, we are especially indebted to Dr. Hugh Odishaw, executive director, United States National Committee for the International Geophysical Year, National Academy of Sciences, and to Dr. J. Wallace Joyce, Head, Office for the International Geophysical Year, National Science Foundation. The contribution by other scientists in the field to our study is indicated in sections of the report which follow.

Of great value was the warm and full assistance received from our Foreign Service representatives:

Ambassador Val Peterson, Counselor James W. Gantenbein, and Consul Robert W. Caldwell, Copehhagen, Denmark; Ambassador Douglas MacArthur II, Minister Outerbridge Horsey, Minister Ben H. Thibodeaux, Counselor Philip H. Trezise, and First Secretary Edward A. Bolster, Tokyo, Japan; Ambassador Charles E. Bohlen Minister Horace H. Smith, and Attaché Edward M. Milans, Manila, Philippines;

Consul General Frank A. Waring, Consul Joseph L. Dougherty, Consul Nicholas Hardy, Sydney, Australia; Ambassador Francis H. Russell, Counselor Samuel D. Berger, Public Affairs Officer James T. Pettus, Jr., and Comdr. G. E. Hoffman, Wellington, Australia.

Informed aid was also received from Administrator James Pyle, Civil Aeronautics Administration; Irving Roth and Joseph Watson, Civil Aeronautics Board; Laurence C. Vass, Director, and Henry T. Snowden, Aviation Chief, Office of Transport and Communications, and John Leahy and Miss Beverly Gahimer, Office of Legislative Liaison, Department of State.

Discussions were had with representatives of foreign governments, cabinet officials, and members of Parliament, representatives of regional airlines, and of American businesses located abroad. We are especially appreciative of the cordiality, hospitality, and frankness evinced by the Governments of Australia and New Zealand, including their Embassies here, and by the Honorable H. F. Jensen, Lord Mayor of Sydney, Australia, and Sir Leonard Wright, Mayor of Dunedin, New Zealand.

The meeting of the heavy schedule via commercial airlines was made possible by the unstinted services of Capt. William Taylor (USNR, retired) representing Scandinavian Airlines System, and of William J. McEvoy, representing Pan American World Airways, both of whom accompanied us on this study.

The International Geophysical Year

Geophysics is the application of the tools of physics to the earth; a study of the behavior of the earth.

Of fundamental and continuing interest to us all is the problem of our physical environment. The factors which make up this environment control many aspects of our physical life such as our food, our clothing, our domiciles, our travels, our communications systems, and, in some cases, our very lives.

To cope with these perplexing and often violent factors we must know more about them, their basic nature, how they operate, how they affect each other, and, perhaps more importantly, how we can circumvent the unfavorable results and amplify the beneficial ones.

The field of knowledge most directly concerned with these conditions is known as geophysics. As the name implies, it deals with the physics of the earth and its atmosphere and the space in the immediate vicinity of this atmosphere. A very important aspect of the problem is the sun itself. The sun is the principal source of all energy that reaches the earth and, therefore, is an important factor in most, if not all, of the physical phenomena which are included under the broad head of geophysics.

Over 70 years ago a young German lieutenant, named Karl Weyprecht, in considering problems on weather and the earth's magnetic field in the Arctic, recognized the importance of obtaining observations of these physical factors over as large a portion of the Arctic area as possible and within a relatively short time interval. His proposal that a concerted effort be made to measure certain geophysical phenomena was the basis for a period of special observations which has since been referred to as the first polar year. Some 10 nations, including the United States, participated in this undertaking during the period 1882–83. The gains in knowledge in the fields of meteorology and geomagnetism fully justified Lieutenant Weyprecht's judgment.

Fifty years later, 1932–33, a second polar year was instigated and this time the United States and some thirty-odd other countries took part in the program. Again the Arctic regions received the principal effort, although there were some stations established in the Southern Hemisphere. Out of this period came a better understanding of the ionosphere and its effect on radio communications, a recognition of the importance of aerometeorological observations in weather-prediction processes, and an increased knowledge of characteristics and variations of such things as the earth's magnetic field, cosmic rays, and aurora.

In 1950, a group of American scientists met informally at the home of one of them in Silver Spring, Md., to greet Prof. Sydney Chapman, of England, one of the world's leading geophysicists. Out of this very informal evening discussion came a suggestion from Dr. L. V. Berkner that a third polar year be organized during the 1957–58 period in order to take full advantage of the tremendous advances that had been made in scientific instrumentation during the preceding decade. A second impelling reason for such an interval was the realization that further progress in a number of fields of geophysics was becoming more and more dependent on the availability of synoptic data which could only be gotten through such a concerted effort.

These proposals were submitted to the International Council of Scientific Unions (ICSU), which established a special international committee called the Comité Spécial de l'Année Géophysique Internationale (CSAGI) to coordinate activities during the International Geophysical Year. Substitution of the word "geophysical" for "polar" reflected recognition of the need for worldwide coordinated observations. During 1952 invitations were sent to science academies of all nations to form national committees to plan activities for the IGY.

The CSAGI held its first formal plenary session in Brussels in July 1953, and promulgated a provisional program, based on the proposals received from 23 countries. The criteria and nature of the IGY endeavor were established at this and during subsequent meetings, which were attended by delegates from the various national committees. Emphasis was placed on those measurements and observations which required simultaneous study on a worldwide scale and on epochal measurements which could reveal long-range trends and changes in man's physical environment. Within this framework, each national committee planned its own program.

Sixty-seven countries now are participating cooperatively in what has evolved as man's greatest unified attack on the mysteries of the planet on which we live. During the International Geophysical Year (IGY), which formally commenced July 1, 1957, and terminates December 31, 1958, studies are being conducted at over 2,500 stations girdling the globe manned by more than 10,000 scientists and technicians. The aurora is being investigated in both polar regions; the ionosphere is under intense study from hundreds of stations, including the south pole, as well as at several stations on the Arctic icepack; meteorological stations have been reinforced around the world, and a special pole-to-pole chain of stations has been established along the 70° to 80° west meridian through the Americas.

Corollary investigations of the earth's magnetism, the intensity and distribution of cosmic rays, and solar activity are also being conducted. Oceanographers are undertaking many special voyages, investigating currents, depths, obtaining and examining bottom cores, and attempting to gain a better understanding of the interaction of the ocean surface and the air above it. Glaciologists are encamped on scores of glaciers in the Arctic, temperate and equatorial, and Antarctic regions. Further investigations are being made of the high atmosphere with the use of newly developed rockets and satellites.

The earth satellite program is the most dramatic and publicized aspect of IGY. The satellite program, in effect, represents an extension of the rocket program, and is a tool which can provide data over a long period of time, over considerable heights above the earth, and over large expanses of the atmosphere about the earth. While 7 nations are engaged in the rocket program, 2—the U. S. S. R. and the United States—agreed to undertake satellite-launching programs, although many others are cooperating in the tracking and ground-based observations. The U. S. S. R. launched its first satellite October 4, and its second November 3, 1957, and the United States launched ts first satellite January 31, 1958.

A concerted attempt is being made to make observations simultaneously from as many stations as possible during certain special events such as solar flares, eclipses, and other intervals of interest. A special worldwide warning system has been organized, which in a matter of minutes can flash a signal to hundreds of stations to intensify their operations for a special "solar" or other event. In many disciplines synoptic observations are of great importance, and special emphasis is made on maintaining continuity of work.

In an effort to obtain global coverage particular attention has been given to establishing stations in remote and arid areas. The Arctic and Antarctic are now dotted with scores of stations, which are contributing new and valuable information from these areas, especially valuable in that these data are being recorded simultaneously with those from the rest of the world.

UNITED STATES PARTICIPATION

The United States National Academy of Sciences, which is the adhering body to ICSU for the United States, accepted the invitation to join in the IGY and selected a United States National Committee for the IGY (USNC–IGY) during 1952. The committee with special regional subcommittees and technical panels gathered the Nation's leading geophysicists to develop the United States program, and an appropriate executive staff was organized. The USNC is under the competent and effective direction of Dr. Joseph Kaplan, Chairman; Dr. Alan H. Shapley, Vice Chairman; and Dr. Hugh Odishaw, Executive Director.

(The composition of these committees is shown in appendix I.)

The National Science Foundation participated and cooperated in the planning of the United States IGY program and obtained special funds from the Congress for this purpose. In early 1954 a budget for \$13 million was prepared and submitted to the Congress. In 1955 and 1956 the Congress granted additional funds, primarily to mount the earth satellite program, for a total of \$39 million overall.

THE UNITED STATES INTERNATIONAL GEOPHYSICAL YEAR PROGRAM

The United States program embraces all IGY disciplines and has been planned by the leading geophysicists of the Nation. Under the general direction of the National Academy of Sciences and its National Committee for the IGY, the actual field operations are being carried out by many research institutions, including Government agencies, universities, and other organizations.

This program includes projects in 13 geophysical disciplines and areas of scientific activity involved in the IGY: aurora and airglow, cosmic rays, geomagnetism, glaciology, gravity, the ionosphere, longitude and latitude determinations, meteorology, oceanography, seismology, solar activity, and rocket and satellite studies of the upper atmosphere.

Hundreds of United States–IGY stations are located throughout the United States, Alaska, and Hawaii. New United States stations have been established in the Arctic, Antarctic, and Equatorial Pacific, and additional United States stations are being maintained in many other countries through cooperative arrangements with the other IGY national committees. A typical example is the comprehensive rocket launching facility which was erected by the United States Army Corps of Engineers at Fort Churchill, Canada, with the cooperation and assistance of the Canadian National IGY Committee and Government.

Some of the scientific results already are proving to be extremely interesting, such as for example, the immense thickness of the ice sheet on the Antarctic Continent; and the existence of deep ocean currents, which are in the opposite direction to the surface currents in the ocean. The existence of weather stations on the continent of Antarctica have made possible weather forecasts which have already improved very greatly for the Southern Hemisphere in particular.

It appears that the ionosphere layer extends much farther out than had been thought and its study will therefore be of great importance. Further, it appears that the earth is in a sense in the sun's atmosphere or corona in that particles and various matter which are sent out from the sun reach as far as the earth, which had not been realized before.

There are anomalies that have appeared in communications that are extremely interesting, such as one of the Arctic stations receiving steady signals from the Russian satellite as it went around the earth through its complete circuit of the earth. There is some mysterious channel by which this must take place. The signals were not only heard when the satellite was over this Arctic station but on all of its way around.

Many additions to our knowledge already have been obtained and are briefly summarized in a report covering the first 5 months of IGY prepared by Dr. Hugh Odishaw, executive director, United States National Committee for the IGY, which is included as appendix II.

While we, of course, are interested in the entire IGY program, our particular concern on this study trip was with the United States program in the polar and subpolar regions, particularly in the Antarctic. The chief emphasis of the remainder of this report, accordingly, is upon that program and our other activities in the Arctic and the Antarctic.

UNITED STATES ARCTIC INTERNATIONAL GEOPHYSICAL YEAR PROGRAM

There are vast differences between the IGY programs in the Arctic and in the Antarctic. These arise in part because of the different nature of the two regions. The Antarctic is an extensive and high continent, surrounded by great oceans. The Arctic conversely is largely a major ocean basin surrounded by continents. Furthermore those continents, embracing as they do the north temperate zone and most of the world's population centers, result in an urgent need for comprehensive information on the geophysical aspects of the Arctic for immediate and future practical application to many pressing problems of the human race. These problems involve transportation, communication, natural resources and economics.

By tradition also the IGY effort is deeply concerned with the Arctic. The present IGY is the lineal descendant of the first and the second polar years that were involved primarily with the Arctic. The first polar year was in 1882 and 1883, and then, as now, Point Barrow, Alaska, was one of the centers of the work. The second polar year, 1932 and 1933, included auroral studies, ionospheric physics, glaciology, ice studies, and northern hemisphere weather charts.

The United States International Geophysical Year effort in the Arctic is being carried out in Greenland, Canada, Alaska, and the Arctic Ocean over approximately 150° of longitude. Altogether there will be about 50 stations, although some are only minor observation points. All but 2 or 3 of the USNC–Technical Panels have some part of their programs in the Arctic. (The roster of the USNC Arctic Committee under the chairmanship of Dr. John C. Reed is included in appendix III.)

The logistic problem in the Arctic is far different and, in general not as complex as in the Antarctic. No large continuing task-force support is needed as in the case of the Antarctic. Nevertheless the problem is very substantial and the Air Force and other armed services have met the challenge magnificently.

Responsibility for the establishment, maintenance, and conduct of the two United States stations in the Arctic Basin has been delegated by the USAF to a major air command (the Alaskan Command for station A, and the Strategic Air Command for Fletcher's Ice Island Station). The primary representative of each command at the drifting stations is an Air Force officer responsible for the maintenance of the station as a whole and the safety of all personnel. Responsibility for the execution of the IGY scientific program at each United States Arctic Basin Drifting Station is delegated to a USNC–IGY station scientific leader. The scientific leader at Drifting Station A is Maurice J. Davidson of the Lamont Geological Observatory and the leader at Fletcher's Ice Island is John Murray of the Weather Bureau. The station scientific leader is responsible for the supervision of the overall scientific program at his station and for the coordination of scientific duties of all personnel at the station.

UNITED STATES ARCTIC INTERNATIONAL GEOPHYSICAL YEAR STATIONS

Drifting station A

In early March 1957, air reconnaissance was conducted by the Alaskan Air Command and Col. Joseph O. Fletcher, then Arctic Basin projects leader for the USNC–IGY, in order to locate a suitable site in the vicinity of 75° north, 155° west, for a planned USNC–IGY ice-floe station. It was discovered that ice conditions in the desired region were unsuitable for establishment of a station owing to an excessive amount of open water arising from an unusually warm winter in the western section of the Arctic Basin. Search was continued farther north and west, and on March 30 the first landing was made on an ice floe, which later was found would not meet requirements. On April 12, a subsequent landing was made on another floe at about 80° north, 159° west. Five men and a tent were left, with a radar reflector and minimum supplies, to start work on construction of the station.

Station A is on a large ice floe, several years old, which averages approximately 7 feet in thickness. During the summer months the surface of the floe is partially covered with melt water ponds, and during the winter with several feet of drifting snow. The floe is drifting northwest at about 1½ miles a day and it is expected will continue the drift in a northerly direction tending toward the east in the course of the 2-year period. As the greatest hazard at an ice-floe station is the breaking up of the floe due to pressure from neighboring floes and the interaction of ocean currents and winds, emergency procedures have been established to insure the safety of personnel and equipment.

The major airlift to the station was made during the week of May 20–25. On May 21, the 5,000-foot runway was completed and the first C–124 aircraft landed successfully. From that date five flights daily were made until all cargo had been landed. Nine scientists and about the same number of support personnel will be at station A during its period of occupation in a total facility consisting of 20 Jamesway huts.

Fletcher's Ice Island

Fletcher's Ice Island is a large tabular piece of very thick ice drifting in the Arctic Ocean, with dimensions roughly 9 miles in length, 4½ miles in width, and 140–160 feet thick. The origin of the ice island is probably the shelf ice of the north coast of Ellesmere Island. Fletcher's Ice Island has been under surveillance since its discovery in 1950, and the general direction of its travel is clockwise in the area between the Pole and the Canadian Archipelago. It is not pack ice, being more massive, and can be considered permanent. The ice island is located favorably for the staging and air delivery of construction material, scientific equipment, and personnel from Thule Air Force Base, Greenland.

On February 13, 1957, Fletcher's Ice Island was relocated on a reconnaissance flight some 150 miles from Thule Air Force Base at about 82°50′ N., 99° W. The first landing was made on March 7. On April 5, construction of a 5,000-foot runway was begun and 2 C–54's and 2 ski-equipped C–47's landed.

On April 23, a Tactical Air Command (TAC) C–124, with Col. Robert W. Gates, Commander Task Force T–3 aboard, made the first wheeled landing after the runway had been completed. By the 18th of May, airlift of a 2-year supply of equipment and supplies was completed to the stations.

UNITED STATES ARCTIC INTERNATIONAL GEOPHYSICAL YEAR RESEARCH PROGRAM

Scientific program at station A

Aurora program.—The Aurora program on station A consists of two instruments operated by personnel from the Lamont Geological Observatory under contract with the Geophysics Research Directorate of the Air Force Cambridge Research Center. The first of these instruments is the all-sky camera, which takes a picture of the sky hemisphere every 5 minutes. The second instrument is the patrol spectrograph, which is an automatic instrument having its slit alined with magnetic north, and taking spectrograms at a variable rate depending on the intensity of the light in the sky. Like the camera this instrument is intended for night use.

Geomagnetism program.—The geomagnetism program consists of one instrument supplied by the United States Coast and Geodetic Survey and operated by personnel from Lamont Geological Observatory. The instrument is an Askania variograph, which will operate continuously. In addition the instrument can be used to make absolute determinations of declination, and is being modified to enable this to be done more easily. The accuracy of this determination will be limited by the accuracy of determining a geographical azimuth by celestial means.

Arctic Sea ice heat budget program.—The purpose of the project is to determine quantitatively the individual components of heat exchange at the sea-ice-atmosphere interface and ice-ocean interface; and to relate the heat exchange between the ice pack and its atmosphere and oceanic environments to seasonal variations in thickness and thermal regimen of the ice pack. Quite aside from its importance to determining the physical relationships which lead to formation and maintenance of the ice pack, the heat exchange studies planned under this program form a very basic and integral part of the determinations of the heat budget of the Arctic Ocean, and of the modification of air masses moving over the Arctic Basin.

The program is being carried out through the Department of Meteorology and Climatology, University of Washington, Seattle, Wash.

Arctic Sea ice physics program.—The purpose of this program is to determine physical properties of sea ice, and in coordinated study with the heat budget program, to relate these properties of the sea ice to exchange of mass and energy between the sea ice and its meteorological and oceanographic environment. Specific studies include structure, air content, density, salinity, composition of salts, latent heat of melting, heat capacity, thermal conductivity, strength, problems of pressure ridges, and morphology and thickness.

Meteorology program.—The meteorology program falls into the main categories: Surface synoptic, upper air, and specialized programs for radiation, carbon dioxide, precipitation chemistry, airborne radioactivity, and snow crystals.

Oceanography program.—The oceanography program being conducted by Woods Hole Oceanographic Institution on station A consists at present of the following:

(*a*) A hydrographic station using Nansen bottles and reversing thermometers in order to obtain a vertical profile to bottom of temperature, salinity, and oxygen content.

(*b*) Measurements of ambient noise level in the Arctic Basin as part of underwater sound program.

(*c*) Measurement of the temperature gradient in the ocean bottom sediments. As part of the program being conducted at Harvard University to determine the heat flow of the earth.

The temperature gradient coupled with conductivity measurements in sediment cores obtained under the GRD program should yield a number for the heat flow in the Arctic Basin.

Human factors program.—A human factors program is planned by personnel of the Aeromedical Laboratory at Ladd Air Force Base.

Geophysical Research Directorate program.—The Lamont Geological Observatory is carrying on a program under contract with the Geophysical Research Directorate for taking of ocean-bottom photographs and obtaining of cores; measurement of ocean water currents and comparison with ice movements; refraction and reflection seismic work; and study of magnetic field and values of gravity.

Scientific program at Fletcher's Ice Island

The meteorological program at Fletcher's Ice Island is being carried out by the United States Weather Bureau. It consists essentially of synoptic observations plus specialized observation similar to those that are being made at drifting station A. Those include study of radiation, carbon dioxide, precipitation chemistry, and snow crystals. The Woods Hole Oceangraphic Institution is responsible for an oceanography program at the Ice Island, bottom cores are being taken; circulation cycles are being studied, and age determinations are being made.

Gravimeter measurements are being made under the cognizance of the University of Wisconsin. There is close coordination at the Ice Island, as at drifting station A, between the gravity program and the program of the Geophysics Research Directorate. The Army Signal Corps is conducting the ionospheric physics program made up primarily of vertical incidence soundings. The Geophysics Research Directorate is carrying on a substantial program similar to that at drifting station A. Primarily it includes aurora investigations, oceanographic, and thermal budget studies.

UNITED STATES ANTARCTIC INTERNATIONAL GEOPHYSICAL YEAR PROGRAM

Detailed planning for the USNC–IGY Antarctic program was started as early as November 1953 when the United States National Committee formed its Antarctic Committee under the able direction of Dr. Laurence M. Gould, who was later appointed Director of the United States IGY Antarctic program, and Dr. Harry Wexler, Vice Chairman and Chief Scientist. This new Committee immediately concerned itself with drawing up preliminary plans and examining scientific proposals in the various geophysical disciplines for Antarctic work. An Antarctic office was organized as part of the Academy's IGY staff. This office coordinated the development of the United States IGY Antarctic program and its logistic requirements. It worked closely with various branches of the United States Navy, as well as with a polar operations group in the Weather Bureau; and coordinated the United States activity with that of other countries.

The composition of the USNC Antarctic Committee and the USNC Antaractic program direction, together with the scientific leaders and scientific personnel at the respective stations, is set forth in appendix IV.

By late 1957, 12 countries have established 60 stations in the Antarctic region: Argentina, Australia, Belgium, Chile, France, Japan, New Zealand, Norway, the Union of South Africa, the United Kingdom, the U. S. S. R., and the United States. The United States has a station at the South Geographic Pole, and France a station at the South Magnetic Pole. The U. S. S. R., unsuccessful in putting a station last summer at the South Geomagnetic Pole, has reached that pole this past month. The location of these stations is shown on the accompanying map.

Antarctica presents special problems because of its inhospitable climate and its inaccesibility. The logistic support for our farflung Antarctic IGY activities provided by the Department of Defense is even now one of the greatest achievements in the history of polar exploration. Under the able leadership of Rear Adm. George Dufek, the commanding officer of Task Force 43, Operations Deep Freeze Nos. 1 (1955–56), 2 (1956–57), and 3 (1957–58), have successfully established and supplied our six scientific bases, including one operated jointly with New Zealand, in addition to the naval operational base at McMurdo Sound. Byrd Station, at 80° south, 120° west, and the Amundsen-Scott Station at the South Pole are the first permanent inland or winter stations ever established in Antarctica.

While the problems of carrying out the observations in the International Geophysical Year in Antarctica are formidable, yet the results will be of major importance because it is the largest unoccupied area of the globe. Most fields of geophysics now demand, for completeness, specific data that are available only from observations on the polar continent.

The total scientific program is of such magnitude and complexity that only a few major relationships can be pointed out in this brief account. Each special field is characterized by its global nature and its relationship to solar activity, for solar radiation in electromagnetic and particle form is the major source of energy for the earth's atmosphere and is responsible for all types of life.

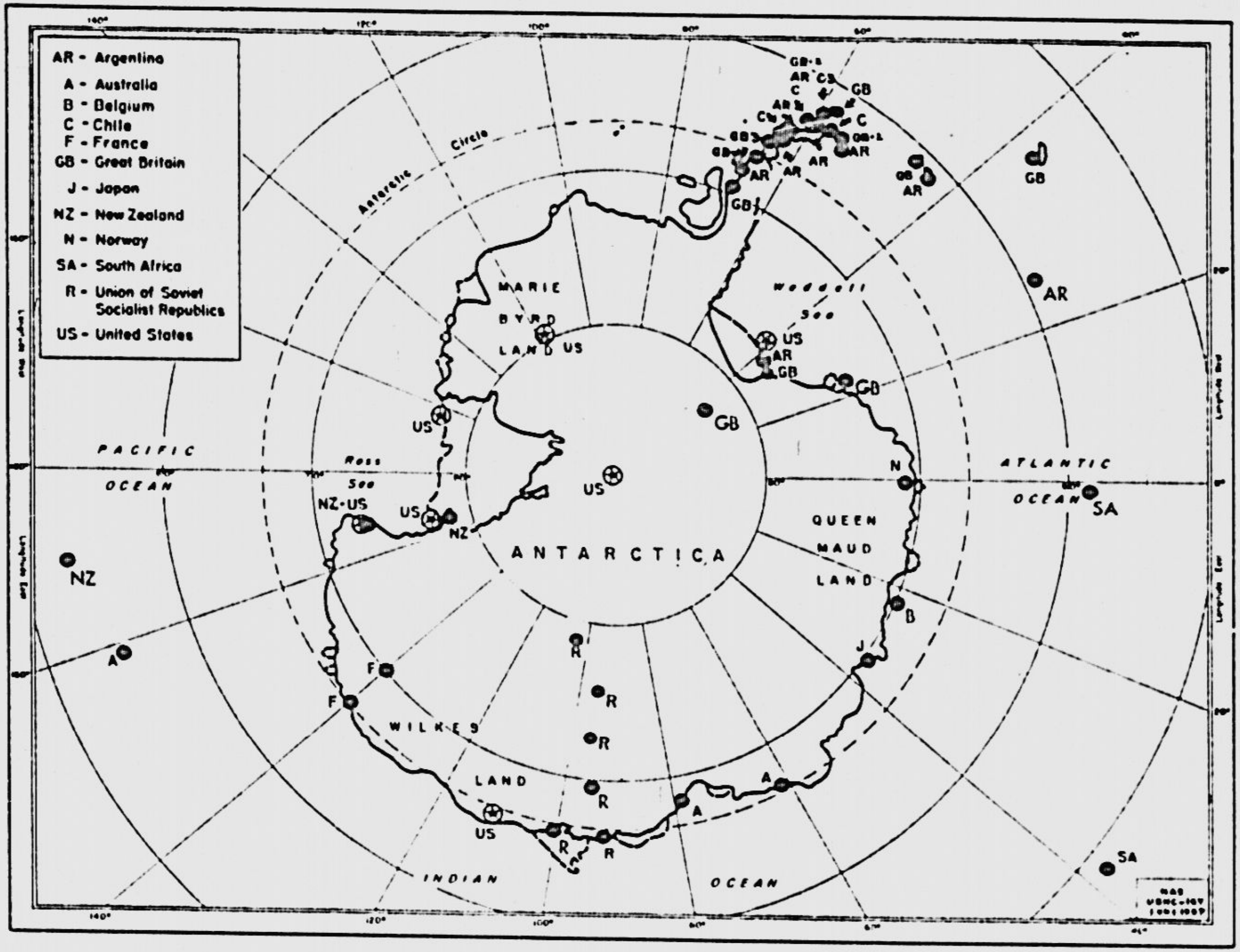
The fields of meteorology, oceanography, and glaciology have very special interrelationships, for they involve the earth's store of water. Water exists in the atmosphere as vapor; in frozen form as glaciers, snow, and ice sheets; and in water as rivers, lakes, seas, and the oceans. There is a continuous process of interchange among these depositories, and all of them are related to the circulation of the atmosphere and the heat budget of the earth.

The atmosphere provides the ingredients of oxygen and moisture which sustain life. It further makes that life possible by shielding us from dangerous cosmic radiations and solar radiations that might be lethal. But no other property of the atmosphere is quite as important as its motion. In a windless world, the Tropics would become intolerably hot and the rest of the earth unbearably cold. The life of the planet as we know it depends upon the distribution of heat and moisture by wind. The atmosphere is the working fluid of a great heat engine driven by the sun that picks up heat in the Tropics and discharges it in the polar regions. Between latitudes 38° north and 38° south, the earth receives more radiation than it keeps. Beyond these latitudes, there is a deficit, with the resulting major exchange of air masses. There is still much that is not known about the manner in which this exchange takes place.

Oceanography is second only to the atmosphere in conditioning weather and climate. For the first time in man's history, we are able

International Geophysical Year

ANTARCTIC STATIONS



to make simultaneous measurements of the fluctuations in sea level all over the world. This is a most effective means of studying the weather of oceans. We know that the major movement of the oceans is, roughtly, like that of the atmosphere. The cold waters from the polar regions move slowly along the ocean bottoms toward the lower latitudes, where they rise, become warm, and then proceed from the Tropics polarward. Within this general circulation there are all sorts of ramifications yet to be studied. Surprisingly little is known about the deep currents of the oceans.

One of the intriguing problems in oceanography and meteorology relates to the content of carbon dioxide in the atmosphere. Carbon dioxide is one of the atmosphere's principal ingredients, which enables it to retain solar heat for the earth. It is the normal result of combustion. If we continue to burn up our fossil fuels of coal, oil, and gas at the present rate, within 50 to 75 years the amount of carbon dioxide in the atmosphere may be doubled. Should this happen, magnolias might bloom in Greenland again. But there are some unknown factors which would alter such a situation. We do not know how rapidly carbon dioxide is absorbed by the oceans and by the various masses of glacial ice. Measurements will be made during the IGY.

During the great ice age, glaciers covered more than 30 percent of the surface of the earth. Even today, they cover more than 10 percent of it. Our studies in glaciology will give us our first world view of the variations of glaciers. This will reveal much about past climates and help us to develop a yardstick for long-range forecasts in the future, for glaciers are very sensitive indicators of climatic changes.

The ionosphere, geomagnetism, cosmic rays, and the aurora are so related that a study of one involves a study of the rest. All have direct relations to solar activity and radio blackouts.

The ionosphere is the rarified, ionized part of the atmosphere from 50 to 250 miles above the surface of the earth. In somewhat the same way a mirror reflects light, the ionosphere reflects radio waves, making possible radiotelephony and navigation and long-range radio communication. One expert has stated that the "long-time equivalent value of the ionosphere is in excess of $10 billion."

Solar radiation is assumed to be the principal agent in breaking up atoms to form the ionosphere. Our base at the South Pole will discover what happens to the ionosphere when there is no direct solar radiation for 6 months. Does it thin out almost to the point of disappearance? Does it descend much below 50 miles above the surface of the earth?

Only on Antarctica can the aurora australis be fully observed.

While most of the earth's magnetic field originates in the solid core of the earth, the major variations and fluctuations stem from electric currents in the ionosphere.

The earth's atmosphere is constantly bombarded by electrically charged particles from outer space, most of which are believed to be protons. The high-speed particles produce cosmic rays, while the relatively slow-speed particles produce (1) ionospheric storms, (2) magnetic storms, and (3) the aurora, the luminous trace of the charged particles where they are funneled into the earth's atmosphere over the magnetic poles.

The magnetic field of the earth is the chief instrument for analyzing cosmic rays. The rays are bent in such a way that the low-energy rays can only enter in high latitudes near the magnetic poles. The connections between solar effects and cosmic rays are more conspicuous for low-energy rays than for others. Observations in the far South and the far North may therefore reveal new fundamental facts on the origin of cosmic rays.

The hub of the atmospheric circulation for the Southern Hemisphere is located on Antarctica, but whether or not it coincides with the South Geographic Pole is but one of many meteorological questions that await solution. The Antarctic icecap is the world's greatest cold weather factory; but whether the great masses of cold air which form there play an active part in the general atmospheric circulation of the earth or whether they are largely sealed off from the rest of the atmosphere is not known.

More than half a century ago Simpson, a meteorologist on the first Scott Expedition, pointed out that from time to time great pressure waves or surges of air spread out from what is now the general neighborhood of Byrd Station. Whether Simpson's assumptions are valid we still do not know, though later meteorologists have shown that some polar outbreaks of air can completely disrupt midlatitude circulation.

A unique phase of the glaciological program in Antarctica is the measurement of the thickness of the great icecap. Inasmuch as an estimated 90 percent of the world's land ice is on Antarctica, the thickness of the ice and changes in its volume are not merely matters of interest to the glaciologist alone. The return of but a few feet of thickness of ice as melt water to the oceans would have serious effects in many places; and if all the ice were melted into the sea, its level would rise from 150 to 200 feet. All the world's seaports and much of its most densely populated areas would be submerged. Great changes in volume of Antarctic ice have occurred in the past and such changes may occur again, but they will not do so with catastrophic speed.

Arctic ice masses have been melting at such a rapid rate during the 20th century that if the rate continues to the end of the century, ships will easily navigate the now ice-clogged Arctic Ocean. Whether similar melting conditions obtain in Antarctica now, we do not know, although looking back over a long period of time we find evidence that the Antarctic icecap was at one time at least 1,000 feet thicker than now.

In summary, then, as to why we are interested in the Antarctic from a geophysical point of view?

First, it is a large part of our planet—some 6 million square miles in area—and a largely unknown part, too.

Second, it is the largest repository of ice in the world, containing 86 percent of all the world's glacial ice.

Third, it is the world's most efficient cold-air factory, far more so than the Arctic. It also contains the pole or hub of the atmospheric circulation in the Southern Hemisphere.

Fourth, its melting ice creates vast amounts of cold water, which sink to the bottom of the ocean and, as the Antarctic Bottom Current moves across the equator, moves into the Northern Hemisphere.

Fifth, it enables study to be made of the aurora australis and comparisons with the aurora borealis.

Sixth, it contains the South Magnetic Poles and affords the opportunity for extensive geomagnetic studies.

Seventh, it presents a stable platform for the study of the thermal and electrical properties of the atmosphere cut off from sunlight for many months, for the study of ionospheric phenomena affecting radio propagation, and for the study of concentrations of cosmic radiation.

Eighth, it offers a stable platform for the tracking of earth satellites having the significant North-South orbit.

UNITED STATES ANTARCTIC IGY STATIONS

The United States has established and is operating 6 major research stations (1 jointly with New Zealand) and a naval air facility in Antarctica for the IGY. These stations are:

Little America Station
Amundsen-Scott South Pole Station
Byrd Station
Hallett Station (with New Zealand)
Wilkes Station
Ellsworth Station
Naval air facility, McMurdo

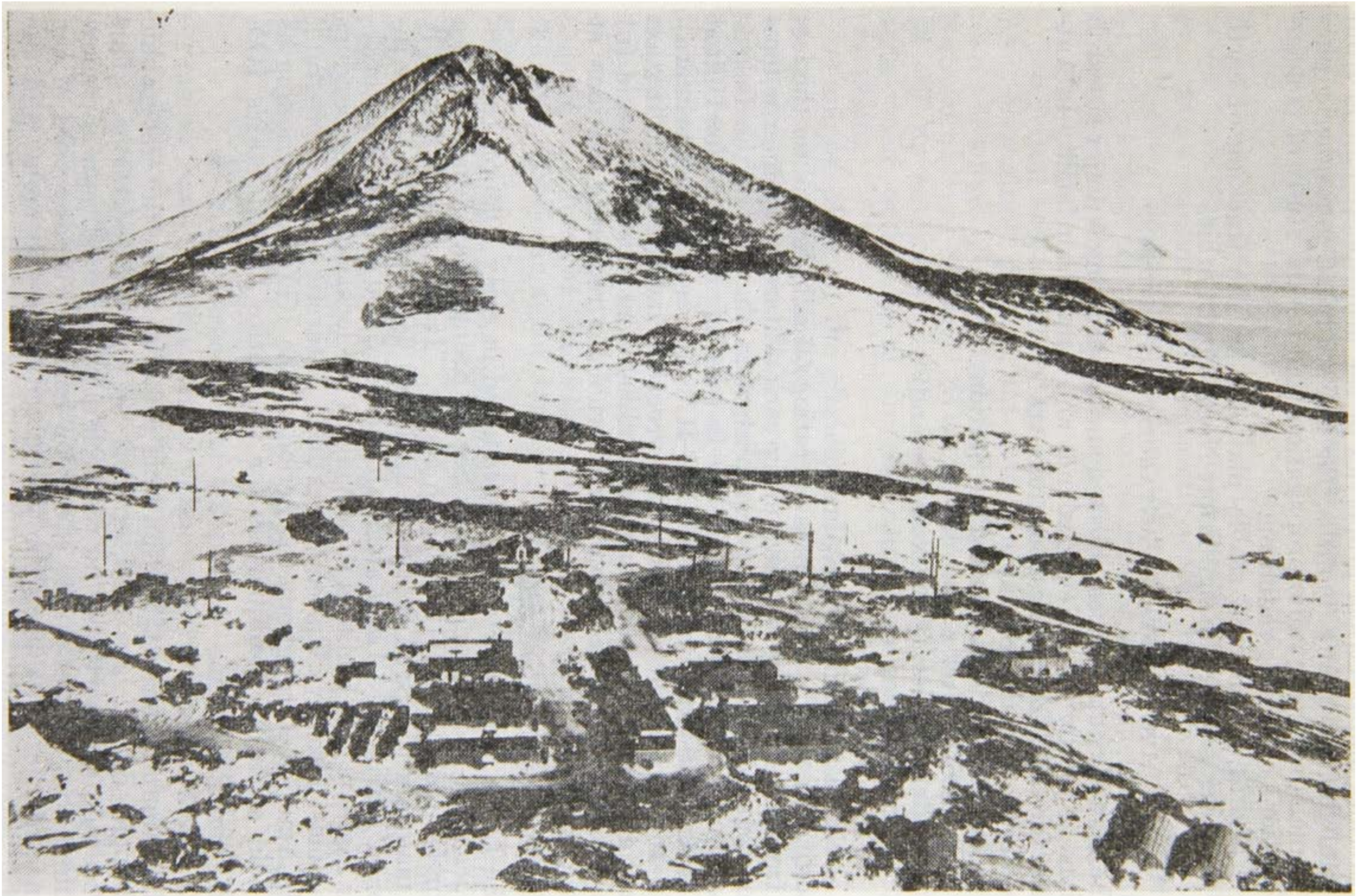
In addition a small substation is operating 50 miles inland on the icecap from Wilkes Station, and during each Antarctic summer a temporary auxiliary air facility is established at the foot of the Beardmore Glacier, on the Ross ice shelf. In selecting locations for United States Antarctic stations, the USNC–IGY has been guided primarily by (i) the general needs of the IGY program, including coordination with the plans of other nations for establishment of stations, and (ii) consideration of special geophysical problems requiring stations at specific locations.

Little America and Byrd Stations

The Little America Station, constructed in early 1956 on the 800-foot ice shelf floating on the Ross Sea at Kainan Bay, functions as a major United States IGY research center. It is also used to supply and maintain the Byrd Station, established 647 trail miles in the interior of Marie Byrd Land at an altitude of 5,000 feet on the Rockefeller Plateau. In addition to serving as the location for the conduct of the most intensive United States IGY Antarctic research program, Little America, throughout the period of the IGY, is functioning as the field scientific headquarters for the entire United States IGY Antarctic program.

South Pole Station

The Amundsen-Scott Station was established at the geographic south pole, during late 1956, entirely by aircraft operations. This offers a unique opportunity for research in glacial conditions and snow accumulation, studies of the effects on ionospheric properties of the absence of the sun during the protracted Antarctic night, and the auroral phenomenon within the maximum auroral zone. It also serves as the terminal station on the international pole-to-pole lines of meteorological stations.



Official U. S. Navy Photo

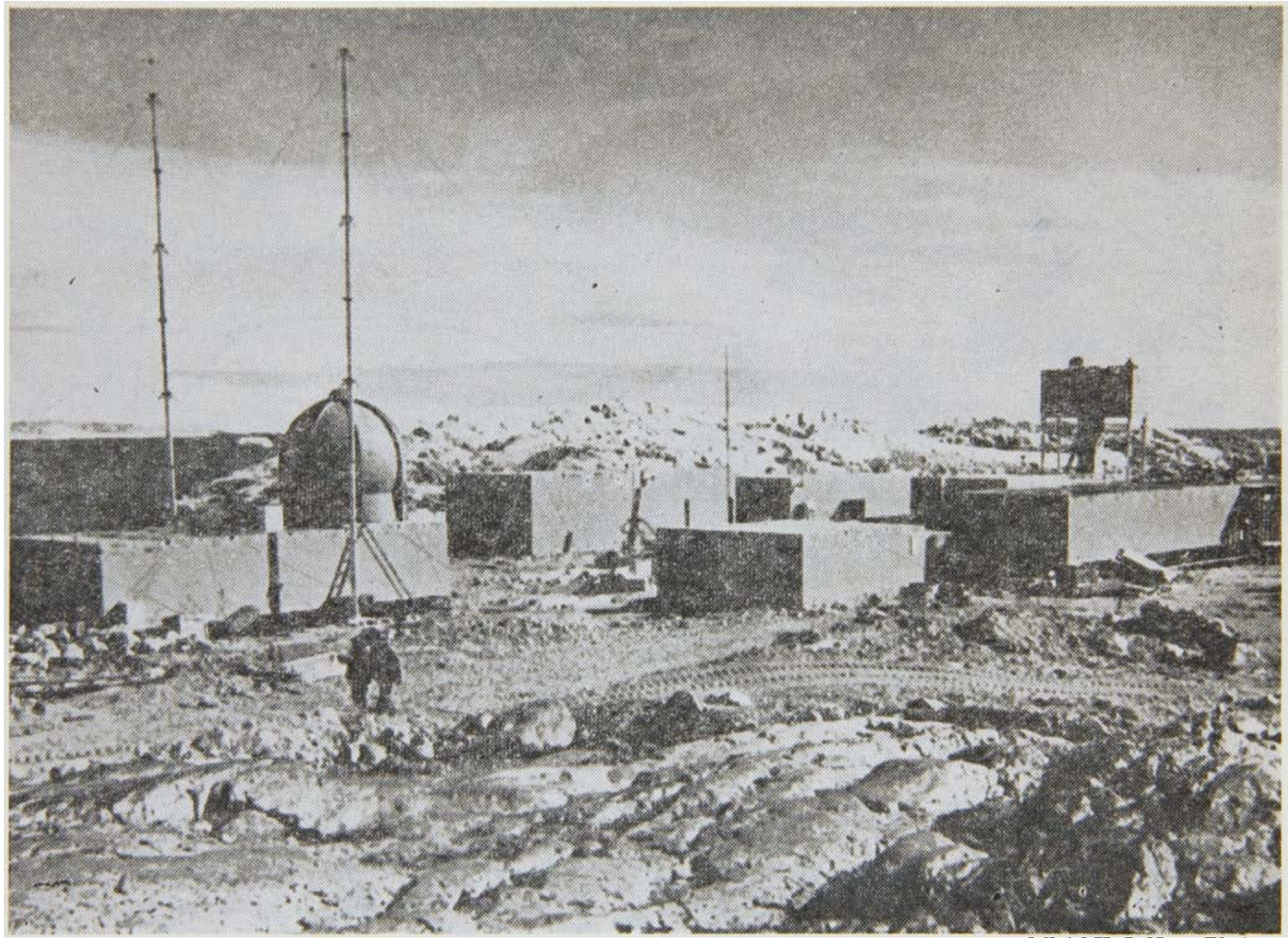
Naval air facility and Observation Hill, McMurdo Sound, December 1956.

Official U. S. Navy Photo

Little America Station, January 1957.

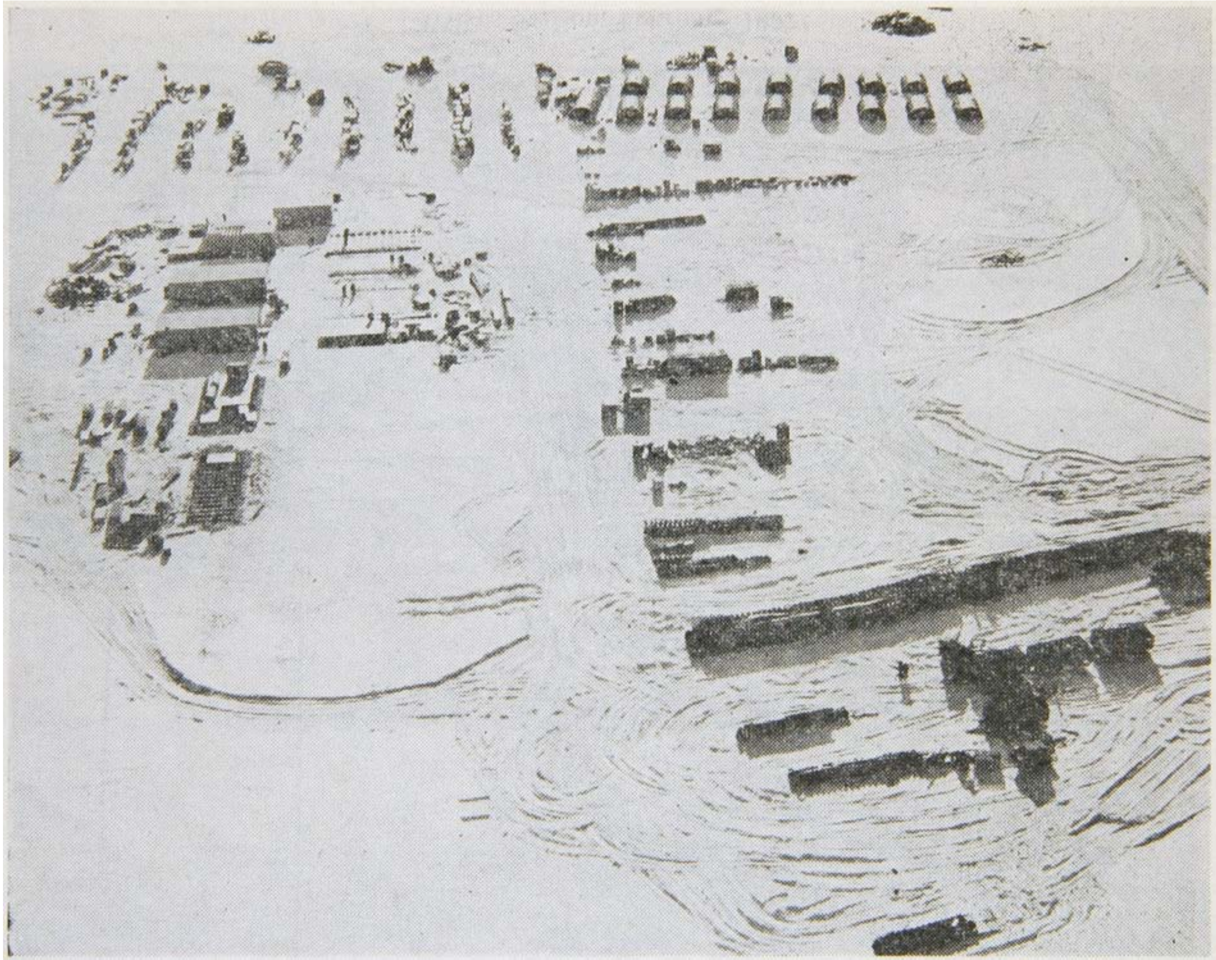
Official U. S. Navy Photo

Amundsen-Scott South Pole Station: Top photo aerial view (construction progress) December 1956; bottom photo, completion of station, February 1957.



Official U. S. Navy Photo

Wilkes Station, February 1957



Official U. S. Navy Photo

Ellsworth Station construction progress, February 1957

Byrd Station construction progress, January 1957

Official U. S. Navy Photo

Hallett Station, February 1957

Ellsworth and Wilkes Stations

The Ellsworth Station was constructed in January 1957 on the Filchner ice shelf, east of Gould Bay and edging the Weddell Sea, and Wilkes Station was erected in January 1957 on Clark Island in Vincennes Bay, off the Knox Coast. The latter fills an important gap in the international coverage of the continent between the French Station on the Adelie Coast and the Soviet stations on the Queen Maud Coast.

Hallett Station

Hallett Station, a joint New Zealand-United States station, was also established during January 1957 at Cape Hallett. It is fulfilling an extremely important role in the meteorological network of the continent.

McMurdo

The Naval Air Facility, located at Hut Point on Ross Island in McMurdo Sound, serves primarily as the base of operations for the airlift to the South Pole Station and for long-range air supply of the Byrd Station.

UNITED STATES ANTARCTIC INTERNATIONAL GEOPHYSICAL YEAR RESEARCH PROGRAM

All stations are conducting programs in aurora, ionospherics, and meteorology. With the exception of Little America and Ellsworth Stations, located on floating ice shelves, all United States stations have seismology programs, and all but Hallett, established in terrain which is snow-free during the summer, have glaciology programs. Geomagnetic observations are being made at all stations but Ellsworth.

At Wilkes and Ellsworth Stations, cosmic ray observations are made. Meteorological and glaciological studies are conducted at the small Wilkes Icecap Station, and meteorological observations are made at the Air Facility at McMurdo.

The oversnow traverses include programs in glaciology, gravity, meteorology, and seismology. Aboard ships to and from Antarctica, observations are made in cosmic rays, meteorology, oceanography, and rocketry. Collateral investigations are being made in dentistry, physiology, psychology, and zoology. Summer studies in botany and microbiology are being conducted.

A number of important observations already have been made, as well as some startling avenues of speculation and further investigation and analysis opened up by the results of the first few months. These are outlined in the report for the period July 1957–January 1958 by the USNC Antarctic Committee to the ICSU, which is contained herein as appendix V. The full program of the USNC Antarctic Committee is set forth herein as appendix VI, and we believe it unnecessary here to dwell upon it in detail. There are a few aspects of the program, however, which we do wish here briefly to mention.

Antarctic glaciology

Perhaps the most comprehensive United States Antarctic program is glaciology which has for its main objectives the gathering of definitive information on the present volume of the Antarctic ice, the topography of the ice surface and the land beneath the ice; investigation of the present status of the Antarctic ice sheet (whether it is gaining or losing in mass and volume, and the manner in which this gain or loss is taking place); and obtaining information relating to the history of the Antarctic ice and the determination of the trend of the ice and how it will react to changes in solar radiation and ocean temperatures. Observations will be made both at the stations and by oversnow traverse parties.

Oversnow glaciology traverses

Intensive studies of the ice sheet are being made by three such traverse parties traveling over a wide area from Little America, Byrd, and Ellsworth Stations. Limited traverses are also being made from Wilkes Station. These parties which operate from November to February, are kept small, 3 to 4 vehicles and 5 to 6 men, for maximum mobility and efficiency. They are resupplied entirely by air support during the traverse, and each party carries a "crevasse detector" for maximum safety. Information from these traverses, which cannot be obtained in any other way, will go far toward determining the climatic patterns of the interior of Antarctica and the hydrological budget of the ice sheet.

The traverse parties from Little America are studying the Ross Ice Shelf and the Rockefeller Plateau area in the western portion of Marie Byrd Land. The Ellsworth traverses are covering the Filchner Ice Shelf and portions of Edith Ronne Land. The traverses from Byrd Station are examining the Ellsworth Highland and the area to the south toward the pole. These traverses are being conducted during the present Antarctic summer season, 1957–58, and will also take place during the 1958–59 summer season. During these traverses observations will be made in glaciology, seismology, and gravity. Corollary work will include gross topographical mapping, as well as collection of geological samples from exposed nunataks.

Antarctic Meteorology and Weather Central

A full surface and upper-air meteorological program is in operation at all United States stations in Antarctica. These stations complete the meridional lines of IGY stations so that for the first time meteorologists are able to prepare atmospheric cross sections from pole to pole. These stations are also part of the network of more than 40 Antarctic meteorological stations. Thus, also for the first time it is possible to draw meteorological charts, both surface and upper air, of the entire southern polar region using observed data.

In order to utilize effectively the meteorological data from all of the Antarctic stations and to prepare weather forecasts and advisories for the many scientific and exploratory operations of all countries participating in the IGY, an IGY international Antarctic Weather Central was organized at the request of the international IGY coordinating body by the USNC–IGY and established at Little America Station during early 1957. The Weather Central, to which are attached several meteorologists from other countries in addition to the United States staff, collects, analyzes, and disseminates to other meteorological centers, synoptic weather reports from every meteorological observatory in the Antarctic region. This is accomplished by means of a complex communications system relaying weather reports from every source through fixed subcollection centers on regular schedules to the Weather Central. Data are also received from whaling vessels, expedition ships, aircraft, and oversnow transverse parties.

In our visit to this station we had opportunity of observing the operations of weather control which is in charge of William B. Moreland of the Weather Bureau in Washington and of B. W. Harlin, and conversed with J. A. Alvarez of Argentina and V. I. Rastorguev from Russia, who are attached to the station.

Geomagnetism, ionosphere, and radio propogation

The geomagnetic program for Antarctica emphasizes surface observations which provide data on temporal changes in the magnetic field of the earth. The results of these measurements will be useful in the interpretation of observations at the same sites in other disciplines, particularly in auroral and ionospheric physics. One of the reasons for the IGY is the study of why the earth has a magnetic field. To assist in the study a string of stations has been built from the North Pole to the South Pole so that simultaneous attention might be given to the effect of solar activity. Under the direction of the Geodetic Survey, we have stations at Little America, Byrd, Wilkes, and the South Pole. At Little America we visited at some length with J. O. Annexstad, of the Geodetic Survey, at the time of an unusually severe geomagnetic storm.

During periods of maximum solar activity and the ensuing "geomagnetic storms," radio communications are often interrupted by fadeouts or blackout. On these occasions pulses transmitted to the ionosphere by ionosphere sounders are not reflected as usual but absorbed. The work in the ionosphere and radio propogation being conducted in the Antarctic is of unusual significance, as the origin of the ionosphere which enables radio communication is in ultraviolet rays, and for 6 months of the year there is little ultraviolet in Antarctica. Ionospheric physics measurements in the Antarctic include vertical incidence sweep frequency soundings at all scientific stations, recording of atmospheric radio noise at Byrd Station, and recording of whistlers at Ellsworth Station. At Little America, we observed the type of observations being taken under the direction of Hans Bengaad (of Denmark).

OPERATIONS DEEP FREEZE

Logistic responsibility for the establishment and maintenance of the scientific stations in Antarctica was assigned to the Department of Defense, which, in turn, owing to the Navy's long tradition in the Antarctic, was assigned to the Department of the Navy. Early in the Navy's planning and operations it became evident that full success for the proposed program would require the assistance of all the military services, and they readily and freely cooperated in supplying the forces which make up Task Force 43, the logistic supply for Antarctica.

The history of the planning for this logistic operation, the landing of equipment in the Ross Sea, the building of the supply bases, the overland tractor train and establishment of the interior Marie Byrd Station, the air lift of personnel and equipment for the erection of a station at the South Pole, the penetration of the Weddell Sea and Knox Coast for construction of the Ellsworth and Wilkes Stations, the creation of a runway and air facility at McMurdo, and the furnishing of personnel to man and supplies to maintain the United States and New Zealand stations, represent a saga ranking with the top of man's most heroic exploits and achievements.

The story has been told in words and pictures, in the press and on television, and though our own experience in being privileged to observe some of these accomplishments and to meet with the men who participated in them would prompt the retelling, we refrain from doing so. To round out the Antarctic picture, however, we comment briefly here on the chief aspects of the preliminary phases and of the various Operations Deep Freeze. So that one who wishes may obtain a better appreciation of just what is involved in these operations, we are including as appendix VII the report of Admiral Dufek, commander of Task Force 43, on the mission and results of Deep Freeze II, the 1956–57 phase.

Cruise of the U. S. S. "Atka," 1954–55

During the fall of 1954, attention turned to the expeditionary phases of Antarctic operations. The United States Navy, which had been given the responsibility by the United States Government for implementing USNC–IGY logistic requirements for its Antarctic operations, began to organize a staff under the command of Capt. (later Rear Adm.) George Dufek. This staff, which was subsequently reorganized as Task Force 43, had for its first responsibility the organization of a reconnaissance expedition by the icebreaker U. S. S. *Atka.*

The *Atka* left the United States on December 1, 1954, on a 4-month voyage. Its primary mission was to investigate the Antarctic coast for possible station sites. It was discovered that a substantial portion of the Bay of Whales, where four previous United States stations had been established, had disappeared with the breakoff of a massive section of the shelf ice. Kainan Bay, 30 miles to the east, was determined to be the only access to the Ross Ice Shelf in this area. The *Atka* continued its voyage eastward, skirting the icepack and carrying out reconnaissance of other possible station sites. During the voyage a limited number of scientific observations were carried out in such fields as meteorology, cosmic rays, oceanography, glaciology, seismology, and radio wave propagation.

With the information made available by the voyage of the *Atka,* the USNC–IGY further developed its Antarctic program plans. These were outlined as the First and Second CSAGI Antarctic Conference at Paris and Brussels during the summer and fall of 1955. Representatives of 11 national IGY committees coordinated their Antarctic programs at these conferences, discussing not only their anticipated scientific program, but also such topics as the best distribution of stations and the critical interstation Antarctic communications network which was to be established.

At the Paris Conference, the United States delegation assumed responsibility to establish two additional stations in Antarctica, one on the Filchner Ice Shelf in the Weddell Sea, and the other on the Knox Coast of Wilkes Land. The Brussels Conference resulted in the development of plans jointly by the United States and New Zealand National IGY Committees to establish and maintain a station in the vicinity of Cape Adare (subsequently changed to Cape Hallett).

1955–56 operations (Deep Freeze I)

The 1955–56 United States expedition, under the name Operation Deep Freeze I, had for its mission the construction of Little America Station at Kainan Bay on the Ross Ice Shelf and a naval air facility at Hut Point, Ross Island, in McMurdo Sound. The United States National Committee together with the Navy formulated the details of the expedition and of the construction of the primary scientific station and the two inland stations which were to be established subsequently.

This expedition transported all construction and plant equipment and most of the scientific material for the Little America, Byrd, and South Pole Stations as well as for the naval air facility, which was established at McMurdo Sound. The expeditionary work was carried out successfully and the Little America Station was completed in February 1956.

A site was located for the later construction of Hallett Station at Cape Hallett on the east coast of Victoria Land, and for Wilkes Station at Vincennes Bay, on the Knox Coast. In addition, nine long-range exploratory flights were successfully completed, including reconnaissance over areas where the South Pole and Byrd Stations were to be established during the following season. Again limited scientific observations were made. One of the ships was specially equipped with a cosmic radiation laboratory, which operated continuously throughout the expedition. The neutron monitor, which was utilized, gathered information which led to a more precise positioning of the magnetic equator, upsetting earlier conceptions of its location. A special meteorological unit operated as a weather center throughout the expedition, receiving reports from all ships as well as from land stations.

A third international CSAGI Antarctic Conference was held in July 1956 at Paris to coordinate the final effort for the establishment of the IGY stations and the initiation of the scientific programs. Plans were refined for the communications system and for the establishment of the Antarctic IGY Weather Central at the United States Little America Station.

1956–57 operations (Deep Freeze II)

The United States operations during 1956–57 began during September and October when units of the Naval Air Development Squadron Six and the 52d Troop Carrier Squadron of the 18th Air Force arrived in New Zealand. On October 20, airlift operations to Antarctica began. A number of preliminary reconnaissance flights were made over the South Pole and over the Beardmore, Scott, and Liv Glaciers, resulting in the establishment of an auxiliary air facility at the foot of the Liv Glacier on October 29. This station was to serve as an emergency refueling point for the later cargo flights during the establishment of the South Pole and Byrd Stations.

On October 31 the first historic landing since Amundsen and Scott reached it in 1911–12 was made at the South Pole by Adm. George J. Dufek in a ski-equipped Navy R4D aircraft. With him were Capt. Douglas Cordiner, Lt. Comdr. Conrad G. Shinn, pilot (who flew us trom McMurdo to Little America this past fall); Capt. William Hawkes, copilot (who has a long history of Antarctic reconnaissance flights); Lt. John Swadener, navigator; John Strider, AD2; and Dearney Aville, WYA. Landing at 2034, they remained 45 minutes and returned to McMurdo Sound with a stop at Beardmore Glacier for refueling. The flight was accompanied by Air Force Globemaster (Maj. C. J. Allen, pilot) of the 52d Tactical Squadron, which circled overhead during landing. The temperature was −57° F. and takeoff performance extremely marginal, even with the assistance provided by 15 jet-assist takeoff bottles. Owing to these conditions, further operations in this area were delayed until November 20 when the first airlift of construction personnel and equipment was made. Round-the-clock airdrops were made during late November and early December as construction of the station began. By March 25, 1957, final details of construction were completed at the station, which has been determined to be within 1,000 yards of the geographical South Pole. Wilkes, Hallett, and Ellsworth Stations were also constructed during this period by separate ship operations, and Byrd Station by an oversnow tractor train operation from Little American Station.

1957–58 operations (Deep Freeze III)

Deep Freeze III executed a plan utilizing minimum forces to resupply the stations established in the Antarctic during Deep Freeze I and II in support of the United States National Committee for the International Geophysical Year.

The basic mission was to resupply the established stations, replace wornout equipment, perform supplementary construction, and to transport the relief scientific and naval personnel to the Antarctic, and to return the relieved personnel to the continental United States.

In order to provide the required air support for this operation, Navy long-range aircraft arrived at Wigram Aerodrome, and USAF cargo aircraft arrived at Harewood Field, Christchurch, New Zealand, prior to September 15, 1957. A United States Navy destroyer escort was stationed as picket midway between New Zealand and the Antarctic to provide weather data, communications guard and homer navigational facilities. A Navy icebreaker provided surface search and rescue potential in the event of a plane crash on sea ice.

On October 1, 1957, aircraft of the Navy and USAF commenced lifting cargo and personnel into the Antarctic from New Zealand. Upon arrival at McMurdo Sound ice airstrip, the personnel for the outlying stations at Little America, Byrd, Hallet, and South Pole were delivered by Navy aircraft to destination.

When the fly-in of cargo was completed from New Zealand, globemasters of the USAF 53d Troop Carrier Squadron commenced the resupply of South Pole Station and Byrd Station, by airdrop. The resupply by airdrop of the above stations amounting to over 700 tons was completed on schedule and the personnel relieved and returned to the continental United States prior to Christmas.

In addition 2 round-trip tractor trains, consisting of seven 35-ton D–8 tractors, each pulling two 20-ton sledges, supplied Byrd Station with some 300 tons of cargo from the Little America Base. Total resupply logistic operation for the 1957–58 season required transport to Antarctica of approximately 30,000 tons of equipment and supplies, and 700,000 gallons of bulk petroleum.

Ship units of Task Force 43 commenced surface resupply operations of the coastal stations at the beginning of the navigational season in

December 1957. Resupply of all stations was completed on schedule by February 1, 1958.

Air operations experienced a number of forced landings at various points en route South Pole and Byrd Stations., but all aircraft were subsequently repaired under extreme conditions and continued to operate in support of the assigned mission.

The U. S. S. *Atka* (AGB–3) suffered one broken propeller blade. The U. S. S. *Glacier* suffered 2 broken blades and 2 cracked, which were subsequently repaired in drydock in Wellington, New Zealand. The *Atka* is scheduled for repairs in the next few days.

The U. S. S. *Burton Island* (AGB–1) is en route to assist the Japanese ship *Soya Maru* penetrate the heavy pack ice in the vicinity of the Japanese station on the Prince Olav coast.

Scientific projects carried out aboard USN vessels and still in progress include oceanography, cosmic ray, rockoon exploration of the upper atmosphere, and meteorology.

Admiral Dufek made the first solid-ground landing in the history of the Antarctic Continent, on January 31, 1958. The landing was made on a newly prepared strip of beach at Marble Point in the Cape Bernacchi area. The Navy is currently conducting a 2-year survey to determine the feasibility of the Marble Point area as a possible site for a major, year-round, solid-earth airfield. We had opportunity of viewing this area on November 25 and comment elsewhere on the significance of a landing strip here.

Operation Deep Freeze I cost $9,124,000, 2 lives, and extensive ship damage from ice. Operation Deep Freeze II cost $22 million and 6 lives. The total loss in lives has been 9 since 1954: 1 in helicopter crash in 1954; 2 through the ice in 1955–56; 4 in plane crash, 1 through the ice, 1 in helicopter crash. Considering the magnitude of the task, this is a splendid record, and is comparable with that of any undertaking of 3,500 men, year after year, involving some 35 aircraft and 12 support ships that are at sea 5 to 6 months.

Aviation—Arctic

The great upsurge in international and intercontinental air traffic following the close of World War II and the development of longer-range aircraft led to increased interest in "great circle" routes through the Arctic regions.

To the committee, at the time of its visit to Stockholm in the fall of 1953, Scandinavian Airlines System expressed its interest in a route from Scandinavia via Greenland to Edmonton, Canada, branching from Edmonton to Los Angeles, and from Edmonton via Alaska to Tokyo. That airline already had made exploratory flights in November and December 1952 with DC–6B aircraft covering the Scandinavia-west coast route, and in May 1953 and in April and May 1954 with DC–6B aircraft made survey flights between Oslo, Stockholm, and Copenhagen via Bodo, Thule or Frobisher Bay, Anchorage or Fairbanks, Shemya or Cold Bay, and Tokyo. Following request by the Danish Foreign Office of the State and Defense Departments in the fall of 1951 for permission to operate a survey aircraft from Los Angeles to Copenhagen via Canada and Thule, the 3 Scandinavian countries in September 1952 made formal request of the State Department to open negotiations for a route from Scandinavia via intermediate points to points on the west coast. In August 1954, Scandinavian Airlines System applied to the Civil Aeronautics Board for a certificate covering the Scandinavia-Los Angeles route. The Board, because it questioned the economic feasibility of the route, granted only a 3-year permit, which was approved by the President in October, and service commenced in November 1954.

Initial twice-weekly service with DC–6B equipment provided for fuel stops at Sondre Stromfjord, Greenland, and Winnipeg, Manitoba, breaking the route into 3 segments of 2,176 miles Copenhagen to Sondre Stromfjord, 1,987 miles thence to Winnipeg, and 1,573 miles Winnipeg to Los Angeles. By March 1955, service was increased to 3 flights weekly, by April 1956 to 5 flights weekly, and for July–September 1956, and again starting April 15, 1957, to 7 flights weekly. With inauguration of DC–7C equipment early in 1957, flights are made with only a stop in Winnipeg except 2 each which also stop at Sondre Stromfjord at request of Danish Government.

The committee had occasion in the fall of 1955, in the course of its study of current developments in the jet and feeder-type-replacement aircraft fields, to utilize this route from the west coast to Europe. On its return, the committee in the course of hearings again made an effort to ascertain reasons delaying the entry of American carriers into this route, and found no American carrier seemed especially impressed with the traffic potential. In the meantime, in the United States-German bilateral air agreement concluded July 5, 1955, and in the amendment to the United States-British bilateral agreement concluded August 16, 1955, a west coast-Europe route was made available to the carriers of each of those countries.

With Scandinavian increasing its frequencies and showing a load factor rising from 65 in 1954–55 to 69 in both 1955–56 and 1956–57, awakened interest was shown by American carriers, and both Pan American World Airways and Trans World Airlines applied to the Civil Aeronautics Board for the Hudson Bay route. Certificates from west-coast points to London and Paris were granted to each, and service commenced via Frobisher Bay, on Baffin Island, in September 1957. Each is scheduled four times weekly, Pan American with DC–7C equipment and Trans World with Super-Constellations. Both have experienced direct flights without need for the intervening fuel stop at Frobisher Bay. All three airlines, Pan American and Trans World which do not reach the Arctic Circle at Frobisher Bay, and Scandinavian, which is just over it at Sondre Stromfjord, euphuistically advertise this route as a polar route.

Scandinavian's earlier decision to postpone activation of the North Pole route via Alaska to Tokyo until the availability of longer range commercial aircraft, was revised with the advent of DC–7C equipment. In January 1955, the Scandinavian countries took up with the State Department a proposed Scandinavia-Alaska-Tokyo route, and requested traffic rights for the Alaska-Scandinavia segment. Though the latter were not granted, Scandinavian notified the Civil Aeronautics Board January 14, 1957 of its intention to proceed with the route, making Anchorage a fuel stop only, and on February 24, 1957 initiated service.

Service over the North Pole route now consists of twice weekly combined first-tourist class, with DC–7C equipment. The flight from

Copenhagen over Norway, Spitzbergen, the North Pole, and Fairbanks into Anchorage is some 4,507 statute miles, with a 17-hour schedule. The flight from Anchorage to Tokyo is 3,695 miles with a 13½-hour schedule. The total distance is 8,202 miles, compared with Scandinavian's Copenhagen-Karachi-Bangkok-Tokyo route of of 10,281 statute miles, and with Copenhagen-New York-Tokyo routes of some 11,000 to 13,000 miles. In elapsed time, the flight over the North Pole is some 31½ hours compared with 51 hours via Bangkok.

Traffic over the polar route has been better than 60 percent load factor on aircraft with a usual configuration for 45 passengers, including berths (though it was nearly 100 percent load factor at the time of our trip over the route last November). It is understood that Scandinavian is currently negotiating for a third flight weekly.

Air France has concluded negotiations with the Japanese Government for an Arctic route to France, and has announced service will be commenced in June 1958.[1] KLM also has the approval of the Japanese Government for an Arctic route, upon giving 6-month notice at its inauguration, but to date KLM has not announced its intention. It is understood that the Japanese Air Line will seek a Tokyo-Alaska-New York route, as will the Korean Airline, and that Philippine Air Line also desires a similar route. To date, although American carriers are flying "great circle" routes from the west coast to the Orient on the one hand, and to Europe on the other, no American carrier has expressed an interest in the polar or Arctic routes.

The communications system servicing the North Pole route consists of stations at Lulea, Sweden; Andenes, Norway; Isfjord, Spitzbergen; Nord and Thule, Greenland; Resolute Bay, Cornwallis Island, Canada; and Point Barrow, Alaska. Scandinavian has experienced fairly stable communications conditions for the east part of the Polar network east, where the ground stations at Andenes, Isfjord, and Nord, engineered for maximum ground radiation, provide a solid coverage of the area overflown. Within the west part of the network east, and within the east part of the network west, the communication is still good, although the great distances between the network stations indicate that the coverage of airborne and ground-based stations does not provide as good an overlap. While outages in air-ground communication and outages in the point-to-point radio link from network stations do occur, the airline's experience has been that in a comparison of the communications reliability of the Polar route with the North Atlantic routes, better success has been obtained along the Polar route than for flights over the North Atlantic.

Scandinavian's experience with flying conditions in the Polar regions has been that they are much more favorable than the conditions on the North Atlantic routes. Icing and turbulence have not been experienced north of 75° N. Tops of clouds are much lower over the Arctic than over the North Atlantic, and ontop flying is the general rule. During the summer the average altitude of cloud tops is of the order of 11,000 to 12,000 feet, with occasional thin layers above. In late autumn, winter, and early spring, the tops are normally below 6,000 feet.

The airline's comparison of the USAF Ptarmigan flights, Fairbanke to the North Pole, with the North Atlantic flights shows that ths

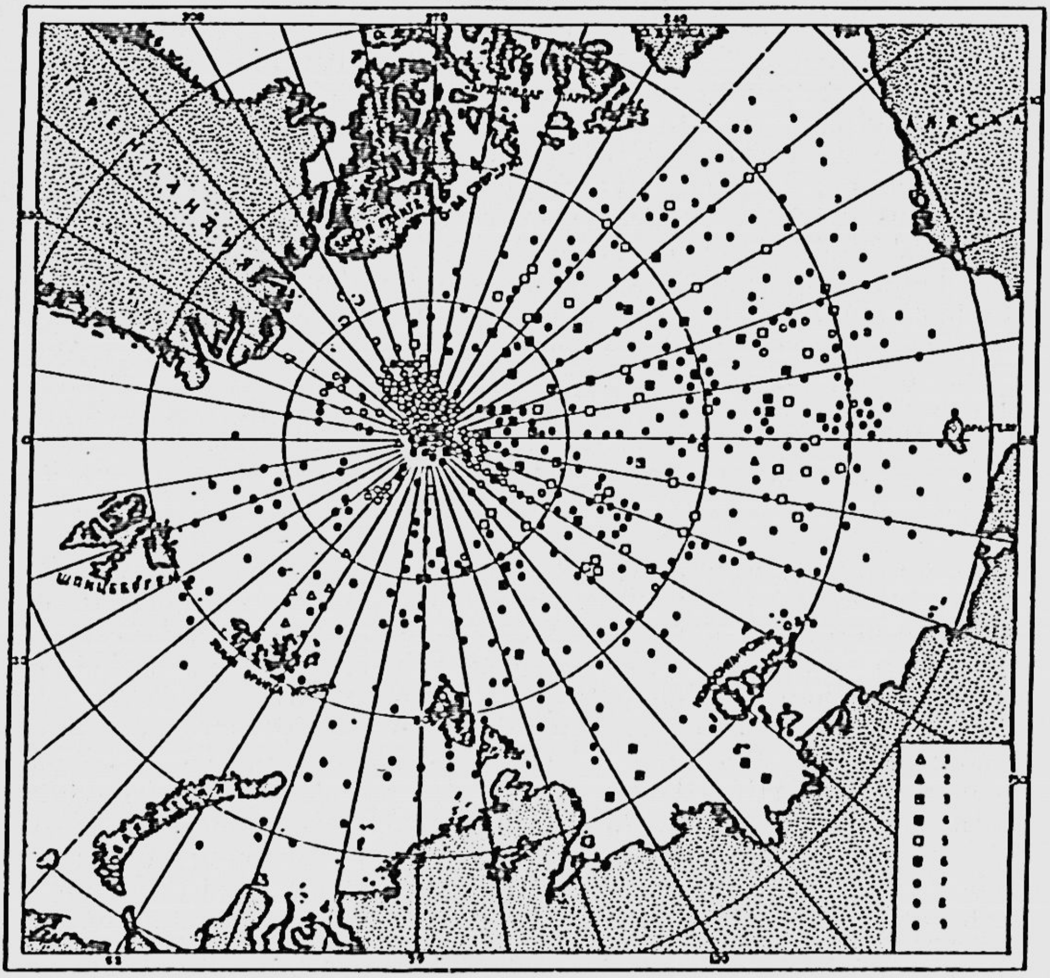
[1] Air France's survey flight to Tokyo on January 27 and 28, 1958, was made in a Constellation 1645, Paris-Anchorage nonstop, and Anchorage-Tokyo, nonstop. It is not yet known what fuel stops may be involved, any, under payload traffic conditions.

percentage of time icing occurred over the Ptarmigan route was 2 percent compared with 19 percent over the North Atlantic. Over the Ptarmigan course precipitation was reported in only 1 case out of 753 reports, whereas 14 percent of the flight time over the North Atlantic was in precipitation. Continuous instrument flights were found to exist 13 percent of the time over the North Atlantic compared with the smaller figure of 4 percent over the Ptarmigan track.

Meteorological service for the North Pole flights is provided by the Government Meteorological Office in Copenhagen and the United States Weather Bureau Office in Anchorage. These offices receive all synoptic surface and upper air data from the Russian weather stations as well as from the five Russian ice stations in the Polar Basin during the winter period.

In connection with the Russian activities in the Arctic it is of interest to note the extensive number of landings made by Soviet aircraft on the Arctic ice pack during the 20-year period 1937–56. (See map.)

LANDINGS MADE BY RUSSIAN AIRCRAFT ON THE ARCTIC PACK ICE DURING THE PERIOD 1937–56



Карта станций, осуществленных Высокоширотными воздушными экспедициями разных лет: 1—экспедиция 1937 г.; 2—1941 г; 3—1948 г,; 4—1949 г.; 5—1950 г.; 6—1950 г. (гидросамолет); 7—1954 г.; 8—1955 г.; 9—1956 г.

(Translation): Map of the landings made by the high-latitude aerial expeditions of the various years: 1—expedition of 1937, 2—1941, 3—1948, 4—1949, 5—1950, 6—1950 (hydroplane), 7—1954, 8—1955, 9—1956.

AVIATION—ANTARCTIC

With Operations Deep Freeze I, II, III clearly demonstrating that aircraft can be flown into and within Antarctica, question naturally arises as to the future of Antarctica on any international air routes. One informed observer commented as follows to the committee:

> I think we are in Antarctica today where we were in the Arctic about 10 or 15 years ago. The great circle—the air route—over Antarctica is the same as over the North Pole.
>
> Up to the present time, there has not been a demand for shorter air routes over the South Polar area because the trade is not as heavy in the Southern Hemisphere as that in the north. And, at the present time, we get from Chile or Argentina to Australia by flying up north over Honolulu and down again. Approximately one-third of the distance would be saved if we flew over the South Polar region.
>
> I believe that within the next 10 or 15 years the Northern Hemisphere will become saturated and that large numbers of people living in the Northern Hemisphere will of necessity, convenience, and economic advancement, move into the Southern Hemisphere, in view of the fact that opportunities are opening up in South America, Africa, Australia, and New Zealand. When that happens, and such change may not be too far distant, possible South Polar air routes (air operations) will be as relatively important as they are now over the Northern Hemisphere.

The savings in distances through use of the great circle Antarctic routes between points in the Southern Hemisphere as against present Mercator routes are as pronounced as those in the Arctic. From Punta Arenas, Chile, to Christchurch, New Zealand, direct is 4,142 nautical miles, or via McMurdo Sound is 4,726 nautical miles, compared with 12,562 miles in the present route via Los Angeles and Honolulu. From Capetown, South Africa, to Christchurch, New Zealand, direct over Antarctica is 5,943 nautical miles, or via McMurdo is 6,060 miles, while the present route through Mauritius, Cocos, Darwin, and Sydney is 9,516 miles.

Equally as startling as the savings in route miles obtainable through use of great circle Antarctic routes, is the creation of alternate routes that this great circle makes possible. From London to Christchurch over present routes it is some 13,300 statute miles via New York, San Francisco, and Honolulu, and some 13,200 statute miles via the Middle East, India, and Australia. Compared with this is a possible route of some 13,400 statute miles, London, Rio de Janeiro, Buenos Aires, and Antartica to Christchurch. Indeed, compared even with New York to Christchurch, New Zealand, a distance of approximately 10,000 statute miles average on existing routes via San Francisco and Honolulu, the possible alternate route via Santiago and Punta Arenas, Chile, and Antarctica, appears to be less than 10 percent longer.

From a tourist point of view, the magnificent scenery of the Andes can be matched, if not surpassed, only by the grandeur of the glacier-capped sheer mountain peaks of the Victoria Range bordering the Ross Sea. The potentialities of tourist, let alone commercial, travel, to the Far East, or around the world, starting from the United

States southward through South America, and including the wonders of the Antarctic, the beauties of New Zealand's Southern Alps, and the bustle and charm of Australia, stagger the imagination. As one of our group, the indominable Robert Hale, who, next to Sir Hubert Wilkens, holds the distinction of being the eldest statesman to reach the South Pole, put it:

> I can see a travel office right now on Fifth Avenue with posters depicting the glories of Mount Erebus and of the Beardmore Glacier; this scenery is unsurpassed in the world.

The utilization of the Antarctic route depends, of course, upon adequate air navigational and base facilities. Presently the direct distance from Punta Arenas, Chile, to New Zealand, stretches the operational range of today's aircraft, although flights exceeding this distance are made regularly, under favorable weather conditions, over both the North Pole and the Hudson's Bay Arctic routes. A landing field for fueling and other purposes presently is required in the Antarctic, with the area of McMurdo Sound being the logical choice. This divides the distance, though slightly longer, into extremely feasibly segments, shorter than those flown every day between New York to Europe. It also provides the means for viewing some of the great land mass of the Antarctic.

The present runway at McMurdo consists of a landing strip laid out on the bay ice. This was made operable during the period of Deepfreeze I, and on October 20, 1955, the first planes were flown into the Antarctic from a land base, covering the distance from New Zealand in some 14 hours. From this base, a series of reconnaissance flights was made over Antarctica before the deterioration of the bay ice impaired the safety of the landing strip and necessitated the return of planes to New Zealand on January 18, 1956.

In Deepfreeze II operations, the Air Force flew into McMurdo on October 26, and made some 7 flights from McMurdo in dropping 1,000 tons of equipment and supplies for the South Pole and Marie Byrd Stations. From here, Admiral Dufek and Capt. William Hawkes took off by Navy skiplane on October 31, 1956, and made a successful landing at and takeoff from the South Pole. This was followed by Navy skiplanes taking in engineers for construction of a base and scientists and military personnel for manning it. By December 19, 1956, the deterioration of the ice runway in the summer thaw was sufficient to necessitate the flying back to New Zealand of the land-based Globemasters. The runway was repaired and became operable by February 9, 1957, and airlift operations of food and supplies to interior posts was reinstituted.

Again, in the Deepfreeze III activities, the runway became usable early in October 1957, and with the experience gained during the previous years and under the proficient direction of Comdr. Bill Flynn, was operable until Christmas 1957. During this period the Air Force from McMurdo made some 50 drops at the South Pole and Marie Byrd Stations of over 1,370,000 pounds of equipment and supplies.

It is clearly evident, however, that despite the astounding and heroic feat of establishing and maintaining this runway, the utilization of this airstrip for land-based planes depends upon the vicissitudes of the weather, the warmth of the summer and firmness of the ice, and of the existence of the bay ice, itself. The icebreaking operations enabling supply ships to enter the sound have successively encroached on the permanent bay ice. Moreover, some 30 years ago the sound was relatively free of ice and at the time of the Scott-Shackleton expeditions, 50 years ago, it was sufficiently free of bay ice to permit ships to reach Ross Island and Pram Point without icebreakers. Such condition might easily recur.

Permanent and regular air service into and through the Antarctic thus must be predicated upon the location and establishment of a permanent landing strip. Such seems to have been found across McMurdo sound at Marble Point near Cape Bernacchi. If this location should prove up to its suggested potentialities, the problem of adequate landing facilities may be resolved.

While today's operation of the Arctic routes, and of flights into the Antarctic, is a great tribute to the navigational skill of the flight personnel, the standard air navigational aids in both regions need considerable improvement. The achievement of greater reliability in radio communications in the polar regions, as well as better forecasting of weather conditions, is one of the major results which we believe will come from the studies of the International Geophysical Year. Such achievement will make international flying via the Antarctic fully feasible and provide the safety features that are desired. We, ourselves, experienced radio communications blackouts that also affect all electronic equipment, and appreciate the uncomfortable feeling that can accompany navigation only by ability physically to observe one's position.

Weather, of course, is not always most favorable for visual landing in McMurdo Sound area, and many landings have been skillfully effectuated through use of GCA and other electronic aids. Such problem, however, is one that is not confined to that area, and exists today in transoceanic arrival at either of our coasts. It is only somewhat accentuated through the absence of alternate open landing fields.

OBSERVATIONS AND RECOMMENDATIONS

The importance of the International Geophysical Year studies

From the information presented to us, as well as from our own observations, we are convinced of the importance of the studies being conducted under the International Geophysical Year. We cannot express this better nor more concisely than has our chairman:

> We are convinced that it is one of the most important undertakings and could have the most far-reaching implications of any scientific work we have anywhere at this time.
>
> The American people should not get any other idea, because some of the things that are being found out now about the behavior of the earth as it reacts to some of the happenings in the solar system will have great bearing on the future course of human existence.

Geophysics is the application of the tools of physics to the study of the earth and its atmosphere. All of man's major activities are inextricably bound up with the geophysical sciences. To a large extent they are the determining factors in such fields as agriculture, transportation and communication of all sorts. Because of his ever-increasing mobility man must know more and more about his environment. Safety on land, sea, and in the air depends upon better forecasting of the weather, better knowledge of usable radio frequencies, and better knowledge of the upper air for transportation and guided missile flights.

All geophysical phenomena are related in one way or another to the sun, which is the principal source of all energy that reaches the earth. In the succinct words of Dr. Laurence Gould:

> Man's existence depends upon man's knowledge of his environment and this environment is dependent upon the sun.

Thus it has naturally followed that the interval 1957–58 was selected for the observations and studies of the International Geophysical Year, for solar activity is near the top of its 11-year cycle at this time.

Geophysics has had a long period of incubation. Since the time of his earliest speculations about his world, man has been measuring the earth, recording data about its climate, its oceans, and other geophysical phenomena; yet even now, in the middle of the 20th century, our records in all fields of geophysics are fragmentary and local. The various fields are so intermeshed that no single discipline can advance indefinitely. Advance, in turn, is dependent upon the tools developed by the physicist and the engineer. With the electronic instrumentation now available, for the first time it has been possible to study these phenomena in and expect to receive results from a period of high-solar activity.

Certain accretions to our knowledge already have been obtained, although to a substantial degree the results of the observations taken during the International Geophysical Year will depend on future analyses. These noteworthy additions to our knowledge of these basic sciences have been strikingly summarized by Dr. Hugh Odishaw, Executive Director, USNC for the International Geophysical Year, and are included in appendix II.

We cannot but be impressed with the nature of the work being conducted in Antarctica in all of the geophysical disciplines, and especially with that in weather, the ionosphere, and radio propagation which have such immediate practicality in our commerce and transportation. We also are convinced of the importance not only of this work but of all our activities in that area. As Dr. Harry Wexler has stated:

> The plain fact of the matter is that with man's greater mobility, the earth is getting too small for the human race. As we cannot yet go to other planets, we must look at Antarctica and all spaces.

Additions to our knowledge already have been made, and these are summarized in the report on the Antarctic program included as appendixes V and VI.

Continuance of work on geophysical disciplines

While much already has been ascertained and may become known from the results of the current observations, much remains to be done. Indeed, constant and never-ending attention must be accorded studies and research in these basic sciences. Some results may be of immediate practicability, but ever-advancing contributions to basic knowledge must be sought to preserve and augment our ability to live in our environment.

We are concerned with the direction and magnitude that our post-International Geophysical Year program should take. The International Geophysical Year program contemplated that observations should cease at the end of 1958. Though such program be eminently successful, we must continue these scientific pursuits. We must have a further program. "Man must shape himself to a new mark once the old one goes to ground" (Sir Ernest Shackleton, October 27, 1914).

Obviously, the continuation of a program is of varying significance among the respective scientific disciplines. Manifestly, too, the prolonging of activities presents numerous concomitant problems, especially in Antarctica. There further are challenges in setting up a program in fields such as geology, where little yet has been essayed. There also are complications in continuing a program that has been privately directed with private funds as well as Government financial assistance and other support, although we believe the past arrangement under the overall direction of the National Academy of Sciences has been a successful procedure redounding to the greatest benefit to all.

We recommend that the National Academy of Sciences be called upon by the committee to assist the committee in its legislative deliberations, as it has in the past, by creating a committee to evaluate the United States participation in the International Geophysical Year, assess the studies under the respective disciplines and the need for continuation of work hitherto undertaken, and outline the organization and budget for the work deemed appropriate to be pursued.[2]

Continuation of logistic support by Defense Department

We have been impressed with the fine work carried on by our highly qualified participants in the International Geophysical Year program whether they be scientists, civilians, or military personnel. The cooperation we observed in Antarctica among the branches of our military services under the leadership of Adm. George Dufek in supplying logistic support to the scientists is spectacular. It is a fine example of unification, and together with the cordial and understanding cooperation existing between the services and the scientific personnel, illustrates the manner in which all can work together for the attainment of desired goals.

The logistic support has demonstrated the capacity of man, planes, vessels, and equipment to cope with the unusual and excessive demands placed upon them by the rigors of the polar region. These have been laboratories for the testing, proving, and developing equipment for the conditions of experiences. These activities should continue. We believe they have been and can be best handled by the Defense Department under this type of continued service participation.

We are mindful of budgetary considerations which arise in the Defense Department's rendition of logistic support for such scientific program. Although the Congress appropriated $39 million to the National Science Foundation for assisting the National Academy of Sciences' International Geophysical Year Committee, substantial additional funds directly or indirectly were utilized through Defense and other departments and agencies in the furtherance of the program.

[2] This has been done, by letter of Chairman Harris to Dr. Detlev Bronk, January 13, 1958. Dr. Bronk, on January 24, stated he was creating such committee, with Dr. Laurence Gould as chairman, and Dr. Harry Wexler as one of the members.

On the procedure of having numerous direct and indirect appropriations utilized for a continuing program as against combining these in one direct appropriation, we are conscious of need for further examination before we are prepared to express an opinion.

Maintenance of Antarctic stations

For a number of scientific reasons the Antarctic is best suited for the continuance of geophysical studies. These same reasons would be also applicable to the Arctic regions if those were equally possessive of a stable land mass for observation purposes. A few of such reasons may be recapitulated. As mentioned above, there is considerable speculation concerning the origin of our global weather in the Antarctic. Polar regions possess geomagnetic poles representing concentration of the earth's field of magnetic force and hence lend themselves best to the study of ionosphere, cosmic rays, and solar activity. The polar regions, too, are unique in that they have one long day and night, aiding the studies of the ionosphere, radio propagation and the ozone. The Antarctic is devoid of living vegetable or animal matter and thus particularly valuable to the study of the carbon-dioxide content of the atmosphere. The Antarctic also is of unequaled importance in supplying a stable platform for the observation of satellites having the highly significant north-south orbit.

We have established 5 scientific stations of our own and 1 in conjunction with New Zealand, together with a supply base for supporting these stations. The establishment, construction, maintenance, and staffing of these stations was a magnificent feat. Once established, the cost of maintenance is low; abandoned, the cost of reestablishment and rehabilitation is high. We believe that the scientific stations in the Antarctic should be continued. We recognize the possible desirability of certain adjustments in the location and operation of some of these stations and of the logistic supply base.

There are reasons, other than scientific, motivating a decision that these stations should be continued. At the September 9, 1957, meeting in Stockholm of the ICSU on the subject of the continuation of scientific study after IGY, the general tenor at first was negative as most countries felt the projects were too expensive. This consensus altered rapidly after the arrival of the Russian delegate, who was a day and a half late. The delegate indicated on a map where the Russian Antarctic stations were and where they wanted to go, said they expected to continue their studies in the Antarctic, and expressed the opinion that while Russia did not wish to influence other countries to go ahead if they did not wish to do so, they felt in such case new nations should be invited in to carry on the studies. The ICSU appointed several committees to consider post-IGY activity, and scheduled a meeting for early 1958 to determine what the participating nations would do.[3]

This country has been the first to establish a station at the South Pole, and is now operating the station at the South Pole. We are of the opinion that we should stay there. We are convinced that were this station to be abandoned by us, the Russians would take it over.

While our belief that these Antarctic stations should be continued is adequately buttressed by scientific interests, such possibility, as

[3] This is taking place at The Hague, February 3-6, 1958, with Drs. Laurence Gould and Harry Wexler as United States delegates.

well as other nonscientific reasons, but further emphasizes the need for their continuance.

A 1958–59 Antarctic program

While the nature of our scientific program and our other activities in all regions merits thoughtful and attentive consideration, time does not wait in the Antarctic. The summer season there is drawing to a close and with it, Operation Deep Freeze III for the logistic support of scientific stations in the Antarctic. Before the winter freeze sets in, decision must be reached whether to maintain or abandon the supply bases which have enabled the construction, provisioning, and staffing of the scientific stations.

We are fully conscious of the fact that a long-range program cannot be worked out within a short time. We are equally conscious of the fact, however, that some program must and will eventually be evolved. No gap must occur, however, in our activities in the Antarctic.

We recommend that it straightway be decided that our activities in the Antarctic will continue for another year, that the National Science Foundation prepare a budget for additional funds enabling it to continue to act as fiscal agent for the scientific studies, and that the National Security Council authorize and direct the Defense Department to furnish logistic support.[4]

Airports and aviation

The maintenance and supply of scientific bases in the Antarctic necessitate the establishment of a permanent supply base. The present supply base on Ross Island in McMurdo Sound is a temporary one. It was so constructed merely to meet the exigencies of the International Geophysical Year period. It further depends for air contact with the outside world upon a runway built upon bay ice. Outstanding as has been the feat in establishing this runway, its utilization is limited to a short period in the spring before the summer thaw and a short period before the long winter sets in. Furthermore, the runway itself is in jeopardy as the bay ice has been receding and, indeed, at times in past years it has been nonexistent at this point as evidenced by the Scott expeditions.

There appears present a potential windswept, snow-free airstrip location across the sound at Marble Point. Studies should be made to determined the feasibility and cost of construction of air facilities at this point.[5] If such studies prove their feasibility they should be constructed. In anticipation of the location of air facilities in the Ross Sea area, consideration also should be given to the United States position under our bilateral and multilateral agreements and otherwise, respecting international air routes to and through Antarctica.

We also are firmly of the opinion that renewed consideration should be given by the committee to the establishment and operation of an air route, whether a national-interest route or otherwise, by an American carrier over the North Pole. Without in the least detracting from the credit due Scandinavian Airlines for pioneering this

[4] Under date of January 17, 1958, we so recommended to the President. On January 24, Dr. Alan T Waterman, Director, National Science Foundation, informed the committee that the United States would continue scientific operations in the Antarctic beyond December 1958, and that the Navy was issuing instructions to Admiral Dufek to make necessary preparations for continued support of the scientific program beyond the International Geophysical Year period.

[5] On January 31, 1958, 2 single-engine Navy Otter planes made the first landing on ground in the Antarctic, when they landed on a 1,200-foot runway carved out by Navy Seabees at Marble Point. In the first plane were Adm. George Dufek, Sir Edmund Hillary, and a group of correspondents.

route, we are amazed in view of the long and prominent record of the United States in aviation fields, that we have lagged behind in the establishment of this route as we did in that between our west coast via the Arctic to Europe. The need for such renewed consideration is enhanced by the already indicated following of Scandinavian by Air France and KLM in operation over Arctic regions.

Resolution of territorial claims

While the understanding of the participating nations in International Geophysical Year is that territorial claims will not be made during International Geophysical Year, the establishment of permanent scientific stations in the Antarctic and of facilities for their supply as well as the development of air routes, precipitates the need for attention to the various territorial claims which have been made in Antarctica.

Hitherto, New Zealand, Australia, France, and Norway have asserted claims to specific areas of Antarctica, and Argentina, Chile, Great Britain, and Union of South Africa have asserted claims, some of which are overlapping, in the Palmer Peninsula and Weddell Sea areas. Russia, Japan, Belgium, and the United States, though operating International Geophysical Year stations in Antarctica, have asserted no claims.

The United States position with respect to interests in Antarctica has been the same since promulgated by Secretary Hughes in 1924; namely, that no claims then could be recognized until followed up by development and settlement, and that the United States has not claimed territory and does not recognize the claims of any other nation. The United States, however, has informed other nations that the United States reserves all rights based upon the activities of its citizens in the Antarctic during almost a century and a half.

We are of the opinion that the time has arrived for a reevaluation of this position. We appreciate the ramifications attending any such reevaluation. We have made our recommendations in this connection by letter under date of January 17, 1958, to the President and to the responsible Government departments, and feel it inappropriate to delineate them here.

Personnel and equipment

We have been greatly impressed with the work being conducted by the scientists, especially in Antarctica where our opportunities for observation were greater. The undertaking is under qualified and imaginative leadership in the chairmanship of Dr. Laurence Gould and vice chairmanship of Dr. Harry Wexler, who are among the most renowned and outstanding scientists of our day. The stations have been under competent and productive leaders in Albert Crary, G. R. Toney, Paul Siple, J. A. Shear, Carl Eklund, and Finn Ronnie, and their successors this coming year are equally noted and capable. These have been accompanied in their research objectives with many men of high caliber and proficiency, a number of whom we have been privileged to meet. We cannot but be aware, however, that to a regrettable degree a number of our Nation's outstanding men in their respective fields are not more prominent in their highly momentous Antarctic work. Whether this be through lack of their availability owing to being engaged otherwise in International Geophysical Year pursuits, or of our not having had enough outstanding men in these various fields, we do not know. We have been fortunate in recruiting younger scientists to assist in the Antarctic. We are of the opinion that the training and experience they have gained in this work should be retained through proper inducements being made for them to continue in these scientific fields.

We also have been impressed with the ability and dedication of the men from the various branches of the services which make up and contribute to the success of Task Force 43. The morale is good, and the sense of self-satisfaction in having volunteered for, participated in, and seen through this unique and historical enterprise, is pervasive. The task faithfully has been carried through under conditions fraught with no little discomfiture, to say the least. It would appear only appropriate that such devotion to assignment be recognized, though it cannot be compensated, through grade advancement or additional pay allowances.

We similarly have been greatly impressed by the tremendous logistic job done through the cooperation of Navy, Army, Air Force, Marine Corps, and Seabees under the effective and inspiring direction of Adm. George Dufek. Again, however, we cannot but entertain the thought that to some degree these construction and supply forces have not been given the most suitable or up-to-date equipment. Indeed, in a measure there is an appearance of some of our obsolete military equipment being written off by having been relegated to them. The importance of this job requires that it be properly supported with the best of equipment. In such regard in passing, we also should remark that we are of the opinion that icebreakers should be built adequate for the terrific tasks faced by them in this area.

Conclusion

We cannot refrain from using this opportunity to comment in a more general way upon lessons learned from this cooperative scientific program under the International Geophysical Year.

The statement of Dr. Detlev Bronk, President of the National Academy of Sciences, to the committee, is to the point:

> I think there are two things one might deduce from whatever conclusion we come to. One is that we are going to be out on the frontiers of knowledge dependent upon the degree of interest in intellectual exploration and the support of science and all other forms of creative activity.
>
> We are not going to be able to maintain our position out on the forefront or to move further out to the forefront unless we do so in a continuing way. It is not going to be done by mere crash programs. It is going to be the result of a continuing effort on the part of our people to continue in the spirit of pioneers.
>
> Secondly, I think a part of national maturity should be a realization of the fact that we are not going to be able to do everything of importance first, that other nations, too, will make great achievements. If they are for the benefit of mankind, we should rejoice with them. If they are potential threats against us, we should be prepared to prevent that by making greater efforts ourselves.

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It is all too evident that the quest for knowledge in the fields of the basic sciences must be a continuing one, and that the success of this quest in contributing to man's ability to live in his environment depends upon the degree of sustained interest in and support of these endeavors.

There is a vast need for greater interest in and support to scientific activity in this country in basic research, limited only by the competence of individuals and their imagination. It is obvious that we have reached the threshhold of a great experience that has been more than adequate and abundant justification for the effort expended. As man moves out into space to the degree that he has never gone before and is able to observe and study beyond the atmosphere, this is inevitably of great significance to our whole intellectual horizon, to our spiritual expansion.

If we are to continue to be a vital, vigorous country, we must do everything within our power to encourage and support the creative mind in all forms of intellectual exploration. We have no doubt about the future of our country so long as we preserve an energetic determination to continue to grow in every way, especially to grow in understanding that can be achieved through scientific activity.

In such connection, therefore, we believe that the committee, in accordance with its legislative responsibilities, actively should inquire into the role of the Federal Government in the stimulation of research and education in the basic sciences.[6]

We also are aware of the great cooperation attained during the International Geophysical Year among the scientists of the participating nations. We had occasion to observe for ourselves the research being made by scientists of other countries and their active contribution to the observations and research being conducted by our own scientists. The lesson that may be learned from the ability of these men to strive together for common objectives, perhaps can be stated in no more appropriate words than those to the committee of Dr. J. Wallace Joyce, head, Office for the International Geophysical Year, National Science Foundation:

> Aside from gains in scientific knowledge, certainly the very pattern itself established during the International Geophysical Year of 64 nations working toward a common goal also warrants careful study as a venture in international cooperation. There has never been a coordinated undertaking of this magnitude in the past, but we can perhaps look forward to continuing further efforts based on our experience during this momentous period.

OREN HARRIS, *Chairman*.
SAMUEL N. FRIEDEL.
JOHN J. FLYNT, Jr.
TORBERT H. MACDONALD.
ROBERT HALE.
STEVEN B. DEROUNIAN.

[6] A series of hearings inquiring into this subject was initiated jointly by the committee's Subcommittees on Transportation and Communications and on Health and Science, on January 24, 1958.

APPENDIXES

APPENDIX I

UNITED STATES NATIONAL COMMITTEE FOR THE INTERNATIONAL GEOPHYSICAL YEAR

Chairman: Joseph Kaplan, National Academy of Sciences, National Research Council, 2101 Constitution Avenue NW., Washington 25, D. C.
Vice Chairman: A. H. Shapley, National Academy of Sciences, National Research Council, 2101 Constitution Avenue NW., Washington 25, D. C.
Executive Director: Hugh Odishaw, National Academy of Sciences, National Research Council, 2101 Constitution Avenue NW., Washington 25, D. C.
Members:
Leason H. Adams, Carnegie Institution of Washington
Allen V. Astin, National Bureau of Standards
H. G. Booker, Cornell University
Lyman J. Briggs, National Bureau of Standards
G. M. Clemence, United States Naval Observatory
Earl G. Droessler, Department of Defense, Research and Development
Hugh L. Dryden, National Advisory Committee for Aeronautics
C. T. Elvey, Geophysical Institute, University of Alaska
Laurence M. Gould, Carleton College.
E. R. Piore, International Business Machines Corporation
F. W. Reichelderfer, United States Weather Bureau
E. B. Roberts, United States Coast and Geodetic Survey
J. A. Simpson, the Enrico Fermi Institute for Nuclear Studies, The University of Chicago
Paul A. Siple, Office of Polar Affairs, Department of the Army
Athelstan F. Spilhaus, University of Minnesota
Merle A. Tuve, Carnegie Institution of Washington
A. Lincoln Washburn, Dartmouth College
Harry Wexler, United States Weather Bureau
Ex officio and liaison:
Wallace W. Atwood, Jr., National Academy of Sciences
Lloyd V. Berkner, Associated Universities, Inc.
Robert Brode, University of California, Berkeley
Maurice Ewing, Lamont Geological Observatory
Leo Goldberg, University of Michigan
J. Wallace Joyce, National Science Foundation
Walter M. Rudolph, Science Advisor's Office, Department of State
H. W. Wells, Carnegie Institution of Washington

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L. V. Berkner
L. M. Gould
Joseph Kaplan, *Chairman*
Hugh Odishaw
F. W. Reichelderfer
A. H. Shapley, *Vice Chairman*
A. F. Spilhaus
M. A. Tuve

Ex officio

J. W. Joyce

Appendix I—Continued

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Hugh Odishaw
Richard B. Black
Bernt Balchen
Albert P. Crary
George Dufek
John Hannessian, Jr.
A. H. Shapley
Paul A. Siple
A. Lincoln Washburn
John Jones, *Secretary*

Consultants

J. Glenn Dyer
William O. Field
Finn Ronne

USNC Arctic Committee

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N. C. Gerson, *Vice Chairman*
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C. T. Elvey
E. O. Hulburt
Gordon G. Lill
Homer E. Newell, Jr
A. H. Shapley
H. Wexler

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F. E. Roach, *Vice Chairman (airglow)*
J. W. Chamberlin
Sydney Chapman, *ex officio*
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E. R. Manring
D. H. Menzel
A. M. Peterson
Richard Tousey
J. A. Van Allen
E. H. Vestine
D. K. Berkey, *consultant*
G. Gordon Little, *consultant*
A. B. Meinel, *consultant*
Peter Millman, *consultant*
B. W. Currie, *consultant*

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A. Opitz, *consultant*
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M. M. Shapiro, *consultant*
Douglas L. Worf, *consultant*

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J. G. Reid, Jr., *secretary*
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J. A. Van Allen
Fred L. Whipple
J. P. Hagen, *consultant*
J. W. Joyce, *consultant*
T. J. Killian, *consultant*
P. A. Smith, *consultant*
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Walter Elsasser
Roger R. Revelle
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Victor Vacquier
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Alvin G. McNish, *consultant*
J. H. Nelson, *consultant*

APPENDIX I—Continued

USNC TECHNICAL PANELS—Continued

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R. P. Goldthwait, *consultant*
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A. H. Waynick
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Harold E. Dinger, *consultant*
A. M. Peterson, *consultant*
Roger Gallet, *consultant*
H. G. Sellery, *consultant*

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Carl I. Aslakson
G. M. Clemence
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Appendix I—Continued

USNC Technical Panels—Continued

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John P. Hagen
A. H. Shapley
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A. F. Muir, *consultant*
M. E. Nason, *consultant*

APPENDIX II

INTERNATIONAL GEOPHYSICAL YEAR

A REPORT ON THE UNITED STATES PROGRAM THROUGH NOVEMBER 1957 [1]

By Hugh Odishaw, Executive Director, United States National Committee for the International Geophysical Year, National Academy of Sciences

The International Geophysical Year began on July 1, 1957 and will continue through all of 1958. This document presents a brief account of some of the activities during the first 5 months, July 1 to November 30, 1957.

Although this account is primarily concerned with the United States program, some references are made to the activities of other participating countries. It should be noted that 67 countries are cooperating in this study of the earth and its cosmic environs; the types of work described here are also being conducted by other national IGY groups. For convenience the IGY investigations may be classified under three categories: (i) the physics of the upper atmosphere; (ii) the earth's heat and water regimen; and (iii) the earth's structure and interior. Subjects in the first category include solar activity, aurora and airglow, cosmic rays, ionospheric physics, and geomagnetism. This category also includes rockets and satellites, tools for sending instruments into the upper atmosphere. Subjects in the second category include meteorology, oceanography, and glaciology, and those in the third include seismology, gravity, and determinations of longitude and latitude.

The following sections report briefly the activities in each of the fields in each of the three categories. A final section outlines aspects of the collection and interchange of data in the IGY program.

PHYSICS OF THE UPPER ATMOSPHERE

Solar activity.—As particles radiated from the major solar flare of June 28, 1957 began to arrive at the earth 2 days later, a storm wracked the earth's magnetic field. The ionosphere—the layer of electrically-charged gas between about 40 and 200 miles above the earth—was torn by electrical disturbances; long-range radio communication was blacked out for a long period of time. The flare was first observed at the Krasnaya Pakhra Observatory in the Soviet Union. Immediately a message was flashed to the World Warning Agency operated for the IGY by the National Bureau of Standards at Fort Belvoir, which declared a state of alert beginning at 1600 u. t., June 28.

[1] Also released for appearance in January 17, 1958, issue of Science, weekly publication of American Association for Advancement of Science.

Alerts are declared when there is probability of solar disturbances. When the probability is high that terrestrial disturbances will also occur, special world intervals are promulgated calling for an increased number of measurements of solar-terrestrial phenomena. The first such interval in IGY was declared on June 29, commencing at 0001 u. t. June 30. Throughout the world observations of the sun were intensified, and balloons and instrumented rockets were sent up by many nations to observe the increased ultraviolet and X-radiation and to monitor cosmic ray intensity. Observations and measurements were speeded up to record more carefully and fully the northern and southern lights, to measure disturbances in the earth's magnetic field, and to probe the ionosphere.

During periods of maximum solar activity radio communications are often interrupted by fadeouts or blackout, particularly after the occurrence of a flare on the sun. On these occasions pulses transmitted to the ionosphere by ionospheric sounders are not reflected as usual but are absorbed. It had long been thought, but not heretofore conclusively established, that this absorption must be caused by increased ionization in the lower atmosphere. On July 4, radio signals received from a rocket fired up through the ionosphere demonstrated the presence of an additional layer of ionization extending for about 12 miles below the normal lowest point. Even more remarkably, the rocket data showed that the normal ion distribution throughout the ionosphere above the D, or lowest, layer, seemed to remain undisturbed during the blackout. In another recent IGY rocket experiment, it was ascertained that the additional electron layer was caused by solar X-ray emission associated with the occurrence of solar flares.

Rockets are only one means of studying solar phenomena. Solar astronomers have organized themselves in a worldwide solar patrol, keeping watch on the sun all over the world throughout the 24 hours of the day. Solar observation stations are operated by 33 countries; of 126 stations all over the world, 14 are operated by the United States, not including rocket-firing sites.

By observing the sun through special filters which limit transmission to the light of certain radiations of hydrogen or calcium, astronomers look for the giant eruptions or flares on the sun which are responsible for radio blackouts, auroras, and magnetic storms. Very narrow band filters are used, since the flares would otherwise be invisible against the bright surface of the sun.

Special instruments are also in use to photograph the chromosphere of the sun, a shell of very incandescent gas just above the sun's surface, and the corona, and envelope of gas that may extend all the way to the earth. The chromosphere and corona are invisible except when an eclipse shuts off the light of the disk, or when the sun is artificially eclipsed in a special telescope called the coronograph. Using the coronagraph, scientists are able also to photograph solar flares at the edge of the sun; these flares sometimes shoot out into space for several hundred thousand miles at very high speeds.

At Mount Wilson Observatory in California, measurements are being made of the magnetic field of the sun at its surface. It has already been found that magnetic fields at the sun's surface may be very high, as much as 8,000 times that of the earth's field at the Equator. These magnetic fields are thought to play a very important role in disturbances and storms on the sun's surface as well as in sunspots.

Geomagnetism.—Thirty countries throughout the world are operating 129 magnetic observatories, from the North to the South Pole, and in almost every region of the earth's surface; 31 of these stations are part of the United States program in geomagnetism.

Newly established United States IGY geomagnetic stations are in operation in the Arctic, in the Pacific Ocean, in continental United States, and in South America with the cooperation of IGY scientists in Peru. Certain of these stations are set up in chains, with carefully planned spacing, to study in detail the magnetic storms which occur during great solar disturbances. It has been suggested, but not before positively established, that the magnetic effects we observe on earth during magnetic storms may be due to great electric currents, of perhaps several hundred thousand amperes, flowing around the earth high in the atmosphere. Two of these currents are believed to circle the north and south magnetic poles while the third circles the earth at the geomagnetic equator. This theory is being examined.

The stations in South America and in the Pacific Ocean—at Guam and Koror in the Western Pacific, and at Jarvis, Palmyra, and Fanning Islands in the Eastern Pacific—were established especially to study the existence of the so-called electrojet. The electrojet is believed to be the equatorial electric current, but narrowed down into a neck of limited horizontal dimensions with consequent increased current density and intensified activity at local noon. The United States Coast and Geodetic Survey, which operates many of the magnetic observatories established by the United States, reports tentative confirmation of this phenomenon. Initial data from Koror reveal the existence of the equatorial electrojet and its rather limited horizontal extent.

Aurora and airglow.—A worldwide comprehensive auroral observation program in 49 countries is underway for the first time during the IGY. Many of these 49 countries are in low latitudes where auroras are seldom seen. Nevertheless, in all of them, auroral reporters have been appointed to collect reports of visual observations in the event that a very great aurora should occur. A number of such auroras have been reported in the last century, but these events of great scientific importance have usually been inadequately described. One hundred and forty-two camera and instrumental auroral observation stations, as well as extensive amateur visual observing programs, have been organized in 17 countries.

The 39 stations and hundreds of amateurs participating in the United States program have already had much to observe. The fact that the IGY was scheduled for a period of expected maximum solar activity has greatly enhanced the value of the program, for already three of the largest solar flares (class 3+) have resulted in extensive auroral displays visible as far south as Havana, Cuba. Synoptic maps have been prepared depicting all auroras observed and reported from the United States during the months of July and August. This is the first time that such a complete description of auroral data has been assembled for the use of geophysicists studying auroral and such related phenomena as ionospheric and geomagnetic effects.

English scientists at the University of Manchester have reported that simultaneous radar observations indicate that auroras occur simultaneously in the Northern and Southern Hemispheres, a condition long believed to be true by scientists, but not previously established. Additional polar radio data which provide further evidence on this question have been obtained in the United States program.

The systematic reduction of the variations in the intensity of the night airglow is proceeding. Charts of the "patchiness" and movement of night sky luminosity resulting from oxygen emissions are being produced on a routine basis from IGY observations.

Ionospheric physics.—One of the major problems in ionospheric physics is predicting the future state of the ionosphere. If we can determine the condition of the ionosphere in advance, we can do much to develop more reliable radio communications with direct rewards in safer travel in the air and at sea. Forty-one nations are conducting studies of the ionosphere during the IGY, and a worldwide network of 253 ionospheric observing stations has been established. Seventy-one of these stations are sponsored by the United States. The data obtained by the network will provide a worldwide picture of the behavior of the ionosphere.

New information about the farthest reaches of the atmosphere is being obtained from the study of "whistlers"—whistle-like sounds which can be detected at very low radio frequencies. These signals, originating in lightning flashes at the surface of the earth, swing out thousands of miles along the earth's lines of magnetic force before they return to the opposite polar hemisphere. Early IGY experiments demonstrated that that ion density and molecular concentration along the whistler path at altitudes of as much as twice the earth's radius must be much greater than formerly anticipated. Indeed, there seems to be confirmation for the theory that the earth's atmosphere extends far beyond the level where it had been previously thought to "end" and that there may be a very tenuous atmosphere—the sun's corona—filling all the space between the earth and the sun.

Other records of previously unexplained radio noise at very low frequencies have stimulated the hypothesis that solar particles arriving in the very high atmosphere transfer energy to very low frequency radio waves there. According to this hypothesis, the radio signals thus amplified are the very low frequency radio emissions observed at ground level. Data now being gathered will throw further light on this hypothesis, which is based on the traveling wave tube principle as noted by Roger Gallet.

Ionospheric characteristics are deduced from the analysis of echoes arising from the reflection of radio pulses transmitted to the ionosphere at vertical incidence. Since the IGY began there have been several major solar events that caused disruption of long-range, short-wave radio communications which depend upon reflections from the ionosphere. For the first time, a synoptic picture has been obtained of the growth and decay, station by station, of such fadeouts.

The principal, regular variation in the ionosphere is the diurnal one. Ionization density increases during the day when the sun is present and decreases at night. What would happen to the ionosphere during long absences of solar radiation and the nature of any diurnal variation during such periods have been subjects of speculation. Only at or near the geographical poles can these questions be examined, and the South Pole affords the best platform for an observatory. Investigations during the last year at the South Pole Station of the United

States have yielded interesting results: in spite of the absence of the sun, the electron concentration seems to remain very high throughout the polar night; moreover, there is a diurnal variation that can only, it appears, be associated with geomagnetic activity. The evidence so far obtained suggests that ionospheric behavior in the two polar regions is essentially the same. Analysis of these observations may appreciably alter our concepts of the ionization and recombination processes in the atmosphere.

Cosmic rays.—Cosmic rays are electrically charged particles which bombard the earth continuously and from every direction. Although their existence has been known for 50 years, their source and precise nature remain uncertain. In particular, the source of these particles is one of the major questions in astrophysics and the answer is one of major importance in understanding the cosmos from which the rays take their name. These particles, consisting largely of nuclei and having energies ranging from 10^8 to 10^{19} electron volts, are influenced by the earth's magnetic field. Low energy particles are deflected toward the vicinity of the two geomagnetic poles, and only the more energetic ones penetrate at the middle latitudes.

During the IGY, the scientists of 31 nations are studying cosmic rays at 195 stations; neutron monitors and meson telescopes, cloud chambers, ionization chambers, special photographic emulsions, and window geiger counters are being used. Rockets and balloons, as well as earth satellites, are important tools for observing these rays. Typical of international cooperation during the IGY is the Swedish-Canadian-American cosmic ray experiment carried out aboard the Swedish merchant ship MS. *Lommaren* sailing between Sweden and the Union of South Africa.

Investigations at the 20 United States cosmic ray stations have already provided interesting results. The work of scientists from the University of Chicago has shown that the location of the line where the cosmic ray intensity is a minimum—the "cosmic ray equator"—deviates systematically from the geomagnetic equator. The experiments leading to this result began in 1954–55 when a neutron pile detector was installed aboard the U. S. S. *Atka*, which conducted a reconnaissance of the Antarctic prior to the establishment of IGY stations in following years. Measurements were made on the trip down, around Antarctica, and back; these measurements were repeated in the 1955–56 and 1956–57 Antarctic seasons aboard the U.S.S. *Arneb* and were supplemented by aircraft flights in a zig-zag pattern around the geographical equator in October 1956. These studies showed a 40° to 45° shift to the west of the inclined cosmic ray equator with respect to the magnetic equator. J. A. Simpson suggests that this warping may well indicate the presence of important magnetic fields, probably of extraterrestrial origin, which alter the trajectories of the incoming primary cosmic ray particles.

Preliminary balloon flights in and near Minnesota with ionization chambers have shown that, at constant altitude, there is a strong latitude effect. This is so strong that latitude changes as small as 7 miles can be detected by cosmic ray measurements. Other balloon experiments at Fort Churchill and Thule have shown that cosmic rays of lower energy (less than about 2 Bev) effectively disappeared during the present period of high solar activity, with ionization at high altitudes down to half the value it had in 1954 or 1955.

Perhaps one of the most interesting observations made in the course of IGY cosmic ray experiments was that of relatively soft radiation in the high atmosphere, associated with primary auroral radiations. Rocket and balloon flights have led to the positive identification of the soft radiation: it is X-radiation in the range between 10^4 and 10^5 electron volts. There appears to be good correlation between the presence of such radiation and solar, magnetic, and auroral activity. The effect is probably a secondary one; it is believed that incoming auroral particles create the X-rays by bombardment of atmospheric particles.

Rockets and satellites.—Rockets provide 1 of the 2 important ways of measuring directly phenomena and processes in the upper atmosphere. Rockets are, moreover, unique in that they permit studies of the altitude-dependence of various quantities and events—for example, temperature, pressure, density, and composition. Seven nations are engaged in rocket programs: Australia, Canada, France, Great Britain, Japan, the United States, and the U. S. S. R.

Some 200 rockets are involved in the United States rocket effort. Firings are underway in the Arctic, Antarctic, Pacific, and continental areas. A major facility at Fort Churchill, Ontario, within the north auroral zone, was constructed in cooperation with Canada, and a joint Canadian-United States program is underway.

There were 29 rockets fired in the pre-IGY test period. These included Aerobees, Rockoons, and Nike-Cajuns. Firings took place at the newly erected facilities at Fort Churchill as well as at White Sands, N. Mex., Guam, and from shipboard off the California coast and in the North Atlantic. These firings were successful, and the preliminary information gained was of considerable value in the final detailed planning of the schedules for firings during the IGY period.

The United States IGY program in rocketry actually began on July 5, 1956, at Wallop's Island, Va., when the first IGY test rocket was fired successfully. To date 81 rockets have ~~been fired during the~~ IGY. Included have been those in programs conducted at Fort Churchill (9 Aerobees, 5 Nike-Cajuns); White Sands (2 Nike-Cajuns); Point Mugu, San Nicolas Island, Calif. (13 Nike-Deacons); a shipborne operation in the Arctic (18 Rockoons); and a shipborne operation in Pacific and Antarctic waters concluded in mid-November (36 Rockoons). The following are some preliminary findings:

1. A firing at Fort Churchill indicated that the first atmospheric temperature maximum occurred at an altitude of about 60 kilometers. Normally this maximum is found below 50 kilometers at lower latitudes, indicating that, at northern latitudes, the rise is more gradual. (Temperatures decrease up to the stratosphere, rise during the next 20 to 30 kilometers, decrease through the next 30 kilometers, and then rise again.)

2. A rocket, instrumented for ionospheric studies, was sent through a polar blackout for the first time. Data were obtained which indicated that a very dense D-region exists at a significantly lower altitude and with a much greater density, than is found at lower latitudes.

3. A firing at Fort Churchill during the summer of 1957 measured electron distribution in the ionosphere up to an altitude of 250 kilometers during a polar blackout. The results of this experiment confirmed theories that the D-region of the ionosphere is primarily responsible for radio blackouts.

4. During a series of firings with Aerobees and Nike-Cajuns instrumented for studies of pressure, temperature, and density, it was determined that the distribution of pressure and temperature in the atmosphere at high latitudes is much different than it is at lower latitudes. Many of these rockets attained altitudes greater than 200 kilometers, and thus the first density measurements made at high latitudes were recorded. Launchings were made during both summer and winter, day and night. The resulting data indicate that the density of the high atmosphere is under strong solar control. There appear to be a latitude effect, a seasonal effect, and a strong diurnal effect; none of these effects appear at lower altitudes at Fort Churchill or lower latitudes.

5. An experiment with a mass spectrometer at Fort Churchill appears to confirm the belief that diffusive separation of gases under gravity is present above 100 kilometers at that latitude. Below this point the gases in the atmosphere appear to be well mixed.

6. During July and August 1957 the DAN rocket flare patrol program took place at Point Mugu, Calif. This program was primarily directed toward determining the radiation source of the fadeouts resulting from flares observed on the disc of the sun. For the first time, measurements were made of X-ray and ultraviolet bursts from the sun during a solar flare. These data will help in explaining radio blackouts, which are present during periods of unusually high degree of ionization, and which are closely associated with solar flares.

7. During the shipboard firings in the Arctic, an excellent survey was made for the first time of auroral particles and their association with actual auroras. Also conducted for the first time at high latitudes were magnetic field measurements.

Satellites represent an extension of rocketry useful in probing the high atmosphere. Satellites provide means to secure data on the variation of phenomena with time and over a vast expanse of space. Two nations are engaged in satellite-launching programs: the U. S. S. R. and the United States. Many nations are cooperating in tracking and ground-based observations. In the United States program, precision radio and optical stations have been established not only in the United States but in 13 other countries whose scientists are cooperating closely with United States scientists.

The U. S. S. R. launched its first satellite on October 4, 1957. This satellite, a sphere nearly 23 inches in diameter and weighing about 184 pounds, carried transmitters broadcasting on frequencies of 20 and 40 megacycles per second. The second Soviet satellite was launched on November 3. Weighing about 1,120 pounds, the last rocket stage was reported to carry 2 transmitters (20 and 40 megacycles), a dog, and instruments to measure satellite temperatures, ultraviolet light, X-rays, and cosmic rays. The initial period of the second satellite's revolution was 103.7 minutes with an apogee of approximately 1,056 miles and a perigee of about 150 miles.

The United States program is proceeding according to schedule. The Navy has responsibility for the rocket system and launching in the Vanguard series; the Army for the Jupiter-C series. The IGY Committee of the Academy is responsible for the scientific aspects, both internal experiments and the radio and optical observation programs. Two types of satellites have been designed: test spheres for use during the test period for the Vanguard rocket system and equipment-laden satellites thereafter for both the Vanguard and Jupiter-C vehicles.

The test spheres are 6.4 inches in diameter and weigh 4 pounds. They have six 12-inch antennas and 6 solar cells mounted on the skin. These spheres are designed primarily to transmit signals for radio tracking purposes; they carry 2 separate transmitter systems operating on frequencies of approximately 108 megacycles. One is battery-powered, while the other is powered by the 6 solar cells, affording the prospect of indefinite transmitter life.

The IGY equipment-laden satellites have three main configurations. All but 2 are 20-inch spheres constructed primarily of magnesium, weighing 21.5 pounds, and equipped with four 29-inch antennas. Of the other satellites, 1 is a sphere approximately 13 inches in diameter, with a protruding cylinder approximately 13 inches long and 2.5 inches in diameter; this satellite will be accompanied by an inflatable sphere, 30 inches in diameter and weighing less than 0.7 of a pound, which will be ejected from the carrier rocket at the same time as the satellite is released. The last configuration, a cylinder to be launched in the Army vehicle (Jupiter-C), is approximately the same weight as the spherical satellites to be launched in the Navy Vanguard rocket.

Equipment carried by these satellites will include instruments to measure the intensity of the solar hydrogen Lyman-alpha line; temperatures of the satellite's surface and interior; meteoric erosion, flux, and penetration; geographical, temporal, and altitudinal variations of primary cosmic ray intensity; total magnetic field at altitudes above the more densely ionized regions of the upper atmosphere; air drag; the geographical distribution of the energy received by and radiated from the earth; and the changing patterns of the cloud cover of the earth.

The satellites will be located and data will be obtained from them by means of radio, precision camera, and visual observations. The precision radio tracking system is known as Minitrack; it was developed by and is operated under the supervision of the Naval Research Laboratory. There are 10 Minitrack stations, most of them along the 75th meridian west.

The 12 precision optical tracking stations, using Baker-Nunn Schmidt-type cameras, are under the supervision of the Smithsonian Astrophysical Observatory. They are located in 1 longitudinal and 2 latitudinal belts (75th meridian west and 30° to 40° north and south).

There are three programs based on amateur participation in satellite tracking which are designed to supplement precision tracking efforts. The first, for volunteer visual observation teams, is being administered by the Smithsonian Astrophysical Observatory and has been named Moonwatch. Over 100 Moonwatch teams located both in the United States and abroad have been registered and are in operation.

A similar program called Moonbeam has also been established to coordinate the participation of radio amateurs and other volunteer groups having the capability to record telemetry and radio position data. Employing Minitrack Mark II, developed by the Naval Research Laboratory, and Microlock, developed by the Jet Propulsion

Laboratory of California Institute of Technology, these volunteer groups supplement the primary Minitrack stations in tracking the satellite and should also provide valuable scientific data.

The third volunteer tracking program is called Phototrack; it was organized under the supervision of the Society of Photographic Scientists and Engineers. Participants in this program use standard cameras of good quality to photograph the satellite against a fixed background of stars of known positions.

EARTH'S HEAT AND WATER REGIMEN

Meteorology.—Almost all of the energy that the earth receives comes from the sun. This energy evaporates water from the oceans, lakes, and rivers; heats the ground, which in turn heats the air above it; and in general supplies all of the energy which drives the winds of the atmosphere.

In the equatorial regions there is more energy received from the sun that is lost back to space; in the polar regions the reverse is true. Since we know that on the average, considering a year's time, the earth as a whole does not heat up or cool off appreciably, the excess energy gained in the tropics must be balanced by the loss of energy in the polar regions. The flow of energy between the tropics and the poles is part of the driving force of the atmospheric circulation. A very important factor in the general circulation also is the rotation of the earth. As is well known, the speed at the surface, due to the daily rotation of the earth, is greatest at the equator, which is farthest away from the axis of rotation, and least in the polar regions, becoming zero at the pole itself.

In order to study the winds and circulation of the atmosphere during the IGY, meteorologists of nearly every participating country have intensified their efforts at setting up new stations in hitherto uncovered areas, and are making every attempt to send meteorological balloons as high into the atmosphere as possible to measure temperature, humidity, and winds; all countries are collecting meteorological data. In cooperation with the Canadian Weather Bureau, the United States Weather Bureau is operating some key stations in the Far North, supplementing its complex of stations in Alaska and the United States. In cooperation with scientists and weather bureaus of the various South American countries, five new complete weather observatories are now in operation in Chile, Peru, and Ecuador. These five stations are important in a chain of stations reaching from the North Pole, where the U. S. S. R. maintains a station, through Canada, Eastern United States, the Caribbean Sea, western South America through Antarctica, and finally to the South Pole, where United States scientists have established a complete scientific observatory.

In addition to this chain of stations, 12 nations have cooperated in locating more than 50 scientific observatories in the vast unknown continent of Antarctica. For the first time, synoptic meteorological charts of this area are being drawn on a daily basis. Weather forecasting has already been markedly improved in the Southern Hemisphere. Aside from the forecasting and synoptic aspect, the scientific value of the observations in Antarctica are potentially of great value in understanding the atmospheric circulation and its relation to solar radiation and topography.

The Antarctic is the coldest place on earth. The continent itself is elevated and mountainous, the South Pole being almost 10,000 feet above sea level. Byrd Station, in the interior, has reported temperatures of about 100° below zero (Fahrenheit), and recently the South Pole Station reported an even lower temperature, 102.1° below zero.

In the Antarctic meteorology program, large neoprene balloons have been sent to altitudes of over 80,000 feet, and the average is about 60,000 feet. Meteorological balloons sent up at 112 non-Antarctic United States stations are reaching altitudes ranging from 85,000 to 107,000 feet, carrying instruments to radio back to the ground the temperature and humidity.

In addition to these broadscale programs, several specialized programs are underway, and preliminary results have been received. For example, there is in Little America an instrument which measures the minute quantity of ozone in the air at the ground level. Ozone mainly occurs in a layer-like region about 15 miles high in the earth's atmosphere. Some ozone diffuses to the ground, or is formed at lower levels by ultraviolet light. It has been noticed that, at Little America, there is about 25 percent more ozone at the ground than there is in New Mexico. Although ozone is a minor constituent of the atmosphere, it is thought to play an important role in the circulation of the high atmosphere, because of the energy it can absorb and release.

Another minor constituent of the atmosphere which may play a major role in climatic changes is carbon dioxide. This compound is present in the atmosphere in amounts of about 350 parts per million. It absorbs infrared or heat radiation and may act like a trap for such radiation, much as glass does in a greenhouse, and it may play a very important role in the heat balance of the atmosphere. Our industrial civilization burns tremendous quantities of fossil fuel each year, pouring millions of tons of carbon dioxide into the atmosphere. Most of this is absorbed by plant life and by the waters of the oceans, but there is the possibility that eventually the carbon dioxide content of the atmosphere will rise enough to affect the world's climate. At United States stations and aboard ships, there are seven instruments in use monitoring the content of CO_2 in the atmosphere, and scientists are collecting thousands of air samples for later analysis. It has been found already that the concentration of carbon dioxide in the Antarctic is about what it is over the rest of the world away from immediate industrial contamination.

The United States National Committee for the International Geophysical Year was designated by the Comité Spécial de l'Année Géophysique to establish and maintain a Weather Central at the Little America Station to collect and disseminate Southern Hemisphere weather information, particularly for the Antarctic region. The basic program at Weather Central involves the reception and recording of weather data from many contributing sources; preparation and analysis of meteorological charts, maps, graphs, and cross sections—mostly synoptic; and broadcasting of current weather information and analyses for use in forecasting by stations throughout Antarctica and the remainder of the Southern Hemisphere.

The Weather Central staff consists of United States meteorologists together with meteorologists assigned in turn by other nations participating in the Antarctic program.

Preliminary reports indicate that significant improvements in the weather forecasts of Southern Hemisphere countries have been made since data from the Antarctic Weather Central became available.

Glaciology.—United States glaciologists encamped on glaciers and ice fields in Greenland, on the frozen Arctic Ocean, in the mountains of Alaska, on a small glacier in the State of Washington, and on the ice shelves and the great ice sheet of Antarctica, in a broad program designed to map not only the extent of the glaciers and ice but also to understand their flow and their relation to and effect on the local climate. Twenty-seven other countries are also making observations covering all the known ice areas of the world, including glaciers on the Equator—at Mount Kilimanjaro and Mount Kenya in east Africa.

Technical advances and discoveries have already been made in the two greatest reservoirs of ice in the world, Greenland and Antarctica. In Greenland, scientists and engineers of the United States Army's Snow, Ice, and Permafrost Research Establishment have perfected techniques for drilling deep holes in the ice with hollow drills, much as an oil well is drilled, to obtain a "core" of ice. The first hole was drilled in Greenland in 1956 and reached a depth of over 1,000 feet. The second hole was successfully drilled in 1957 in Greenland, and a similar operation is now under way in the Antarctic in Marie Byrd Land.

The recent boring in the ice of Greenland reached a depth of 1,438 feet. A complete series of cores 4 inches in diameter were obtained from the first 1,040 feet. Below this depth, recovery of the core is difficult because the release of strains as the ice is drilled causes the ice to shatter. Dissolved gas, which is under great pressure in the ice at these depths, also causes trouble because it bursts through pockets in the ice, increasing the amount of shattering. However, a core was obtained from 1,200 to 1,220 feet, and another from 1,320 to 1,338 feet. These cores are being studied with great care in the laboratory, for they are an invaluable index of climate and precipitation over the past many hundreds of years. Their layers are studied in much the same fashion as tree rings are studied. From the first hole in Greenland, the 1912 layer was identified by the ash from a volcano which erupted in Alaska. The dust from the great explosion in 1883 of the volcano Krakatao, in the East Indies, will be a help in checking the dating of the annual layers of precipitation in the cores. Because precipitation is lower in the Antarctic than in Greenland, it is expected that this ash layer will be found at a depth of about 150 feet in Greenland and at about 60 feet in the Antarctic.

The great ice sheet of the Antarctic, over 6 million square miles in extent, cannot be studied in anything but a spotty fashion. However, teams of glaciologists, seismologists, and support personnel are traveling by tractors and special over-snow vehicles thousands of miles across the ice in a series of traverses to obtain the profile of ice thickness across the continent and to attempt to learn something of the underlying terrain, or formation of the ice-covered earth. For example, after the Byrd Station was established some 600 miles from Little America by a tractor party, a traverse team then crossed the ice shelf from Little America and continued to Byrd Station exploring the ice as it went.

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The surface ice is examined by taking samples and determining the density, digging shallow pits to learn about the layers of the most recent several seasons, and making measurements of the temperature and heat conductivity of the ice. The deep ice is explored by setting off small explosions on the surface and by listening to echoes reflected by the bottom of the ice and by any deeper layers of the earth's crust. The time the echoes take to return allows calculation of the depth of the ice.

During this first traverse, it was discovered that Byrd Station, at an elevation of about 5,000 feet above sea level, stands upon ice almost 10,000 feet thick. Further explorations will reveal whether this is a frozen fjord or inland sea and what part of this submergence may be due to the bending inward of the earth's crust as a result of the weight of the ice.

United States scientists at two locations in the Arctic Basin are now making studies of the melting of the ice pack, the freezing of new ice, and the general relations between the state of the ice and the local climate. One of these stations, Drifting Station B, is on an ice island 7 miles by 3 miles in extent and about 140 feet thick. This block of ice was probably calved off the Ellesmere Island ice sheet many hundreds of years ago and has been circulating in the Arctic Ocean since, driven by the winds and ocean currents. This ice island, known as Fletcher's Ice Island, has been occupied previously by United States scientists in studies of the Arctic Basin. It is currently at latitude 81°08′ N. and longitude 107°05′ W., about 611.8 miles from the North Pole.

The second station, called Drifting Station A, is now located at latitude 85°30′ N. and longitude 170° W., 310.5 miles from the pole. It is on the icepack itself, on a floe a few miles in area and only some 7 to 12 feet thick. Scientists there have noted that during the past summer season about 12 inches of ice on the upper surface has melted, while as much as 18 to 24 inches of new ice have frozen on the bottom of the floe. This observation will be placed in proper perspective when all the information on radiation from the sun, ocean currents, and temperatures of the air, ice, and oceans has been studied.

Oceanography.—The oceans, which cover about three-quarters of the earth, are a great storage trap for energy; the oceans are responsible for the fact that the climate of lands near seacoasts is more uniform than that of the interior of continents. Great ocean currents such as the Gulf Stream affect climates in the northern parts of the Atlantic Ocean. For example, Iceland and the British Isles have far less severe winters than they would have were the Gulf Stream not flowing. The surface currents of the oceans are related to the great wind systems, and it has been shown that the Gulf Stream, for example, follows the great clockwise atmospheric circulation in the Atlantic Basin. Benjamin Franklin was one of the first to observe the nature of the Gulf Stream; Lt. M. F. Maury, the founder of the United States Navy Hydrographic Office, collected much information from mariners bearing on the set and speed of surface currents in this area, and several years ago an expedition of several ships, Operation Cabot, explored the Gulf Stream in a thorough fashion. It was found that besides the main stream there were many small eddies and side currents.

Recently, in a test of instrumentation developed by J. C. Swallow of the National Institute of Oceanography in England, the *Atlantis*, a research vessel of the Woods Hole Oceanographic Institution, and the British research vessel, *Discovery II*, explored the eastern edge of the Gulf Stream and for the first time were able to map the underlying flow of water. They found that, at depths of about 6,500 feet, there was either very little or erratic movement; shallower depths showed set to the northeast, as expected, but at about depths of about 9,000 feet, the current sets southwest at the relatively high speed of 8 miles per day. This new technique, in which the Swallow neutral buoyancy float is used, enables IGY oceanographers the world over to map both surface and relatively deep currents. Thirty-four countries are participating in oceanographic work for the IGY, some with ships and others with coastal and island observatories.

The deeper currents of the oceans have proved difficult to observe. Cold water is formed in the polar regions from melting ice; this water, being dense, sinks, displacing lighter water which then flows away from the polar regions toward the equatorial regions. Bottom topography such as ridges, canyons, and mountain ranges, influences the flow of bottom waters, and it is possible that some bottom waters become trapped in basins. It is not known whether bottom water makes a circuit from pole to Equator and back in tens, hundreds, or thousands of years. The bottom waters play an important role in man's economy, for the extent to which the seas can support life is dependent upon the food supply in the water. The bottom waters are rich in chemical nutrients and wherever these waters upwell, there are found the great fishing banks such as the Grand Banks off Newfoundland and the Peruvian fishing grounds.

Several United States ships have already made extensive cruises for the IGY. The work of the *Atlantis* has already been mentioned. The *Crawford*, also of the Woods Hole Oceanographic Institution, made a 4 months' cruise in the Atlantic. The *Crawford* reoccupied many stations taken years ago by the German ship *Meteor* and discovered that there have been pronounced changes in the amount of oxygen dissolved in the Atlantic in the region of 15° south latitude. The difference in oxygen content over the past 30 years may mean that deep bottom water is not being formed as fast now as it was previously, but further data and analysis are needed for proper interpretation of the present observations.

The *Vema*, a research vessel operated by the Lamont Geological Observatory of Columbia University, has completed an extensive cruise in the southern Atlantic Ocean, working along the coasts of South America and Africa, and crossing the Atlantic at high southern latitudes between Argentina and Cape Town. The *Vena* cooperated with the *Bahia Blanca*, a survey vessel of Argentina, in making explorations of the submarine crust by seismic methods. Considerable marine biological work was also done, and Lamont has reported that living organisms—a small shell fish and a worm one-fourth of an inch long—were recovered alive from depths of 13,200 and 16,200 feet respectively. Lamont scientists believe these to be record depths for retrievement of live marine samples. The *Vema* left New York in November for a 10-month trip to the Atlantic and Indian Oceans as the second phase of Lamont's oceanographic work for the IGY.

In the Pacific, the *Brown Bear* of the University of Washington worked in the northeast Pacific Ocean last summer. The deep currents in that area were studied. The *Horizon* and *Baird*, research vessels operated by the Scripps Institution of Oceanography of the University of California, left San Diego in October for a 2-ship, 5-month expedition through the central and southeast Pacific. They will call at Tahiti (Samoa), Easter Island, Valparaiso (Chile) and Callao (Peru), and make seismic explorations of the submarine crust, study surface and deep currents, take bottom samples and occupy about 40 oceanographic stations, where water samples down to great depths will be obtained for later analysis of chemical content. The *Jakkula*, of the Agricultural and Mechanical College of Texas, will cruise in the Caribbean Sea and western Atlantic in the summer of 1958.

Another part of the IGY oceanography program is the study of the mean sea level over the period of the IGY. It has been found from study of tide data that there seems to be an exchange of water between the Northern and Southern Hemispheres as the seasons change. Some of the change in mean sea level between summer and winter has to do with the expansion and contraction of water with temperature. New tide gages are being set up to supplement the existing network: instruments are already operating in Bermuda, Iceland, and the Azores in the Atlantic, and in the Caroline, Marshall, and, with the cooperation of French scientists, at French islands in the southeast Pacific. A station is in operation on Pitcairn Island under the supervision of a descendant of one of the mutineers of H. N. S. *Bounty*. At least 200 tide gage stations are being operated in the worldwide program, 32 of them by the United States.

In the Arctic Basin, United States oceanographers pursue their science from camps on the frozen ocean. The track of one of the stations has carried observers over what appears to be a newly-discovered ridge, or underwater mountain chain. Scientists of the Soviet Union are doing similar work on two stations in the Arctic Basin.

In the Antarctic the ships of the various nations supporting scientific stations on the continent engage in oceanographic observations enroute to and from the area. Thus, U. S. S. R. and New Zealand ships have added to our knowledge of these waters. Ships of United States Navy Task Force 43 are also exploring the coast, charting the bottom, and taking bottom and water samples for future study.

EARTH'S STRUCTURE AND INTERIOR

Seismology. During the IGY, seismologists of 50 nations are obtaining earthquake information from almost all regions of the world, particularly in those regions hitherto uncovered as, for example, the Antarctic continent. In addition, several new types of seismographs with wide range and high sensitivity have been located at observatories throughout the world. The Lamont Geological Observatory has constructed 10 special long-period seismographs and has installed most of them at observatories ranging from Hawaii to Fiji and from Bermuda to the Antarctic. These long-period instruments are sensitive to surface waves of periods of about 400 seconds, generated only by the very largest earthquakes. These wavelengths are so long that they penetrate to the interior of the earth, and, in fact, the whole earth itself may be set into vibration. Recently, workers at Lamont have discovered the existence of certain intermediate waves with periods of about 100 seconds. These waves, which were previously only known in the crust in continental structures, have been identified now in the mantle, or the next layer beneath the crust. These waves permit better resolution of structural details than the longer 400-second waves, and study of their propagation is expected to provide new information on the distribution of materials in the interior of the earth.

Seismologists from the department of terrestrial magnetism of the Carnegie Institution of Washington worked on exploration of the roots of the Andes Mountains in South America last summer and fall. They have found roots of unsuspected depths and are now working on their data to obtain better understanding of the crustal structure under this great mountain chain.

Seismologists of the United States Coast and Geodetic Survey have installed new seismic equipment in the Pacific at Truk and Koror and have been obtaining records of Pacific earthquakes. These new stations, together with those in the Antarctic will add significantly to our knowledge of seismicity and the structure of the earth.

Gravity. The earth is the attracting mass for all bodies on the earth. The earth, however, is not a perfect sphere, nor is its mass uniformly distributed. Furthermore, it is rotating. These conditions add up to the fact that gravity is not uniform and constant all over the earth. In general, because of the fact that the earth bulges somewhat at the equator and centrifugal force is greatest there, gravity is least at the equator and increases toward the poles. This effect is large enough to make a 200-pound man weigh one pound more at the pole than at the equator. In addition to this nonuniformity, great continental mountain masses, underground ore bodies, undersea mountains and, in general, the uneven distribution of mass around the crust of the earth, contribute to local anomalies, some of which may be sufficiently large enough to deflect a plumb bob away from the vertical. Although this deflection is less than 10 seconds of arc, there are a few locations—Puerto Rico is one—where it exceeds one minute. This effect is significant in geodesy wherever geodetic control depends on astronomical observations.

The IGY program in gravity is aimed at increasing the reliability of measurements of gravity over the world, particularly in providing very accurate and reliable measurements at certain key locations to provide connection points between the gravity networks of various countries. Many measurements have been made already, including observations in the Arctic Basin taken from United States IGY stations on the drifting ice. An important new station is located in Antarctica, where first-order measurement of gravity was made to provide a calibration for future measurements in the interior.

The first successful surface measurement of gravity on the open sea were made on November 22, 1957, by J. Lamar Worzel, of the Lamont Geological Observatory, using a sea gravimeter developed by Anton Graf, of Munich. In the past gravity measurements for oceanic areas required measurements aboard submarines at quiet depths below the surface. The difficulty of obtaining and fitting submarines for this purpose made it impossible adequately to survey the seas: only about 4,000 such measurements have been made throughout the world. The new instrument, mounted on a gyro-stabilized platform, will make it possible to obtain data simply and quickly anywhere at sea with a precision of one part per million, similar to that attainable on land.

As the moon rotates around the earth, and the earth rotates around the sun, the solid earth undergoes the same kind of tidal bulging that occurs in the oceans, although, of course, by a much lesser amount. Yet, it is enough to be observed with the most sensitive gravimeters. As the earth heaves in tidal motion, the distance of a point on the surface from the center of the earth changes by a small amount, perhaps a few tenths of an inch to several inches. This can be detected directly by instruments which are now in use recording the "pulse" of the earth, instruments which are sensitive to 1 part in 1 billion of the average value of gravity.

Latitudes and longitudes.—Scientists of 29 countries of 45 IGY stations around the world are in the process of determining longitudes and latitudes more precisely. Besides making transit observations at stations, the United States is furnishing 21 of the moon position cameras developed at the Naval Observatory for use at stations in the United States and throughout the world; the first camera is now in operation at the United States Naval Observatory in Washington, D. C. When used in conjunction with the Danjon impersonal astrolabe, this instrument will permit more precise location of the earth's land masses than was hitherto possible.

INTERNATIONAL GEOPHYSICAL YEAR DATA

The preceding sections suggest the nature of the IGY activities as shown by the United States IGY effort in the first few months of the program. With 67 nations cooperating in the endeavor and some 10,000 scientists and technicians making observations and measurements at more than 2,000 stations, the volume of data stemming from the program will be considerable. To insure the safety of the raw data and their accessibility, the international IGY committee has approved the establishment of three world data centers.

World Data Center A is located in the United States and has 11 subcenters: visual auroral observations (Cornell University), instrumental auroral observations (University of Alaska), airglow and ionospheric physics (National Bureau of Standards, Central Radio Propagation Laboratory), cosmic rays (University of Minnesota), geomagnetism, gravity, and seismology (U. S. Coast and Geodetic Survey), glaciology (American Geographical Society), latitude and longitude (U. S. Naval Observatory), meteorology (U. S. Weather Bureau, National Weather Records Center), oceanography (agricultural and Mechanical College of Texas), solar activity (University of Colorado, High Altitude Observatory), and rockets and satellites (National Academy of Sciences).

World Data Center B, operated by the U. S. S. R., has two subcenters. The first, at Novosibirsk, includes meteorology, geomagnetism, longitude and latitude, glaciology, oceanography, seismology, and gravity. The second, at Moscow, includes aurora and airglow, ionospheric physics, solar activity, and cosmic rays.

World Data Center C, operated by several nations in Western Europe and the Pacific, consists of the following subcenters: geomagnetism (Denmark and Japan), aurora (Sweden and Great Britain), airglow (France and Japan), ionosphere (Great Britain and Japan), solar activity (Switzerland, Italy, Great Brltain, France, German Federal Republic, and Australia), cosmic rays (Sweden and Japan), glaciology (Great Britain), meteorology (World Meteorological Organization (Geneva)), and seismology (International Central Seismological Bureau (Strasburg)).

Each data center will acquire a complete set of all IGY data. Each center will archive and index its compilation of data, holding it accessible to research workers. Schedules for the orderly flow of data into the centers have been arranged. These schedules vary, depending upon the nature of the data in a given discipline and upon the definition of a reasonable "lot" of data to simplify the handling problems. A "lot" of data may be 1 month's observations in 1 field or several months' in another.

The procedures in handling data and forwarding them appropriately involve a series of steps of the following kind: (i) collection of a "lot" of data at a field station, (ii) transmittal of the "lot" to the home laboratory of the field station, (iii) checking of field data at the home laboratory, (iv) transmittal to one of the World Data Centers, (v) copying of the data by one World Data Center for the other two and appropriate transmittal, and (vi) indexing and archiving at World Data Centers.

The data centers are in operation, and data are flowing into the centers. The steps outlined above lead to a peak early in 1958, a steady 18-month plateau through at least the first 6 months of 1959, followed by a "cleanup" period extending probably into the first quarter or so of 1960.

ACKNOWLEDGMENT

The preparation of this narrative would not have been possible without the cooperation of many scientists and institutions engaged in the IGY program. Although some of them are mentioned in the text, it has not been possible in this summary to refer to all. The United States IGY program has only been possible because so many individual scientists as well as public and private institutions have participated and cooperated in the endeavor.

Particular acknowledgment is made to members of the Academy's IGY staff who have helped in the preparation of this report: Stanley Ruttenberg, Phillip Mange, John Hanessian, Jr., and John Truesdale.

Appendix III

USNC ARCTIC COMMITTEE

Name	*Other international geophysical year assignments*
Dr. John C. Reed (Chairman), staff coordinator, U. S. Geological Survey, Department of Interior.	Technical Panel on Glaciology.
Mr. N. C. Gerson (Vice Chairman), Crosley Research Co.	USNC, recording secretary; Executive Committee, recording secretary; Antarctic Committee; Technical Panel on Rocketry.
Mr. A. P. Crary, Glaciology Headquarters, National Academy of Sciences.	Technical Panel on Seismology and and Gravity.
Dr. C. T. Elvey, University of Alaska	USNC; Technical Panel on Aurora and Airglow, Chairman.
Dr. E. O. Hulburt, National Academy of Sciences.	Technical Panel on Geomagnetism Chairman; USNC, Secretariat, Senior scientist; CSAGI, adjoint Secretary, Western Hemisphere.
Mr. Gordon G. Lill, Office of Naval Research.	Technical Panel on Oceanography, Chairman.
Dr. Homer E. Newell, Jr., Naval Research Laboratory.	Technical Panel on Rocketry, Vice Chairman; Technical Panel on World Days and Communications; Technical Panel on Earth Satellite Program.
Dr. Alan H. Shapley, Central Radio Propagation Laboratory, National Bureau of Standards.	USNC, Vice Chairman; Executive Committee; Antarctic Committee; Technical Panel on Ionospheric Physics; Technical Panel on Solar Activity, Chairman; Technical Panel on World Days and Communications, Chairman.
Dr. Harry Wexler, U. S. Weather Bureau.	Executive Committee, alternate; Antarctic Committee, consultant; Technical Panel on Meteorology.
Major J. H. Fox, Headquarters Air Research and Development Command.	----------
Mr. George Grimminger, Office of Scientific Adviser, Department of the Air Force.	----------
Mr. R. R. Philippe, Engineering Research and Development.	----------
Dr. L. O. Quam, Office of Naval Research.	Department of Defense representative; Technical Panel on Glaciology.

APPENDIX IV

USNC ANTARCTIC COMMITTEE

L. M. Gould, *Chairman*
Harry Wexler, *Vice Chairman*
John Jones, *Secretary (1957–)*
Bernt Balchen
Richard B. Black
Albert P. Crary
George Dufek
John Hanessian, Jr., *Secretary 1954–57)*
Hugh Odishaw
A. H. Shapley
P. A. Siple
A. L. Washburn

Consultants

J. Glenn Dyer
W. O. Field
Finn Ronne

USNC ANTARCTIC PROGRAM DIRECTION

L. M. Gould, *Director*
Harry Wexler, *Chief Scientist*
Albert P. Crary, *Deputy Chief Scientist*
D. S. Carder, *seismology*
Albert P. Crary, *glaciology*
P. A. Humphrey, *meteorology*
J. H. Nelson, *geomagnetism*
N. J. Oliver, *aurora*
M. J. Rubin, *weather central*
Harry Sellery, *ionosphere*
J. A. Simpson, *cosmic rays*
S. F. Singer, *cosmic rays*
J. A. Van Allen, *rocketry*
G. P. Woollard, *gravity*

USNC ANTARCTIC STATION SCIENTIFIC PERSONNEL

LITTLE AMERICA STATION

1956–57

A. P. Crary, *station scientific leader*
J. A. Alvarez, *Argentina*
H. J. Bengaard
H. F. Bennett
W. W. Boyd, Jr.
R. L. Chappell
W. J. Cromie
P. C. Dalrymple
B. W. Harlin
G. L. Harter
H. Hoinkes
J. P. Krank
W. P. Lavris
B. J. Lieske
F. M. Milan
W. B. Moreland
V. I. Rastorguev, *U. S. S. R.*
B. F. Remington
P. A. Shoeck
W. C. Sutton
R. C. Taylor
R. L. Viets
S. A. Wilson
C. O. Wyman

1957–58

A. P. Crary, *station scientific leader*
M. Alt, *France*
A. J. Arruiz, *Argentina*
R. A. Brown
J. B. Burnham
S. P. Hyde
H. B. Cochrane
S. L. Den Hartog
H. S. Francis
M. B. Giovinetto
J. J. Gniewek
T. I. Gray
L. LeSchack
A. J. Morency
K. Morley, *Australia*
W. C. Noble
F. D. Paxton
N. J. Ropar
J. S. Sherwin
D. A. Shoemaker
(Weather Central) *U. S. S. R.*
W. S. Weyant
C. E. Williams
C. R. Willson

APPENDIX IV—Continued

USNC ANTARCTIC STATION SCIENTIFIC PERSONNEL—Continued

BYRD STATION

1956–57	1957–58
G. R. Toney, *station scientific leader*	S. Barnes, *station scientific leader*
E. A. Alf	J. O. Annextad
V. H. Anderson	C. R. Bentley
V. W. Barden	F. L. Darling
C. R. Bentley	J. V. Knack
L. E. Davis	L. Lenches
M. B. Giovinetto	J. B. Long
D. P. Hale	W. E. Long
N. F. Helfert	N. L. Peters
R. H. Johns	D. T. Spencer
A. J. Morency	M. N. Todd
N. A. Ostenso	D. L. Willson

AMUNDSEN-SCOTT SOUTH POLE STATION

1956–57	1957–58
P. A. Siple, *station scientific leader*	Palle Mogensen, *station scientific leader*
R. F. Benson	D. M. Baulch
E. C. Flowers	P. C. Dalrymple
J. F. Guerrero	J. A. Dawson
H. L. Hansen	S. P. Fazekas (*glaciologist*)
W. S. Hough	C. R. Greene
W. F. Johnson	K. J. Hanson
A. U. Landolt	A. E. Jorgensen
E. W. Remington	

HALLETT STATION

1956–57	1957–58
J. A. Shear, *station scientific leader*	K. J. Salmon (*New Zealand*) *Station scientific leader*
*J. R. Canavan	K. A. Bargh (*New Zealand*)
*E. R. Evans	*N. S. Benes
*R. W. Hennessey	*W. H. Highland
J. G. Humphries (*New Zealand*)	*K. J. Keeler
C. E. Ingham (*New Zealand*)	G. A. King (*New Zealand*)
M. W. Langevad (*New Zealand*)	*F. J. Robbins

WILKES STATION

1956–57	1957–58
C. R. Eklund, *station scientific leader*	W. L. Tressler, *station scientific leader*
*C. T. Bailey	W. L. Allison
R. J. Berkley	H. Birkenhaver
R. L. Cameron	S. R. Borrello
G. Dewart	*W. J. Connors
R. Glasgal	C. Cronk
R. A. Honkala	D. R. Denison (*glaciologist*)
*B. R. Lilienthal	L. A. Johnson
Olav Loken	A. Ommundsen
R. L. Long	R. A. Robertson
J. R. Mulholm	L. C. Semprebon
*J. T. Powell	*R. E. Smith
G. H. Stonehocker	*J. R. Swan
*P. A. Wyche	*J. R. Wertman
	V. D. Urban

See footnotes, p. 73.

APPENDIX IV—Continued

USNC ANTARCTIC STATION SCIENTIFIC PERSONNEL—Continued

ELLSWORTH STATION

1956–57	1957–58
Finn Ronne, *station scientific leader*	M. J. Brennen, *station scientific leader*
*T. A. Ackerman	E. A. Bradley
N. B. Aughenbaugh	A. I. Burgess
J. C. Behrendt	D. H. Edman
J. B. Brown	R. J. Goodwin
*W. A. Butler	*J. Grant
*G. C. Camp	*F. Kaminski
G. R. Fierle	*F. W. Mackemer
*W. H. May	*F. M. Patrick
J. M. Malville	J. Pirrit
H. A. Neuburg	D. R. Reed
D. Skidmore	F. T. Turcotte
E. C. Thiel	A. D. Warren
P. T. Walker	

NAVAL SUPPORT FORCES ANTARCTICA (TASK FORCE 43)

Rear Adm. George Dufek, *Commander*
Capt. G. L. Ketchum, *Deputy Commander*
Capt. W. F. Dickey, *Commander, Naval Support Units Antarctica (1956–57)*
Capt. E. H. Maher, *Commander, Naval Support Units Antarctica (1957–58)*

*Meteorological personnel provided by U. S. Navy. In addition, the Navy has contributed additional station-support personnel.

Appendix V

National Academy of Sciences, 2101 Constitution Avenue NW., Washington 25, D. C.

United States National Committee for the International Geophysical Year

UNITED STATES INTERNATIONAL GEOPHYSICAL YEAR ANTARCTIC PROGRAM REPORT ON THE PERIOD JULY 1957–JANUARY 1958, TO THE FIRST MEETING OF THE SPECIAL COMMITTEE ON ANTARCTIC RESEARCH OF THE INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS, FEBRUARY 3–6, 1958, THE HAGUE

1. Introduction

The purpose of this report is to present briefly the progress of the United States International Geophysical Year Antarctic program during the period of July 1957–January 1958. In some instances the scientific review covers a period preceding July. Since the scientific material was assembled from necessarily brief radio reports, they are incomplete and are subject to correction after analysis has been made of the original data which are now in transit to the United States.

A more detailed description of the scientific program, stations, logistics and personnel is found in the National Academy of Sciences-National Research Council publication 553, September 1957. (Included herein as appendix VI.)

In this report, a description is presented by station and by scientific discipline. In addition to these station activities scientific programs have been conducted aboard ship. A rockoon program was carried out aboard the U. S. S. *Glacier* by Dr. J. A. Van Allen and Mr. L. J. Cahill of the University of Iowa and cosmic ray, aurora, and magnetic data were obtained between 39° and 72° South latitude. In addition, oceanographic, ice, and meteorological observations are being taken by four icebreakers and by a picket ship at 60° S., 170° E.

2. Amundsen-Scott IGY South Pole Station (90° S.)

The total wintering-over personnel complement of this station is 19, which includes 10 IGY scientific personnel and 9 support personnel. This increase of one person over last year's complement is accounted for by the presence of Mr. Paul C. Dalrymple, who will conduct a micrometeorology program. Mr. Dalrymple wintered-over at Little America last year where he conducted a similar program with Dr. H. C. Hoinkes. Dr. Paul Siple has been succeeded by Mr. Palle Mogensen as Station Scientific Leader.

AURORA

The program includes an all-sky camera, patrol spectrograph, and visual observations (including meteors).

Auroral observations were terminated in September with the appearance of the sun. During the year 5,332 visual observations were made, 3,400 feet of 16-millimeter film were taken with the all-sky camera and 300 feet of 16-millimeter film were made with the patrol spectrograph.

GEOMAGNETISM

In December successful observations to determine absolute values of the various components of the earth's magnetic field were completed at the station.

GLACIOLOGY

The 20° inclined snow mine is approximately 85 meters long and 27 meters deep. Systematic photography of snow layers and crystal sizes continues. Snow density and grain size were studied in 8 locations to a depth of 60 centimeters. Sastrugi and hoar frost formation were also observed.

IONOSPHERIC PHYSICS

During the past 6 months the ionosphere recorders have been in operation approximately 98 percent of the time.

METEOROLOGY

A new record low-surface temperature of −74.5° C. was observed on September 17, 1957. This eclipses the previous low of −73.5° C., which occurred on May 11. During the intervening period, spanning from about mid-autumn to late winter in the Antarctic, South Pole temperatures fell below −70° C. 17 times.

The mean temperature throughout the past winter was −58° C.; the maximum temperature reached was −32° C. For 90 percent of the time during the winter night, the temperature was below −50° C. The high mean wind speed of 16 miles per hour, with peak gusts of about 53 miles per hour, was unexpected; there were only 25 hours of calm weather during the entire winter. Snowstorms, with very small crystals, occurred frequently.

The first 17 days of September comprised the coldest period of the winter, with an average temperature of −64° C., and for a 4-day period, during which the record low was reached, temperatures never rose above −68° C. By September 25, however, the temperature had risen to −58° C.

Twice daily, and on occasion four times daily, rawinsondes have been taken regularly. During the winter, due to soaking of the balloons in warm diesel oil, the average height reached was between 16 and 18 kilometers. In summer, because of the higher temperatures, the treatment was suspended and the balloons averaged over 22 kilometers. The station is now supplied with 200 larger balloons which are expected to reach heights in excess of 30 kilometers.

Station pressure ranged from 657.3 millibars in July to 704.7 millibars in December. The number of clear days from 0 to 0.3 cloudiness increased from 8 in March to 27 in June.

Visibility less than one-quarter mile occurred on about 5 days each month. Annual accumulation is about 1.5 centimeter water equivalent.

3. Byrd IGY Station (80° S., 120° W.)

The total wintering-over personnel complement of this station is 22, of which 12 are IGY scientific personnel and 10 are support personnel. Mr. Stephen Barnes has succeeded Mr. George Toney as station scientific leader.

AURORA

The program includes an all-sky camera, patrol spectrograph, and visual observations.

August was the most active month, with a bright aurora on August 9, and a bright to very bright flaming aurora on August 10 (the pattern of these two being that of the red preceding the green). A rare yellow aurora was observed on August 30. Other phenomena observed were twilight shadow rays, probably noctilucent clouds, clouds resembling mother of pearl, and a bluegreen meteor near fireball brilliance in the south.

Lines of neutral and ionized oxygen, nitrogen, and sodium appear in the spectrograms. Hydrogen lines were relatively rare. A red diffuse surface and violet corona appeared September 13. On September 14, a bright aurora with rotating rays and one aurora with simultaneous green and violet rays was reported. Four bright and one very bright aurora occurred on September 9 and 10. A blue aurora appeared on the 14th.

GEOMAGNETISM

Normal speed (20 millimeters per hour) and rapid run magnetographs (4 millimeters per minute) are in operation. Instruments to provide absolute control are in use. In September there were 17 days with more than 3 hours' duration of great disturbance. Equipment tests during the early part of the season have made certain adjustments necessary to improve readings.

GLACIOLOGY

The influence of the past winter and summer on snow temperature has been detected at depths of 8 and 16 meters, respectively. In September, warming was detected at a depth of 4 meters. A core has been taken from the bottom of the deep pit at 12 and 30 meters depth for observations of density and stratigraphy. Air samples were taken at a depth of 30 meters. Melted cores were filtered to obtain precipitate material.

Oxygen isotope samples from the deep pit represent an estimated 2 complete-year accumulation. Tritium samples from the top, center, and base of the deep pit each represent a year's accumulation layer.

DEEP DRILL PROJECT

Deep coring of the Byrd Land Ice Plateau began on December 16, and the project was fully operational on December 29, with the initiation of the study of ice cores. Ice cores 7.6 centimeters in diameter have been obtained by hand drilling to depths of 18 meters. The depth of the drill hole on January 18 was 225 meters. Studies of these cores include density, detailed stratigraphy, petrofabrics, microfiltration of melted sections of the core, thermal measurements, and hole deformation.

Unbroken cores 10.2 centimeters in diameter, up to length of 6 meters, have been obtained, allowing the study of detailed stratigraphy to depths of 320 feet. Photo records are being made of the visual stratigraphy to aid in the interpretation of annual accumulation over the past. Preliminary data suggest an accumulation in water equivalent of approximately 20 to 25 centimeters per year. It is estimated that accumulation at the depth of 150 meters was deposited in the early or mid-17th century. It is intended to continue drilling to depths of at least 300 meters, and to repeat the operation next season on the Ross Ice Shelf.

IONOSPHERIC PHYSICS

The program operated satisfactorily during the past season. In September 187 hours of blackout conditions out of 720 hours were reported.

An unusually high individual foF_2 value was recorded on December 10, at 1000 local time. A sudden enhancement of atmospherics was also reported about this time.

METEOROLOGY

The average temperature in 1957 was −28° C. with an absolute minimum of −57° C. and a maximum of −4° C. Wind speed averaged near 20 knots from the northeast, with a maximum speed of 70 knots. Visibilities less than one-fourth mile occurred 2 days out of every 3. The number of clear days ranged from 15 in May to 0 in January and February. Station pressure ranged from 833.1 millibars in May to 775.5 millibars in July.

In winter rawinsondes averaged near 16 kilometers and in summer near 22 kilometers. Two hundred extra-large balloons which are expected to exceed 30 kilometers are now at the station.

SEISMOLOGY

Eighty-nine disturbances were recorded during the past 6 months. The equipment was inoperative on December 12 while the recorders were moved to another building. The recorders are now mounted on permanent plywood tops on piers extending through the floor. The piers are free of contact with the building and the recorders are now free from interference.

TRAVERSE OPERATIONS

The Byrd Station traverse, led by Mr. Vernon Anderson, glaciologist, departed on November 19. The equipment consists of 3 Sno-Cats, three 2½-ton sleds, and 1 mess wanigan. The traverse travels approximately 30 miles daily and stops on alternate days for glaciological pit and seismic studies.

The first leg of the traverse was completed December 13, terminating at an unnamed mountain at about 76° 25′ S., 112°38′ W. at mile 248.

Samples of volcanics and lichens have been collected. The party departed on December 16 for the Sentinel Mountains. An attempt to circle the mountains to the west and north was abandoned due to cracks and crevasses often extending 5 miles from the base of the mountains. The party was required to return to mile 240 in order to pass the mountains to the south.

Penguin tracks and feces were found at approximately 77° 32′ S., 98°55′ W. on January 1, at 2135 hours Greenwich mean time. This is over 150 miles from the nearest known coast. Their course was 160° true. These tracks were examined for over a mile and their course varied less than 2°. The regularity of the track indicated the bird was in good condition. The bird traveled on its belly for all but 6 feet of the part examined. Its footprints measured 8 by 5 centimeters and appeared 3-toed and webbed. Print separation was 21 centimeters and standing stride about 30 centimeters. Measurement photos were taken.

A skua gull was seen at mile 420, position 77°18′ S., 102°42′ W. on December 30, at 2315Z hours.

Snow petrels have been observed. There is no information that any have ever been observed farther south or farther from the ocean.

A summary of station elevations and ice thicknesses in meters observed so far at representative points on the traverse are as follows:

Latitude	Longitude	Elevation	Ice thickness	Remarks
79°11′ S	116°36′ W	1,715	2,425	Southwest border of hilly region.
78°44′ S	114°57′ W	1,810	2,100	Maximum surface elevation.
78°30′ S	114°50′ W	1,760	1,575	Minimum ice thickness, highest point of rock floor 20-mile zone; only area with rock floor above sea level.
77°54′ S	113°16′ W	1,525	2,500	Basin area.
77°28′ S	112°22′ W	1,410	2,130	Second hilly region.
76°48′ S	112°50′ W	1,285	2,830	Basin adjoining mountain.
76°19′ S	111°46′ W	1,500	0	Exposed rock on mountain.
76°58′ S	109°07′ W	1,189	2,345	Represents 100-mile-flat surface and bottom east from mountain.
77°27′ S	100°26′ W	1,410	3,300	Maximum ice thickness.

The traverse is now on the last leg of the approximately 1,200-mile triangle and is due to arrive back at Byrd Station in mid-February.

4. Ellsworth IGY Station (77°40′ S., 41°20′ W.)

The wintering-over personnel complement of this station is 39, which includes 14 IGY scientific personnel and 25 support personnel. Eleven of the support personnel are associated with the aviation activities. The U. S. S. *Wyandot* arrived on January 9, with the relief party and supplies. Dr. Matthew J. Brennan succeeded Mr. Finn Ronne as station scientific leader on January 18, 1958.

AURORA

This program includes an all-sky camera, patrol spectrograph, auroral photometer, and visual observations (also micrometeroites).

Flaming aurorae were observed seven nights of the winter, the most persistent one lasting for 4 hours. It was too faint and swift to photograph the motion. Almost all of the sky exposures were successful at 10 seconds. Forty seconds were used to record faint semipermanent quiet arc features of S–3 and S–4 morning hours. Photometry in blue and red light of zenith brightness during twilight shows marked recurrent variations with change of solar zenith angle. Molecular scattering was first observed as the sun reached the region near 200 kilometers.

The last aurora was observed September 18. The N variometer shows correlation between the onset of magnetic bays and breakup of overhead aurorae. Photometry of twilight was also carried out. A technique has been developed for separating micrometeorites from melted snow by an electromagnet; collecting irregular magnetic fragments and shiny magnetic perfect spheres 5 to 50 microns in diameter.

Photometric measurements have been made of zenith brightness during the solar eclipse.

The number and size of meteoric spheres increased sharply on October 23, presumably due to an Orionid shower. A special magnetograph was in operation during the entire period.

GEOMAGNETISM

This program has progressed satisfactorily.

GLACIOLOGY

The deep pit was completed August 1, and is sloped 15° from the vertical, with slope depth 32.4 meters and vertical depth of 31.3 meters. A three-inch core hole was cut 26 meters below the floor of the pit 10° from the vertical. Ice from the deep cores show elongated bubbles of perferred orientation. The density of the deepest core was approximately .89. Temperature readings were taken at 5 meter intervals throughout the depth of the pit and core holes. Thermometers were placed 3 meters into the wall for pit measurements. The measurements show decreasing temperature with depth which appears to approach a lower limit. Samples for oxygen isotope analysis were taken of the strata from the surface down to depths of 20 meters. Local magnetic declination is being determined with greater precision than has been possible previously.

Pit closure pins have been placed at 5 meter intervals and triangulated. The shallow pit has been dug to 3 meters depth.

IONOSPHERIC PHYSICS

Very regular observations of appearance of sporadic F layers and occasional sporadic E layers as low as 69 kilometers have been observed.

Twenty-three hours of continuous records were taken on October 23. A definite F–1 layer was recorded during October. The appearance of E–2 layers was noted and E layers as low as 60 kilometers were also noted in November. In December many records were lost due to sticking of the 35 millimeter camera, and a faulty variable frequency oscillator which was replaced for the third time. Much deviative absorption was noted during the month.

WHISTLER

The whistler equipment was relocated in the aviation building on July 16, resulting in a much improved signal-to-noise ratio. It is now operating with only a few marred recordings due to low ambient temperature and radio interference.

It is reported that whistler activity has been remarkable and that often whistlers have been received at rates too high to count. Also, the dawn chorus was recorded almost every day during the month of August. Wagon wheels have definitely been recorded, and what are believed to be noise whistlers were recorded during the month of September. Work has been started on a whistler spectroanalyzer and it is hoped that a critical experiment to test the feasibility of this idea may be performed. During December whistler activity was minimal. However, the dawn chorus was still active.

GRAVITY

Bihourly measurements for the amplitude of Weddell Sea tides were concluded July 20.

As an experiment to determine the density of snow removed from the glaciological pit, measurements were made of vertical gravity gradients on the aurora tower and in the deep pit.

METEOROLOGY

All information is not yet at hand but the highest temperature in December 1957 was 0.6° C. and the lowest in July was −51.7° C. Rawinsonde heights averaged near 16 kilometers in winter and several kilometers higher in summer. July had 3 clear days, 23 partly cloudy, 5 cloudy, 5 days with visibility less than one-quarter mile, 13-knot average wind from the south with peak gust of 46 knots from the east-northeast.

SEISMOLOGY

The seismic pit study was completed in September. Knowledge of density and P and S wave velocities has allowed complete determination of elastic properties of snow at seismic frequency to 55 meters depth.

The shelf ice seismic refraction program is well underway. Shots are from 1 mile on out with geophone spacings at 1, 5, and 30 meters.

TRAVERSE

On October 28, the IGY traverse party, led by Dr. Edward C. Thiel, departed from Ellsworth Station. A crevasse-free passage was discovered from the eastern end of the rift with an elevation of 210 to 900 meters above sea level. A mountain range was discovered in Edith Ronne Land which spreads approximately 160 kilometers or so in an east-west direction and extends south to less than 640 kilometers of the pole. It is estimated that some of the peaks are about 3,300 meters. It was the intention of the traverse party to divert approximately 200 kilometers from the originally planned course to permit collection of rock specimens and geological studies of these mountains.

Approximately 160 kilometers south of Ellsworth Station, in mid-November, the party came upon a heavily crevassed area undetected by aircraft. On November 30, the traverse was approximately 240 kilometers south of Gould Bay at an elevation of 510 meters in the highlands.

On December 7, the traverse party reported that at 81°30′ S., 50° W., the elevation was 960 meters and seismic soundings indicate land underneath the snow and ice cover to be 90 meters above sea level; it has not yet been determined whether this is an island or part of the mainland directly south of Gould Bay.

On December 22, the 5-man traverse party reached the mountains first sighted on the March 16, 1957, reconnaissance flight. The party camped at 540 meters elevation about 11 kilometers north of a mountain range which was estimated to have an average height of 2,000 meters. Black horizontal bands were observed high up on the mountains. The range extends 50 kilometers in an east-west direction, between 51° and 55° W., and 82°30′ S. The mountains form a 1,500 meter high escarpment on their southern side.

Reconnaissance and resupply flights have also sighted mountains 200 kilometers away to the southwest. They are located between 60° to 70° W., and 83° to 84° S.

A new island was observed to the south and west of Gould Bay extending from its cape for 320 kilometers to 80° S. The island's eastern escarpment at 43° W., has three embayments, the largest about 80 kilometers in depth. Extending in an east-west direction for about 290 kilometers, the highest elevation of the snow covered island was observed to be 960 meters above sea level at 80° S., 48° W. During the party's crossing of the island, seismic soundings showed land underneath the snow and ice to be several hundreds of feet above sea level.

Other islands whose contours were not fully delineated, were seen still farther westward and appear to tie in with land in the Catherine Sweeny and Lowell Thomas mountain groups. These observations appear to limit the size of the Filchner Ice Shelf from Molke Nunataks to Gould Bay where it terminates.

Since leaving Ellsworth on October 28, the traverse party has covered approximately 720 kilometers in a southerly direction, then proceeded in a northerly direction toward Mount Hassage. The traverse position on January 2, was 78°40′ S., 69°00′ W., or within 130 kilometers of Mount Hassage.

The relief party which arrived on board the U. S. S. *Wyandot* was airlifted to the position of the traverse vehicles and will complete the last leg of the traverse triangle. The original party was flow back to Ellsworth where it will take passage home on the U. S. S. *Wyandot.*

5. Hallett IGY Station (72°18′ S., 170°19′ E.)

The total wintering-over personnel complement of this joint NZ–US–IGY station is 14 which includes 7 IGY scientific personnel (3 New Zealand and 4 United States) and 7 support personnel. Dr. James Shear, United States, has been succeeded by Mr. Kenneth Salmon of New Zealand as station scientific leader.

AURORA

This program includes an all-sky camera, patrol spectrograph, and visual observations.

The observations for this year were terminated in October. Some equipment difficulties were reported, but results are considered to be satisfactory.

GEOLOGY

A New Zealand geological party is working in the vicinity of the station in the general areas of Moubray Bay, Tucker Inlet, Football Mountain and Tucker Glacier.

GEOMAGNETISM

Installation of the absolute magnetometer was completed in September and at first there was some doubt as to the magnetic stability of the site but it was later determined that the instrument operated satisfactorily. Reduction of records was accomplished on undisturbed days. A correlation between the onset of geomagnetic disturbances and the enhancement of auroral activity was noted.

IONOSPHERIC PHYSICS

The progress of this program during the past 6 months has been excellent. On October 23, total absorption was noted during the solar eclipse.

METEOROLOGY

The average temperature during July 1957 was −26° C.; high, −15° C. on July 26; and low −37° C. on the 15th of July. No measurable precipitation was reported. The prevailing wind direction was southwest with an average velocity of 9.6 knots with peak gusts up to 80 knots on July 23. Average station pressure in July was 986 millibars. There were 4 clear days, 21 partly cloudy days and 6 cloudy days, and 5 days with visibility of one-fourth mile or less. Because of the local high horizon to the east, the average height of 68 radiosondes was 13,864 meters.

SEISMOLOGY

This program progressed satisfactorily. The Wilmore seismometer was relocated in a pit 150 feet from the seismic shack in December and a marked improvement was noted in terms of the wind noise level. A total of 45 disturbances were recorded during the month of July.

6. Little America IGY Station (78°12′ S. 162°15′ W.)

The total wintering-over personnel complement of this station is 107 which includes 22 IGY scientific personnel and 85 support personnel. The 22 scientific personnel include Weather Central participants from France, Argentina, U. S. S. R., and Australia. Mr. Albert Crary will continue as station scientific leader and deputy chief scientist for the entire United States Antarctic program for a second year.

AURORA

This program includes an all-sky camera, patrol spectrograph, visual aurora and meteor and meteor radar studies.

The all-sky camera program was terminated on September 17. The data from both Little America and Byrd stations have been microfilmed for return to the United States.

The meteor radar was installed in the ionosphere building for joint use with the ionospheric program. Observations were taken 2 to 4 hours daily. The frequency of echos indicates a dependency on ionospheric absorption with a variation usually between 4 and 15 echos per hour.

GEOMAGNETISM

Normal speed (20 millimeters per hour) and rapid run magnetographs (4 millimeters per minute) are in operation. Instruments to provide absolute control are in use. A magnetic storm occurred on August 29. During the first 3 hours ranges of 1,560 gammas vertical intensity, 1,635 gammas horizontal intensity, 6°54′ declination were recorded.

Successful magnetic field observations were made with the Ross Ice Shelf traverse at about 82° S., 170° E.

GLACIOLOGY

The deep pit was finished at a depth of 20 meters. Cores were obtained at depths of 20 to 40 meters with hand augers. The approximate ice temperatures at various depths were: 16.8 meters, −23.3° C.; 26.3 meters, −22.6° C.; 39.0 meters, −22.2° C. One hundred sixty-five samples for oxygen isotope studies were taken at depths of 15 to 19 meters. Stakes have been located across two inland valleys for movement rate studies. During a blizzard on August 30, the following results were observed from 70 accumulation stakes: 34, erosion; 14, no change; 22, accumulation; average, 0.8 centimeter erosion.

ICE DEFORMATION STUDIES

The ice deformation program under the direction of Dr. James H. Zumberge, began reconnaissance flights in September. A camp was established in November at 78°33′30″ S., 163°49′48″ W. Triangulation points were established and a snow pit completed to 3 meters. Stratigraphy, back to 1951, is reported to be excellent. Weather observations were taken every 3 hours and thermometers installed. After having successfully completed approximately 6 weeks of ice deformation observations, the party returned to Little America Station on January 6.

GRAVITY

Gravity observations of tidal amplitude were concluded July 13. Three hundred and sixty-three values were obtained in 33 days. In the main tidal period of 24 hours a maximum amplitude during full and new moon was approximately 1.5 meters.

Mr. Sparkman has completed gravity measurements at McMurdo, Beardmore Glacier camp, Hallett Station, Little America Station, Byrd Station, and Amundsen-Scott Station. He is now awaiting passage on the United States icebreaker for subsequent visits to Wilkes Station and the U. S. S. R. IGY station at Mirny.

IONOSPHERIC PHYSICS

Program results are considered satisfactory and routine operations average over 97 percent of the past 6 months. Records for both Byrd and Little America Stations have been microfilmed for return to the United States.

METEOROLOGY

In July a total of 67 upper air soundings averaging 18,180 meters was made. The net accumulation on 4 snow stakes during July was 8.8 cm. Halos were observed on 11 days. July mean temperature, −35.6° C.; high −14.4° C. on July 24; low −51.7° C. on July 10; precipitation 0.9 cm.; mean station pressure, 974 millibars; highest sea level pressure 1,007 on July 7; lowest sea level pressure, 958 on July 22. The average wind velocity was 12.6 knots, the highest being 34 knots from the northeast on July 24. There were 10 clear days, 11 cloudy days, and 10 partly cloudy days.

Ozone content of the surface air averaged about 30 percent higher than in New Mexico. Total ozone content measurements were made on 147 days by means of the Bobson ozone spectrophotometer.

The carbon dioxide analysis operated satisfactorily.

At Little America there is a micrometeorological program utilizing both United States and European radiation instruments for comparative studies. There are also two towers for temperature and wind gradient studies. Both aspirated electrical resistance thermometers and specially shielded thermocouples are used in the temperature gradient studies, and special plastic cup anemometers for extremely low wind speeds are used for the wind gradient measurements.

PHYSIOLOGY

In August the second series of basal metabolic rate determinations and exposure to standardized cold stress in the coldroom was 80 percent complete. Physical fitness was being assayed by determining oxygen debt during submaximal exercise.

Thermal balance studies have continued and a study of nutritional intake and energy expenditure of 5 IGY and 5 support personnel was completed in September.

In October the third series of basal metabolic rate response to standardized cold exposure, skin fold measurement, oxygen consumption during exercise, and vascular response to finger immersion in an ice bath, were 60 percent complete.

On December 13, Dr. Nello Pace, professor of physiology, University of California, Berkeley, Calif., and Dr. William Siri, arrived at McMurdo Sound. Both are with the University of California Donner Laboratory of which Dr. Pace is director. While in Antarctica they will participate in the joint British and American medical-physiological expedition conducted under the auspices of the Office of Naval Research and the British Medical Research Council.

SEISMOLOGY

An analysis of records from seismic sites away from the barrier edge has been completed. Tables and charts have been compiled for ice thickness and water depth measurements. The shelf thickness varies from 240 to 320 meters.

TRAVERSE OPERATIONS

The traverse party departed from Little America on October 24. Mr. Albert Crary is leader of this expedition. The six personnel are equipped with three Sno-Cats towing three 2½-ton sleds. The traverse is supported by aircraft which land at the traverse site about every 10 days. Data obtained include ice thickness, ocean depth, ice surface elevation, magnetic field strength, magnetic compass variations, seismic velocity change with depth, gravity observations, and snow surface wind drift patterns.

The first leg of the traverse along the barrier was completed December 5, to 170° E., then the traverse party turned south. By January 1, the second leg was completed to the foot of the Beardmore Glacier at about 84°51′ S., 166° W. and the party turned northeast toward Little America Station, which will be reached in mid-February after completing the approximately 1,300-mile traverse triangle.

Scientific observations to date have included 17 seismic, 61 gravity, and 59 magnetic stations. Fourteen pit studies, 60 ramsondes, and 90 weather observations. Temperature and density were measured in 13 holes 10 meters deep, 1 hole 17 meters deep, and 1 hole 20 meters deep. Elevation has been obtained by altimetry leapfrog method with continuous readings of atmospheric pressure changes during the move.

Two small islands have been noted immediately west of Roosevelt Island.

Dr. Trevor Hatherton, chief scientist of the New Zealand Scott IGY Station, traveled with the traverse for several days on the second leg of the traverse triangle to Beardmore Glacier.

7. McMurdo Sound (77°51′ S., 166°37′ E.)

The New Zealand Scott Base carries out the IGY program in the area with the exception of the upper air meteorological observations which are being done by United States observers at the nearby United States naval air facility.

John C. Cook and William W. Vickers are conducting glaciological and seismic investigations on the Victoria Land Plateau west of McMurdo Sound with logistic support provided by aircraft from McMurdo Sound.

The geology work is being carried on in the McMurdo area by Dr. A. L. Washburn, Dr. Troy Pewe, and Mr. Norman R. Rivard. Dr. Pewe reports that evidence has been found for possibly three major glacial advances. Algae for carbon-14 dating has been collected from permafrost. Information has been obtained on the origin of the polygons, positions of the glacial fronts over the last 50 years, and depth to and temperature of frozen ground.

Dr. George Llano studied the lichenology of the area.

8. Wilkes IGY Station (66°15′ S., 110°35′ E.)

The total wintering-over personnel complement of this station is 28, which includes 15 IGY scientific personnel and 13 support personnel. Dr. Willis Tressler is scheduled to succeed Mr. Carl Eklund as station scientific leader, upon arrival of the U. S. S. *Arneb*.

During the past 6 months station personnel have made numerous scientific explorations of the area around the station. In July a survey of unmapped islands near the station was made along the coast to the Balaena Islands, 24 miles northeast of the station. In September the routine operation of all disciplines aided in the completion of mapping and fieldwork on islands and the coastline northeast to Cape Folger. In December a trip was made for 73 miles northeast along the coast for mapping, glaciological and biological studies. An auxiliary icecap station has been established 50 miles east southeast of the station at an altitude of 4,000 feet for glaciological, meteorological, and auroral observations.

AURORA

This program includes an all-sky camera, patrol spectrograph, and visual observations.

Because of the poor visibility experienced during the past 6 months, observations of all but strong aurora were hampered. On July 14 an aurora of strong intensity and color was observed. The atomic oxygen line was greatly enhanced at the expense of positive and negative groups of nitrogen which though present were very weak. On August 31 an aurora was observed having rayed bands with red lower borders.

The all-sky camera and spectrograph operated continuously the entire winter without interruption. On October 17 operations were suspended for the summer.

COSMIC RAYS

Equipment operated routinely during the past season. A count decrease of 5 percent maximum was recorded on the Sanborn chart from October 22 at 0100 Greenwich mean time, to October 23 0400 Greenwich mean time in conjunction with a magnetic storm. A low count of 10829 was recorded on November 26. A low count was detected on August 30, 1957, and the time was correlated with a cosmic ray decrease in northern latitudes.

GEOMAGNETISM

Normal speed (20 millimeters per hour) and rapid run magnetographs (4 millimeters per minute) are in operation. Also instruments to provide absolute control are in use.

Equipment operated routinely during the past season. The month of October was extremely active. The approximate averages of D, H, and Z were 82–40.8, 9372, and 65430. Sudden commencements were noted on October 20 at 0315 Greenwich mean time, on the 13th at 0046 Greenwich mean time, on the 22d at 1344 Greenwich mean time, 29th at 0016 Greenwich mean time.

Magnetic bearings in the area to the south indicate a possible declination of 90° on Mitchell Island and 105° on Robinson Ridge. There has been no opportunity to investigate but additional data should be acquired as glaciologists complete their study of the area.

GLACIOLOGY

Thirty stakes were placed in the ramp area to measure ablation. Accumulation stakes, set out in February 1957 along a 25-mile due-east profile, have been measured. Studies at points along the trail leading to the Icecap Station included mean annual air temperature, density, stratigraphy, and ram hardness. It was possible to distinguish annual layers. Ice cliffs to the north of the station have been studied; no movement was found when compared against the terminal moraine. Routine observations in the ramp area continue. The ice deformation tunnel at the Icecap Station has been remeasured. The horizontal closure is negligible; vertical closure is as much as 4 centimeters. The glaciological deep pit was excavated at a depth of 34.5 meters in November; a hand-drilled hole at the bottom has extended the depth to 60 meters. Density measurements of firn at the Icecap Station from the drill hole at the bottom of the 35-meter pit gave high values up to 0.90. The flow rate at the center of the Vanderford Glacier has been confirmed to be approximately 6 feet per day.

The ice cliffs from Clark Peninsula to approximately 65°50′ S., 113° E. were studied during a weasel trip on sea ice on the 5th and 6th of December. Elevated beaches were studied on several islands of the Windmill group.

IONOSPHERIC PHYSICS

Ionospheric equipment at the station was in operation approximately 98 percent of the time during the past season. Disturbed conditions were noted July 1–6 and to a lesser degree on July 25 and 29. During August high absorption conditions existed from the days of 10th–14th, 23d–24th, on the 26th and 29th–31st, with very high absorption on the 30th. During December disturbed conditions were observed on the 1st, 13th, 14th, 18th, 20th, and 29th of the month.

METEOROLOGY

Mean temperature for August was −12.5° C. with a maximum of 0° C. and minimum of −24° C. Average station pressure was 982.6 milibars, with maximum of 1004.7 and minimum of 957.7 millibars. There were 20 days with precipitation totaling 4.5 centimeters. Average wind speed was 12.9 knots, prevailing direction east-southeast, highest hourly average 57 knots on the 25th. The peak gust was 80 knots on the 25th. Winds exceeding 50 knots and over on 5 days. Ten radiosonde releases were lost during August due to high winds. All bay ice broke up during month.

The Ice Cap Station summary, based on 216 observations, is: mean temperature, −23.4° C.; maximum, −19.4° C.; and minimum, −34.1° C. Average wind speed was 27.8 knots, prevailing direction east-southeast.

SEISMOLOGY

Sixty-three disturbances were reported during the last 6 months. During November the largest disturbances commenced on the 20th and the 29th. The latter continued for 5 hours. During December a quake in Outer Mongolia gave the greatest amplitude of surface waves recorded during the year. The P phase was large and distinct.

ZOOLOGY

In November 120 skuas had been banded and 27 recaptures made of birds banded last year. A survey of 11 Adelie penguin rookeries on the Windmill Islands has been made and detailed studies continued in the Clark Peninsula rookery. Collections were made for the United States National Museum. A census of penguins near the station is in process.

Twenty-five Weddell seals were branded in November.

A nesting survey of the Windmill Islands was continued in December. During this period 73 skuas were banded and 34 recaptures made of birds banded last year.

Temperature telemeter studies were completed with 9 days' continuous recordings of incubating penguin and skua eggs.

9. IGY Antarctic Weather Central

OPERATIONS

Weather Central relief personnel arrived at Little America December 1, 1957. After a 2-week overlap with the previous wintering-over group the new men assumed the Weather Central duties. Since the staff has been increased from 6 to 7 men it is planned to augment the number of levels being analyzed. The program will include the analysis of the surface, 700-, 500-, 300-, 100-, and 50-milibar charts as well as vertical time sections and pseudoadiabatic charts for selected stations. The wintering-over Weather Central staff includes three Americans and representatives from Argentina, Australia, France, and the U. S. S. R. During the summer period a representative from the Union of South Africa was also present.

RESULTS OF THE 1957 WEATHER CENTRAL PROGRAM

Preliminary results obtained from data gathered at the Weather Central indicate a number of interesting circulation features in the Antarctic. Limitations of the data due to radio fadeouts, garbling, and brevity of the period of time covered make possible preliminary results. More conclusive results must await the time when all the IGY data become available for an intensive research program.

Daily as well as monthly mean charts indicate three persistent tropospheric circulation features in the Antarctic. Two of them are the already well known Ross Sea and Weddell Sea cyclones while the third is an anticyclone located over the interior of eastern Antarctica. The exact location of this latter system could not be determined due to the lack of reporting stations. However, the establishment of U. S. S. R. stations in the interior of Antarctica will aid in determining more exactly the properties of this large anticyclone. Available data now indicate that it is more than a shallow cold-surface high. At times its influence extends upward into the lower stratosphere.

Two major cyclone tracks occur in the Antarctic. One from the Ross Sea through Marie Byrd Land into the Weddell Sea. Another is along the periphery of the coast of eastern Antarctica. A more detailed report of these and other Antarctic circulation features which was prepared by Mr. J. Alvarez (Argentine representative, 1957) and

Mr. V. I. Rastorguev (U. S. S. R. representative, 1957) will be distributed to the countries involved in Antarctic research.

Stratospheric circulations over the Antarctic were followed on 50-millibar daily charts. A large polar vortex forms during the winter night with strong westerly winds around the periphery of the continent. During October a rapid heating occurs with a complete reversal of circulation to light easterly by the end of November.

Radiosonde flights made during the winter over the continent indicate the existence of an isothermal layer near 20 kilometers. Thus it may be found that the so-called disappearance of the tropopause during the dark period may actually be only a readjustment of its height; a winter time tropopause and stratosphere may exist at much higher elevations. A more complete report of the stratospheric circulations including results of total ozone observations taken at Little America is being prepared by Mr. W. E. Moreland, who was chief of the Weather Central during 1957. Continuing work at the Weather Central during 1958 will undoubtedly reveal more new and interesting features of Antarctic circulation and weather.

The effectiveness of the Antarctic Weather Central is critically dependent upon the complete and reliable receipt of synoptic meterological observations, not only from Antarctica but also from the remainder of the Southern Hemisphere. The Weather Central staff wish to express their appreciation for the splendid cooperation received from the personnel at all the Antarctic stations and Southern Hemisphere meteorological services in forwarding these data to the Weather Central as rapidly as circumstances permitted. We hope that further improvements will be forthcoming as a result of the experience gained during the first year of operations of the Weather Central.

10. COMMUNICATIONS

In general, during the past 6 months the reliability of the mother-daughter network has been reported good to fair. The schedules between most mother stations and McMurdo Sound became quite routine except during periods of radio greyout or blackout. The radio teletype circuit between Little America and McMurdo proved quite reliable and the radioteletype schedules between McMurdo and Balboa, C. Z., are very good for approximately 8 hours daily. Radioteletype schedules between McMurdo and Music Point, New Zealand have greatly improved.

The new radio transmitter building and new transmitter installation were completed at McMurdo Sound during the early winter night. This facility is located approximately 1 mile from the main camp and the radio receiver building.

The weather broadcasts are being transmitted simultaneously on 3 frequencies instead of 2 frequencies as originally planned (this was discussed at the CSAGI Antarctic Conference, Paris, June 1957) and in an effort to increase signal strength to the receiving stations, the three radio transmitters used for the broadcast were modified to radiate 1 kilowatt instead of 500 watts.

Excerpts from the Weather Central monthly reports are quoted below for information.

July–August

Mawson is now sending its weather to McMurdo via Mirny. Three schedules per day have been established with Mirny and an effort is being made to increase the number of schedules with other mother stations. Beginning August 1, Mirny will make four daily weather broadcasts at 0200, 1130, 1800, and 2100 Greenwich mean time. Weather collective broadcast times become effective August 1, and are as follows: 0415, 1015, 1615, and 2215 Greenwich mean time. A special broadcast for analysis and synoptics will be made at 1900 Greenwich mean time. Mirny will rebroadcast our analysis at 0200. Mirny is now relaying a few South African synoptics and our collective, which includes selected Australian and New Zealand reports. The reliability of the reception of weather data from New Zealand and Australia is about 80 percent. A weekly roundtable discussion over amateur radio with United States Antarctic stations is being held for aurora, gravity, ionospheric physics, and meteorology with usually 2 or 3 stations participating in addition to Little America. Complete radio blackout was experienced August 5, 29, 30, and 31.

September

Operation of Weather Central has improved greatly since August 1. Reports are now being received four times daily from all mother stations except Mawson who sends weather via Mirny. Port Stanley sends weather eight times daily. Weekly network schedules have been established with Halley Bay. It is expected that it will be possible to broadcast analyses about 12 hours after synoptic map time beginning early in September. Weather reports from United States stations are coming in more rapidly. Reports from the Japanese and Norwegian stations are not being received soon enough for analysis but work is being done to improve the situation. Reports from Kerguelen, Marion, and Amsterdam Islands are not being received reliably and South African reports are received only sporadically. Selected reports are being received from O'Higgins and Decepcion. New Zealand is sending reports four times daily via radioteletype.

The weekly voice contact with Mirny for exchange of information continues.

October

Receipt of mother-daughter weather data deteriorated considerably during October. This presumably is due to personnel changes, increased operational traffic in connection with the resupply and air operations. Delays have been as great as 12 hours. To relieve the communications load at McMurdo during the summer, Little America Station will take over Mirny weather schedules from McMurdo beginning November 3.

November

Mother-daughter network data was received more rapidly than during October with delays reduced to an average of 3 hours.

Australia and New Zealand weather was not received during the latter part of the month due to a partial radio blackout.

December

About 85 percent of Antarctic data sent by radio is being received. Sixty percent is being received from Australia and New Zealand, 40 percent from South America and none from South Africa.

Ten percent of the data analysis has been delayed beyond transmission time due to short data supply caused by radio grayout or blackout conditions.

APPENDIX VI

ANTARCTIC PROGRAM OF THE UNITED STATES NATIONAL COMMITTEE FOR THE INTERNATIONAL GEOPHYSICAL YEAR[1]

1. UNITED STATES STATIONS

The Antarctic program of the United States National Committee for the International Geophysical Year (USNC–IGY) of the National Academy of Sciences includes the operation of a network of 6 full scientific stations to be operated throughout the IGY, 1 of which (Hallett Station) is being manned jointly by New Zealand and the United States. In addition, a small station is operated 50 miles inland from Wilkes Station. An air operations facility for logistic support of the scientific program is being maintained at McMurdo Sound, and an auxiliary air facility is maintained during the summer season at the foot of the Liv Glacier.

The USNC–IGY has taken note of the recommendations of the Comite Special de l'Annee Geophysique Internationale (CSAGI), made during the Rome meeting in September 1954, to investigate possibilities of filling existing gaps in the planned station distribution in Antarctica. The recommendations of four subsequent special CSAGI Antarctic conferences have also been studied carefully. In selecting locations for United States Antarctic stations, the USNC–IGY was guided primarily by (i) the general needs of the IGY program, including coordination with the plans of other nations for establishment of stations, and (ii) consideration of special geophysical problems requiring stations at specific locations. The locations of the stations are given in table I.

TABLE I.—*Location of United States stations*

Station	Latitude	Longitude
Little America Station	78°11′ S.	162°10′ W.
Byrd Station	79°59′ S.	120°01′ W.
Amundsen-Scott South Pole Station	90°00′ S.	
Hallett Station (jointly with New Zealand)	72°18′ S.	170°18′ E.
Wilkes Station	66°15′ S.	110°31′ E.
Wilkes Icecap Station	66°28′ S.	112°17′ E.
Ellsworth Station	77°43′ S.	41°08′ W.
Naval air facility, McMurdo	77°51′ S.	166°37′ E.
Auxiliary naval air facility (Liv Glacier)	84°30′ S.	168°00′ W.

The Little America Station, established in January 1956 on the ice shelf edging the Ross Sea at Kainan Bay, functions as a major United States station. It is also used to supply and maintain the Byrd Station, established 647 trail-miles in the interior of Marie Byrd Land on the Rockefeller Plateau. It is through Little America, serving as

[1] Publication 553, September 1957, National Academy of Sciences, National Research Council, Washington, D. C.

International Geophysical Year

U.S. ANTARCTIC STATIONS

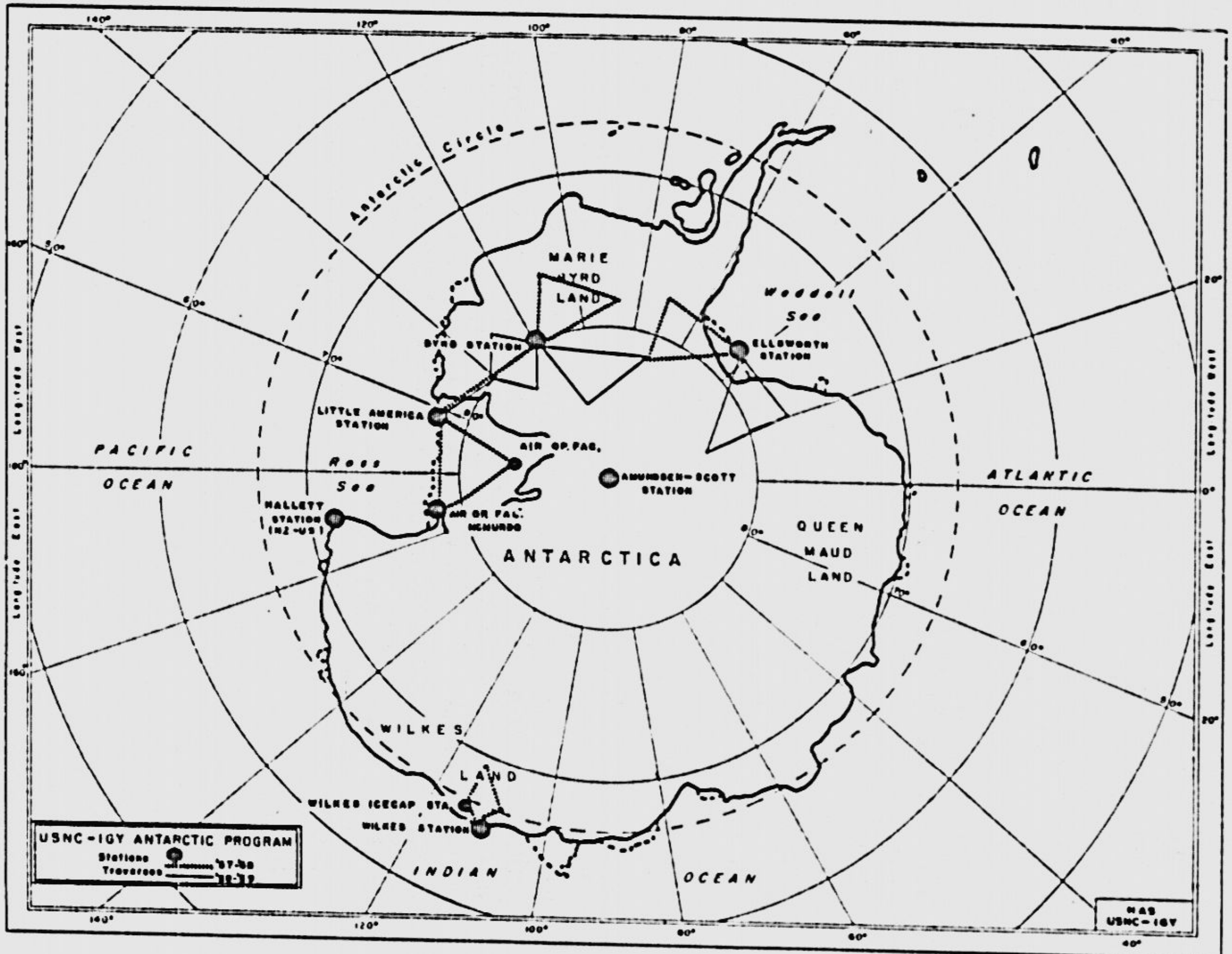

PLATE I

a port of disembarkation, that personnel and equipment are transported by tractor swing and aircraft to Byrd Station.

In addition to serving as the location for the conduct of the most intensive USNC-IGY Antarctic research program, Little America, throughout the period of the IGY, is the field scientific headquarters for the entire USNC-IGY Antarctic program. The IGY Antarctic Weather Central and its coordinated radio communications system, operated by United States scientists and technicians at the request of CSAGI, is located here. The glaciological-seismic traverse exploration of the Ross Ice Shelf and the western Rockefeller Plateau, an operation which will be conducted during 2 consecutive 5-month austral summer periods (October 1957–February 1958 and October 1958–February 1959), will use the Little America Station as its base of operations.

Location of the Byrd Station, in the interior of Marie Byrd Land, facilitates the study of a phenomenon revealed by weather observations of the Scott Expedition a half century ago. These records revealed the existence of pressure waves, or "surges," presumably spreading outward from the neighborhood of 80° S. 120° W. Since the Antarctic has the coldest atmosphere in the world, both winter and summer, and also has in its Ross Sea area the most persistent low-pressure belt found anywhere, the effect of Antarctica on world weather may be proportionately much greater than is indicated by its size. Data from the Byrd Station, studied in conjunction with observations from other stations, should reveal to what extent this is true. In addition, the Little America, Byrd, and Ellsworth Stations, near the edge of the maximum auroral zone, and the Amundsen-Scott South Pole and Wilkes Stations, within the maximum auroral zone, are well situated for observations of the aurora australis. Finally, the Byrd Station will serve as the base for the second of the three planned glaciological-seismic traverse parties. This unit will conduct a scientific program on the Marie Byrd Land Plateau, to the northeast and southeast of the station.

The Amundsen-Scott South Pole Station, established within a thousand yards of the geographic pole, during November-December 1956, accomplished entirely by aircraft operation, offers a unique opportunity for research in glacial conditions and snow accumulation, studies of the effects on ionospheric properties of the absence of the sun during the protracted Antarctic night, and the auroral phenomenon within the maximum auroral zone. It also serves as the terminal station on the international pole-to-pole lines of meteorological stations, and a small yet exceedingly important scientific research program is being conducted to utilize this exceptional location. Furthermore, as a centrally located station in the interior of the continent, the station assumes importance as an intermediate point or terminus for station-to-station continental traverses.

The Ellsworth Station has been constructed at Bahia Chica, east of Gould Bay, edging on the Weddell Sea. In its physical location, this site is similar to that of Little America Station, as it is also established on the edge of an ice shelf, the Filchner ice shelf. The Ellsworth Station will serve as the base of the third glaciological-seismic traverse operation, which will conduct observations, over two austral summers, of the Filchner ice shelf and the adjoining continental profile to the southeast of the station in Edith Ronne Land and to the southwest

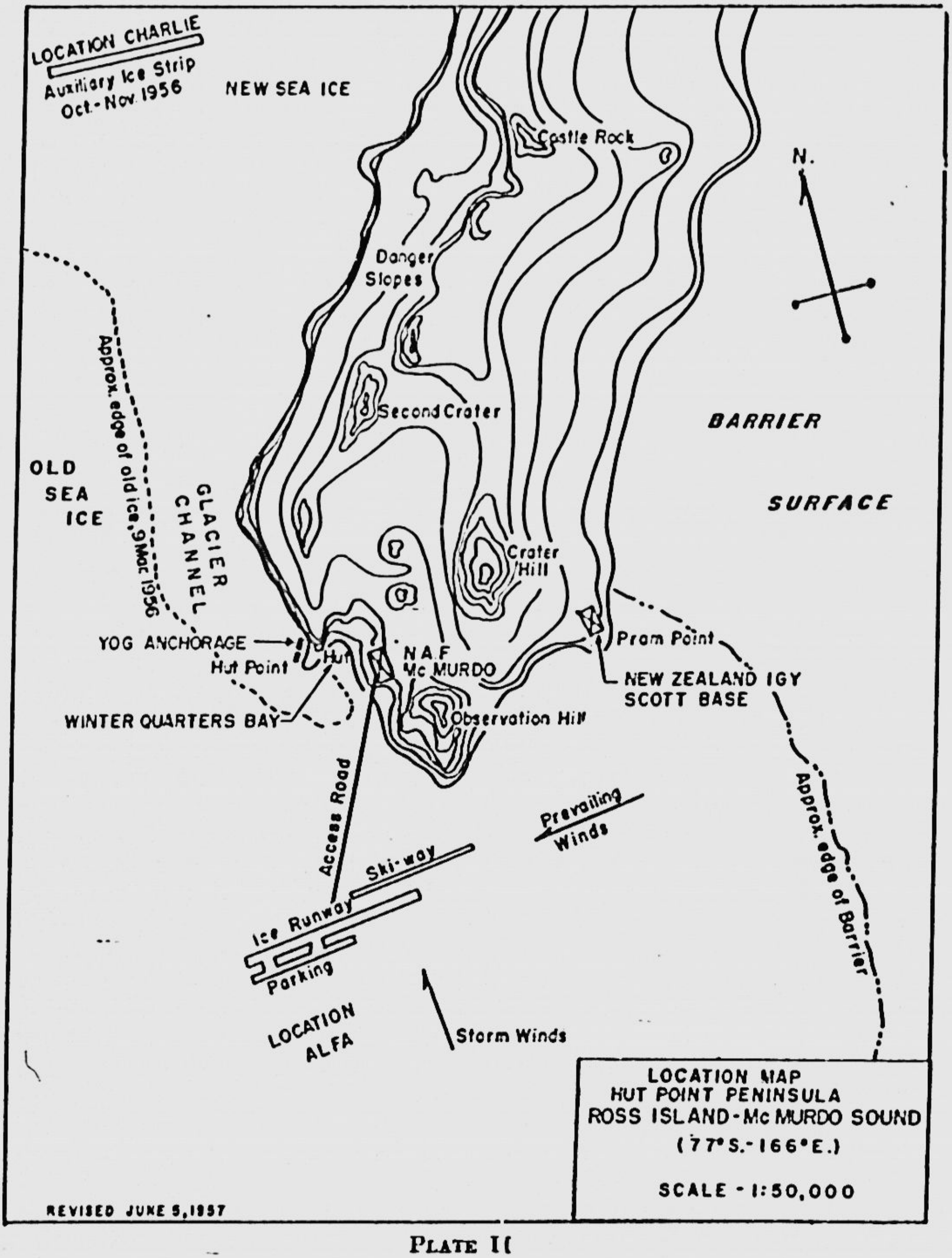
LOCATION CHARLIE
Auxiliary Ice Strip
Oct.-Nov. 1956
NEW SEA ICE
Castle Rock
N.
Danger Slopes
Approx. edge of old ice, 9 Mar. 1956
Second Crater
BARRIER
OLD SEA ICE
GLACIER CHANNEL
SURFACE
Crater Hill
YOG ANCHORAGE
Hut Point
Hut
N.A.F. Mc MURDO
Pram Point
NEW ZEALAND IGY
SCOTT BASE
WINTER QUARTERS BAY
Observation Hill
Access Road
Prevailing Winds
Ski-way
Approx. edge of Barrier
Ice Runway
Parking
LOCATION ALFA
Storm Winds
LOCATION MAP
HUT POINT PENINSULA
ROSS ISLAND-Mc MURDO SOUND
(77°S.-166°E.)
SCALE - 1:50,000
REVISED JUNE 5, 1957

PLATE II

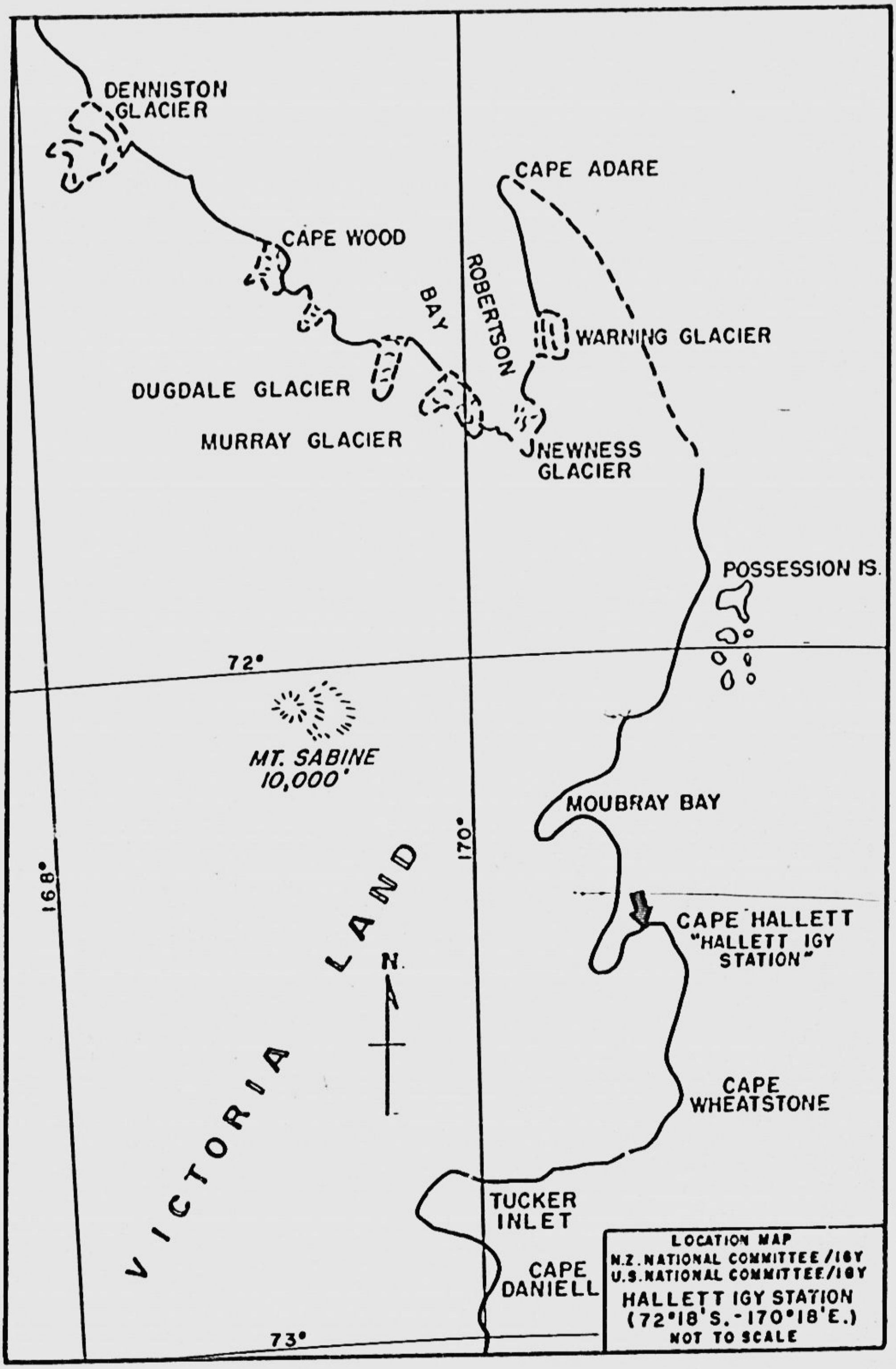

PLATE III

21652—58——7

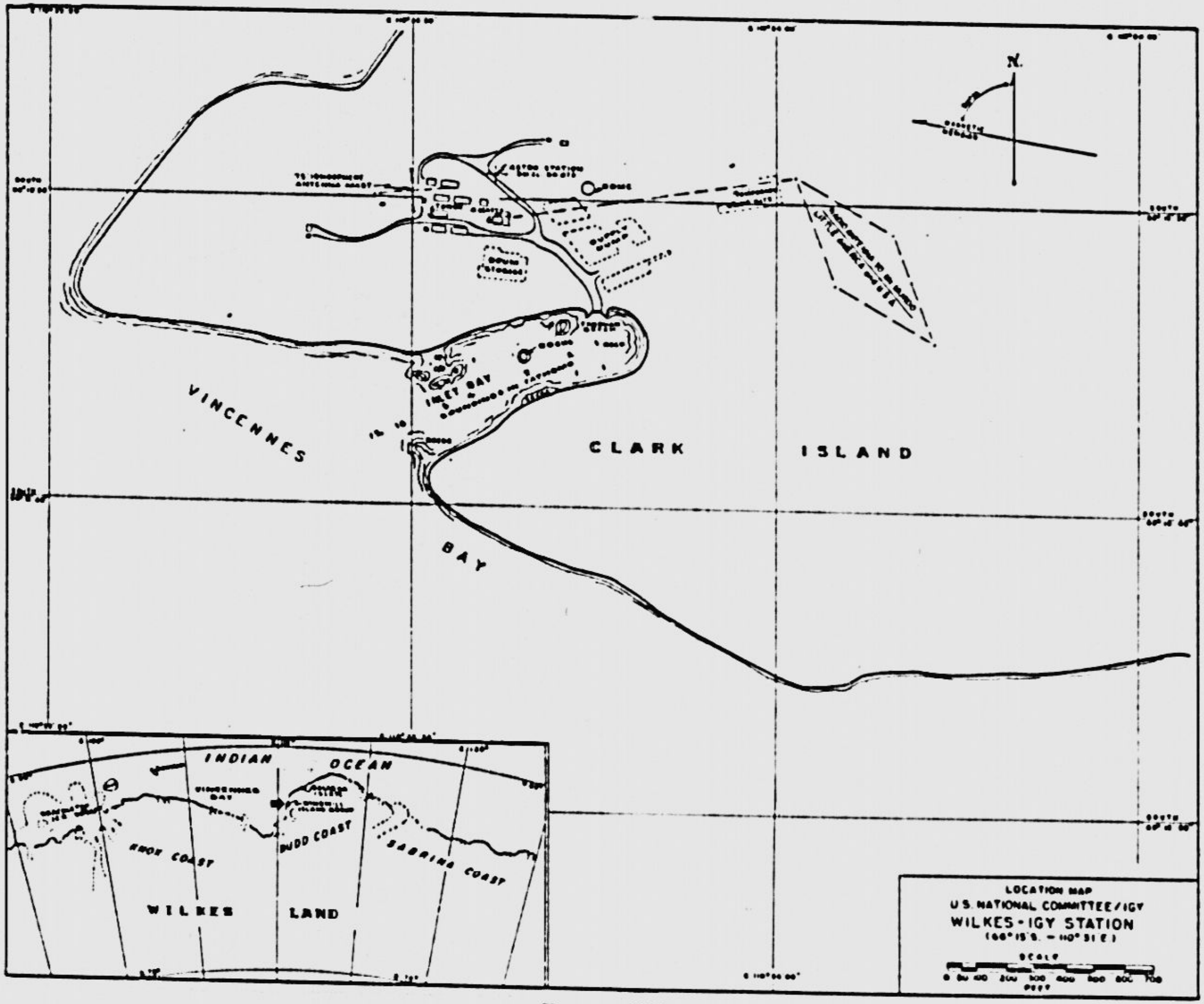
N.
VINCENNES
BAY
CLARK
ISLAND
INLET BAY
INDIAN
OCEAN
KNOX COAST
BUDD COAST
SABRINA COAST
WILKES
LAND
LOCATION MAP
U.S. NATIONAL COMMITTEE/IGY
WILKES-IGY STATION
SCALE
FEET

PLATE IV.

into Coats Land. The scientific program at the station is coordinated with those at the neighboring Argentinian and United Kingdom stations.

The Wilkes Station, which was established during January 1957 on Clark Island in Vincennes Bay, off the Knox coast, fills an important gap in the international coverage of the continent between the French station on the Adelie coast and the Soviet stations on the Queen Maud Coast. The easy access to the icecap permits limited range traverse operations from an icecap station established during February 1957 50 miles inland at an altitude of 4,000 feet. Glaciological and meterorological studies are conducted at this station. The presence of bedrock at the main-station site makes it an excellent location for seismic studies. Because of its proximity to the geomagnetic pole, Wilkes Station has been selected as the location of special cosmic-ray equipment. The remaining observational scientific programs at the station are similar to those of Byrd Station.

Hallett Station, a joint New Zealand-United States station, established January 1957 at Cape Hallett, is fulfilling an extremely important role in the meteorological network of the continent. In addition to accommodating a scientific program in aurora and airglow, ionospheric physics, geomagnetism, and seismology, the station functions significantly in air operations and communications, as it lies directly on the flight path from New Zealand to the naval facility, McMurdo. An emergency landing strip and refueling facilities are located here.

The naval air facility, located at Hut Point on Ross Island in McMurdo Sound, serves primarily as the base of operations for the airlift to the Amundsen-Scott South Pole Station and the long-range air supply of Byrd Station. It is used extensively for aircraft maintenance and support and as a communications and meteorological center. It is from this facility that all the supplies and material were air delivered for the construction and establishment of the Amundsen-Scott South Pole Station.

During the summer air operational periods a temporary air auxiliary camp is established at the foot of the Liv Glacier.

2. SCIENTIFIC PROGRAM

2.1 Summary of fields of activity

All IGY stations are conducting programs in aurora and airglow, ionospheric physics, and meteorology. With the exception of Little America and Ellsworth Stations, located on floating shelf ice, all stations have seismology programs and all but Hallett, established on terrain which is snow-free in summer, have glaciology programs. Geomagnetic observations are being made at all stations but Ellsworth.

At Wilkes and Ellsworth Stations cosmic ray observations are made. Meteorological and glaciological studies are conducted at the small Wilkes Icecap Station, and meteorological observations are made during the summer occupation of the auxiliary air facility at Liv Glacier and year-round at the air facility at McMurdo.

The oversnow traverses include programs in glaciology, gravity, meteorology and seismology. Aboard ships en route to and from Antarctica, observations are made in cosmic rays, meteorology, oceanography and rocketry. Collateral investigations are being made in dentistry, physiology, psychology, and zoology. Summer studies in botany and microbiology are also conducted.

The station-by-station distribution of these scientific programs is shown in table II, and the allocation of scientific equipment and supplies in table III.

TABLE II.—*Scientific program distribution*

Station												
Little America Station	A		Gm	Gl	Gr	I	M	O		S	Sp
Byrd Station	A		Gm	Gl	Gr	I	M			S	Sp
Amundsen-Scott South Pole Station	A		Gm	Gl	Gr	I	M			S	Sp
Hallett Station	A		Gm			I	M	O		S	Sp
Wilkes Station	A	C	Gm	Gl	Gr	I	M			S	Sp
Wilkes Icecap Station				Gl			M				
Ellsworth Station	A	C		Gl	Gr	I	M				Sp
Naval Air Facility, McMurdo					Gr		M				Sp
Auxiliary Air Facility, Liv							M				
During traverses				Gl	Gr		M			S	
On board ships		C					M	O	R		

Key:
A = Aurora and airglow.
C = Cosmic rays.
Gm = Geomagnetism.
Gl = Glaciology.
Gr = Gravity measurements.
I = Ionospheric physics.
M = Meteorology.
O = Oceanography.
R = Rocketry.
S = Seismology.
Sp = Special studies.

2.2 *Description of IGY scientific program*

Aurora and airglow.—The United States auroral observation program in the Antarctic includes several of the modern techniques of investigation. Patrol spectrographs and all-sky cameras are being operated. These automatic recording devices are supplemented by an extensive program of visual observations and, in addition, a scanning spectrometer has been installed at the Little America Station. These investigations represent a major step toward the establishment of a reasonably satisfactory network of stations in the Southern Hemisphere. Observations with essentially identical equipment at Northern Hemisphere counterparts make possible investigations on simultaneity of auroral phenomena in the two hemispheres. Close coordination of northern and southern auroral observations during the equinoctial months is being maintained.

The Meinel-Oliver photographic patrol spectrograph using a transmission grating and a spherical mirror and lens system, contains a spectrum along the magnetic meridian from 5° above one horizon to 10° above the other horizon. The variation of intensity along any spectrum line represents the distribution of that radiation along the magnetic meridian. The presence of hydrogen lines shows the location of the incident protons. Some lines in the spectrum of the aurora are sensitive to one type of particle excitation, while others are sensitive to another type. Thus, the patrol spectrograph gives the distribution of these radiations of the spectrum during an auroral display with respect to both time and geography.

Photographs of the aurora are taken at regular intervals with a specially built, automatic sequence all-sky camera, which covers the sky almost from horizon to horizon. The instrument incorporates a 16-millimeter motion-picture camera which photographs the entire sky as seen in a convex mirror. Exposures are taken at least once every 5 minutes and at each minute during active displays and during SWI. The schedule of exposures is coordinated with the schedule of the ionospheric sounders. The program is accelerated on world days. Data on auroral forms and intensities as a function of sky location and time are read from the film for use in synoptic maps of the distribution of aurora. Methods of automatic reduction of these data—i. e., punchcard machines—are currently being investigated.

Observers use alidades, diagram cards, and mark-sense punchcards for recording visual observations along the magnetic meridian zone through each station. Maximum detail is recorded near the zenith but data is obtained for about 5° of latitude—both toward and away from the geomagnetic pole. The visual observers have available a simple, narrow band interference filter. The alidade is a welded framework used as a grid to divide the sky into definite regions. Both the visual and photographic observations of aurora have as objectives the creation of synoptic maps showing the distribution of aurora at regularly spaced intervals, and the collection of data for statistical studies of aurora. These observational data are also correlated with other geophysical phenomena and solar activity. If 100 kilometers is the assumed height for the lower edge of aurora, an observer using either photographic or visual techniques can see auroral light emitted over areas within a radius of about 500 kilometers.

A scanning spectrometer is being operated at the Little America Station for detailed studies of the auroral spectrum. The program has been designed to provide information on the rapid changes of auroral spectra during the periods of high geomagnetic activity expected during the period of the IGY. The variation of short-lived auroral spectral features, especially the O_2 bands, will provide useful information on the constituent-altitude profile where records can be correlated with height measurements. Studies of rapid variations of sodium and other atomic lines will yield new information, including probable energies involved, on excitation processes. If feasible, a spectrograph with dispersion as high as 40 A/millimeter will be used at the Little America Station. Such an optically fast photographic instrument will provide detailed information for analysis of the complex auroral spectrum.

A sensitive photoelectric photometer utilizing a narrow band interference filter is in use at Ellsworth Station for a study of H Beta emissions of the aurora. H Beta was chosen as it lies in a clear portion of the spectrum.

By means of a special patrol spectrograph mounted on a turntable making one rotation per day, the twilight sky is being studied at the Pole Station. The length of twilight and clearness of the atmosphere are important factors in the significance of the experiment.

The principal objectives of the twilight observations are (i) investigation of the twilight changes of intensity in the oxygen lines at 6300 A and 6364 A, (ii) investigation of daily and seasonal variation of the 5200 A line, (iii) contribution to the study of possible variation in airglow emission with latitude, (iv) study of background continuum in the green region of the spectrum with the object of determining the part of the continuum due to upper atmosphere origin, (v) determination of whether the seasonal variation of the intensity of the sodium 5893 A line has a maximum in phase or 6 months out of phase with the northern hemisphere maximum; and, (vi) investigation of the first positive band system of molecular nitrogen in the scattering at twilight. It may also be possible to estimate the depth of the earth's atmosphere; the possible enhancement of calcium and sodium emissions in polar regions will be investigated to corroborate indications that these emissions result from calcium and sodium entering the atmosphere by way of meteors and/or micrometeors.

Observers using the method employed by Thomas C. Poulter during the Byrd Antarctic Expedition II (1933–35) are undertaking a program of visual meteor observations at each Antarctic Station. Low-power radar equipment, operated at approximately 30 megacycle, is being utilized at the Little America Station for detailed meteor and some auroral studies.

Each of the scientific stations is supplied with an automatic patrol spectrograph (16 millimeter film), an all-sky camera, and materials for visual observations of meteors. Visual auroral observations are being made at all stations.

Cosmic rays.—At Wilkes Station, a meson telescope is in operation and is providing a continuous record of the meson flux, which is related to primary cosmic radiations. This will aid in the study of the effects of solar phenomena such as magnetic storms.

A neutron monitor will be installed at Ellsworth Station. This instrument will serve as the southernmost station of a meridional monitor chain. This chain of stations has been set up to study the variation of the primary flux as a function of magnetic latitude.

A neutron monitor was in operation on shipboard during the summer voyages of 1955–56, and 1956–57 as part of the total IGY latitude study of cosmic-ray intensity. These observations provided important data on the great solar flare event which occurred on February 23, 1956. Observations of this event were carried out aboard ship at Wellington, New Zealand. En route to and from Antarctica, the purpose of the program is to observe cosmic-ray intensity with changing magnetic latitude at differing geographic longitudes.

During the 1958–59 voyage to the Antarctic, balloon flights with small counter telescopes will be made. These flights will be coordinated with similar flights to be conducted in New Zealand.

Geomagnetism.—The geomagnetic program for Antarctica emphasizes surface observations which provide data on temporal changes in the magnetic field of the earth. The results of these measurements will be useful for the interpretation of observations at the same sites in other disciplines, particularly in auroral and ionospheric physics. To obtain such geomagnetic information, special magnetic observatories have been installed at Little America, Byrd, and Wilkes Stations. At these locations complete sets of photographic recording variometers, which make permanent records of changes in magnetic declination, horizontal intensity and vertical intensity, are in operation. This photographic recording equipment not only records magnetic activity at standard recording speeds, but also provides for rapid-run recordings so that magnetic variations of short periods may be resolved. To provide control for the photographic recording equipment at each of these observatories, absolute values of three components of the earth's magnetic field will be measured at regular intervals. Inclination (dip) is being measured with a standard earth inductor and the declination and horizontal intensity by an oscillation-deflection type magnetometer.

In addition to the standard equipment at the Little America Station, a visible recording H variometer is maintained to provide immediate indications of the commencement or termination of unusual magnetic activity. Semiportable three-component (D, H, and Z) variographs of fairly low sensitivity are maintained to measure transient variations of the earth's magnetic field at the Amundsen-Scott South Pole, and Hallett Stations. Some special geomagnetic observations are being carried out at irregular intervals at Ellsworth Station in connection with the auroral program.

Timing facilities at all geomagnetic stations in the Antarctic region are controlled by precision type land chronometers. The programing of the time control is by special battery operated equipment so that power failures will not interfere with the station-timing arrangements.

Observations with identical equipment in the Northern Hemisphere counterparts to the Antarctic stations and in the equatorial zones of the Pacific Ocean permit investigations on the simultaneity of the incidence of geomagnetic disturbances and related geophysical phenomena in the two hemispheres.

Glaciology.—The main objectives of the United States glaciological program in the Antarctic are to gather further information on the present volume of the Antarctic ice, the topography of the ice surface, and the land beneath the ice; to ascertain the present status of the Antarctic ice sheet (whether it is gaining or losing in mass and volume, and the manner in which this gain or loss is taking place); to obtain information relating to the history of the Antarctic ice and to determine the trend of the ice and how it will react to changes in solar radiation and ocean temperatures. Observations will be made both at the stations and by traverse parties.

(1) Station programs: Detailed observations will be performed at each US–IGY station, except the joint New Zealand-United States Hallett Station, by glaciological and geophysical techniques. The surface movements of the ice, relative and absolute, are being determined at each station. The change of mass, i. e., accumulation or ablation, is obtained at regular intervals. Deep pits have been dug to determine the stratigraphic relationships, and the age of ice at various depths is being determined through tritium-content measurements. Standard equipment for pit studies includes coring tubes, a triple-beam balance, hardness gage, ramsonde penetrometer, thermohm strings, a Wheatstone bridge, crystal-size ring, hand lenses, and hand-drilling equipment capable of drilling to 100 feet.

Microscopes and universal stages for study of ice-crystal characteristics will be used at Little America and Wilkes Stations. Thirty-five millimeter still cameras will be used for photography.

At Little America Station a detailed micrometeorological program is being conducted to study the mechanisms of energy transfer between the meteorological environment and the ice sheet. Micrometeorological equipment at this station includes a 12-point recorder, thermocouples, thermal conductivity meters, and precision potentiometers.

The limits of portions of the ice sheet will be mapped to ascertain its present extent for future reference and to determine what changes have occurred during the interval since previous observations. To the extent possible, observations will be made of the glacial geology and geomorphology of the exposed land areas.

Other programs at present in various stages of planning include chlorine 36 analysis, paleomagnetic studies of rock specimens at Hallett

Station and a program of lichenology along the coastal areas at McMurdo Sound.

(2) Deep-drilling studies: A deep-drilling program will be carried out at the Little America and Byrd Stations. The development of techniques and drilling equipment for securing undisturbed core samples of ice will permit glaciological data to be collected to depths of 1,000 feet. Deep drilling was inaugurated on the Greenland icecap in 1956, and has been continued and improved through a 1957 drilling program. A modified Failing "1500" drill rig and specially designed core barrels and bits are used. Ice cuttings are removed from the drill hole by compressed air that has been specially cooled to the required temperatures. A 1,000-foot hole will be drilled at Byrd Station in November-December 1957. During the 1958–59 season, coring will be conducted on the Ross Ice Shelf at Little America Station.

Three-inch ice cores from the drill hole will be broken down into yearly stratigraphic units by density measurements and visual examination. Microscopic examination and photography of thin sections of ice at different depths will permit studies of crystal structure and orientation of different depths. Selected portions of the core will be melted and filtered for particulates, and studies of the ratio of O^{16}/O^{18} will reveal changes of ice and entrapped air bubbles as a function of depth. Volcanic-ash horizons such as Katmai (1912) and Krakatoa (1883) eruptions have been found in the Greenland cores. Similar horizons, and horizons of Antarctic volcanic eruptions will provide further means for time-dating the core samples.

(3) Ross ice shelf deformation study:

During late 1957 and through early 1958 studies of deformation of the Ross ice shelf will be conducted by a four-man party in the vicinity of Little America Station. Field stations will also be established on Roosevelt Island or in Prestrud Inlet.

The objectives of this project will be the mapping, measurement, sampling, and study of a part of the Ross ice shelf with special reference to both macro- and micro-structural features. With respect to measurement and mapping, both the shelf ice and sea ice will be treated as rock formations. Hence, the standard geological field methods will be applied to their study. These include mapping by plane table and alidade, the use of transit where necessary, and making of observations with Brunton compass where feasible. Aerial photographs will be employed in recording of features over broader areas than can be surveyed by regular field methods. Stratigraphy will be determined so that the structural elements can be interpreted correctly. These details may be collected from bore holes and the walls of crevasses. Specimens whose orientation in the ice is preserved for reference, will be collected for the purpose of petrofabric studies. Some of the petrofabric work can be done at Little America Station, but the majority of specimens will be transferred to the United States for further examination in cold rooms.

The party will be equipped to descend into crevasses, to study details of shelf stratigraphy and structural features not visible at the surface. A lightweight magnetometer is included in the scientific equipment of this party, and it is anticipated that some magnetic profiles can be made across the Roosevelt Island prominence.

Air reconnaissance and aerial photography will be conducted early in the season to locate the field stations in the most favorable sites. Once established at the stations, the party will be aided by helicopter support, especially during the field mapping operations.

Traverse parties.—

(1) General information: The glaciological program includes intensive studies of the ice sheet made by traverse parties traveling over a wide area from Little America, Byrd, and Ellsworth Stations, as well as a limited traverse from the Wilkes Station. Such studies include glacial meteorological observations, determinations of rates of annual accumulation and wastage which help make up glacier regimen, stratigraphy and structure of the upper layers of the ice sheet, and measurements by seismic techniques of the thickness of the ice and a determination of the character of the subglacial floor. Gravity observations are also made during the traverses. Similar observations are being made at the stations during the winter season.

The traverses outlined will furnish much information which cannot be obtained in any other way. This information will go far toward determining the climatic patterns of the interior of the continent, the hydrological budget of the ice sheet, its volume, the changes in its mass which have occurred in recent geological time, the nature of the subglacial floor and exposed land surface of the interior of the continent, and the various gradations in terms of such factors as distance, elevation, and latitude.

Traverses from Little America will study the Ross ice shelf and the Rockefeller Plateau area (between Byrd and Little America Stations) in the western portion of Marie Byrd Land. The Ellsworth Station (Weddell Sea) traverses will cover the Filchner ice shelf, Edith Ronne Land, and Coats Land ice sheet. Finally, the Byrd Station traverses will examine the Ellsworth Highland and the area south of Marie Byrd Land and Ellsworth Highland.

The basic organization of each major traveling unit will be 2 glaciologists and 2 seismologists with supporting personnel, equipped with oversnow vehicles and cargo sleds. Additional personnel representing other disciplines may be added as may seem advisable. The vehicles selected for this work are Sno-Cat freighters and Army Weasels, both equipped with cabs for living and working.

The range of operation of such a field party depends on the establishment of airborne fuel depots at specified intervals. Preliminary studies indicate that such a unit can operate about 300 statute miles on the fuel it can carry.

Each unit is as self-sufficient as possible. It will carry radio equipment and emergency gear in case any vehicle or sled is lost. Each unit will include personnel who can drive the vehicles, perform the necessary trail maintenance on them, navigate, operate radios, perform emergency radio repairs, and maintain a field camp.

The traveling units will operate during two Antarctic summer field seasons (1957–58 and 1958–59), which begin in October and end in March. Personnel may be shifted in January 1958 as the men who arrived in Antarctica the previous January are evacuated and a new group takes their place. Despite this interruption, it is hoped that at least a full 4 months of fieldwork may be carried out each season on oversnow treks. The work during the first year will be to some extent exploratory and devoted to working out procedures, techniques, and the logistical organization required for efficient operation. It is hoped that by the second year the mobile operations will be perfected so that maximum results may be obtained.

(2) Little America Station: Traverses during the first year (1957–58) have as an objective the study of the Ross ice shelf, which extends 450 miles in a north-south and 500 miles in an east-west direction. Although parts of it are crevassed and may not be traversable, much of its area is believed to be accessible to such surface parties. During the 1957–58 Antarctic summer, the traverse party from Little America will cover the Ross ice shelf, touching at McMurdo, the Liv Glacier, and finally returning to Little America. During the 1958–59 Antarctic summer the little America based traverse unit will cover the Rockefeller Plateau in the area of Marie Byrd Land east of Little America. These traverse paths are shown in plate I. It will be noted that the second year (1958–59) traverse from Little America will range from the station to 80° S., 140° W., to 77° S., 130° W. to 80° S., 125° W., to 83° S., 130° W., and back to Little America Station.

The principal features of the Ross ice shelf program may be broadly described as a study of its mass and volume, hydrological economy, morphology, and structure. Among the observations to be made are the following:

(*a*) A survey of its extent and the mountain front which encloses it on the east, south, and west, and mapping of the northern margin by ship or aircraft.

(*b*) Glaciological traverses to obtain the following data by means of shallow-drilling and pit-study techniques: (*i*) The rate of annual accumulation, (ii) the rate and form of annual wastage, (iii) the stratigraphy and structure to depths of 25 feet in pits and 100 feet with manual auger, (iv) the termal regimen to a depth of 100 feet, or more if feasible, and (v) the surface movement, whenever this can be determined.

(*c*) Determination by seismic and gravity measurements of the following: (i) the thickness of the shelf ice from the terminus to the inland margins, (ii) the internal structure as regards the depth of transition from firn to ice, (iii) the portions of the ice shelf aground and afloat, and (iv) the depth of water and the character of the subglacial topography.

(*d*) Studies of the sources of supply of the Ross ice shelf to determine the nature and proportion of the contribution from the valley glaciers and other outlets of the inland ice and from snow accumulation on the surface of the ice shelf.

(*e*) Glacial meteorological observations designed to record the following: (*i*) The meteorological conditions prevailing over different parts of the surface of the ice shelf, which can be related to the observations made at the main station and other stations, (ii) the response of the shelf ice to various meteorological conditions, and (ii) measurements of heat exchange at the surface of the shelf ice.

(3) Byrd Station: The principal feature to be studied by the traveling party at Byrd Station will be the inland ice. The range of travel will be determined by the available logistical support for establishing fuel depots and maintaining contact with the station, the accessibility of the region as determined by crevassed areas and protruding mountain ranges and nunataks, and the features which are selected for special investigation as a result of preliminary air reconnaissance.

The routes of travel fall within three main categories:

(*a*) From the Little America Station to the Byrd Station (a surface trail distance of about 650 miles): This traverse was made soon after the first scientific parties landed at Kainan Bay in January 1957. It originated at Little America Station, moved parallel to the ice shelf edge, across crevassed area (about 79° S.) and from there on crossed latitude 79° S., to the north and roughly parallelled it, went east and terminated at Byrd Station (80° S., 120° W.), in late February 1957.

Marie Byrd Land offers much of interest as an icecap area. During the 1956–57 season, the traverse from Little America Station found by seismic studies that the ice depth in the vicinity of Byrd Station increased as Byrd Station was approached from the west in an order of 6,500 to 7,800 feet. The ice depth under Byrd Station (elevation of 4,940 feet) was extrapolated to be 9,840 feet. The ice has been established to rest on land, approximately 5,000 feet below sea level.

(*b*) Traverses will be made to the east of Byrd Station: These traverses will cover as much of Marie Byrd Land as possible during the 2 years of occupancy. Traverses of 350 to 400 miles in any direction from the Byrd Station would provide much information of value. The areas to the north and northeast of the station for over 350 miles and to the southeast for 1,000 miles are unknown. An important objective will be to determine the general nature of the ice sheet and the mountain structure in the following areas: First year—eastern Marie Byrd Land and Ellsworth Highland, east of Byrd Station; second year—southern portion of Ellsworth Highland to the east of Byrd Station. During the 1957–58 summer season, the traverses from Byrd Station will cover from this station to 76° S. 110° W. to 77° 30′ S. 85° W., and back to Byrd Station. During the 1958–59 summer period, the traverses will cover a route from this station to 84° S. 110° W. to 81° S. 75° W., and back to Byrd Station.

The scientific program will be somewhat similar to that described for the Ross ice shelf parties, except that it will be conducted on the inland ice: (i) a survey of mountains and the establishment of ground control wherever rock outcrops occur, (ii) glaciological observations to determine rates of accumulation and other regimen factors, structure and stratigraphy, thermal regimen, and variations of surface features, (iii) determination of ice thickness and character of subglacial topography, (iv) glacial meteorological observations, (v) observations of outcrops to determine structure and type of bedrock, geomorphological processes, and evidence of previous glaciation above the ice surface, and (vi) meteorological observations for comparison with observations obtained at other Antarctic stations to determine the climate and weather conditions prevailing on the inland ice.

(4) Ellsworth Station: The field party at Ellsworth Station will have a program similar to and complementing that planned for the Byrd Station. It will, however, operate on both shelf and inland ice, and the scientific work will be similar to that performed on the traverses from the Little America and Byrd Stations. The 1957–58 summer traverse will cover from the station to 77° 30′ S. 71° 30′ W. to 81° S. 75° W., and back to Ellsworth Station. During the 1958–59 traverse, a track from the station to 82° 30′ S. 20° W. to 77° 30′ S. 20° W. and back to Ellsworth Station will be made.

(5) Wilkes Station: In addition to the above-mentioned traverses, a 500-mile glaciological traverse in Wilkes Land will be conducted

during October and November 1957. The traverse party will proceed inland in a southerly direction to approximately 68°30′ S., thence to Mount Long and return to Wilkes Station by way of Vanderford Glacier. Glaciological traverse work will include snow pit studies with emphasis on density, stratigraphy and temperature, ramsonde tests between pits and 10 meter core borings. At Mount Long, bedrock structure and glacial geology will be studied.

Support of the inland operation will be effected by the surface establishment of fuel caches; 2 vehicles and 1 dog team will be employed by a 5-man party of glaciologists and geologists.

(6) Airborne seismic program: Supplementing the oversnow traverses, an airborne seismic and glaciological team, composed of two scientists, will operate from McMurdo Sound or Little America Station. The program will consist of spot measurements in areas inaccessible to the oversnow traverse groups. A 12 trace HTL seismograph is to be utilized. Approximately 12 landings each summer are to be made at the following locations:

(*a*) At points 50 miles apart on the south polar plateau along 60° E. longitude and 120° W. longitude, extending outward from the Amundsen-Scott South Pole Station.

(*b*) At 50-mile intervals west of McMurdo Sound along south latitude 77°30′ and from longitude 158° east to longitude 140° E. Additional observations may be made at scattered points on the Ross ice shelf and on Marie Byrd Land.

Gravity measurements.—In order to form a common and permanent gravity base on the Antarctic continent which can be used as a reference for the gravimetry of the United States programs and of those of other nations, both gravimeter and pendulum equipment have been flown in from New Zealand to the naval air facility at McMurdo Sound and the value of gravity on the Potsdam datum determined there. A second order connection between the United States and the Ellsworth Station has been established using a high-range geodetic meter.

Gravity measurements with portable gravimeters are made between the various bases as transportation facilities permit and in connection with the glaciological studies conducted on the oversnow traverse described above.

Ionospheric physics.—Ionospheric physics measurements in the Antarctic include vertical incidence sweep frequency ionospheric soundings at all scientific stations, recording of atmospheric radio noise at Byrd Station, and recording of whistlers at the Ellsworth Station. The soundings will not only contribute to the mapping of average ionospheric characteristics over the Antarctic Continent, but will provide the necessary data for simultaneous north-south comparisons. The noise recordings will provide a checkpoint for the world maps of radio noise propagated via the ionosphere. The study of whistlers is expected to shed light on recently discovered upper atmosphere problems in the fields of ionospheric physics and geomagnetism.

Vertical incidence soundings are being made at regular intervals throughout each day using automatic sweep frequency ionospheric recorders. This equipment sweeps from 1 to 25 megacycles in a period of 15 to 30 seconds, measuring the virtual heights and critical frequencies of the ionospheric layers. Normally, a sweep is made at the beginning of each hour and every 15 minutes thereafter. During

World Days or other special intervals, the equipment can be adjusted to make more frequent sweeps up to a maximum of 1 every 15 seconds.

Recordings are being made on 35-millimeter film with some continuous parallel runs on 16-millimeter film. These are processed and scaled daily for significant ionospheric characteristics. These data and film records will be forwarded to the Central Radio Propagation Laboratory of the National Bureau of Standards for final reduction and publication. Monthly, and in some instances daily, summaries of data are transmitted by radio to the CRPL for use in forecasting special geophysical phenomena and SWI.

Measurements of atmospheric radio noise at Byrd Station involves recently developed automatic equipment. This equipment is operated in a special hut removed from the station and its sources of manmade noises. A survey was made to determine whether measurements could be made at Little America Stations; but background noise level proved too high. The equipment runs continuously 24 hours a day, measuring the absolute value of the average power of atmospheric noise on eight frequencies (50 kilocycles, 113.45 kilocycles, 246.5 kilocycles, 2.4975 megacycles, 4.9975 megacycles, 9.9975 megacycles, and 19.993 megacycles). The recording range is 100 decibels with a short-time dynamic range of 40 decibels at a band width of 300 cycles per second. Measurements are made simultaneously on 2 frequencies and integrated over a 7-minute recording period, after which the equipment automatically switches to 2 other frequencies for an equal period. It is expected that the instrument will record cosmic radio noise at the lower frequencies during routine operations since atmospheric radio noise should be minimal at these frequencies in the Antarctic.

Observations of the recently discovered whistling atmospherics, or "whistlers," are being made at Ellsworth Station to elucidate further the theory of their generation and transmission and to clarify the nature of the phenomenon. Waves having their origin in lightning flashes are thought to travel far outside the region of maximum ion-density of the ionosphere, following the magnetic meridian, and come to earth at the conjugate geomagnetic location in the opposite hemisphere. After striking the earth, the energy is reflected back, it is believed, to the point of origin along the same path. During the course of its travel the energy is dispersed in frequency so that it can be recorded as an audible whistle. Observations at Ellsworth Station are being recorded for correlation with those at the conjugate point in Labrador. The results of the whistler program are expected eventually to contribute significantly to the understanding of phenomena bearing upon radio wave propagation and geomagnetism.

Meteorology.—A full surface and upper-air meteorological program is in operation at all United States stations in the Antarctic. These stations complete the meridional lines of IGY stations so that for the first time meteorologists will be able to prepare atmospheric cross-sections from pole to pole. These stations are also part of the network of more than 40 Antarctic meteorological stations. Thus, also for the first time, it is possible to draw meteorological charts, both surface and upper air, of the entire southern polar region using observed data.

In order effectively to utilize the meteorological data from all of the Antarctic stations and to prepare weather forecasts and advisories for the many scientific and exploratory operations of all countries, an IGY Antarctic weather central is in operation at the Little America

Station. Meteorological information is obtained on all oversnow traverses and transmitted to the weather central. Weather observations are also available from aircraft flights.

The basic program at the Little America, Byrd, Amundsen-Scott South Pole, Wilkes, Ellsworth and Hallett Stations and at the air facility at McMurdo includes the following observations:

(*a*) Three-hourly standard synoptic observations.

(*b*) Twelve-hourly rawinsonde observations, providing upper air measurements of temperature, humidity, and pressure, plus wind direction and speed. Pilot-balloon observations are made, when required, for aircraft operations.

At each station the following surface parameters are recorded:

Air temperature	Sunshine duration
Barometric pressure	Hemispheric heat flux
Wind direction	Surface albedo
Wind speed	Solar radiation

An attempt is being made at the stations to measure both the amount of precipitation with standard gages and depth of snowfall with snow stakes. Snow collections are also being made at all IGY stations for precipitation chemistry investigations. For upper air observations, the stations have GMD–1A automatic tracking rawin sets, pibal theodolites, and low-pressure hydrogen generators. Some of the liquid and glass thermometers measure temperature to −130° F., and an electronic recorder at the pole station has been modified to measure temperatures to −140° F. Conventional three-cup anemometers and wind vane are used at all stations for wind observations. The stations also have aerovane wind systems for continuous records of wind speed and direction. Cloud heights are determined by a ceiling projector and ceiling balloons.

The IGY scientific stations have nonrecording precipitation gages, snow sticks for measuring snow accumulation, and snow-collection gages for obtaining samples to be used in precipitation chemistry studies. Standard 50-junction pyrheliometers are used with recorders at the 6 stations to measure direction and diffuse solar radiation on a horizontal surface. With a shade to reduce the effect of light from above, the same type of pryheliometer is used to record surface albedo. The Little America, Amundsen-Scott South Pole, and the Byrd Stations have been using recording normal incidence pyrheliometers. All of the IGY stations have sunshine-duration recorders and hemispheric radiometer recording systems in operation.

The Little America, Amundsen-Scott South Pole, and Wilkes Stations record additional observational data, using net radiometer systems. A 15-meter tower is in use at Little America for recording temperature gradient data, and it is hoped that a similar tower can be operated at the Amundsen-Scott South Pole Station during the second year of the IGY Antarctic program. Air samples for the geochemistry program have been collected at Little America, Amundsen-Scott South Pole, and Wilkes Stations, using vacuum glass bulbs. This work will be continued at the Little America Station, which has the largest scientific program. The meteorological personnel operate a sky-brightness meter, a Dobson spectrophotometer for total ozone measurement, continuous surface ozone recorders, a continuous carbon dioxide recorder, and an infrared hygrometer. Time-lapse photography of meteorological phenomena is being made at the Little America Station, and there are plans for a similar program at the Amundsen-Scott South Pole Station during the second year.

Weather central.—The IGY Antarctic weather central is collecting, analyzing, and disseminating to other meteorological centers synoptic weather reports from every meteorological observatory in the Antarctic region. This is accomplished by means of a complex communications system relaying weather reports from every source through fixed subcollection centers on regular schedules to the weather central. Arrangements have been made to receive further meteorological data from whaling vessels, expedition ships, aircraft, and traveling parties. Another communications procedure has been prepared to collect weather data regularly from ocean islands and from stations in Australia, New Zealand, Africa, and South America. The Antarctic data collected at the weather central are, in turn, made available to other international collection agencies.

At the weather central, using the latest meteorological methods of analysis consistent with the type and amount of data available, synoptic charts are prepared routinely to show the sea-level and upper air conditions in and around Antarctica. In addition, current synoptic charts of the entire Southern Hemisphere are prepared in coordination with analyses emanating from centers in Australia, New Zealand, South America, and the Union of South Africa, so as to evaluate the mutual influences of Antarctic and large-scale Southern Hemisphere circulation. Hydrographs, analyses of vertical temperature soundings, and time-sequence sections of upper air data for key Antarctic and sub-Antarctic stations are also in preparation. Pressure-center movements, trough and ridge displacement, tropopause variations, thickness changes, and cloud systems are being recorded and studied.

In addition to collecting and disseminating current weather reports and forecasts, weather central personnel are engaged in studies of past and current meteorological data in an attempt to understand the large- and small-scale features of the atmospheric circulation. Although the Antarctic station network is relatively small and only a limited knowledge of Antarctic meteorology is presently available, the opportunity of collecting simultaneous weather observations from several points in Antarctica will make possible the development of a reliable analysis and forecasting program.

Rocket exploration of the upper atmosphere.—A pioneering program of rocket firings is planned for the Antarctic region. It will be carried out during the 1957–58 summer season with rockoons (rockets launched from balloons at about 22-kilometer altitude) from an icebreaker en route to Antarctica and in the southern auroral zone off the coastal ice shelf. These small rockets are expected to reach altitudes of about 120 kilometers. A total of 55 flights are scheduled for the expedition, with 26 to be conducted in the vicinity of Antarctica. The scientific objectives are as follows:

(*a*) Survey of the cosmic-ray intensity at altitudes up to 120 kilometers over a wide range of latitudes (15 flights).

(*b*) Investigation of electrical currents flowing in the ionosphere by means of rocketborne magnetometers. Regions of special interest are the equatorial zone and the southern auroral zone (20 flights).

(*c*) Direct measurements on the auroral radiation at high altitudes in the southern auroral zone, using rocketborne equipment (20 flights).

Seismology.—The net of seismographs in the Antarctic helps provide a southern control for earthquakes in the Southern Hemisphere, including those in the South Indian and South Atlantic Oceans. These observations will make possible a more accurate delineation of the seismic belts of the Far South, including those which may extend into Antarctica. The following instruments are utilized in the Antarctic seismological program.

(1) Station seismographs: Located at the Byrd, Amundsen-Scott South Pole, Wilkes, and Hallett Stations. The following observations are being conducted:

(*a*) Recording of earthquake waves in order to determine the seismicity of Antarctica.

(*b*) Recording of earthquake waves which will indicate a figure for the average thickness of Antarctic ice.

(*c*) Recording microseisms to study their relation to Antarctic weather.

(*d*) Obtaining seismic recordings of the impulsive development of cracks and crevasses formed by the movement of the inland and shelf ice.

The Byrd and Amundsen-Scott Stations are utilizing three-component galvanometric recording seismographs. The seismometers are of the moving-coil type, designed by the Coast and Geodetic Survey and Dr. Hugo Benioff. Standard recording apparatus is being used at both stations; a film recorder with standby photopaper recorder at the Amundsen-Scott South Pole Station and photopaper recorders at the Byrd Station. Special three-component seismographs, built at the California Institute of Technology, are at Wilkes Station. Similar units, built by the Lamont Geological Observatory, are in operation at the Hallett Station.

(2) Portable seismographs: Observations made by these units complement glaciological studies on the oversnow traverses previously described. Portable, 12- or 24-trace, reflection-refraction seismograph units, using both horizontal and vertical geophones, and designed to cover the frequency range of 5 to 500 candlepower, are used by the traverse field parties.

Records will be read daily, and readings of global interest will be transmitted at stated intervals to the Coast and Geodetic Survey or to other data centers.

2.3 *Special studies*

Recognizing the fact that the IGY program includes activities in regions of difficult access or regions not ordinarily frequented for scientific research, the United States National Committee for the IGY has encouraged the conduct of basic research in fields of science, other than geophysics, which may best take advantage of the unique opportunity provided by the IGY Antarctic program.

During the winter and summer period, special investigations are conducted in dentistry, botany, microbiology, physiology, psychology, and zoology at the United States IGY Antarctic stations.

Dentistry.—Dental investigations are being conducted at the Little America Station and at the air facility at McMurdo Sound. Additional data will be collected at all other United States stations by the station physician.

Among the factors being investigated are those conditions which give rise to pain under conditions of extreme cold, and their relation to dental effects. Various types of material used for fillings are being tested, as are certain protective devices, such as rubber teeth guards. Temperature changes in the mouth are being measured. Also under investigation is the relationship of dental complaints to psychosomatic factors; e. g., stress, and incidence of medical complaints.

Botany.—During the 1957–58 period of summer operations, a botanical program will be conducted at the naval air facility, McMurdo Sound. Representative collections of lichens, mosses, and fresh-water algae will be taken. While emphasis will be on land plants, collections of marine algae from shallow-water areas will be made as opportunity permits, and insects and arachnids will be collected whenever possible.

In addition to carrying out a research program, the investigator will instruct various members of the IGY Antarctic program, especially members of traverse parties, in the correct methods of collecting and recording field collections. Wherever possible, the investigator will work jointly with these traverses and if time permits, coordinate various aspects of this program with the program of microbiology.

Microbiology.—A team of microbiologists will make observations during the summer period of 1957–58. The program will consist primarily of examinations of ice cores, Antarctic air, microbial content of sea water and marine sediments surrounding Antarctica. Bacteria of sanitary significance will also be studied and the impact of human habitation upon an otherwise sanitary environment investigated. An examination of rocks, coal and mosses, and lichens will be undertaken. Where possible, this part of the program will be coordinated with the botanical investigations.

Physiology.—Research is being conducted at the Little America Station by a physiologist, assisted by the station physician. At other stations, physicians are carrying out various types of physiological measurements as space and facilities permit.

Measurements of changes in the thickness of body fat, heat production, mobility of joints and touch discrimination, are being taken. Measurements on personnel whose duties involve a maximum of out-of-door work are being compared with personnel whose duties require a minimum of outside work.

Important correlary data is being obtained on the degree of physical fitness, increase or decrease in cold injury and their relationship to these measurements.

Psychology.—The psychological research program has as its aim the collection of historical data of reasonably intimate personal significance by two methods: Written diaries and voice recordings. These data are being collected from personnel at the Amundsen-Scott South Pole, Byrd and Hallett Stations by the station physician.

Zoology.—The migration and distribution of the south-polar Skua are under study by means of colored plastic bands attached to the bird's leg. Banding is done at all stations. Bands of a distinctive color for each station have been supplied in order that subsequent observations will provide information as to their point of origin.

The migration of seal in Antarctic coastal waters are under investigation. Seals will be distinctly marked at the Wilkes Station. Pre-

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sonnel at other coastal stations will record the appearance of these seals.

3. PERSONNEL

3.1 Summary requirements

During the 1957 Antarctic winter, 339 scientific, technical, and support personnel will occupy six USNC–IGY Antractic scientific stations and the naval air facility at McMurdo Sound. The scientific program involves 143 scientists, technicians, and administrative personnel, including 16 naval aerological personnel, three New Zealand scientists who will continue to be stationed at the joint New Zealand—United States Hallett Station and participants from other countries to the IGY weather central at Little America. It also includes 55 personnel for the summer season of 1957–58. To maintain the six scientific stations, 251 support personnel will be employed, including those stationed at the naval air facility at McMurdo Sound from which the major air support of the USNC–IGY program is centered. Personnel requirements during 1956–57, which included a total of 330 personnel, are illustrated in table IV.

TABLE IV.—*Summary of Station personnel, 1956–57*

Description	LAS	Byrd	Pole	Hallett	Wilkes	Ellsworth	NAF	Ships	Total
International Geophysical Year science	24	13	9	[1] 4	10	10			70
Support aerologist				3	4	4	4		15
Support maintenance [2]	85	10	9	7	13	25	83		232
Total	109	23	18	14	27	39	87		317
	Additional summer personnel, 1956–57								
International Geophysical Year science	7	1				1	3	1	13

[1] 3 are New Zealand personnel.
[2] Including support personnel for aircraft operation.

Each period of operation is for a period of approximately 18 months and most personnel are rotated at the end of each period. The first contingent of IGY personnel left the United States in late 1956 and will return about April 1958. The second contingent will leave September-November 1957, returning April 1959. This schedule has been planned to allow sufficient time for rotation of personnel at the most distant stations and includes suitable overlap for the coordination of the first and second year programs. Scientific personnel being relieved will have an opportunity to discuss their individual programs of the preceding months with relief personnel and to instruct them in the functioning of station equipment. Minor changes in the second year's program may necessitate a few additional personnel at certain stations.

TABLE V.—*Summary of station personnel, 1957–58*

Description	LAS	Byrd	Pole	Hallett	Wilkes	Ellsworth	NAF	Ships	Total
International Geophysical Year science	[1] 25	13	9	[2] 4	12	9	--------	--------	72
Support aerologist	--------	--------	--------	3	4	4	5	--------	16
Support maintenance	55	10	8	7	13	15	91	--------	199
Aviation	16	--------	--------	--------	--------	11	25	--------	52
Total	96	23	17	14	29	39	121	--------	339
	Additional summer personnel, 1957–58								
International Geophysical Year science	[3] 19	[4] 12	--------	[5] 9	2	2	6	5	55

[1] Includes 4 non-United States meteorologists at weather central.
[2] 3 will be New Zealand personnel.
[3] Includes 2 non-United States weather central participants.
[4] Includes a deep core-drilling crew of 10.
[5] Includes a New Zealand geological party of 8.

3.2 Scientific personnel

Scientific administration.—Planning and direction of the IGY Antarctic effort of the United States have been conducted by the United States National Committee for the International Geophysical Year, its Antarctic Committee, and subject-matter panels. The chairman of the Antarctic Committee, who is responsible for directing the USNC–IGY Antarctic activities, is aided by the chief scientist and the deputy chief scientist. The latter, who is wintering over at the Little America Station, is responsible for the actual field administration. In this task he is assisted by the individual station scientific leaders who coordinate and maintain the scientific programs at their stations.

The chairman of the Antarctic Committee (Director of the US–IGY Antarctic program) and/or the chief scientist are present during the Antarctic summer months to supervise the operational aspects of the several scientific programs and to arrange the changeover of personnel between the first and second year's operations.

General description.—The scientists and technicians are conducting research programs in the following IGY disciplines: aurora and airglow, cosmic rays, geomagnetism, glaciology, gravity measurements, ionospheric physics, meteorology, oceanography, rocketry, and seismology. In addition, special investigations in physiology, dentistry, biology, botany, and psychology are being conducted.

A full program in eight disciplines is being carried out at Little American Station, while Byrd and Ellsworth Stations are conducting somewhat reduced programs. The programs for the Wilkes, Amundsen-Scott South Pole, and Hallett Stations include fewer disciplines than those of the other three stations.

The ionospheric physics program utilizes two men at all stations but Amundsen-Scott. Meteorology requires a minimum of four men at each station to maintain the surface and twice-daily rawinsonde observational program; and the disciplines of glaciology and seismology, which involve extended field activities, require teams comprised of both glaciologists and seismologists, together with gravity personnel.

Whereas the meteorological programs at most of the stations follow a similar pattern in personnel requirements, Little America has an additional staff of six personnel to maintain the IGY Antarctic Weather Central. The breakdown in meteorological personnel is shown in table VII.

Of the 10 glaciologists at the Antarctic stations 7 (3 at Little America Station, 2 at Byrd Station, and 2 at Ellsworth Station) accompany traverse parties during the Antarctic summer months. Glaciological personnel on the Little America traverse are joined by two seismologists and a gravity observer. The 22 glaciologists on the Byrd and Ellsworth Station traverses are joined by 2 seismologists and 1 gravity observer; the 3 glaciologists and seismologist at Wilkes Station are not only engaged in a station program, but glaciological studies are being made at the inland location some 50 miles south of the station, and will also be conducted during short traverses. Additional glaciological and seismic personnel at Little America Station will conduct a station program and an airborne spot-check program for the Little America Station traverse team.

TABLE VI.—*Summary of scientific personnel, 1957–58*

Description	LAS	Byrd	Pole	Hallett	Wilkes	Ellsworth	NAF	Ships	Total
Aurora and airglow	1	1	1	[1] 1	1	1			6
Cosmic rays					([2])	([3])			
Geomagnetism	1	1		[1, 4] 1	1				4
Glaciology	[5] 3	2	[6] 2		3	2			12
Gravity	1	1			1	1			4
Ionosphere	2	[7] 2	1	[1, 8] 1	[2] 2	[3] 2			10
Meteorology	6	4	4	1	2	[9] 1			18
Oceanography	([10])				([11])				
Seismology	2	2		([1, 4])	1	2			7
Special studies	[12] 1	([12])	([12])	([12])	([12])	([12])	([12])		1
Weather Central	[13] 7								7
Administrative	[8] 1	([7])	1	([1, 4])	[11] 1	([9])			3
Total	25	13	9	4	12	9			72
Navy aerologist				3	4	4	5		16
Total	25	13	9	7	16	13	5		88
	Additional summer personnel, 1957–58								
Aurora and Airglow	1								1
Cosmic rays								1	1
Geomagnetism	1								1
Glacial programs [13]	6	11		9	1		5		32
Ionosphere	2	1				1			4
Meteorology	1								1
Oceanography								([14])	
Rocketry								2	2
Special studies	1				1		1	2	5
Weather Central	[15] 3								3
Administrative	[16] 4					1			5
Total	19	12		9	2	2	6	5	55

[1] 3 New Zealand personnel.
[2] Program is conducted by ionospheric personnel.
[3] Program is conducted by ionospheric personnel.
[4] The geomagnetician also operates the seismograph.
[5] 1 glaciologist is also station scientific leader.
[6] 1 is a micrometeorologist.
[7] 1 ionospheric physicist is also station scientific leader.
[8] The ionospheric physicist is also the station scientific leader.
[9] Meteorologist is also station scientific leader.
[10] Program is conducted by glaciologists.
[11] Program is conducted by station scientific leader.
[12] Additional special studies are carried out at all stations by the doctor.
[13] Includes research in glacial geology, gravity, deep-core drilling, ice physics, airborne seismology and geology. (See table VII.)
[14] Program conducted by naval hydrographers.
[15] Includes 2 non-United States meteorologists.
[16] Includes director and chief scientists, United States-International Geophysical Year antarctic programs.

During the 1956–57 austral summer, 2 gravity personnel carried out pendulum observations at naval air facility, McMurdo, and Little America Station, while another gravity observer accompanied the ships into the Weddell Sea; 1 man operated the shipboard cosmic ray program. For the establishment of both the Weather Central and the meteorological program at Little America Station, each program included a director during the installation period. Additional summer scientific personnel at Little America Station included a New Zealand meteorologist at the IGY Weather Central and a physiologist who was responsible for establishing a program at the station. Summer administrative personnel included the Director and Chief Scientist of the USNC–IGY Antarctic programs. Additional administrative personnel included a field liaison officer at naval air facility, McMurdo, during the early operational season and one at Byrd Station, coordinating the establishment and construction of the station.

TABLE VII.—*Meteorological and Weather Central personnel, 1957–58*

Description	LAS	Byrd	Pole	Hallett	Wilkes	Ellsworth	NAF	Total
Head meteorologist	[1] 2							2
Recording seismograph technician	1							1
Recording seismograph observer	4	2	2					8
Recording seismograph technician-observer		1	1					2
Meteorologist-observer		1	1					2
Meteorologist				1	2	1		4
Meteorologist (analyst)	[2] 6							6
Totals	13	4	4	1	2	1		25
	Navy aerology personnel							
Naval recording seismograph observer				4	4	3	4	15
Naval aerologist							1	1
Total				4	4	3	5	16
Total	13	4	4	5	5	5	5	41

[1] Includes supervisor of Weather Central.
[2] Weather Central personnel, including 4 non-United States meteorologists.

NOTE.—An additional 2 non-United States meteorologists as well as the director will be present at the Weather Central during the 1957–58 summer.

TABLE VIII.—*Glaciology program personnel, 1957–58 (including seismologists and gravity personnel)*

Description	LAS	Byrd	Pole	Hallett	Wilkes	Ellsworth	NAF	Total
Glaciology	3	2	1		3	2		11
Gravity	1	1			1	1		4
Seismology	2	2			1	2		7
Micrometeorology			1					1
Total	6	5	2		5	5		23
	Additional summer personnel, 1957–58							
Glacial geology							4	4
Gravity	([1])	([1])	([1])	([1])	([1])		1	1
Deep core drilling		10						10
Ice physics	4							4
Airborne seismology	1							1
Geology				[2] 9	1			10
Glaciology	1	1						2
Total	6	11		9	1		5	32

[1] 1 man will make gravity observations at all stations but Ellsworth.
[2] Includes New Zealand geological party of 8.

Additional scientific personnel during the 1957–58 summer season will conduct the following programs:

(1) Little America Station: Ice physics and deformation, airborne seismology, additional participants in the weather central program, and several senior scientists, who will review the individual scientific programs, data and equipment with the 1957 wintering personnel.

(2) Byrd Station: Deep core drilling program, gravity studies.

(3) Amundsen-Scott South Pole Station: Gravity studies.

(4) Hallett Station: Collection of rock specimens for paleomagnetic studies.

(5) Wilkes Station: Microbiology studies.

(6) NAF McMurdo: Glacial geology studies, gravity observations and lichenology.

(7) Shipboard programs: Rocketry, oceanography, and cosmic rays.

Selection of personnel.—Selection is based on scientific ability, physical fitness, and personal characteristics. Requests for employment which have been received by the USNC–IGY have originated from students, university faculty members, and research workers in private industry.

3.3 Support personnel

To maintain the IGY stations 146 support maintenance personnel are utilized at the 6 stations. These personnel include doctors, a dentist, radio operators, electronic technicians, cooks, mechanics, machinists, electricians, builders and other personnel required to effectively support all phases of the scientific program. An additional 52 naval aviation personnel are distributed among Little America and Ellsworth Stations and the Naval Air Facility at McMurdo. The latter also has a winter complement of 91 other personnel.

TABLE IX.—*Support personnel, 1957–58 (planned figures)*

Description	LAS	Byrd	Pole	Hallett	Wilkes	Ellsworth	Subtotal	NAF	Total
Senior naval officer	1	([1])	([1])	([1])	1	1	3		
GCA officer	1						1		
Communications officer	1						1		
Supply officer	1						1		
Chaplain	1						1		
Doctor	1	[1] 1	[1] 1	1 [1]	1	1	6		
Dentist	1						1		
Navigator	1						1		
Electrical technician	3	1	1	1	1	1	8		
Radio operator	13	2	2	2	2	2	23		
Clerk	1						1		
Storekeeper	3						3		
Cook	3	1	1	1	1	2	9		
Machinist	1						1		
Electrician	2	1	1	1	1	1	7		
Driver	3	1					4		
Machinists	4	1	1	1	1	1	9		
Builder	2	1			1	1	5		
Steelworker	1						1		
Utility	2	1	1		1	1	6		
General duty	3				2	2	7		
GCA technician	4						4		
Photographer	1				1	1	3		
Hospital corpsman	1					1	2		
Subtotal	55	10	8	7	13	15	108	91	199
Aviation	16					11	27	25	52
Aerographer				3	4	4	11		
Total	71	10	8	10	17	30	146	116	251

[1] The doctor also acts as senior naval officer.

4. STATION FACILITIES AND EQUIPMENT

4.1 *General information and station layouts*

The special prefabricated buildings being used at the USNC–IGY Antarctic stations are similar to those which have proved outstanding habitations in extreme low temperatures over a period of years in the Canadian and Greenland Arctic. The structures which were shipped to the Antarctic during 1955–56 have since been modified following experience gained in erecting and inhabiting the buildings under field conditions at the Little America Station and the air facility at McMurdo. Therefore, those structures erected at other United States Antarctic stations during 1956–57, vary in some details from those utilized earlier.

Illustrations which follow indicate the plans for the six scientific stations, as well as for several of the typical buildings. As far as it is possible, each station layout presents the as-built plan while the building interior arrangements are only typical and not to be taken as actual construction. The station plan may be further altered in the field according to the demands of expediency, and space allocations within the buildings may be revised to provide more suitable arrangements.

The buildings are erected on the snow surface except at Wilkes and Hallett Stations and Naval Air Facility, McMurdo where the buildings have been placed on rock. Tunnels connecting the buildings with roofed-over caches have been constructed at Little America, Byrd, Amundsen-Scott South Pole, and Ellsworth Stations. At strategic points in these tunnel systems, escape hatches for access to the snow surface have been constructed, and doors to prevent the spread of fire or fumes are located in the connecting tunnels between buildings. The tunnel system is lighted electrically.

The exterior of the buildings and tunnels are quickly drifted up with snow, at least to the level of the building roofs, giving the station area the appearance of a level plain dotted with snow mounds. Until the area between the large snow mounds builds up to roof level no great amount of snow is expected to accumulate on the building roofs. For this reason skylights have been provided for roofs over certain work and recreation areas.

Placement of the buildings has been governed by the following considerations: (*i*) safety (fire) requirements, (*ii*) special scientific requirements, (*iii*) the desirability of cache areas (not indicated on site plans) convenient to each building, (*iv*) the relationship between complementary buildings, as barracks and latrines, (*v*) accessibility of buildings and cache areas during resupply periods, and (*vi*) the possibility of future station expansion if required.

Two special tower structures, one to house aurora and airglow equipment, and the second supporting a meteorological rawin dome, are erected at each Antarctic IGY station. Extensible tower supports were designed in order that the tower structures may be elevated as required by the accretion of snow beneath them. Because of air drop limitations, the aurora and rawin towers were modified in erection at Byrd and Amundsen-Scott South Pole Stations. The extensible columns supporting the towers at these stations will be erected during 1957–58 operations.

Among the recreation facilities at each station are a library offering a wide range of reading matter; motion picture projectors, screens and films; commissaries where tobacco, candy, and toilet articles are available. Complete medical facilities and a doctor are provided at all stations; a dentist and dental equipment are provided at Little America Station and the air facility. In addition, amateur radio facilities are provided at each station for the transmission of personal messages (see Chapter 5).

4.2 Structures and space allocations

Standard building structures.—The prefabricated buildings utilize 4 feet by 8 feet by 4 inch modular panels in the assembly of the shell. Refrigerator-type exterior doors with triple-pane skylights, and hatchways are integral parts of special 4 feet by 8 feet panels. In assembly, wall panels rest on floor panels, and roof trusses and panels on walls. All components are locked together through use of a splined keying system which provides maximum rigidity with minimum heat loss.

Since the design of the buildings obviates the need for load-carrying interior walls, plywood is used as partitions within the buildings. The partitions extend from the underside of the roof trusses to the floor. Interior doors have been provided only where required; for sleeping quarters and other areas where permissible, curtains only are used. The floor covering is vinyl tile for durability and ease of maintenance.

The original buildings have aluminum sheathing on the interior surface of the wall panels. In the wall panels of the buildings designed for shipment during the 1956–57 season, aluminum foil moisture-barrier is laid between the interior plywood surface and the insulating material. The interior surfaces of these walls and partitions of both new and old buildings are covered with attractive fire-resistant paint.

When erected on permanent snow, the buildings utilize a saddle-type foundation support extending a distance of 2½ feet beyond the building wall. The purpose is to reduce the possibility of differential settling beneath the structures.

Special structures.—

(1) Meteorological rawin tower: Mounted on columns, a 20- by 24-foot platform made of 4- by 8-foot standard floor panels, accommodates a fiberglass rawin dome for housing electronic equipment used in tracking upper-air sounding balloons. Access to the platform and dome is by means of a ladder terminating at a hatch in the tower floor. At Byrd Station the rawin dome has been erected temporarily on the top of the meteorology building.

(2) Aurora and airglow tower: This special structure, housing natural sky-illumination recording equipment, is mounted like the rawin tower, on columns with access by means of a ladder terminating at a hatch in the building floor.

(3) Inflation shelter: This building, 20 by 24 by 12 feet high, is used to manufacture hydrogen and to inflate and launch meteorological upper-air sounding balloons. The building is erected at the surface, and since snow drifts to roof level, release of the balloons is effected through a large hatchway in the roof. A chimney-like arrangement within the building, together with demountable wind deflectors on the roof provides sufficient lift to launch the balloons. Additional coaming sections will be added to raise the "chimney" height as required by snow accretion above the building.

Because of the danger of an explosion of the hydrogen gas in the inflation building, heating for the inflation shelter is accomplished from a separate small utility building nearby. Heat is provided by a spark-proof hot air heater. Buildings are bonded together to reduce the possibility of sparks caused by static electricity.

(4) Geomagnetic buildings:

(*a*) Little America, Byrd, Ellsworth, and Wilkes Stations: Since building specifications permitted up to 7 percent ferrous content in the aluminum sheathing or foil and since such ferrous concentration would adversely affect certain sensitive geomagnetic recorders, the geomagnetic buildings at these stations differ from the other buildings in that aluminum is not used in panel construction. Instead, brass hardware is utilized and special nonmagnetic electric heaters made of glass are provided for heating. The foundations of these special buildings are constructed entirely of timber to preserve the non-magnetic nature of the buildings.

(*b*) Amundsen-Scott South Pole Station: Here a 4- by 4- by 8-foot-high instrument shelter has been constructed of dunnage and crating material with brass hardware. No special foundation is required.

(*c*) Hallett Station: The geomagnetic instrument shelter is an 8-foot cube formed of standard panels without the moisture-barrier foil.

(5) Garages: Special floor panels for that portion of the building where vehicles are stored are constructed of 4- by 6- foot hardwood framing, with one-half-inch marine plywood forming the bottom of the panel surface and 2- by 6-inch tongue-and-groove lumber the wearing surface. Standard floor panels are used elsewhere in the building.

(6) Temporary housing: Prefabricated, framed, canvas-covered structures at each station are used for temporary housing during times when an influx of personnel occurs, as during the supply season and the period of the relief of personnel. At other times these huts are available for storage, workshops, and recreation areas.

Space allocations.—Scientific laboratory and work areas have been designated on the basis of compatibility of disciplines, special scientific requirements, and available space. Thus, at the Amundsen-Scott South Pole Station, the ionospheric physics program, which must be as remote as practically possible from the radio building, shares a building with aurora and airglow, and geomagnetism programs.

Because of the narrow width of the buildings, corridors were eliminated; quarters line one side of the typical "science" building, while the various disciplines occupy the open areas.

4.3 Station facilities

Electrical systems.—Diesel-electric generating sets were selected for use at the IGY Antarctic stations. Utilizing the caterpillar D–315 diesel engine with self-regulated generator, the units provide 60-cycle, 34-kilowatt continuous output at 1,200 revolutions per minute. One percent frequency regulation has been specified in accordance with certain scientific demands. The electrical power is 3-phase, with 110- and 220-volt outlets in each building. Provision has been made to parallel generators as required. At Amundsen-Scott South Pole and Byrd Stations the power is single-phase.

One or two generators per station are located at a site other than the main power building. These generators are for use as emergency power in the event of disaster (fire, etc.) to the main power building.

Plumbing systems.—

(1) Mess halls: The basic unit of the plumbing system is the snow-melter, a 2- by 3- by 4-foot tank of 180-gallon capacity located in each kitchen. Snow blocks are placed in the tank through a hatch in the building roof or wall directly above or adjacent to the tank. A circulating water line runs from a water-jacket in the kitchen range to the tank to assist in melting the snow.

Water lines extend from a 300-gallon overhead cold water storage tank to the kitchen sinks and to the diesel-oil-fired, 139-gallon-per-hour-capacity hot water heater; a hot water line connects the heater with the kitchen sinks.

Waste water is dumped directly into a 180-gallon waste tank located beneath the sinks. Stored until the tank is nearly full, the water is discharged into a waste sump under the building.

(2) Latrine-darkroom-laundry: The snow-melter associated with the latrine-darkroom-laundry water system at the Little America Station is located in the power building, where heat from the generator exhausts melts the snow. An electric pump transfers water from the snow-melter to a 975-gallon settling tank, thence to a 975-gallon storage tank, both also located in the power building. As required, the water is then transferred through an insulated passage connecting the generator room with the latrine, to a 300-gallon water storage tank in the latrine. Gravity flow furnishes cold water directly and hot water via a diesel-oil-fired, 139-gallon-per-hour hot water heater to the darkroom and to the washstand, the shower, and the washing machine in the latrine section of the building. Waste water is transferred by the washing machine pump into a latrine waste pit; individual washbowls are dumped by hand; and water from showers and darkroom flow into the latrine waste pit. At the time of discharge the waste water is released into the latrine waste pit, thus aiding in keeping the pit open.

The latrines at the other stations utilize snow-melters located in the power buildings or within the latrines. The water is pumped into storage tanks and transferred as required to a 183-gallon water tank in the latrine building. Waste water is disposed of in the manner described above.

Heating systems.—Four methods of heating are used at the IGY Antarctic stations.

(1) Jet-Heet furnaces: The 56,000 B. t. u./hr. Jet Heet J–70A–JO furnace has proved to be efficient and satisfactory at the Antarctic stations. It was selected for use in buildings where partitions interrupt a normal heat flow or where blasts of hot air are required, e. g., against the domes in aurora and airglow towers to reduce clouding or frosting of the domes. Air drawn from the buildings is heated in the furnace plenum chambers and discharged through as many as eight ducts to registers placed as desired. A blower unit on the diesel-oil-burning furnace circulates air through the furnace and ducts.

(2) Space heaters: These heaters are used in buildings where partitions are not prevalent and as supplemental heat in certain buildings where the Jet-Heet furnace is the primary heating unit. Also diesel-oil-burning, the 50,000 B. t. u. hr. heater employs an 18-inch, 2,000-cubic-feet-per-minute fan mounted on the ceiling above the heater, blowing downward to force the hot air down and out across the building floor.

(3) Forced air heaters: Where intermittent heating or uncontaminated hot air is required, the forced air heater will be used. The rawin towers must be heated by Jet-Heeters with special fans to keep the domes clear of frost. Because of the possibility of explosion of hydrogen in the latter structure, a utility building housing the heater is employed. The uncontaminated warmed air passes through a short insulated duct connecting the two buildings, the inflation building being vented to the atmosphere.

(4) Electric heaters: Special electric heaters are used in the geomagnetic absolute and variation buildings to conform with requirements for no ferrous metals in the vicinity of the buildings.

As it is desirable (if not necessary) to preheat fuel oil before transferring it to building storage tanks at the inland stations because of the extreme temperatures expected there, a small supply of drummed fuel is preheated in special rooms within buildings utilizing oil heat before transferring the oil to the storage tanks. Copper tubing connects the tanks to Jet-Heet furnaces; individual space heaters tank are filled by hand.

Alarm systems.—

(1) Fire alarms: Each station has a fire-alarm system consisting of a central annunciator and a series of alarm pulls. The annunciator combines an alarm bell and a locator board. Two or more alarm pulls are connected to the annunciator from each building.

(2) Carbon monoxide alarms: Each building has its own carbon monoxide alarm system. A small suction pump draws air samples from strategic points in the building through a catalyst, where any carbon monoxide contained in the sample is converted to carbon dioxide. The heat of reaction of this conversion is registered on a dial by means of a thermocouple. The dial is preset for any desired concentration of carbon monoxide and activates audible and visible alarms when this concentration is reached. The horn and red light signals continue until the alarm is reset manually.

Intercommunications.—A field telephone system links the buildings at each station. Since it was not planned to have an elaborate main telephone center, each building or telephone has its own coded signal; e. g., 2 short and 1 long ring might be the signal for the mess lounge. In addition, where rapid communications must be effected, as between the meteorological office and the balloon-release point, the meteorological office and the radio shack, etc., wireless intercommunications are used. Little America, NAF McMurdo, and Byrd Stations employ Ampex power amplifiers and tape recorders.

Transportation.—

(1) Cargo: Caterpillar D–2, D–4, and D–8 crawler-tractors, either low ground pressure or standard, depending on the local terrain, are used at the IGY stations in the Antarctic. There is at least one tractor assigned to each station for use in the movement of supplies and snow removal. Certain of these tractors are equipped with a bulldozer, and a 20-foot boom for raising heavy items of equipment, erecting masts, etc.

(2) Personnel carriers: The United States Army Ordnance Corps cargo carrier, M29C Weasel is used by personnel for local station transportation. It has had a long career of service with United

States civilian and military operations in both the Arctic and the Antarctic. This four-passenger, full-track-laying, rough-terrain vehicle is powered by a 6-cylinder Studebaker engine. Under favorable conditions the Weasels can tow a sled load of up to 2 tons. It is specially equipped with a heated cab for the comfort of the driver and passengers. The vehicle is used for local reconnaissance, for the recovery of parachute drop kits during incidental aerial deliveries, for resupply activities, and as a major cargo vehicle in the event of disablement of any of the Caterpillar tractors. Dodge power wagons are being supplied to NAF McMurdo, Wilkes, and Hallett Stations.

(3) Traverse parties: The glaciological traverse parties conduct their reconnaissances with Tucker Sno-Cat, model No. 743, freighters. Capable of transporting 10 passengers or 2,300 pounds of cargo, the aluminum-cabbed Sno-Cat uses 4 independently sprung drive tracks, which are drawn around broad pontoon runners. The runners compact the snow beneath them; when power is applied to the tracks firmly held in the compressed snow, the exerted force slides the frictionless pontoon along the snow surface. Powered by a 180-horsepower, Chrysler V–8 engine, the vehicle can cruise at 10 to 15 miles per hour under suitable conditions. It is capable of towing loads of up to 2½ tons and has a rear door which permits ready accessibility to cargo carried within the vehicle. Weasels will be used by field parties on the traverses to augment the Sno-Cats.

Cache arrangements.—Supply caches were planned for location in close proximity to the buildings where the supplies are used. Most of the Little America Station supplies and the supplies of all of the other stations, including fuel, are cached in covered storage areas connecting with the station tunnel systems. In general, a 6-foot wide supply tunnel is constructed through the center of each station, with entrances to buildings and caches from the tunnel. Supplies are carried from the caches to buildings by hand or by man-haul sleds.

An emergency cache containing fuel, field radio sets, clothing, food, tentage, sleeping bags, etc., established at each station provides against disaster to one or more buildings or caches.

5. COMMUNICATIONS

5.1 General operations

The Little America radio station acts as the control center for both communications and weather data collection. The McMurdo naval air facility radio station is utilized as a supporting communications facility for Little America in order to provide additional communications capabilities, both among the stations within Antarctica and between the Antarctic stations and stations outside the continent.

To coordinate communications between all IGY stations where no plan exists, any station may utilize one of the frequencies of a United States station and at the operator's level coordinate schedules, times, and frequencies for specific purposes of a temporary nature. When the requirement for a regular schedule is established, communications personnel can establish appropriate communications nets on the frequencies provided.

The United States operators use the International Code of signals to implement communication and weather support functions with non-English speaking radio operators.

At least two semiportable radio transceivers with self-contained power supplies are stored in an emergency cache area at each station. In the event of a fire this practice insures minimum emergency communications to support the functions of the station.

Based on communications test data obtained from both previous Antarctic expeditions and the present Antarctic operation, Balboa, C. Z., has been selected and is being used as the relay point to pass message traffic between the United States and the Antarctic. Adequate communications channels exist between Balboa and Washington to preclude unnecessary delays in message handling.

5.2 Little America Station

Communications capabilities for the Little America Station include facilities to meet the requirements of the IGY weather central and to maintain communications circuits to the McMurdo naval air facility, Byrd Station, trail parties, and air-ground operations.

Messages between Little America Station and the United States and between Little America and stations designated as IGY mother stations are relayed via the naval air facility, McMurdo, where higher powered high-frequency radio transmitters and rhombic transmitting antennas are installed. However, Little America is equipped to communicate with the United States direct if required. To expedite delivery of messages a duplex radio-teletype circuit capable of either high or low frequency transmissions has been established between Little America and the naval air facility, McMurdo. This circuit has proven quite reliable on a 24-hour basis during normal ionospheric conditions and it is hoped that the addition of the low frequency circuit will extend usable circuit time during blackout conditions.

In an effort to reduce interference problems, the radio transmitters and transmitting antennas are installed in a location removed as far as practicable from the radio receivers and receiving antennas. The transmitters are remotely controlled from the radio receiving building which is located within the main camp area. The communication equipment for air-ground circuits is installed in the aircraft control tower-operations building.

Both directional and nondirectional receiving and transmitting antennas consistent with individual circuit requirements are installed.

A breakdown of the actual installation is shown in table X. This equipment is augmented by sufficient terminal equipment to permit transmission and reception of facsimile and radioteletype signals. Also, a direction finder and beacon for aircraft operations is provided.

5.3 Naval air facility, McMurdo

Communications facilities installed at the naval air facility provide fixed point-to-point radioteletype circuits to Balboa, C. Z., New Zealand, and Little America in addition to air-ground communications and CW radio circuits to 11 stations of the mother-daughter network. (See par. 5.9.)

In general, the naval air facility communications facilities are similar to those described for Little America. The transmitters and transmitting antennas are removed as far as practicable from the radio receivers and receiving antennas and the transmitters are remotely controlled from the radio receiving building which is located in the main camp area. Rhombic transmitting and receiving antennas are installed and beamed to Balboa, C. Z., and New Zealand. A breakdown of this equipment is shown in table XI. This facility is augmented by sufficient terminal equipment to permit transmission and reception of facsimile and radioteletype signals. Also, a direction finder and beacon for aircraft operation is provided.

5.4 Other United States stations

Amundsen-Scott South Pole, Byrd, Ellsworth, and Wilkes Stations, are equipped with two high-frequency transmitters ranging in power output from 250 to 1,000 watts covering a frequency range from 2 to 18 megacycles. Hallett Station has 1 high-frequency transmitter, 250 watts, 2 to 18 megacycles. All the above stations have at least 1 low-frequency and 3 high-medium-frequency radio receivers. All have mobile and portable equipment compatible with that located at Little America Station and McMurdo naval air facility. In addition, all are equipped with portable direction finder equipment with a frequency range from 1.6 to 18.2 megacycles.

5.5 Oversnow traverse parties

The oversnow traverse parties are equipped with 1 high-frequency transmitter having a frequency range of 0.35 to 9.05 megacyles capable of 125-watt CW or 40-watt voice transmissions and at least 1 medium-high-frequency receiver. In addition, a portable unit capable of transmission and reception on 2 to 18 megacycles CW or voice is provided. The power output of this portable unit is 100 watts. Other portable communications equipment such as hand-carried radio sets are added, if required.

5.6 Aircraft

Normal aircraft installations include voice equipment, crystal-controlled in the VHF band from 100 megacycles to 156 megacycles having a nominal power output of 6 watts. Aircraft will also be equipped to send and receive voice transmissions on UHF equipment from 225 to 400 megacycles on preset crystal-controlled channels.

Aircraft are also equipped with LF direction finders for beacon equipment. Aircraft common frequencies to establish communications are 3023.5-kilocycle voice, 121.5-megacycle voice, and 243-megacyle voice. United States aircraft will be equipped to cover both CW and voice operations in the 2- to 12-megacycle band.

5.7 Auxiliary stations

Auxiliary stations temporarily erected for search and rescue purposes or for the support of IGY programs are equipped with self-contained power-supplied portable units having a capability of 100 watts nominal output, continuous wave and voice, covering a frequency range from 0.3 megacycle to 1 megacycle and from 3 megacycles to 18.1 megacycles. The common frequency for initial voice contact is 3023.5 kilocycles. After establishing communications, stations will shift to code on a mutually agreed working frequency.

5.8 Amateur communications

The installation and use of amateur radio facilities at each station has proved to be of great importance to station morale. Each station has been authorized an amateur radio call sign to identify that station on the amateur network. Each amateur radio station activated follows the rules prescribed by the United States Federal Communications Commission for conduct of amateur radio communications, and the official in charge of each station assumes full responsibility for proper procedures on all radio transmissions. Call signs at the United States stations are listed in table XII.

TABLE XII.—*Amateur call signs at United States stations*

Little America Station	KC4USA
Byrd Station	KC4USB
Amundsen-Scott South Pole Station	KC4USN
Ellsworth Station	KC4USW
Wilkes Station	KC4USK
Hallett Station	KC4USH
NAF McMurdo	KC4USV

Amateur radio communications equipment installed at all United States stations consists of Collins KWS–1 transmitters with the associated Collins 75 A–4 receivers. This equipment covers all amateur radio bands and is capable of continuous wave, voice, and single sideband. Provisions are made for coupling-in radio teletype if desired.

5.9 International network

A list of all Antarctic IGY radio stations as published in the IGY Radio Communications Manual is included as table XIII. This grouping of stations provides for a "mother-daughter" network for Antarctic communications. Extensive communications tests have been conducted between McMurdo and the six stations designated as mother stations. Results of these tests were used to determine the most reliable schedule times and frequencies for use on the mother-daughter network.

Unstable conditions may dictate minor reorganization in order to more effectively pass important notices, such as World Days, ionospheric and weather predictions, etc. Normally, this arrangement is accomplished on the radio operator's level as a temporary measure to develop the most reliable system.

Provision has been made to amplify the mother-daughter concept to include "granddaughter" stations which may become necessary if congestion of traffic under the present system develops. Under these circumstances any group of stations may be grouped together with one of them assuming responsibility as the representative "daughter".

Because of peculiar ionospheric phenomena governing communications in the Antarctic, all stations participating in the IGY are obligated to mutually aid in passing essential traffic. Due consideration is given to the capabilities of the station from which such support is requested, and all mother stations reciprocate in intercommunications to advise of changes of each station's capabilities.

Considerable flexibility of operation among the radio operators has been arranged in order to overcome communications limitations resulting from faulty equipment performance or adverse propagation conditions. Periodic reporting of station "guard", changes in station capabilities, loss of communications with subordinate stations, etc., transmitted direct or relayed to the communications center at the Little America Station will permit logical rearrangements for maximum communications reliability.

6. OPERATIONAL TIMETABLE

Although the International Geophysical Year began formally on July 1, 1957, detailed planning for the IGY Antarctic program of the United States was started as early as November 1953 when an Antarctic Committee was formed by the United States National Committee for the IGY. This Antarctic Committee was at that time concerned with drawing up preliminary plans and examining scientific proposals in the various geophysical disciplines for Antarctic work.

The USNC, with the cooperation of the United States Weather Bureau, in December 1954, organized a temporary Antarctic planning staff, which was responsible for preparing logistic requirements for the establishment of three United States IGY stations in Antarctica. At the Paris CSAGI Antarctic Conference of July 1955, the United States delegation assumed responsibility to establish two more stations in the Antarctic, one on the Filchner ice shelf in the Weddell Sea (Ellsworth Station) and the other on the Knox Coast of Wilkes Land (Wilkes Station). Following proposals of the Brussels CSAGI Antarctic Conference of September 1955, the United States and New Zealand proceeded with plans to establish and jointly operate a station in the vicinity of Cape Hallett (Hallett Station).

6.1 Operations for 1954–55

During the fall of 1954, attention turned to the expeditionary phases of Antarctic operations. The United States Navy, which had been given the responsibility by the United States Government for implementing USNC–IGY logistic requirements for its Antarctic operations, began to organize a staff under the command of Capt. (later Rear Adm.) George Dufek. This staff, which was reorganized as Task Force 43, was first responsible for organizing a preliminary expedition by the icebreaker U. S. S. *Atka.*

The *Atka* left the United States on December 1, 1954, on a 4-month voyage to conduct preliminary reconnaissance along the coast of Antarctica. Although its mission was to examine ice conditions and possible station sites in the area of the former Bay of Whales, a limited number of scientific observations were made in such fields as meteorology, cosmic rays, hydrography, oceanography, snow and ice physics, seismology, and radio wave propagation.

In the field of meteorology, radiosonde soundings to stratospheric heights were made twice daily to obtain temperature and humidity information. During these soundings upper wind data were gathered by radar or by theodolite. Standard surface observations of such parameters as temperature, pressure, clouds, and visibility were made hourly. Air samples were obtained for measurement of the carbon dioxide content.

To facilitate the establishment of future stations and airstrips, observations were made on the density, temperature, hardness, and stratigraphy of the snow wherever the icebreaker tied up to the shore. The site for the Little America station was thus surveyed.

A cosmic ray telescope and a neutron monitor were used for cosmic ray studies. More of the lower energy cosmic ray particles can penetrate the atmosphere in the polar regions than at the Equator, and a maximum number of particles can be counted in the zone where the aurora intensity is greatest. The variation of cosmic rays with latitude was observed from Boston to 78°42′ S., and the region of minimum intensity was therefore crossed twice. The cosmic ray observations were important as no studies of such a complete nature had been made previously.

Routine bathythermograph soundings were made; ice conditions were mapped, bottom samples were obtained whenever shallow water was encountered, turbidity was measured, and deepwater stations were taken at intervals for precise temperature measurements. The thickness of the ice shelf was measured by seismic soundings and some information was obtained with regard to major features of stratification. Seismic techniques could also determine if the ice were floating or grounded. Continuous bathymetric measurements were made using a recording echo-sounder during the entire voyage. The ice front was mapped visually and by radar. These observations have added to existing nautical charts.

In ionospheric physics, preliminary investigation of the recently discovered phenomenon of atmospheric whistles was undertaken. These "whistlers" can be heard under special conditions, utilizing a low frequency radio frequency receiver without the audio circuit, an amplifier and earphones. Radar returns from ice and from targets on ice were also studied.

6.2 Operations, 1955–56

Planning for the 1955–56 expeditions began early in 1955 with the activation of Task Force 43. This expedition, called Operation Deepfreeze I including 3 icebreakers, 3 cargo vessels, an oil tanker, and 2 oil barges, left the United States in November 1955. Its mission was the construction of the Little America Station at Kainan Bay on the Ross Ice Shelf and the naval air facility for logistics support at Hut Point, Ross Island, in McMurdo Sound.

The USNC, together with the Navy, formulated the details of the expedition and of the construction of the main IGY scientific station and the two inland stations to be established subsequently. This expedition carried all of the construction and plant equipment and most of the scientific equipment for the Little America, Byrd, and Amundsen-Scott South Pole Stations, and the naval air facility to be established at McMurdo Sound. A limited amount of scientific work was conducted during the voyage and by the parties that wintered over in 1956–57. During the 1955–56 season Little America Station was constructed; materials for the construction of Byrd Station were assembled at Little America; the naval air facility at McMurdo Sound was constructed; materials for the construction of the Amundsen-Scott South Pole Station were assembled at naval air facility, McMurdo; a site for construction of Hallett Station was located on Victoria Land coastline; the site for construction of Wilkes Station was located at Vincennes Bay, on the Knox Coast; and nine long-range exploratory flights were successfully completed.

6.3 Operations, 1956–57

Operations during this period, Deepfreeze II, included 5 cargo ships, 4 icebreakers, 1 tanker, 1 transport for personnel, and 1 destroyer-escort which served as picket ship during airlift operations.

Operation Deep Freeze II began with the establishment in New Zealand of an advance echelon of Task Force 43, which began in

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July 1956 to arrange for communications and airport facilities for the fly-in to McMurdo Sound in October. During this time a cargo ship departed for New Zealand carrying equipment for use by the advance echelon and for air transport to the Antarctic Continent.

In September 1956, the destroyer-escort U. S. S. *Brough* (DE–148) left to take up her ocean picket station at 57°S, 170°E, between New Zealand and McMurdo Sound in support of flights into Antarctica. The icebreaker U. S. S. *Glacier* (AGB–4) departed shortly after for the same purpose, her picket station being at the edge of the ice pack 170°E. As the *Glacier* would travel to McMurdo Sound follow-in the fly-in, she also carried a cargo of urgently needed material for naval air facility, McMurdo.

During September and early October planes of Naval Air Development Squadron Six (VX–6) and the 52d Troop Carrier Squadron, 63d Troop Carrier Wing, of the 18th Air Force, arrived in New Zealand, and on October 20, airlift operations to Antarctica began.

A number of exploratory flights were made over the South Pole and in the vicinity of the Beardmore and Scott Glaciers. On October 28 an auxiliary air station at the foot of the Liv Glacier was completed and fuel cached there on the 29th. This station served as an emergency refueling point for the cargo flights to establish the Amundsen-Scott South Pole Station. On October 31, 1956, an R4D made the first landing in history at the South Pole.

During the months of October and November cargo vessels and icebreakers departed from Davisville, R. I.; Norfolk, Va.; and Seattle, Wash. The last ship to depart was the U. S. S. *Curtis*, carrying IGY scientific personnel, from San Diego, Calif., in January.

Amundsen-Scott South Pole Station.—The first construction party was landed at the Pole on November 20, 1956. By February 12, all IGY scientific personnel had been transported to the Pole Station and the construction party evacuated. By March 25, construction was essentially complete and observations were under way.

Byrd Station.—The trail reconnaissance party to the site for Byrd Station departed Little America on November 5, 1956. The first tractor train departed Little America on December 6 traveling a distance of 647.3 statute miles. Four buildings were erected and the station was commissioned on January 1, 1957.

Wilkes Station.—Offloading of equipment and supplies was carried out between February 1 and 10, 1957. On February 14, 15 of the 16 buildings had been constructed and scientific observations were well underway by March 15.

Ellsworth Station.—On January 25, 1957, offloading of cargo and equipment began. The last cargo and equipment were offloaded by February 10, and on January 27, construction was virtually complete.

Hallett Station (Joint New Zealand-United States Station).—Offloading of supplies and equipment at Hallett Station was carried out between January 3–9, 1957. On January 9, the ships departed from Hallett and by January 29, erection of all buildings was complete except for a few minor accessories.

6.4 Operations, 1957–58

Activities during 1957–58, called Operation Deepfreeze III, will include the resupply of United States-IGY Stations by ship and aircraft and the replacement of IGY scientific personnel. Table XIV outlines significant events in the development of the United States-Antarctic operations for the IGY.

TABLE XIV.—*Summary timetable of United States operations*

December 1954: Departure of U. S. S. *Atka* from the United States for the Antarctic to conduct preliminary studies of the east portion of the Ross ice shelf and other significant coastal areas.

January–February 1955: Survey of former Bay of Whales, Kainan Bay, and other possible station sites by the *Atka*.

Early October 1955: Assembly at dockside of construction materials, scientific equipment and supplies, and station equipment for Little America, Byrd, and Pole Stations, as well as the naval air facility, McMurdo.

Early November 1955: Departure of expedition from the United States for the Antarctic.

Late December 1955: Arrival of expedition in the Antarctic. Flight of aircraft from New Zealand to McMurdo Sound.

January 1956: Unloading of ships and station construction at Kainan Bay and Hut Point. Long-range reconnaissance flights. Departure of trail reconnaissance party from Little America toward Byrd Station site. Reconnaissance of possible site for Hallett Station. Return flight of aircraft from McMurdo Sound to New Zealand.

February 1956: Completion of unloading and major construction.

Late February 1956: Departure of most of expeditionary ships from the Antarctic.

February–March 1956: Fuel-cache sled swing operation from Little America toward Byrd Station site.

March 1956: Reconnaissance of Antarctic coast for possible sites for Weddell and Knox Stations.

July 1956: Establishment in New Zealand of advance echelon of expedition to arrange October fly-in to McMurdo Sound.

September 1956: Departure of U. S. S. *Brough* and U. S. S. *Glacier*, from United States to take up ocean picket stations along 170° E. between New Zealand and McMurdo in support of the October flights to McMurdo. Arrival of Navy and Air Force aircraft in New Zealand.

October 20, 1956: Airlift operations began between New Zealand and Antarctica.

October–November 1956: Preliminary flights made over the South Pole and in vicinity of Beardmore, Scott and Liv Glaciers. Cargo vessels and icebreakers departed United States carrying resupply equipment for Little America Station and the naval air facility, McMurdo, as well as all construction and scientific materials and IGY scientific personnel for the Wilkes, Ellsworth, and Hallett Stations.

October 28, 1956: Auxiliary air station established by air at foot of Liv Glacier.

October 31, 1956: First landing at South Pole.

November–December 1956: Airlift of construction personnel to the Pole Station site with skeleton temporary station equipment. Construction of temporary station, erection of homing beacon and radio station, delineation of dropzone. Airdrop of station construction material, furnishings, supplies, and scientific equipment. Oversnow reconnaissance party from Little America established a 647.3 mile trail to Byrd Station. Cargo-carrying tractor train reached site December 6 and constructed station. Airlift of personnel and additional supplies to Byrd Station.

January–February 1957: Airlift of personnel and equipment to Byrd and Pole Stations completed. Erection of these stations completed and construction crews evacuated. Arrival of expeditionary vessels in Ross Sea area and delivery of bulk cargo and remainder of scientific personnel for Little America Station. IGY traverse party completed glaciology-seismic traverse from Little America Station to Byrd Station. Construction and occupation of Hallett, Wilkes, and Ellsworth Stations. Evacuation of all construction crews. All cargo aircraft return to New Zealand.

March 1957: Departure of expedition from Antarctic for the United States.

October 1957: Airlift of priority scientific personnel to Antarctica. IGY traverse parties depart Little America, Byrd, and Ellsworth Stations for summer field programs.

October–November 1957: Departure of expedition from the United States for the Antarctic with resupply materials and replacement personnel.

November 1957: Rotation of Byrd and Pole Station scientific personnel by air. Commencement other IGY summer field programs.

December 1957–January 1958: Arrival of expeditionary ships in Antarctica and delivery of resupply materials and replacement personnel.

February–March 1958: Completion IGY summer programs. Departure of expedition from the Antarctic.

Mid-October 1958: Airlift of priority scientific personnel from New Zealand to the Antarctic.

November 1958: Departure of expedition from the United States for the Antarctic.

January 1959: Arrival of expedition in the Antarctic. Return of personnel from the Byrd and Pole Stations.

February 1959: Departure of expedition from the Antarctic for the United States with all personnel, records, and recuperable equipment.

APPENDIX VII

UNITED STATES NAVAL SUPPORT FORCE, ANTARCTICA

Washington 25, D. C.
COMNAVSUPFOR/OOW/jec
A9
Serial: 460
May 1, 1957

From: Commander, United States Naval Support Force, Antarctica (Commander Task Force 43)
To: Chief of Naval Operations
Via: Commander in Chief, United States Atlantic Fleet
Subject: Operation Deep Freeze II; report of
References:
(a) COMNAVSUPFOR ANTARCTICA OpPlan 1–56 of August 1, 1956
(b) CINCLANTFLT ltr FFI–2/A9 ser 718/31 of February 21, 1957
(c) Operation Deep Freeze I Report, ser 1605 of October 1, 1956

1. Forwarded herewith is the post operation report of Deep Freeze II which was organized and executed, in general, as outlined in reference (a).

2. Under the commander in chief, United States Atlantic Fleet, Task Force 43 was organized to carry out the planning and implementation necessary to provide logistic support for United States participation in the Antarctic phase of the International Geophysical Year (1957–58). Operation Deep Freeze is the planned program for operations in the Antarctic covering a period of several years.

3. Deep Freeze I, first year's operation, was devoted primarily to the base construction of two stations. Deep Freeze II which covered the period during late 1956 and early 1957 was on a larger scale and embraced the construction of additional stations and the transporting of personnel and supplies to all United States sites in order to effect United States participation of the IGY on schedule (July 1, 1957).

4. It is the opinion of the task force commander that, in spite of many obstacles imposed by nature, the mission of Task Force 43 was altogether successful. Many significant contributions were made to the growing fund of information of the Antarcitic and the special conditions peculiar to operating in this area.

5. Reference (b), commenting on reference (c), emphasizes the desirability of limiting the post operation report to a summary of major conclusions and recommendations in order that timely action can be taken prior to the commencement of Deep Freeze III. Accordingly a departure is made in this report over previous ones. The report is believed to permit easier reading and aid in planning on a wide distribution level. Reports of individual units have been carefully reviewed and incorporated under the heading of appropriate subjects.

Also, the reproduction of photographs and charts has been kept to a minimum. Individual detailed reports on certain subject matter, such as the one to be made to the Hydrographic Office for instance, are being prepared separately for limited distribution and filing.

6. The task force commander is grateful for the splendid support rendered by government agencies of the United States and New Zealand. On behalf of all elements of Task Force 43 he wishes to thank the countries visited for the wonderful hospitality extended to the task force and also to extend appreciation for the excellent cooperation, behavior, and services of observers and media representatives.

GEORGE DUFEK.

CHAPTER I—NARRATIVE

PREPARATION

Planning for the second phase of the overall operation began promptly upon the return of Admiral Dufek and the staff to Washington at the completion of Deep Freeze I. Construction personnel were based at the Construction Battalion Center at Davisville, R. I., with VX–6 close aboard at Quonset Point. Supplies and equipment soon began assembling at the Davisville embarkation point.

Deployment toward the Antarctic actually began early in July when Lieutenant Commander Simmer (SC) with 3 storekeepers and Warrant Electrician Wren with 4 radiomen established the advance echelon office in Christchurch. About the same time Captain Allen, USAF, also arrived in Christchurch as advance representative for the 52d Troop Carrier Squadron which would base there during Antarctic operations. At the end of the month Captain Cadwalader arrived in Wellington as task force liaison officer with the United States Ambassador to New Zealand, later to move to Christchurch and activate Task Group 43.5, which command handled the operation's activities in New Zealand and provided liaison with New Zealand civil and military officials throughout the operation. CTG 43.5 also had operational control of the U. S. S. *Brough* (DE–148) which acted as an ocean station and weather ship on the air route between New Zealand and McMurdo. Captain Hawkes, upon his return from the early season flying in the Antarctic in December, assumed command of TG 43.5.

ROSS SEA OPERATIONS

Aircraft operations and the Pole Station

Establishment of the Pole Station was a joint Navy-Air Force operation, employing aircraft of AirDevRon 6 under Capt. Douglas L. Cordiner, USN, to fly in the construction and base personnel and their immediate necessities (landing on skis at the Pole) while the bulk of the 500 tons of material needed to construct and supply the base were air-dropped by C–124 planes belonging to the 52d Troop Carrier Squadron, under the command of Colonel Crosswell, USAF. On completion of the base, VX–6 aircraft flew in the remainder of the wintering party and evacuated construction personnel.

Navy and Air Force planes arrived in New Zealand from the United States throughout September and early October, the Navy being based at the RNZAF field at Wigram, the Air Force occupying a camp at a deactivated military field at Weedons and operating their aircraft from the Christchurch commercial field at Harewood. These sites are within 15 miles of Christchurch. RNZAF officers, particularly Group Captain Dix, commanding officer at Wigram, rendered outstanding help to our forces in establishing and maintaining these stations. Rear Admiral Dufek arrived in Christchurch on October 1, and on the 16th departed for McMurdo Sound on the first Antarctic flight of the season in an R5D piloted by Commander Jorda, USN. The following day word was received in Christchurch of his safe arrival, and the remainder of the VX-6 planes then on hand took off for the south, 1 P2V and 1 R5D from Christchurch, while 4 R4D's staged through Dunedin to gain an extra 200 miles. Some concern was felt by those left in Christchurch for the R4D's, and it was with shocked surprise that it was learned later that although they and the R5D had arrived safely the P2V had crashed on landing at McMurdo with the loss of four lives.

On October 20, the Air Force planes began deploying to the Antarctic, all arriving safely. From then on the C-124's commuted regularly between McMurdo Sound and Christchurch, the first one returning to Harewood after a 28-hour round trip, bringing out the injured from the P2V crash for hospitalization. Flights over the pole also began, one being made on October 26, by General McCarty, commanding general of the 18th Air Force, who had come on an inspection of his Antarctic units. The principal event of this period was the first actual landing at the pole made on the 31st by Admiral Dufek, in a ski-equipped R4D piloted by Lieutenant Commander Shinn. This was a red letter day in the entire Antarctic operation because the whole concept of a pole base was predicated on the theory that such a landing would be successful, and now the theory had been proved.

Because of the extreme cold (−57° F.) at the pole, the start of construction was postponed. Due to the limited range of the R4D's to be used for pole landings, a half-way fueling camp was set up at the foot of the Liv Glacier (known as Beardmore Camp because originally planned for the Beardmore Glacier). This camp was established by means of landings in R4D's, augmented by airdrops from C-124's. On November 19 pole flights were resumed, with an initial load of construction personnel and sled dogs. Ski-equipped R4D aircraft continued these flights until February 12, and two P2V-7's which arrived from the States in December and January were also used for transport to the pole, but their performance was somewhat limited by imperfect ski design.

After airdropping about 400 tons of equipment, the wheeled Air Force planes had to delay operations at mid-December because of the deterioration of the McMurdo runway through thawing of the surface, and could not complete their mission until after the first week of February. Increasing cold, and a technique of preparing "ice concrete" carried out under the supervision of its inventor, Dr. Andrew Assur, flown down from the United States for the purpose, restored the runway to working order by that time, and the pole supply was completed.

By the last pole landing on February 12, all wintering personnel had been taken in and all construction party evacuated, and except for some last Air Force drops, the pole station was complete. In a ceremony before leaving McMurdo, it has been commissioned and entrusted to Lieutenant Tuck, USNR, as military commander, and Dr. Paul Siple as scientific leader. With this major task successfully completed, Air Force and the larger Navy aircraft left the Antarctic, the four R4D's remaining at Little America for late season flights and an early start next year.

Byrd Station

The attempt to reach the desired site for the IGY station in the interior of Marie Byrd Land, at 80° S. 120° W. during Deep Freeze I had failed because of the trail party's inability to discover a safe route for heavy vehicles through the crevassed area dividing the Ross shelf from the interior ice cap during the time available. This doubled the job to be done in Deep Freeze II, as establishment of the trail and construction of the base were thus telescoped into one season. Commander, Task Force 43, therefore called for a major effort, with maximum air support.

The command of the operation was placed in the hands of Comdr. P. W. Frazier, USN, and to get the most experienced people possible to run the actual trail operations, the United States Army Transportation Corps were asked to make available veterans of Greenland Ice Cap operations. In response to this, 3 officers and 3 enlisted men under Maj. Merle Dawson, USA, were provided.

Prior to departure from the United States, a careful study of the problem was made by Commander Frazier and Major Dawson, based on all previous air reconnaissance of the area and on the findings of last year's trail party. Accordingly, two possible avenues of approach to the interior plateau were selected, known as the eastern and southeastern approaches. All personnel to be engaged in this venture arrived in the Antarctic in October with the first fly-ins from New Zealand, and immediate air reconnaissance of these two possibilities was begun by R4D. Study and evaluation of the resultant findings caused the southeastern approach to be selected.

Actual trail operations were divided into three groups: air reconnaissance, surface reconnaissance, and tractor trains. These were supported by helicopter, Otter and R4D aircraft from Little America V. The surface reconnaissance party consisting of the Army personnel and 5 Navy enlisted, in 2 weasels, 2 D–8 tractors, and 1 Tucker Sno-Cat got underway from Little America on November 5. One week later they reached the crevassed area adjacent to Rockefeller Plateau, at mile 171. After 2 weeks of continuous effort, involving aerial search by Otter and helicopter, ground search by vehicles equipped with crevasse detectors and probing parties on foot, blasting and dozing of detected crevasses and occasional backtracking for fresh starts, a way through to the crevasse-free area on the plateau was finally found on November 26. It was not until December 1, however, that a safe trail for the heavy tractor parties coming up in the rear was established and marked with trail flags and cairns. From this point a Great Circle course to the destination was set, and the desired site finally reached on December 18, after a total distance made good of 647.3 miles. No one who has not had a glimpse of the kind of terrain traveled can properly evaluate this feat.

Caches for the tractor trains had been established en route, and Air Force C–124's airdropped fuel drums at these and at the Byrd Station site. On the 19th, the reconnaissance party started back, arriving at Little America on January 6. The tractor trains, manned by CB personnel, had meanwhile started from Little America, and each was met at the crevassed area by Transportation Corps officers, picked up by aircraft for this purpose, and escorted through. Both trains then reached Byrd Station without incident, providing the payoff for the splendid work of the reconnaissance party. Construction began at once. The base was commissioned on January 1, 1957, and placed under Lt. B. C. Dalton (MC), USN, as senior military officer and Dr. George R. Toney as senior scientist.

SHIP OPERATIONS

Task organization. (Varied frequently during operation as ships came and went.)

43.4 Ross Sea group: Capt. G. L. Ketchum, U. S. N.

U. S. S. *Glacier* (AGB–4)	Comdr. B. J. Lauff, USN.
U. S. S. *Atka* (AGB–3)	Comdr. C. Bulfinch, USN.
U. S. C. G. C. *Northwind* (WAGB–282)	Capt. J. A. Bresnan, USCG.
U. S. S. *Arneb* (AKA–56)	Capt. N. C. Johnson, USN.
U. S. S. *Curtiss* (AV–4)	Capt. C. T. Fritter, USN.
U. S. S. *Nespelen* (AOG–55)	Lt. G. C. Sup, USN.
U. S. N. S. *Greenville Victory* (TAK–237)	L. Duchowski, Master.
U. S. N. S. *Pvt. J. F. Merrell* (TAK–V4)	R. C. Dollar, Master.
U. S. N. S. *Pvt. J. R. Towle* (TAK–240)	J. Wiis, Master.

Ship operations of Deep Freeze II began dramatically with the U. S. S. *Glacier* (AGB–4) making the earliest penetration of the Antarctic pack in history. After a trip from Davisville, R. I., via Panama and Valparaiso, she reached the northern edge of the pack on October 20. Proceeding southward, between 174° and 175° E., she fought heavy concentrated pack for 8 days, arriving in McMurdo Sound on the 28th. After delivering cargo to NAF and a run to Little America for the same purpose, she steamed north over approximately the same track, finding the ice greatly broken up in the past 10 days, and getting out of the pack in half the time needed going south. She arrived in Port Lyttelton on November 16, to await the next stage of the operation.

The main ship movement south left New Zealand ports on December 10, comprising task group 43.4 with Capt. G. L. Ketchum, USN, deputy commander of the task force, as OTC in the U. S. S. *Arneb* (AKA–56). Other ships were the *Glacier*, the U. S. S. *Atka* (AGB–3), U. S. N. S. *Pvt. Joseph F. Merrell* (TAK–V4), U. S. N. S. *Pvt. John R. Towle* (TAK–240) and the U. S. C. G. C. *Northwind* (WAGB–282). The U. S. S. *Nespelen* (AOG–55) which had left earlier and the U. S. N. S. *Greenville Victory* (TAK–237), following 2 days later, rendezvoused with this formation at the edge of the pack, where *Northwind* and *Arneb* broke off to go to Cape Hallett, Captain Ketchum having shifted his flag to *Glacier*. The remaining ships proceeded through the pack into the Ross Sea, and reached McMurdo Sound on December 20. Three days later *Northwind* and *Arneb*, having been diverted to McMurdo after almost reaching Cape Hallett, also arrived, and all cargo for the NAF was put ashore.

On December 27, *Atka, Greenville Victory* and *Merrell*, followed later by *Nespelen*, proceeded to Little America V, where these ships were organized as TU 43.4.2 under the command of Comdr. P. W. Frazier, USN. The ice had gone out of Kainan Bay prematurely, thereby complicating offloading for Little America, which had to be effected directly onto the shelf, and was frequently interrupted when wind and seas forced ships to get underway from their ice moorings. *Greenville Victory* was unloaded by January 10, however, in time to join TG 43.6 for the Knox coast operation, and a day later *Nespelen* had discharged her AvGas and shortly after left for Melbourne, to return to McMurdo later in the season with another load. All cargo was discharged both at Little America and NAF McMurdo and all ships departed well ahead of the seasonal deadline. There was some difficulty at McMurdo Sound, where cargo was hauled by tractor train over several miles of bay ice between ships and camp, from bottlenecks caused by breakdown of vehicles, but by various expedients the job was completed.

The U. S. S. *Curtiss* (AV-4) arrived in McMurdo Sound on January 21, with a large complement of wintering-over IGY personnel, foreign observers, and miscellaneous visitors. After a visit to Little America she made an ice reconnaissance of the Sulzberger Bay area before leaving the Antarctic. Departing, she carried out the wintering-over personnel of the first year, and also the construction party left at Cape Hallett by TG 43.6, these having been picked up first by the *Atka*.

R. N. Z. N. S. *Endeavour* of the New Zealand Antarctic expedition was also in McMurdo Sound. In a late change of plans the New Zealanders constructed their base at Pram Point, about 2 miles from NAF McMurdo. One thousand tons of cargo for this base had been carried from New Zealand on board the *Towle* and here as in New Zealand cooperation between personnel of the two nations was excellent.

After having a new propeller installed in Wellington as a result of damage received in the Cape Hallett operation, a late season trip to the Ross Sea was made by *Northwind*. With some late cargo and the last mail for wintering personnel, she visited Little America, McMurdo Sound, and Cape Hallett in March, finally leaving the Ross Sea on the 13th, and ending the ship operations of Deep Freeze II.

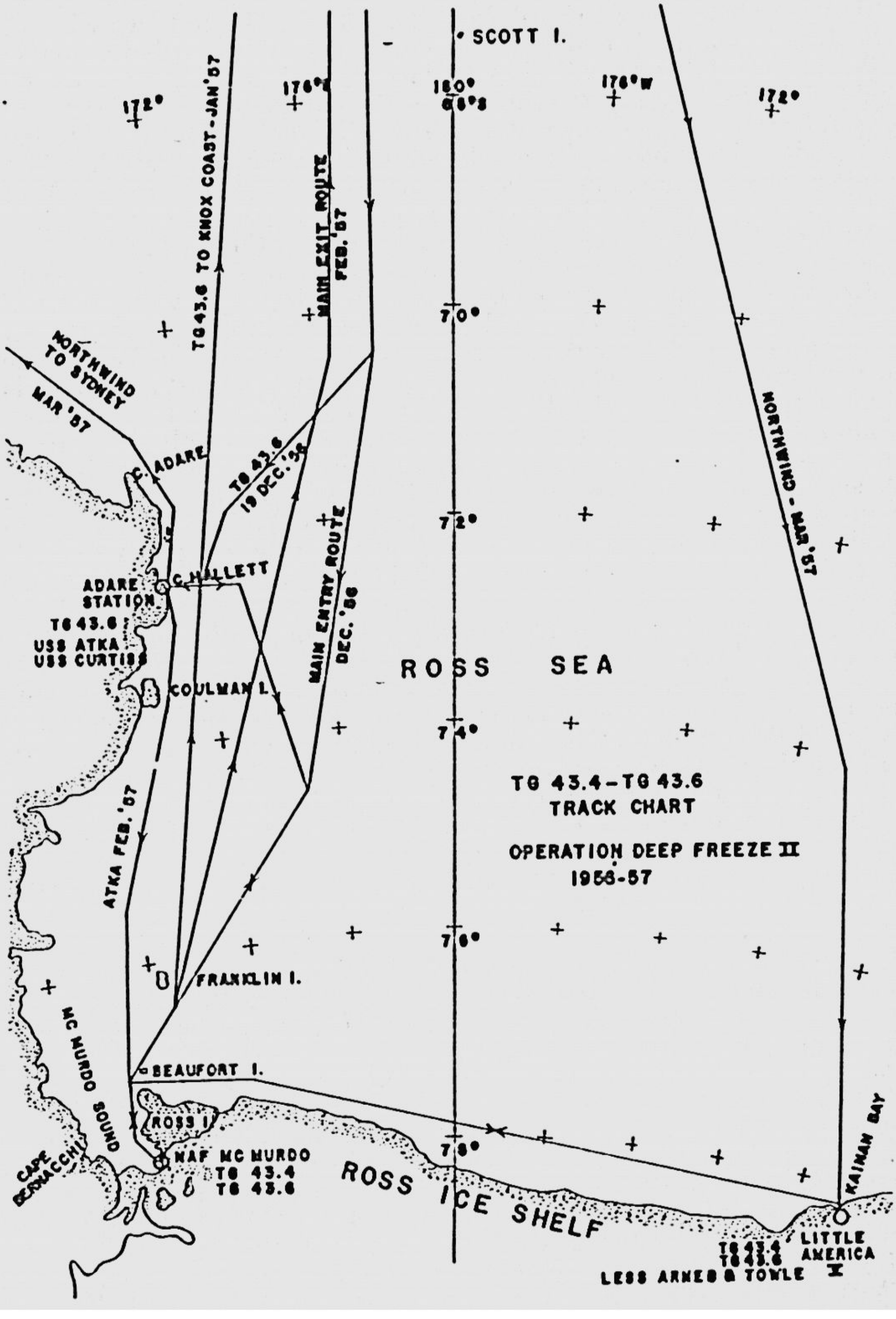
CAPE HALLETT AND KNOX COAST OPERATION

Task organization.

43.6 Capt. C. W. Thomas, USCG (after January 15, 1957, Capt. G. L. Ketchum, USN).

43.6.1 Ship unit: Capt. C. W. Thomas, USCG (after January 15, 1957, Capt. G. L. Ketchum, USN).

U. S. C. G. C. *Northwind* (WAGB-282)	Capt J. A. Bresnan, USCG (until Jan. 15, 1957).
U. S. S. *Arneb* (AKA-56)	Capt. N. C. Johnson, USN.
U. S. N. S. *Greenville Victory* (TAK-237)	L. Duchowski, Master.
U. S. S. *Glacier* (AGB-4)	Comdr. B. J. Lauff, USN (after Jan. 15, 1957).
Construction unit	Comdr. J. A. Hiegel (CEC), USN 1 mobile construction battalion (partial).


SCOTT I.
172°
176°E
180°
68°S
176°W
172°
TG 43.6 TO KNOX COAST - JAN '57
MAIN EXIT ROUTE FEB. '57
NORTHWIND TO SYDNEY MAR '57
70°
C. ADARE
TG 43.6 19 DEC. '56
72°
NORTHWIND - MAR '57
C. HALLETT
ADARE STATION
TG 43.6
USS ATKA
USS CURTISS
MAIN ENTRY ROUTE DEC. '56
ROSS SEA
COULMAN I.
74°
TG 43.4 - TG 43.6
TRACK CHART
OPERATION DEEP FREEZE II
1956-57
ATKA FEB. '57
76°
FRANKLIN I.
MC MURDO SOUND
BEAUFORT I.
ROSS I.
KAINAN BAY
CAPE BERNACCHI
NAF MC MURDO
TG 43.4
TG 43.6
78°
ROSS ICE SHELF
LITTLE AMERICA
TG 43.4
TG 43.6
LESS ARNEB & TOWLE

Task group 43.6 has as its mission the construction and supply of the joint United States-New Zealand base at Cape Hallett and of the base at the Windmill Island area of Wilkes Land. Independent operation of the group began on December 16, 1956, when *Arneb* and *Northwind* were detached from TG 43.4 at the nothern edge of the Ross Sea icepack and proceeded on a generally southerly course following the 177th meridian east, through pack of varying coverage and thickness, but not offering any serious difficulty, until early on December 19, when open water was reached at 74° 45′ S. During this period *Arneb* received a crack in her plating at the waterline just abaft her icesheathing, at frame 40 starboard, apparently the result of ice friction against metal weakened in previous operations, as she had been under no pressure. This was welded without difficulty, by heeling the ship to port in a quite open-water pool within the pack.

On reaching open water course was set toward the Victoria Land coast. Heavy pressured icefields, lay to the north and south, but an easy route through loose pack with many long east-west leads took the formation within 18 miles of Cape Hallett late on the 19th. At this point orders were received from CTF 43 to proceed to McMurdo Sound. Course was therefore reversed, but the northerly current which sets along this coast had closed the previously existing channel. A slugging match through choked leads separating giant floes of hummocky ice ensued, until finally late on the 20th the formation broke through into open water and course was set for McMurdo Sound. Heavy fog was encountered in the belt of pack which extends westward from Beaufort Island, causing long delays, and the formation finally reached the northern edge of the fast ice off Cape Evans, just before midnight of December 23.

The resources of TG 43.6 were now used to assist the Ross Seagroup in unloading. One D-8 tractor was appropriated and reassigned to NAF McMurdo and other equipment and personnel were used to reenforce the trail party carrying cargo to the base. *Northwind* also was employed in ferrying cargo from the cargo ship mooring point up the icebreaker channel to the trail head. On the morning of the 27th the task group got underway again, in company with *Atka*, *Greenville Victory*, and *Merrell* under the tactical command of CTG 43.6. After some delay getting through the Beaufort Island pack, the last three ships were detached to proceed to Little America and TG 43.6 headed for the second time toward Cape Hallett. A north-by-east course with detours to the eastward to avoid tongues of the Victoria coast pack was held until the midwatch on the 29th, when course was gradually altered to the westward and by the forenoon the formation was lying to at the edge of fast ice about 5 miles off Cape Hallett.

Those officers and scientists most concerned went ashore by helicopter to choose a base site, and the low-level spit projecting northwestward from the cape was selected. As the spit was completely covered by an Adelie Penguin rookery, this involved the displacement of enough birds to allow construction, a task which was undertaken by the civilian scientists led by Mr. Carl Eklund of the United States Fish and Wildlife Service, the prospective scientific leader of the Wilkes Base. This party turned to at once, carrying the half grown young and herding the protesting adults to areas outside the proposed base, and erecting a net fence to prevent their return. Meanwhile the constructors under Commander Hiegel surveyed the site, while

Arneb lay to at the ice edge and *Northwind* broke out a channel toward the beach. The shorefast ice was not strong enough to support heavy trail vehicles, so it was decided to break ice as close in as the icebreaker could get, blast out the rest of it and unload via the *Arneb's* six LCM's.

While all hands were so engaged, a southwest wind increased to 30 knots, with a falling glass. All personnel ashore were taken on board *Northwind,* who then headed for *Arneb* to bring her into the lee of the cape. The wind quickly made up to 45 knots, tearing loose the shorefast ice on the south of the channel and closing in on the icebreaker. Fighting desperately to reach the *Arneb,* the *Northwind* damaged her starboard propeller, reducing her power in ice about 15 percent. This delayed her reaching *Arneb,* who was now caught between the fast ice to which she had been moored and the moving pack. Huge masses of ice under the influence of the northerly current, an ebbing tide, and southwesterly wind, were being forced to the northward, grinding along the edge of the fast ice and severely pinching *Arneb.* While *Northwind* fought to reach her, she was holed again at the same spot as before. Later her frames began to buckle and she was in danger of flooding her engineroom. Finally at midnight, December 31, 1956, *Northwind* reached the *Arneb* and relieved the pressure.

Throughout New Year's Day the wind blew with storm force. In addition to the pack itself, the wind set in motion several bergs which had been grounded, and one of these, about 700 feet in diameter and 80 feet high, on a collision course with *Arneb,* was only diverted at the last minute by *Northwind* opening a path for it away from the ship. This kind of situation continued until January 3, *Arneb* suffering further rupturing of plates and bending of frames, but able to control flooding with the aid of pumps borrowed from *Northwind.*

On January 3 the wind moderated, and taking advantage of a lead which opened up off the cape, both ships finally managed to get in close to the beach, in a good lee and open water, and *Arneb* reported her damage capable of repairs by ship's force after her Hallett cargo was removed. *Northwind* broke the remaining fast ice out of the 6-fathom curve within a few hundred yards of the beach, and the UDT unit under Lieutenant (junior grade) Olson blasted a channel from basin to beach. The gale of the preceding days however had demolished the fence around the base site, so the penguins had to be removed a second time. From now on the operation went smoothly and efficiently, with no further interruptions.

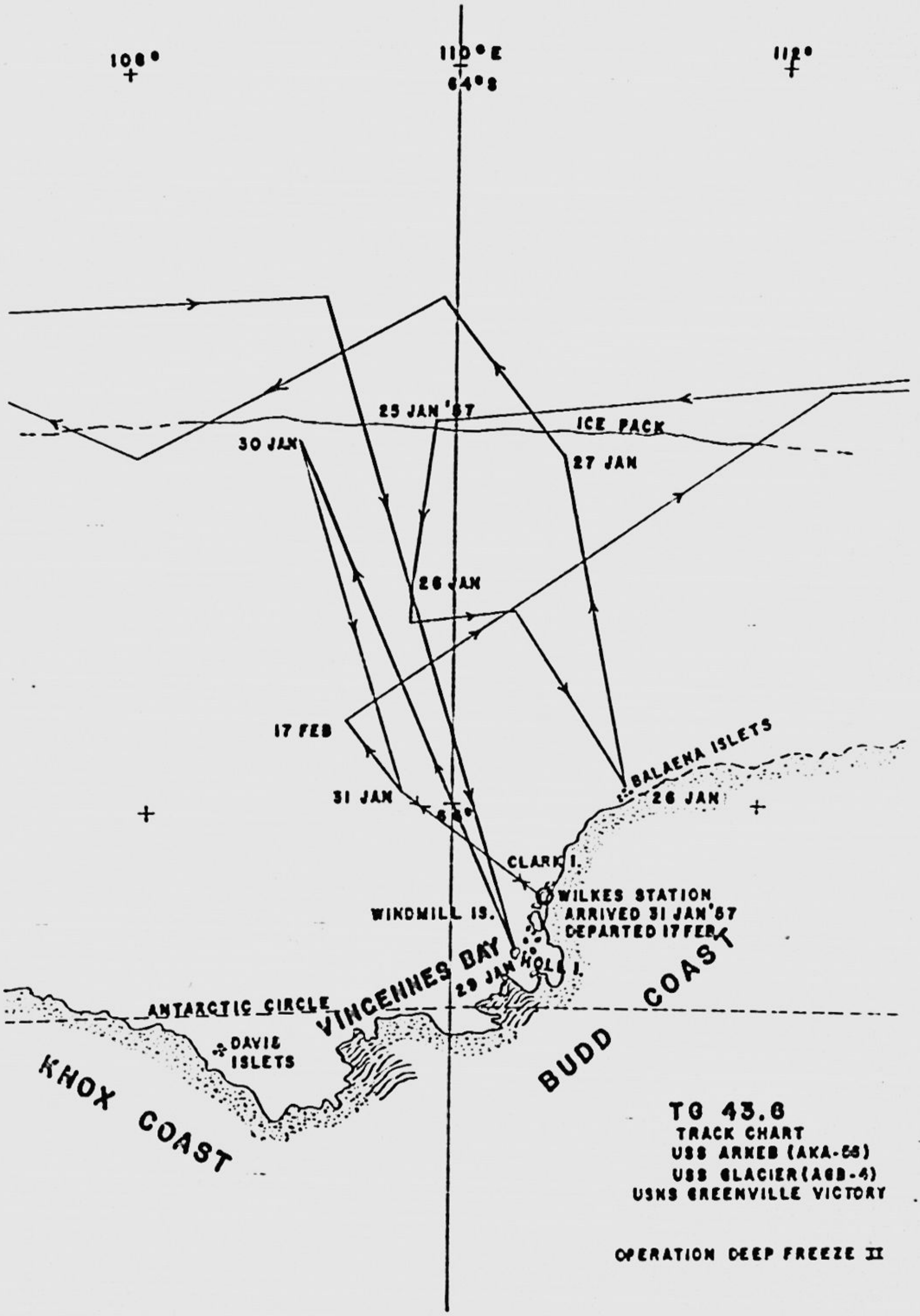
By January 9 all cargo for Cape Hallett construction and supply was ashore, basic structures and communications equipment were completed, and the base was self-sufficient, with its own power, water supply, etc. All equipment to be back loaded was on board, and *Arneb* had completed temporary repairs to the extent that her commanding officer felt confident of his ship's ability to continue her mission. A brief ceremony was held, turning over the base to Dr. Shear, leader of the scientific party, and Lieutenant Tur (MC), USN, senior military officer. Completion of the base was in the hands of a detail from MCB 1 under Lieutenant Loomis (CEC), USN, who were to be evacuated later in the season by the Ross Sea group. An emergency landing strip for aircraft was marked out on the bay ice.

Orders had been received from CTF 43 for the task group to return a second time to McMurdo rather than proceed to the Knox coast as planned, and on January 10 the ships once again headed south. Ice conditions were less severe than before, and about midnight on January 11 *Northwind* and *Arneb* were again at the ice edge in McMurdo Sound. Personnel and equipment were at once turned to unloading the *Greenville Victory*, which continued until January 15. CTF 43 had decided, since ship operations in the Ross Sea were by now approaching completion, to substitute *Glacier* for the damaged *Northwind* in task group 43.6. The operation was now no longer a joint Navy-Coast Guard one. Accordingly, command passed to Capt. G. L. Ketchum, USN, Captain Thomas sailing as chief staff officer. TG 43.6 as reconstituted was now joined by *Greenville Victory*.

At noon on the 15th TG 43.6 got underway, accompanied by *Nespelen* for escort through the pack enroute to Melbourne for aviation gas. The trip north through the Ross Sea was uneventful, and on the 18th, north of the ice, *Nespelen* was detached, *Arneb* and *Greenville Victory* ordered to proceed to Knox Coast, later to be joined by *Glacier*. While *Curtiss* was being escorted south through the Ross Sea pack by *Glacier*, mail and cargo were transferred by helicopter between ships. On one of the last scheduled trips, with all mail and important cargo transferred, the helicopter taking off from the flight platform on *Curtiss'* forecastle was caught by the ship's bow swinging up on a swell and flipped into the sea. Pilot and copilot got out, and were recovered by a smartly handled whaleboat from *Curtiss*, but this left TG 43.6 without a helicopter for future reconnaissance. *Glacier* had another on board, but it was out of commission. On completion of transiting the pack, *Curtiss* proceeded southward, and *Glacier* headed north and west to rejoin the other ships of the task group at the pack edge north of the Windmill Islands, in the southern Indian Ocean.

Late on January 22, the task group rejoined, and continued to the westward to rendezvous with *Kista Dan*, a Danish vessel chartered to the Australian Antarctic group. Some Australian scientists who had accompanied the task group from New Zealand were transferred, along with 16,000 gallons of diesel fuel, and Mr. Glen Dyer of the United States Weather Bureau who was to act as an observer at the Australian Dawson Base. On the 25th, TG 43.6 got underway. Off Vincennes Bay, heavy consolidated pack was encountered, old ice locked in place by a long line of grounded bergs. Several attempts were made to penetrate this ice, first with cargo ships, later with *Glacier* alone. On the fourth attempt *Glacier* forced a passage along the 109th east meridian, and anchored at Holl Island, of the Windmill group, on the morning of January 29.

A party under Captain Thomas set off in the Greenland cruiser to select a base site, and after a rough day in a mean chop kicked up by a fresh southerly found a very promising location on what the imperfect chart of the area called Clark Island but which was in fact a peninsula. Finding this site was a lucky break, as a thorough search of all the rest of the group and the adjacent mainland had not shown any other practicable site, and the area selected was the last possibility. On the party's return to the ship, *Glacier* got underway, rejoined the others on the morning of the 30th and escorted them to an anchorage in open water off the selected site. During this southward passage *Arneb* once again came to grief, this time being holed on her port side just abaft the reinforced plating. As before, she was able to control flooding and make temporary repairs which, reinforced later, enabled her to continue her mission. It may be said in passing that *Arneb*, though skillfully handled by Captain Johnson and her watch officers, had much poorer ice capabilities than *Greenville Victory* whose more thorough ice sheathing and additional power took her repeatedly without difficulty through places which hung up *Arneb* hopelessly.



On January 31 the UDT team began preparation of a landing ramp by blasting away a 12-foot-high ice foot and a few boulders, and soon after, construction material began going ashore by LCM. The remarkably efficient construction group under Comdr. James Hiegel (CEC), USN, made amazing progress, without commotion and seemingly without effort. The entire camp, all the scientific buildings, and the radio station with its 75-foot antennas were completed in 15 days. Great assistance was rendered by working parties from the ships. Meanwhile various parties headed off in different directions, inland and northward along the coast, and by boat among the islands of the Windmill group, and though exploration was hampered by lack of a helicopter, much was done to improve the charts of the area for future use.

On February 16 a commissioning ceremony was held, Captain Ketchum turning over the base to Mr. Carl Eklund, senior scientist, and Lieutenant (Junior Grade) Burnett (CEC), USN, in charge of military personnel. On this last day, for the only time of the operation, boating was made difficult by ice closing in from the westward, apparently having broken off from the shore fast ice to the north. On February 17 the formation got underway and passed through the pack, finding it greatly broken up since 2 weeks before. Once in open water, *Greenville Victory* was detached to proceed to the United States via Wellington, *Arneb* to Sidney for drydocking and repairs, *Glacier* to Lyttelton. On February 18, CTG 43.6 was dissolved.

WEDDELL SEA OPERATION

Task organization.

43.7 Weddell Sea group: Capt. E. A. McDonald, USN.

43.7.1 Ship Unit: Capt. E. A. McDonald, USN.

U. S. S. *Wyandot* (AKA-92)	Capt. F. M. Gambacorta, USN.
U. S. S. *Staten Island* (AGB-5)	Comdr. J. B. Elliot, USN.

43.7.2 Air Unit: Lt. Comdr. K. P. Snyder, USNR.

2 UC (plus 1 spare)	1 HO4S.

43.7.3 Construction Unit: Lt. Comdr. H. E. Stephens (CEC), USN.

1 MCB (partial).

The mission of task group 43.7 was to select a site for and construct an IGY base on the edge of the Weddell Sea, as far to the westward as ice conditions would permit. It was hoped that this could be done at the base of the Palmer Peninsula in the area of Cape Adams. No landings had ever taken place there, as the sea ice on the approaches from northward had proved impenetrable to all previous attempts, but the prevailing southerly winds off the icecap had been observed to form a narrow open channel between the shelf and the sea ice, and an approach to Cape Adams from Cape Norvegia at the eastward end of the sea, along this channel seemed worth the attempt.

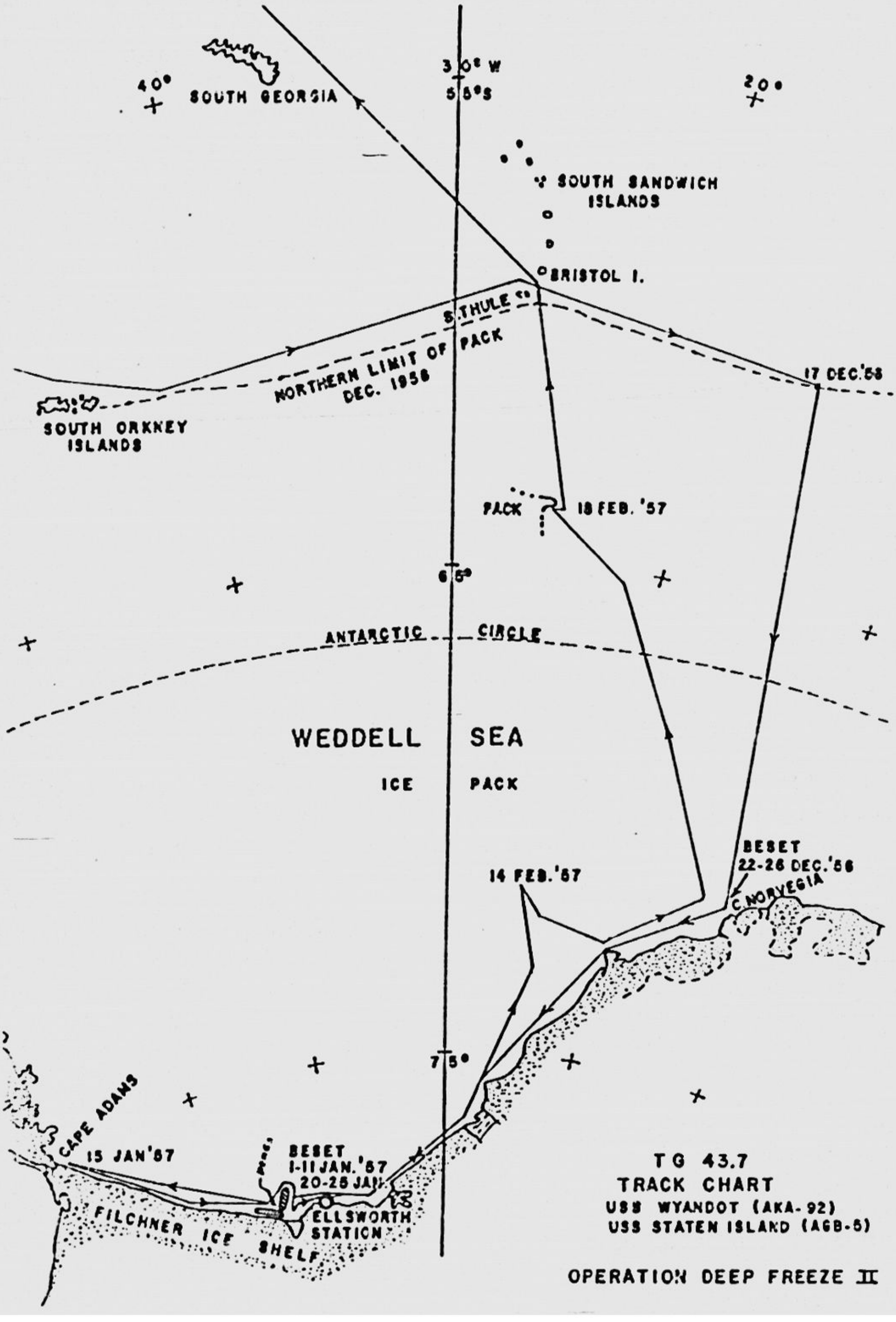
The task group commander, Capt. E. A. McDonald, USN, left Davisville, R. I., early in November on board the U. S. S. *Wyandot* (AKA-92) and rendezvous was effected with the other ship of the task group, the U. S. S. *Staten Island* (AGB-5), out of Seattle, at Panama. A detachment of MCB 1 under the battalion executive officer, Lieutenant Commander Stephens (CEC), USN, and of VX-6 under

Lieutenant Commander Snyder were embarked. After a stop at Valparaiso, the group proceeded southward, and piloted by Lieutenant Commander Botto of the Chilean Navy, passed through English Narrows and Canal Smyth into the Straits of Magellan, apparently the first deep draft United States naval vessels to make this passage. The group then anchored at Punta Arenas, departing for the south on December 7. Course was set for a point at 60° south, 10° west skirting the northern edge of the Weddell Sea pack, and on the advice of a Norwegian whaler, the formation passed between Bristol and South Thule Island of the South Sandwich group and began angling to the southeastward. On December 17 a southerly course was set along 15° west longitude, pack being encountered from 61° southward. Steady progress was made past the Antarctic Circle, which was crossed on the 20th, but from then on the ice was heavier and often under pressure, and *Wyandot* experienced the first of many leaks caused by strained hull plating. After being beset several times and *Wyandot* had damaged the tips of all propeller blades, Cape Norvegia was reached on December 28, and the formation entered the wind-formed coastal channel leading westward. At this time visits were made by helicopter to the British and Argentine stations at Halley Bay and Belgrano Base.

The group proceeded westward until New Year's Day, when heavy pressured ice blocked further progress about 20 miles east of Gould Bay. This congestion was caused by two large grounded bergs near the edge of the ice shelf, which impounded the pack drifting westward with the current, in the absence of southerlies to blow it clear. Ships were beset here for 11 days, during which the growing fuel shortage of *Wyandot* was alleviated by transferring to her a supply of diesel fuel from *Staten Island*. On January 11 favorable winds opened up a passage around these bergs, but *Wyandot* experienced further holing from drifting ice. By the 15th Cape Adams was within hello range, but aerial search revealed no location possible for construction of a base, and so the formation retired to the eastward, *Staten Island* losing a blade off her port propeller at this time. Though no base site was found, this penetration by surface ships of the southwestern Weddell Sea constituted a notable Antarctic "first."

Gould Bay remained solidly frozen on the return trip, and the same grounded bergs were still there to impede progress eastward, but after being beset for 2 days, on January 26 the formation broke through into open leads, and a site on the ice shelf suitable for base construction and offloading was found in a small bight beyond Gould Bay. Bay ice could not be used for offloading because of an unbridgeable tide crack, but the icebreakers broke out a site along the shelf itself, which by good fortune was here only about 20 feet high, as compared to over a hundred feet farther west. Thus on January 28, after continuous battling since mid-December with the most formidable sort of ice, during which *Wyandot* suffered repeated hull damage and both ships lost considerable operational ability through loss and bending of propeller blades, construction finally began.

Offloading began immediately, and construction got underway with the first loads to arrive at the site, about 2 miles from the shelf edge. Because of the danger of the shelf edge calving under heavy weights, all tractors had to be kept away from the ships' sides, and considerable ingenuity was called for in warping and snaking cargo lifts inshore by power from tractor winches and ships cranes, to where tractor trains could safely be formed up. Work was around the clock, and unloading was completed in 12 days, ending on January 29. On February 11 construction was 90 percent complete and the base self-sufficient, and because of deteriorating weather conditions the wisdom of ships remaining longer was in doubt. A commissioning ceremony was held, and Captain McDonald turned the base over to Capt.



Finn Ronne, USNR, as military commander and scientific leader of Ellsworth Base. The ships then proceeded northward through rather difficult ice, emerging from the Weddell Sea on February 17. On the 19th the task group was deactivated, *Staten Island* proceeding to Seattle via the west coast of South America, *Wyandot* to Norfolk via the east coast.

CHAPTER II—SHIP OPERATIONS

To commence this season's ship operations, *Glacier* made history by pushing through 850 miles of ice in 8 days to arrive at McMurdo Sound on October 28. The ice was 1 year old and, whereas only 6 to 8 feet thick, it was extremely pressured and rafted. It is not believed that this feat could have been accomplished without the helicopters, particularly the HTL, which is ideal for ice reconnaissance. Short, frequent hops proved more valuable than long ones, since ice configuration could be well remembered and sketches followed more accurately. Only 10 days later, the pressure of the pack was relieved enough to allow *Glacier* to follow the same track on her outbound trip in 4 days instead of 8. The track followed was between 174° E. and 175° E.

The entry of the Ross Sea group on December 15 presented little difficulty. The main difficulties encountered by this group were on the one hand the need to break a channel through the bay ice at McMurdo to enable the ships to get within reasonable unloading distance, and on the other, the fact that the bay ice at Kainan Bay had gone out and unloading on the barrier at a minimum height of 50 to 60 feet was difficult. This was further complicated by the persistent swells.

The Hallett-Knox group arrived at Cape Hallett with relative ease. Minor damage was incurred by *Arneb* en route, which was repaired before the ships proceeded further. After arrival at Cape Hallett, it was necessary for *Northwind* to break out a channel through bay ice for about 5 miles. While doing this, a sudden and severe storm arose wedging *Arneb* between the bay ice and pack ice, and considerable damage was sustained. In trying to reach her, *Northwind* lost one propeller blade. *Arneb* also lost a propeller blade, as well as many frames and beams bent and twisted, and several holes punched in her hull. The worst damage was repaired and the job completed. The damaged *Northwind* was replaced by *Glacier* and the entry to Knox Coast accomplished with *Arneb* and *Greenville Victory* in company. Although several days were spent in finding a way through the relatively narrow pack, this task was completed without untoward incident. At this time *Glacier* was without helicopters. Base construction at both sites was an amphibious operation.

The Weddell Sea group encountered considerable difficulty in transiting the pack in the Weddell Sea, being beset for periods of 5 days, 11 days, and 3 days respectively. The *Wyandot* sustained many bent and twisted frames and strength members, holes in her hull, and broken-off tips from all four propeller blades. Also, the *Staten Island* lost one blade off her propeller and suffered a broken crankshaft on No. 2 engine. Though able to approach finally to within 16 miles of Cape Adams, no suitable site for cargo unloading operations could be found in that area. On reversing course and proceeding back along the ice shelf, the group was eventually successful in locating a station on the shelf with an excellent unloading site nearby.

Several principles of ice operations were emphasized during Deep Freeze II. The TAK type has proved far superior to the AKA type in the ice. The added power of the former allows it to push through astern of the icebreaker in places where the AKA is stopped. In this connection, except in very heavy ice, a convoy speed of 8 knots proves most effective, with the convoyed ship 400–500 yards astern of the breaker. Any excess over this allows the ice to close in the wake of the breaker, thus impeding the escorted ship. The icebreaker must concentrate continually on leaving a straight track, without turns or knuckles, as sharp turns slow down the cargo ships and damage them. The icebreaker must be alert to warn the cargo ships when she sees ice ahead that is likely to slow or stop her, so that the cargo ships can stop and back. Even so, if the icebreaker is stopped, she should keep her engines ahead full, as her screw current acts as a buffer to stop the cargo ship. The breaker is generally guide for course, while the lead cargo ship is guide for speed. It should be remembered that the higher the speed that can be safely maintained the easier it is for the icebreaker to break ice efficiently, and also to leave a straight track for the cargo ship to follow.

Helicopters on icebreakers are invaluable for essential ice reconnaissance. This reconnaissance should be done by a ship officer who is familiar with the problems of the surface ships. The ideal helicopter for ice operations is the HTL type with its excellent visibility. An HO4S type is also necessary for the many utility missions requiring more lifting capacity.

Although *Glacier* strikes the ice with almost twice the power of a *Wind* class icebreaker, she sustained no propeller damage during Deep Freeze II. Two *Wind* class icebreakers each lost a propeller blade. One theory within the task force is that a blade is broken off when a floe of ice becomes wedged between the blades and is forced against the hull, thus shearing off a blade. If the number of blades were increased, as space between the blades would be reduced, this would probably be less likely to happen.

Chapter III—Air Operations

For the initial fly-in to McMurdo, 2 R5D–3, 4 R4D–5/6 and one P2V–2 (ski-equipped) of Air Development Squadron 6 (VX–6) were deployed on September 10, 1956, to Christchurch, New Zealand. To reduce the flying distance to the Antarctic the four R4D–5/6 were further deployed to Taiere Aerodrome, Dunedin. Aircraft were readied and the United States ship *Brough* (DE–148) ordered on ocean station. On October 16 an R5D with Rear Admiral Dufek aboard made a successful flight to McMurdo proving the suitability of the prepared bay ice runway for wheeled aircraft. The remaining aircraft followed on October 17 and the P2V–2 crashed while attempting a landing at McMurdo. Four crew members died. (See VX–6, accident report, 5–56 dated November 2, 1956.)

In the meantime, eight C–124 aircraft of the 52d Troop Carrier Squadron, 63d Troop Carrier Wing, 18th Air Force had been deployed to Harewood Airport, Christchurch, New Zealand. They commenced logistic support to McMurdo on October 20. Included in the cargo were three UC–1 (Otter) aircraft assigned to VX–6 of which two were subsequently assembled and flown to Little America V for support of the trail party and tractor train operations to Byrd Station. The third remained at McMurdo for local support. During this initial airlift, a C–124 broke a nose strut on landing at McMurdo. Suffering considerable structural damage, it was towed to the parking apron to await repairs.

As an aerial assault on the South Pole requires a supporting station near the base of the Queen Maud Mountains, a site was selected at the foot of the Liv Glacier. By October 30 the R4D's and C–124's had delivered station personnel and air-dropped 29 tons of material, supplies, and POL. All was ready for a Pole landing. This was carried out by two aircraft circling overhead with survival equipment while an R4D with Rear Admiral Dufek aboard effected a successful landing and takeoff. The temperature was minus 57° C and take-off performance extremely marginal even with the assistance provided by 15 15KS1000 jet-assisted takeoff (JATO) bottles. Because of these conditions further operations were postponed until warmer weather prevailed.

Main air operations were now shifted to Little America where preparations for locating a tractor trail to Byrd Station were well underway. Prior to departure of the trail party, which was to prepare an acceptable route, many reconnaissance flights were made to the eastward to locate a suitable ramp approach to the Marie Byrd Land Plateau. This reconnaissance was successful. Upon the trail party's departure, aircraft were required for logistic support. UC and H04S aircraft were also used for close-in reconnaissance. To permit the proper method of bridging crevasses, the procedure was for an ice expert to be lowered into the crevasses by the hoist of a hovering H04S.

On November 12, 3 R4D's were readied at McMurdo to resume the attack on the South Pole. Since a flight on November 19 indicated the weather to be satisfactory, 2 R4D's took off and successfully carried the initial construction personnel and sled dogs with associated survival and camping material to the Pole. After this initial toehold, flights became routine. The Air Force immediately commenced air-dropping material to the construction personnel and on November 25 10 more construction personnel were delivered by R4D. The Air-Force's second casualty occurred November 28 when a C–124 returning from the South Pole landed short of the runway during an actual ground-controlled approach and suffered the same damage as their first—a broken nose strut. An Air Force repair team was dispatched from the United States to repair both damaged C–124's, but unfortunately their plane also crashed upon landing at McMurdo. This one, however, was not repairable, and was subsequently dismantled for spare parts.

The last of the construction party was delivered to the Pole on December 1. Due to the range limitations of R4D aircraft they were required to refuel at the glacier camp upon returning from the Pole which, in turn, meant that an additional R4D must make a flight to the camp to deliver Avgas (a mission that had been planned for the P2V–2 (ski equipped)).

The first P2V–7 arrived McMurdo on December 4 and after preliminary ski landing tests, took off for the Pole with 4,000 pounds of food. After successfully landing and off-loading, the take-off performance at the Pole was definitely disappointing and required 16 JATO bottles.

Air dropping of supplies continued until mid-December when warm temperatures so deteriorated the ice runway that wheeled aircraft operations had to be suspended. At this point C–124's had air-dropped approximately 400 tons of supplies, material, and fuel at the Pole and 39 tons of fuel to the trail party in the vicinity of Byrd Station. Ski-aircraft operations remained feasible at McMurdo so the P2V–7 and R4D's lifted IGY nondroppable cargo and 13 tons of food (required to make the South Pole Station self-sufficient for 1 year) to the Pole. The next step was to exchange the construction group with wintering-over personnel.

At Little America, a tractor train departed on December 5 after a safe trail had been prepared to the plateau. This train required extensive aerial logistic support which became an acute problem as the distance from Little America increased. In addition to delivering spare parts, tools, food, etc., fuel caches had to be placed at 250, 300, and 500 miles from Little America. By using Marine Corps assault fuel farm system components at the caches and carrying diesel in the fuselage avgas tanks a weight saving was realized with a subsequent reduction in the number of flights required. Even so, the adverse weather encountered made it an exacting task. Upon the tractor train's arrival at Byrd Station (80°S.120′W.) additional construction personnel were delivered and the fuel caches along the trail were refilled. By January 5 construction was advanced enough so that 7 of the construction personnel were brought out and 4 wintering-over personnel delivered.

At McMurdo, the second P2V–7 ski aircraft arrived on January 3 and made one flight to the Pole before a failure in the ski design was noted. Further ski operations were halted. Upon takeoff at McMurdo the port ski rigger strut had failed at the wind trailing edge, permitting the ski to assume an extreme nose-high attitude. Considerable aerodynamic drag was experienced but the landing was uneventful. After a temporary "fix," both P2V aircraft were deployed from Antarctica for design analysis and modification for deep freeze III.

With warm (average 32° F.) temperatures the runway at McMurdo melted rapidly. Continuing efforts to repair it and to clear another were of no avail until cooler weather arrived around the first of February. By that time, large, deep potholes of melt water had developed. By using a concrete mixture of snow, chopped ice, and water (which subsequently froze), these holes were filled and a new surface prepared. By February 8, the runway was ready to receive C–124 aircraft; the first arriving from New Zealand on February 9.

By February 24, 35 flights had been made to the South Pole and Byrd Station to complete the airdropping of supplies. On February 12, the last R4D flight was made to the South Pole carrying wintering-over personnel. Colder temperatures precluded further ski landings there and the air-support camp at Liv Glacier was abandoned on February 23.

The second tractor train for Byrd Station departed Little America on January 28 making repeated and continuing demands for logistic air support for ski-equipped planes. These demands continued until late February when the train returned to Little America. Refilling the fuel caches in anticipation of Deep Freeze III was then begun. By February 25, all personnel shifts had been completed and each base was entirely self-sufficient. Four R4D's remained at Little America to provide required air logistic support after summer forces had been withdrawn.

Throughout the entire operation the UC-1's (Otters) and helicopters fulfilled the valuable mission of liaison, reconnaissance, and short-range transport in both the Ross and Weddell Seas. Helicopters proved indispensable in ice reconnaissance and the ferrying of priority cargo.

Chapter IV—Trail Operations

The swing of the Byrd Station Army-Navy reconnaissance party was made up of 2 low-ground-pressure D-8 tractors, 1 Tucker Sno-Cat, and 2 M29C Weasels. It was mounted to be self-sustaining for a 40-day operation on the assumption of a minimum 12-hour workday and an estimated average train speed of 2 statute miles per hour. On November 5, 1956, the swing departed Little America.

During the period November 19–December 3, 1956, the Army-Navy reconnaissance party succeeded in establishing a suitable, cold-weather, limited-use, heavy-equipment trail 7.4 statute miles long, 30 feet wide, through the narrowest area in the extensive crevasse belt which surrounds the Rockefeller Plateau. Due to the nature of the dangerous terrain, complex crevasse systems, operational hazards, and special techniques required to negotiate this trail with heavy equipment, it was desirable to assign Army personnel to guide the subsequent tractor trains through this area. This area was henceforth called Fashion Lane.

The first tractor train consisted of 1 weasel and 6 D-8 tractors each towing two 20-ton Otaco sleds with a net payload of 160 short tons of cargo. Escort officer was Lt. P. M. Smith, USA. The train departed Little America on the 6th of December 1956 and returned on the 5th of January 1957.

The second tractor train consisted of 1 navigation weasel and 7 D-8 tractors each towing two 20-ton Otaco sleds with a net payload of 220 short tons. Escort officers were Maj. P. Mogensen, USA, and Lt. P. M. Smith, USA. The train departed Little America on the 28th of January 1957 and returned on the 28th of February 1957.

The Byrd Station Army-Navy reconnaissance party took departure on the initial precomputed great-circle course from mile zero, which was established as 1,000 feet southeast of Kiel Field administration building. Subsequent great-circle courses were computed from elevation of long- and short-range air reconnaissance data. The heavy-swing element was preceded by the crevasse detector and trail-marking weasels, both of which were equipped with navigational instruments. Direction was maintained by backsighting along a line of the flagged bamboo poles placed at intervals of one-fifth of a statute mile in the direction of the great-circle course. In addition to the bamboo-pole markers a 12-foot snow cairn with a barrel marker was dozed at each 20-statute-mile marker, 40 to 50 feet north of the trail.

The heavy-swing element consisting of 1 Tucker Sno-Cat towing four 1-ton sleds, and two D-8 tractors each towing two 20-ton Otaco sleds proceeded in column formation at distances varying from 1 to 5 statute miles behind the weasel-swing element. On the outbound journey the tractors were operated intermittently in third and fourth gear and homeward bound in fourth and fifth. The equipment's high-performance standard was maintained by close adherence to an established standing operating procedure.

Navigational aids in addition to the backsighting technique, included determining lines of position by use of a theodolite and a chronometer.

Crevasse-detection operations at mile 183.5 were augmented by use of a helicopter.

The party completed its mission and returned to Little America on the 6th of January 1957. Total length of trail was 647.3 statute miles.

Chapter V—Base Operations

The following relates briefly to the establishment of the stations in Marie Byrd Land and at the geographic South Pole as well as data gathered at Little America and at the Naval Air Facility, McMurdo Sound, subsequent to the departure of Deep Freeze I surface and air forces from the Ross Sea area in March 1956.

SUPPLY AND DISBURSING FUNCTIONS

All general-stores items were stored in one area at each base, well marked by flags, and remained in the custody of the supply officer. Custody of all equipment and spares was turned over to officers concerned. Lack of covered storage space was a constant problem and although a locator system was established for the various classes of general-stores items, digging out material from the snow was a constant problem.

Records and inventories for operation of the general mess were maintained, but returns were not required as it was not necessary to stay within a monetary or ration allowance. Food was adequate and very palatably prepared at Little America. The preparation of food at McMurdo left a little to be desired.

Regular disbursing functions were carried on at both stations. An agent cashier paid at McMurdo Sound and the supply and disbursing officer held regular paydays at Little America. Pay was restricted to $15 a payday.

LITTLE AMERICA

Little America was commissioned on January 4, 1956, with Lt. Comdr. R. E. Graham, USN, as officer in charge. From February 15, 1955, to December 30, 1956, Comdr. H. W. Whitney, CEC, USN, was in command of all MCB special personnel. Construction commenced on this date and the last outside construction project was completed in April with the erection of the recreation building.

A combination fuel and fire watch was established to insure the fueling of all heating units, and to provide a systematic check of all buildings. The base was divided into zones and a fire bill drawn up assigning personnel to fire stations and periodic fire drills were held to familiarize personnel with their stations.

Snow was procured from the snow mine located one-half mile from the base. Snow melters were kept filled by personnel assigned to the fire watch. Men occupied their spare time by taking out study courses or pursuing recreation in the form of movies, reading, ping pong, etc.

With the return of daylight all personnel, with the exception of watch-standing personnel, were divided into two divisions, namely the equipment division consisting of drivers and mechanics and the operations division consisting of remaining rates. The equipment division commenced readying equipment for the tractor train and the operations division commenced digging out the Byrd Station construction materials from the snow. Material recovered was checked against the known requirements and loaded aboard sleds for hauling to Byrd Station.

Four radiomen manned circuits on a watch-standing basis. Communications blackouts were experienced on several occasions especially when the aurora australis was present.

Three rated commissary men assisted by 3 mess cooks during the winter and 2 mess cooks during the summer period provided excellent food. All hands up to CPO were assigned mess-cook duty.

Kiel Field, which had been closed for the months of July and August, was the first project started with the return of daylight. All work necessary to make the field capable of accepting aircraft was completed in advance of the arrival of the first aircraft.

NAVAL AIR FACILITY, M'MURDO SOUND

With the departure of the U. S. S. *Glacier* on March 10, 1956, the air operation facility (later changed to Naval Air Facility, McMurdo) commenced its operation as an independent facility with an officer in charge, Lt. Comdr. D. W. Canham, Jr., USNR.

The facility was manned by 83 personnel of MCB (special), 6 VX-6, 2 Air Force, and 2 civilians for a total of 93. Departments were established to handle administration, construction and maintenance, communications, air operations, and necessary housekeeping functions.

The most urgent tasks facing the facility were completion of base construction and development of a runway to accommodate the aircraft to be flown in the following spring. Personnel for these missions had to be assigned from personnel not engaged in camp-support functions. Therefore the following permanent watches were established: OOD and JOOD, communications, Powerhouse, MAA (camp cleanup, sanitation and fueling), fire watch, snow collection for water, galley operation, and medical department.

With the exception of the communications, powerhouse, and medical watches, these assignments were rotated among qualified personnel throughout the camp.

Technical troubles in communications were experienced, both from climatic conditions (Aurora Australis) and shortage of equipment. Because of this, close coordination by the Commander, Naval Bases, Antarctica was often difficult or impossible.

By April 10, 1956, the last building shell was completed. Interior work proceeded. Preparation of material for the subsequent pole drop was commenced. At the same time extensive reconnaissance and tests were conducted on sea ice to locate a suitable site for the ice runway. Snow compaction tests were made in an attempt to devise a technique which would permit development of a compacted runway which would support wheeled aircraft. By July 22 it became apparent that snow compaction was not the answer. All efforts at this stage were then directed toward clearing off the snow cover from the sea ice.

By August 25 a 6,000-foot runway was cleared and taxiways and runways were started. However, blizzards in September negated much of this work. By October 15 a new 5,000-foot runway was completed. Aircraft commenced their fly-in October 17. Work on taxiways and parking areas continued.

Immediately upon arrival of the aircraft the primary mission of NAF McMurdo became support of air operations. All available construction equipment and personnel were directed toward loading aircraft for drops and maintaining runways. Prior to December 19 the Air Force flew over 50 flights to the Pole and Byrd Stations, dropping over 500 tons of materials.

The most pressing problem found during this period was the deterioration of the runway. Unseasonable warmth commencing in November created melt pools over the runway, some of them reaching depths of 3 to 4 feet. On December 19 the runway was closed. Every possible effort was made to effect repairs, but continued warm weather aborted all attempts. It was not until after Detachment One departed McMurdo and sustained cold weather returned that it was possible to reopen the runway.

The cargo ships of Task Force 43 arrived at McMurdo on December 22. Off-loading operations were severely hampered by equipment breakages (particularly the caterpillar LGP traxcavator 955 design flaw) and the need to attempt runway repairs.

Detachment One personnel were relieved by January 20 and boarded ships for return to the United States.

BYRD STATION

Byrd Station construction commenced with the arrival of the tractor train at 80° S., 120° W. Four buildings were erected and the base was commissioned on January 1, 1957. A fire watch responsible for fueling all heating units and fueling the two snow melters was established on a 4-hour watch basis.

Detachment Bravo personnel were flown in the MCB (Special), Detachment One personnel were returned to Little America. With the arrival of the two radiomen a communication watch was established. The TBW radio did not function properly and satisfactory communications were not established until the two 30-kilowatt transmitters were finally installed.

After an airstrip 6,000 feet long by 250 feet wide was laid out and flagged, aircraft from VX-6 commenced flying in food. One cook, assisted by one mess cook, satisfactorily handled the food preparations, while one corpsman was sufficient for medical purposes. Snow was obtained from a snow mine one-half mile from the base and the snow melters kept filled by the fire watch.

Weather reports were sent to Little America every 6 hours after arrival of the two civilian weathermen. Buildings erected consisted of the meteorology building, powerhouse and garage, galley and messhall, and head.

SOUTH POLE STATION

The first construction personnel consisting of 8 men were delivered to a point 8 miles from the Pole on November 20, 1956. After a day, 4 of the 8 men proceeded to the Pole by dog team as the weasel intended for this movement required repairs and parts were not available. On the 25th the remaining four personnel traveled to the Pole to join the first party. A camp was set up, polar location established, and the Air Force commenced airdrop operations.

On November 25 a group of 10 additional men arrived and on December 1 the remaining 6 construction personnel were delivered. This made a total of 24 men and 1 civilian who comprised the construction party which built the station. A construction camp consisting of two Jamesway shelters, several tents, and communication facilities was in full operation by December 1.

Construction proceeded at a rapid rate as the Air Force delivered droppable items. VX-6 delivered all nondroppable items. By the 20th of December the station was effectively completed and the flag was raised on its permanent staff. On the 25th the first group of construction personnel was evacuated and on December 29, eight of the wintering-over military personnel were delivered and 8 of the construction personnel were evacuated.

The final evacuation of the remaining seven personnel was accomplished on January 4, 1957, and the base was turned over to Lt. (jg.) Jack Tuck and Dr. Paul Siple.

Remaining scientists and material were delivered after January 15, 1957, subsequent to reactivation of the runway facilities at NAF McMurdo.

CHAPTER VI—AEROLOGY

Complete weather records of all aerological units participating in Operation Deep Freeze I and II are on file at the National Weather Records Center, Asheville, N. C. Detailed weather data compiled on all phases of both operations are available at Headquarters, Commander, United States Naval Support Force, Washington 25, D. C.

ROSS SEA AREA

The major area of operation was in the Ross Sea sector where aviation forecasting for flights between NAF McMurdo, Little America, Pole Station, Byrd Station, and New Zealand was of prime importance. The ice runway at NAF McMurdo was the only landing place available for the Air Force Globemasters within a 2,200-mile radius and accurate terminal forecasts for the runway were essential to this phase of the operation. Staff aerological officers with supporting aerographer's mates were assigned to NAF McMurdo and Little America Station to provide weather services. Two surface charts (0000Z and 1200Z) and a 700-millibar upper air chart were analyzed daily. Storm warnings and sea condition forecasts were provided for ships from both these stations.

Forecasting for an area extending over 1 million square miles and having only 6 reporting stations demands a regular and reliable weather communications system. During the air and ship operations, the existing communications system proved inadqeuate. The circuit linking the Antarctic stations was unable to maintain the scheduled load of weather traffic. Exchange of 10-group synoptic weather reports between NAF McMurdo and Little America would sometimes take as long as 24 hours even when the radio reception was good.

Beardmore four-man station was occupied on October 28, 1956, as a weather reporting station and a refueling stop for ski-equipped aircraft returning from Pole Station. It was indispensable as a source of weather information during the operating season. The personnel were evacuated after all operations were concluded. The position selected for Deep Freeze II was near the confluence of at least five major glaciers and came under the influence of strong drainage winds from the Polar Plateau. This invariably resulted in heavy blowing snow which reduced surface visibilities to zero even though clear skies and unlimited visibility prevailed westward of the area. It also gave an unrepresentative wind direction.

Weather observations from the numerous flights over the interior of Antarctica during this operation were invaluable in filling a big gap in the meager knowledge of Antarctic weather processes. The upper winds reported are already aiding in determining the general circulation of the air over the continent. The importance of accurate weather observations from aircraft cannot be overstressed.

During the first full year of Operation Deep Freeze no lasting equipment failure was experienced from extremely low temperatures. The thermograph clock at Little America stopped at −60° F. but was started again after all the oil was removed from the gears. The Gill hydrogen generator proved highly satisfactory for cold weather operation. This low-pressure generator was simple and practical to operate. A portable Herman-Nelson space heater has been used in the inflation shelter but a permanent jet heater would be a more practical heater since it is necessary to keep the building warm at all times for efficient and safe generator operation.

WEDDELL SEA AREA

For forecasting and briefing, three surface charts (0000Z, 1200Z, and 1800Z) were analyzed daily. For upper air analysis, the 1500Z radiosondes from Argentine Island and Port Stanley, coupled with intermittent pibals from other British stations, were used in conjunction with the task group upper air observations. Staff aerological personnel (1 officer, 3 AG's) were assigned to the task group commander and utilized facilities aboard both the U. S. S. *Wyandot* (AKA–92) and U. S. S. *Staten Island* (AGB–5).

In addition to the Punta Arenas, Chile, and Port Stanley, Falkland Islands, weather broadcasts, Shackelton, and Halley Bay bases were contacted twice daily on a point-to-point basis at 0100Z and 1700Z using 6689 and 11,000 kilocycles. Weather and ice information were exchanged at these times. While the *Magga Dan* (British expedition ship for Shackelton and Halley Bay) was in the area, the radio operators at Shackelton and Halley Bay made contact with the ship whenever possible, and relayed weather and ice information to the task group.

Punta Arenas (CBM) was a very valuable and reliable source of weather information. CBM broadcasts at 1155Z, 1755Z, and 2255Z on 13,890 kilocycles. This broadcast schedule is not listed in H. O. 206 (vol. I).

Weather reports were received from the following stations not listed in H. O. 206 (vol. II):

Block and station No.	Name	Position
85972	Diego Ramirz	56°35′ S. 68°10′ W.
88940	Hope Bay	63°24′ S. 66°59′ W.
88956	Roux Island	66°54′ S. 66°58′ W.
88959	Horseshoe Island	67°40′ S. 67°15′ W.
89022	Halley Bay	75°31′ S. 26°36′ W.
89034	Shackelton	77°57′ S. 37°16′ W.

Effective March 1, 1957, FICOL transmissions from Port Stanley were broadcast as follows:

0001Z—9800, 11,450 kilocycles
0645Z—14,800, 9800, 7425 kilocycles
1300Z—19,800, 14,800 kilocycles
1900Z—19,800, 14,800 kilocycles.

In obtaining RAWINS, neither ship was able to track RR-32/AM radar reflectors using the AN/SPS-6C air-search radar. The *Wyandot* (AKA-92), however, was able to track the targets released by the icebreaker with AN/SPS-4C radar using the zenith switch.

KNOX COAST GROUP

The staff aerological unit assigned to Commander Task Group 43.6 provided forecasts to ships and construction units while operating in the Western Ross Sea and along the coast of the continent westward to the Vincennes Bay area.

The staff aerological unit consisted of three enlisted personnel and was deployed aboard *Arneb* during the entire operation. Ship's company enlisted personnel aboard icebreakers of the task group assisted in the observational program. Personnel of Mobile Construction Battalion (special) were assigned to shipboard aerological units while en route to the base sites.

Unreliability of weather communications was one of the major problems encountered. Reception was rendered difficult or impossible by distance from broadcast stations, interference from other transmitters either distant or in the task group and atmospherics. Collectives were received from Wellington, New Zealand and Canberra, Australia and reports from other stations and ships in the Antarctic via Fox and task force circuits. *Arneb* was handicapped by lack of radio operating positions.

Forecasts were issued daily for 24-hour periods and at more frequent intervals if conditions warranted revised forecasts. Since a comprehensive surface analysis was difficult to produce due to the lack of observations over the operating area, forecasts were based mainly on local surface and upper air observations with reliable results.

The observational program was divided between the ships in order to collect the greatest amount of data possible with the available personnel. Shipboard radar on *Arneb* was used for upper wind soundings by attaching reflectors to the radiosonde train. When in company, the icebreaker was assigned responsibility for surface observations.

In most cases the aerological equipment used in the operation functioned satisfactorily. The AN/SPS-4A radar on *Arneb* proved valuable in making upper wind soundings. The AN/FMQ-2A on *Arneb* located in a ready service room in the after superstructure remained operative during the operation although excessive vibration occurred while underway.

Most forecasting problems were handled satisfactorily. An exception was the difficulty in forecasting the winds, sudden increase in wind velocity from the polar plateau because of the lack of inland weather observing stations in the vicinity of the base sites. The coastline of the Antarctic Continent is characterized by offshore winds that begin and cease abruptly.

SUMMARY

Reports from the new stations at Cape Hallett, South Pole, Liv Glacier and Byrd Station combined with the reports from NAF McMurdo and Little America Stations, and the reports submitted by aircraft flights, trail parties and shipboard aerological units formed the basis for the daily synoptic charts. Using these charts, fairly reliable forecasts were made for the Ross Sea sector. In addition, a comprehensive observational program was conducted by all units which will contribute materially to the climatology of unexplored areas of the Antarctic.

One of the major problems confronting the forecaster was the inadequacy of weather communications. With 6 stations covering an area of 1 million square miles, each station assumes a position of paramount importance in the aerological picture. Accordingly, failure to receive a single report can delay scheduled operations until communications are restored. Also, the copying of weather messages accurately is vital. It requires personnel who are acquainted with the unique format of weather transmissions.

CHAPTER VII—COMMUNICATIONS

Communications during Operation Deep Freeze II were considered generally good overall. The installation of additional equipment on ships and stations, and the activation of two RATT circuits (McMurdo to Balboa and McMurdo to New Zealand) helped overcome many of the difficulties encountered in Operation Deep Freeze I. Some improvements are indicated to compensate for peculiarities inherent in high latitude regions relative to propagation, and alternate methods of communication for absorbing the impact of surges of operational traffic and clearing normal traffic loads following radio blackouts.

During the early stages of Operation Deep Freeze II, the communication facilities at both Little America and McMurdo Sound were inadequate to properly support the requirements imposed by large-scale air operations—primarily due to insufficient equipment and communication personnel. The modified C-30 communication components specified for both bases lacked proper engineering design and considerable substitution and prefabrication of hookup and cable interconnections were necessitated because of lack of specific items which had been omitted along with the engineering design. Many miscellaneous items such as antenna wire, hardware and spare parts were either lacking or shipped in insufficient quantities. Many of the communication components were shelf-worn, and in some cases, inoperable. No detailed design plans were furnished for guidance of Deep Freeze I wintering-over personnel who were responsible for the installation and operation of the communications equipment.

Many of the crates of material received during Operation Deep Freeze II were incorrectly or poorly marked. For example, one carton marking indicated contents to be an RBC communications receiver; contents was an RBB communications receiver chassis having an RBC nameplate on top and an RBB nameplate on the face. Another box for the Amundsen-Scott South Pole Station bore markings indicating that it contained six AN/PRC–6 transceivers. Inspection of the contents after arrival at the South Pole revealed only packing material. Field portable radio equipment ordered as complete communication component for field use (transmitter, power supply, receiver and antenna system—type MM) was received without receivers. Spare parts for the TBA transmitter installed at McMurdo during Operation Deep Freeze I were not received until the arrival of the ships in Operation Deep Freeze II. The Collins 431–D transmitter ordered for installation at Little America during Operation Deep Freeze I was not delivered until ships returned in Operation Deep Freeze II. Three high frequency receivers ordered for air shipment to McMurdo Sound as an operational requirement for anticipated increase of air operations were placed in the hold of a ship for routine delivery. Spares were not provided with the AN/FRT–24 transmitters received in the Antarctic during Operation Deep Freeze II.

The landline teletype network established within New Zealand proved to be very successful. It is the present intention to reactivate these circuits on a full-time basis when headquarters for the Commander Task Force 43 is established in Christchurch, New Zealand, on the commencement of Operation Deep Freeze III. At the present time it is being operated on a limited basis in caretaker status to serve the needs of our New Zealand echelon physically located in Christchurch.

Efforts for the establishment of a radio teletype (RATT) circuit between McMurdo and Irirangi, New Zealand, were unsuccessful. CAA, Radio Auckland (ZKLF) assumed responsibilities for establishing and maintaining this circuit full-time basis; therefore, no further efforts will be made to establish a schedule circuit with Irirangi.

Communication facilities on the *Glacier*, *Wyandot*, and *Arneb* were much better than during Operation Deep Freeze I. However, none were proven entirely adequate to provide extensive flagship communication capabilities for an operation of this type.

The communication facilities at NAF McMurdo were utilized to the fullest extent while the force flagship was within helicopter range. All outgoing traffic from the flagship was passed to McMurdo by this method for further relay outside the Antarctic. This also included traffic originated by all units of the Ross Sea and Knox coast groups.

Communication equipment limitations at McMurdo Sound did not permit the establishment of a separate CW circuit for passing radio traffic ship to shore between the flagship and naval air facility. A RATT circuit was considered for this purpose to be utilized during periods when McMurdo Sound was not able to work with Balboa; however, this could not be accomplished for two reasons: (1) McMurdo Sound was not equipped with terminal equipment for tone modulated signals; and (2) the *Atka* was not equipped with terminal equipment for transmitting frequency shift keying signals. This resulted in the flagship being unable to pass traffic normally by radio to McMurdo Sound. Therefore, radio traffic accumulated in the flagship when outside of helicopter range from McMurdo Sound and conditions were further aggravated by radio blackouts. It then became necessary to direct all units to work direct through normal ship-to-shore channels.

At one time during Operation Deep Freeze II when ships of the task force were widely separated and encountering difficulties copying Hotel broadcast, the Chief of Naval Operations directed all ships to shift and copy the Bravo broadcast activated for Antarctic area. This arrangement worked out very well for the *Staten Island* and the *Wyandot* which were proceeding south along the west coast of South America, however, it proved entirely unsatisfactory for the ships en route through the South Pacific to New Zealand and those operating in the Antarctic region. Following a recommendation by the Commander Task Force 43, the Chief of Naval Operations directed the securing of Bravo broadcast and directed the ships to copy the Hotel broadcast. It is considered that the Hotel broadcast best serves ships operating in the Antarctic areas, and although the Bravo broadcast may provide better coverage in the Weddell Sea area, the limited number of ships operating in the Weddell Sea would not justify recommendation for activation of a special broadcast.

United States Naval Radio Station Balboa, during Operation Deep Freeze II as in Operation Deep Freeze I, proved to be the task force mainstay for reliable ship-shore communications. Although the other United States Naval radio stations were worked in the worldwide ship-shore system, Radio Balboa consistently provided the best service working under difficult radio conditions.

Some confusion was noted as a result of messages originating within the Task Force 43 using the administrative title COMNAVSUPFOR Antarctica for some messages and Commander Task Force 43 on others. This problem is undergoing study to prevent misunderstandings in Operation Deep Freeze III.

Due to limited transportation facilities, it is believed that little can be done to improve mail services after the ships of Task Force 43 enter the high latitudes. Some difficulties were experienced at McMurdo Sound when locked mailpouches were received, necessitating the cutting along the seams of the mailbag in order to distribute the contents. It is believed that some delay may have been incurred in the outgoing mail from McMurdo Sound since no cancellation facilities were located in McMurdo and required the temporary postal facility established in New Zealand to "work" this mail prior to forwarding it onward. Mail service to the Weddell Sea Group (*Staten Island* and *Wyandot*) was very poor from the time they left Panama en route to the Weddell Sea to their arrival back at South American ports several months later. It is believed that better mail delivery service could have been provided in South America for ships en route to the Antarctic area.

Ships were unable to draw sufficient publications from registered publications issuing offices at their last United States port of call to cover the period of absence until it was possible for them to again visit another registered publication issuing office.

The U. S. S. *Brough* and U. S. S. *Glacier* experienced difficulties due to personnel shortages and equipment limitations and/or failures. Both these ships were required to operate independently in remote areas for protracted periods of time. The *Glacier* was required to operate with one side of the AN/SRT-16 out of commission, one radar inoperative and her TBM broken down. MSTS ships communications capabilities were limited personnel-wise.

Chapter VIII—Logistics

A complete report of logistics matters for Operation Deep Freeze I is included as Annex IX in "Report of Operation Deep Freeze I 1955–56." Matters included herein will be largely restricted to those that are not included in that report.

Logistics planning for Operation Deep Freeze II began in the spring of 1956 upon conclusion of Operation Deep Freeze I. These plans were published in the Logistics Annex (annex E) to Commander Task Force 43 Operation Plan No. 1–56. It is believed that the logistics plan for Operation Deep Freeze II reflects the experience gained in the preceding year's operations, and to this extent it is a refinement of the logistics plan for Operation Deep Freeze I.

A major change from the procedure followed on Operation Deep Freeze I was the shift from MCB (Special) to Construction Battalions, Atlantic Fleet. This was done with the latter's concurrence, it being felt that that organization was much better equipped experience-wise and personnel-wise to undertake the task. Another major change was the discontinuance of disbursing services in the Antarctic and the substitution in lieu thereof a credit system for sale of ship's store stock and other transactions normally involving cash—CTF 43 Instruction 7220.1 of September 13, 1956, refers.

Funding responsibilities at the bureau level were much the same as for Deep Freeze I and closely followed normal bureau funding responsibilities.

By mid-May 1956 a firm cargo estimate of 28,555 measurement tons of dry cargo had been compiled from reports submitted by all units. Cargo had already begun to arrive in measurable quantities.

On July 1 an early surface shipment of 1,980 measurement tons, consisting of materials required by the United States Air Force in early flight operations and items required to be flown in to the Antarctic for use prior to the arrival of the cargo ships, was made by commercial carrier to New Zealand. Distinctive color, destination, and material category markings were not placed on all containers in this shipment by cognizant organizations with the result that great difficulty was later experienced in identifying the ultimate destination of containers and the nature of material included therein.

Since late receipt of material at Davisville in Deep Freeze I had caused considerable ship-loading difficulties, the deadline delivery date for all Deep Freeze II cargo at Davisville was advanced from September 15 to August 31. On August 31, 12,100 measurement tons of cargo were on hand which proved a satisfactory situation for cargo preplanning purposes. Loading operations commenced on October 2, 1956, and were completed on November 14, 1956. Total cargo actually shipped by surface vessel was 32,164 measurement tons for discharge as follows:

Little America	8, 677	Knox Coast	6, 181
NAF McMurdo	7, 558	Weddell Sea	6, 798
Cape Adare	2, 769	New Zealand	181

Stowage factor overall for the cargo ships proved to be 88 cubic feet per long ton.

Both before and after the departure of the cargo ships, heavy air-freight requirements arose. This tonnage was handled by FlogWing aircraft to New Zealand. The larger part of these requirements were generated by submission of requirements by message from the Antarctic for materials needed prior to arrival of the ship group. The remainder was generated by late delivery of material at Davisville.

Ships en route to the theater of operations replenished supplies by normal methods except in New Zealand where a task force supply and disbursing office was established to provide logistics support to USAF, VX–6, ships, etc. The establishment of this office improved greatly the logistics support provided the ships and also provided a disbursing facility to pay USAF and Navy personnel working in New Zealand.

After arrival in the Antarctic unloading operations commenced with conditions varying widely at each station. At McMurdo Sound cargo was discharged to sleds on bay ice. Discharge here was slow due to lack of prime movers and poor condition of the ice at the unloading area. All cargo at this port was discharged between December 20, 1956, and January 28, 1957.

At Little America, due to absence of bay ice, all cargo was unloaded directly onto the barrier which varied between 35 and 40 feet in height. Discharge commenced on January 3, 1957, and was completed on February 5, 1957. Due to the height of the barrier, cargo was moved ashore by an improvised housefall method, the inshore block being rigged to the top of the boom of a D–8 tractor for pulling power. One D–8 tractor was unloaded by driving it over a Balk bridge erected from the deck of the *Greenville Victory* to the edge of the barrier. The D–8 was assisted by hooking on the winch wire from a D–8 tractor unloaded the previous year.

Unloading cargo at Cape Hallett and Knox Coast Stations was accomplished by LCM's carried by U. S. S. *Arneb* (AKA–56). In order to expedite transfer from the boat to the supply dump flatbed trailers were placed in the LCM's and cargo placed on the trailers. Upon arrival at the beach the full trailer was removed by tractors and an empty trailer placed in the boat for the next load. Unloading at Cape Hallett was carried out between January 3, 1957, and January 9, 1957. Unloading at the Knox Coast was carried out between February 1, 1957, and February 9, 1957.

Unloading at the Weddell Sea Station was by direct transfer to barrier ice. Since the height of the barrier here was approximately 18 feet, sleds could be loaded directly from the ship without the use of housefall. In order to avoid the hazard imposed by the weight of a tractor being applied near the face of the ice shelf a system was invoked whereby empty sleds were brought no closer than 75 feet from the edge by the tractor. A line from the ship's winch was then hooked on the rear of a sled and the sled snaked backward into loading position. Failure to observe instructions not to approach the edge of the barrier under any circumstances, on one occasion, did result in the near loss of a D-4 tractor and driver.

During the unloading it became obvious at all stations that great numbers of fuel drums and lack of adequate equipment to handle them properly was the controlling factor. At Little America alone over 15,000 drums were unloaded. The use of bulk petroleum facilities would have reduced the total dry-cargo loading by 30 percent and would have been far more economical.

After arrival in the Antarctic it was determined that some units had not complied with instructions regarding preparation of locator data for packed materials. As a result, great difficulty was experienced in locating specific items for use at the bases except where size or nature made them obvious.

Cargo for construction and operation of the Pole Station was flown from NAF McMurdo Sound to the operating area by USAF C-124 aircraft and airdropped. Lack of adequate ground transportation equipment at NAF McMurdo hampered and frequently brought flight operations to a standstill. Prepackaging of the drop material in wooden boxes added excess weight to the airdrop material and in some cases, due to sharp edges, broke the parachute container straps causing loss of the boxes on drops. Some confusion existed at NAF McMurdo as to responsibilities for Navy coordination of airdrop with the Air Force. The assignment of a Task Force representative to coordinate all airdrops with USAF satisfactorily solved this problem.

Fuel arrangements for aircraft in general proved satisfactory. It must be emphasized, however, that requirements for 115/145 AvGas in New Zealand must be carefully forecast since this grade is not stocked in that country except on specific request.

Ship fuel arrangements, on the contrary, presented a major problem. Changes in planned ship movements due to operational conditions made fuel plans obsolete as fast as they were made. Fortunately, relations with the contractor, Standard Vacuum, were so good that on the spot revisions were made as the situation changed. Due to the time factor, many of these changes were not reflected in contracts at actual time of delivery. As a matter of fact, at the close of the operation, the contractor had received contracts covering only two ships and was delivering fuel on verbal request.

PREPARATION OF ICE SHELF FOR MOORING AND DISCHARGE SITE THROUGH USE OF EXPLOSIVES

In order to prepare a suitable discharge site (a straight side barrier wall in sufficient length to moor Victory-type ships and tankers), extensive blasting was required in the vicinity of the unloading area in Kainan Bay.

Since the ice walls were 30 to 40 feet in height and submerged to a depth of approximately 200 feet the procedure was as follows: Shape charges (40 pounds) were placed on a 12-inch steel tripod cradle, 8 to 15 feet apart and 5 to 7 feet from the barrier edge running parallel to the desired discharge site. Instantaneous electric blasting caps were then inserted in each charge and wires connected in leap frog fashion and then led out to the blasting wire which was carried back approximately 1,000 feet to the blasting machine. (See fig. A.) No more than seven charges should be detonated simultaneously. After all demolition safety precautions were checked, the charges were detonated upon a signal from the officer in charge. Satchel charges were used to remove any remaining underwater ice shelves. Results were effective, efficient, and contributed materially to a successful operation. This operation can be completed in approximately 3 hours.

Due to calving and frequent heavy swells which undercut the barrier and left underwater protuberances, the barrier had to be blasted to improve the mooring and discharge site every 3 to 5 days. The site was not blasted until weather conditions allowed remooring upon completion of blasting.

A 10-day storm in late January caused considerable damage to the barrier, undercutting approximately 4½ feet per day. A survey of the area on February 1 revealed that the previous discharge site had broken off leaving an underwater ice shelf extending outward approximately 30 to 40 feet. It was determined that extensive underwater blasting would be required before the site was again safe for mooring and discharging ships, and the actual mooring should be one ship length forward of the old site.

Daily air photo reconnaissance had been conducted and these pictures provided sufficient detail information to commence demolition operations at 1800 hours, February 1.

A team of 5 men, 1 officer in charge, 1 demolition man, and their assistants were selected to conduct the blasting operations. Satchel charges consisting of eight blocks of C4 explosives each, with primacord attached, were then prepared (best results were obtained by attaching two charges together with a small line fastened to each satchel). The primacord was secured from one to the other, inside the attached charge. One satchel was primed with a stick of gelatin and an instantaneous electric blasting cap. All connections were fastened securely, wires shunted and circuits tested by means of a galvanometer. The blasting machine with 1 assistant attending was stationed approximately 1,000 feet from the barrier edge, the officer in charge and 1 demolition man being secured together with a 120-foot nylon safety line. The charge was then carried with a lowering line and lead wire securely attached, to a predetermined spot on the barrier edge. Meanwhile the assistants were tending a safety line, looped around an ice ax buried handle down in the snow. The man carrying the charges crawled to a selected spot on the barrier and lowered the satchels to a depth of 25 or 30 feet underwater, this being the correct depth for the desired amount of blasting and shock effect. The lowering line and lead-in wire was then secured to an ice ax approximately 150 feet from the planted charge. Then all personnel and equipment were moved back to an area in vicinity of the blasting machine. The circuit was again tested with a galvanometer and if complete the charge was detonated.

It was necessary to wait 10 or 15 minutes after each blast before inspecting the results, because ice continued to surface in a turbulent fashion causing a delay in the breaking off, or loosening of the barrier. All personnel were alerted to listen for any cracking and/or unusual sound, which is prevalent just before ice breaks loose. This sound was accompanied by vibration, visual cracking, and lifting of the barrier. When no sound or lifting action occurred within 10 to 15 minutes, the area was inspected for results. This was accomplished by checking the barrier's waterline to determine the amount of lift caused by the blast. Usually each blast raised the ice from 8 to 10 inches. The maximum rise before the ice broke loose was estimated to be 3.5 feet. When misfires occurred the lowering line and lead-in wires were cut near the barrier edge, leaving the charge to sink in approximately 2,100 feet of water. Twenty-eight hours were spent preparing this mooring.

The U. S. S. *Atka* frequently checked the results close up from seaward and recommended placing of additional charges and/or continued blasting.

Eight hundred and eighty pounds of explosives were expended, and the site was ready to commence discharge operations at 1600 hours, February 2.

ICEBREAKER PREPARATION OF ICE SHELF FOR UNLOADING CARGO

In general an icebreaker can be utilized to advantage in removing shreds of bay ice clinging to the ice shelf or barrier and also to knock off small protuberances existing above the waterline. However, more harm than good can result if any major realinement of the barrier is attempted. Because of the inclined forefoot of the icebreaker the bow merely punches a V-shaped indention in the shelf above the waterline leaving the ice below the waterline unaffected.

In preparing the ice shelf at Ellsworth Station for unloading operations, bay ice was sheared-off cleanly by allowing the icebreaker to come ahead slowly at an angle of 60° to the shelf. On contact with the shelf opposite full rudder is applied. The 60° angle permits the bow to glance off the shelf whereas full opposite rudder keeps the bow snugly against the shelf during the evolution.

CHAPTER IX.—NAVIGATION, HYDROGRAPHY AND ICE

Units of Task Force 43 navigated over long distances of the earth's surface en route to and in the large continent of Antarctica. Surface, air, trail, and ice charts were required in large quantities. Information was gathered to improve charts and sailing directions particularly in Antarctica which is perhaps the least charted area in the world. Reports containing this information have been forwarded to the United States Navy Hydrographic Office. The ships generally expressed satisfaction with standard navigation equipment including installed radar and gyro compasses modified for high latitude. Extensive series of radar photographs of the coast were taken. It is considered that these will be useful for delineation of coastline and ice limits on charts since the steep rise of ice cliffs and coastal features which are most common in Antarctica lend themselves to rather accurate portrayal from radar information. Main reliance was placed on the standard sextant but good results were obtained with the bubble octant while stopped in the ice where pitch and roll of the ship was not a factor affecting accuracy.

A test of the radio sextant, AN/SAN-1 (XN-1) in order to determine its value as an aid to navigation in high latitudes was made on the U. S. S. *Curtiss* (AV-4). In the frequently overcast and stormy conditions of the Antarctic a device of this nature would constitute a highly important aid to navigation. Navigation by soundings was of assistance in some areas of Antarctica, but soundings are extremely sparse on all charts. Excellent results were obtained with the AN/UQN type fathometer. However, inability to record deep soundings with this fathometer may be attributable to protective plates over transducers on icebreakers so equipped. Radio direction finders were carried by some ships primarily for search and rescue purposes. Loran or similar positioning device would be very useful in Antarctica particularly in the McMurdo area where considerable air and surface travel prevails.

Trail navigation to establish the trail from Little America V to Byrd Station was performed with T-2 theodolite and Roeloff solar attachment to obtain geographic positions frequently, usually at intervals of 10 miles. A good deal of topographic data including crevasse information was obtained for the purpose of improving the existing trail charts of this area.

Ice information has been gathered for improvement of existing charts. Best routes for ice navigation into areas where stations have been built are a subject of major importance. Track charts included in this report show the meridians along which penetration has been made. Penetration of the Weddell Sea ice pack was accomplished along the Filchner ice shelf to Cape Adams in an area never before reached by ship. Although this track was the only one possible, a major obstacle was the large bergs, believed to be aground, off Gould Bay which concentrated the ice pack. Channels cleared by katabatic winds close to the ice shelfs presented the easiest means of passage.

One voyage of interest was the passage of Task Group 43.7 (*Wyandot* and *Staten Island*) through the Chilean inland waterway from the Gulf of Penas south to the Strait of Magellan for a distance of 550 miles. Heavy seas usually prevalent in southern South American waters were thus avoided. A speed of 13 knots was averaged. Sharp turns were successfully negotiated and places of high current velocity were transited at slack water. The wind in the waterway was considerably reduced compared to that experienced in the open sea. At Punta Arenas, however, winds of 60 knots were experienced considerably hampering small boating. At First Narrows in the Strait of Magellan a current estimated to be about 10 knots was experienced.

The U. S. S. *Brough* reported that their biggest navigational problem was obtaining navigational fixes during continually overcast conditions while on ocean aircraft station. This required the exercise of good judgment in keeping a DR position because of the high winds and mountainous sea conditions prevailing. Five stops were made by the *Brough* at Perseverance Harbor, Campbell Island using H. O. 2003. Unexpected high winds sweeping across the harbor were experienced making anchorage there undesirable. Piloting in Perseverance Harbor was not difficult after the first entrance had been made but the harbor is very poorly charted and its value as an anchorage and shelter is very limited due to poor holding ground and high winds. Ships caught in a storm in the harbor would probably find it extremely difficult to maneuver safely through the uncharted waters and out of the narrow harbor entrance.

A rhumb line route from Dunedin to Panama (via Callao) was preferred by *Brough* because of the smoother seas and consequent fuel economy and lessened personnel and material strain on the ship although the great circle route was 360 miles shorter.

The obtaining of geographical position ashore by ships personnel was accomplished by observations for several hours of the sun with 1 minute transits and artificial-horizon sextants. Good results were obtained.

Due to a burned out dampening eliminator magnet coil, *Curtiss* lost the use of its main gyro compass until they were able to reach a port where the damage could be repaired.

The Weddell Sea group reported navigational difficulty incident to periods of continued overcast lasting as long as 4 days making celestial navigation impossible. Radar piloting on bergs and the ice shelf was resorted to as being far more accurate than dead reckoning because of the heavy ice conditions.

Chart coverage on a Mercator projection and large scale for the southern Weddell Sea coast is needed since the coastal route from Cape Norvegia is the only ice passage possible to the Ellsworth Station and Cape Adams. The Antarctic chart portfolio (AA) was considerably enlarged and improved for Deep Freeze II with over a hundred new or new editions of charts. The information will be reported and recommendations made in detail by separate correspondence. Operations of the task force are widespread over the vast distances of the Antarctic and there is consequently great need for geographical information.

All ships, except the MSTS ships whose fathometers were limited to shallow water, recorded soundings at all times while underway. Approximately 300,000 miles of soundings smooth plotted and annotated were submitted. Bathythermograph observations were also observed by AGB's and AKA's. A total of several thousand were obtained. Ocean current information was obtained by all ships and submitted to the United States Navy Hydrographic Office.

An oceanographer from the Hydrographic Office and a bathythermograph team from Service Force, Atlantic Fleet, were assigned to each icebreaker. In addition to bathythermograph work, oceanographic casts were obtained for samples at various depths for data pertaining to the salinity, oxygen, and temperature structure of the water, bottom samples and cores, bottom animal life, plankton, transparency and color. Continuous air-water temperature and current observations were made. Considerable more work by the bathythermograph teams was accomplished than in usual operating areas.

All ships recorded continuously ice data encountered. Prominent oceanographic features such as seamounts, deeps, and convergences were reported.

Ice charts of the Antarctic continent and the larger scale charts of bay ice proved helpful. Development of an improved ice chart coverage is needed. Salient aspects of Antarctic ice encountered were—

(1) The rather difficult penetration of the Weddell Sea pack in the vicinity of Cape Norvegia where TG 43.7 was beset in late December although penetration to the eastern edge of the Filchner Ice Shelf was the earliest ever completed;

(2) The ice block in the vicinity of large bergs off the western side of Gould Bay where TG 43.7 was beset for 11 days in early January and for 5 days in late January;

(3) The easy passage from these bergs to Cape Adams where heavy concentrations of ice were again encountered;

(4) The earliest recorded penetration of the Ross Sea ice pack by the *Glacier* in October;

(5) The toughness of the Ross Sea ice pack in October changing to a light ice year later in the season;

(6) The total clearing of bay ice in Kainan Bay early in the season;

(7) The recession of the McMurdo Sound bay ice front southward early in the season as compared to its northern limit of previous years;

(8) The concentration of pack ice off Cape Hallett early in the season.

Task Force 43 built a base at Cape Hallett and obtained information concerning this area about which very little was known. The coast in the vicinity of Moubray Bay is very poorly charted. Cape Hallett is situated in North Victoria Land, about 60 miles south of Cape Adare (Lat. 72° 18′ S., long. 170° 20′ E.). The cape runs north and south and forms Hallett Inlet to the west which is 8 miles long and 4 miles wide (maximum). The Cape Mountain rises 6,000 feet but the cape per se is about 2,000 feet high at its northern extremity.

The Admiralty Range, part of the Antarctic Horst, runs generally north-south and rises abruptly out of the west side of Hallett Inlet, climaxed by the horn of Mount Sabine (11,883 feet elevation). Here, the outcrops are heavily folded slates and quartzite whose beds are contorted by tight anticlinal, synclinal and drag folds. The joint system thus produced has become intruded with quartz.

In sharp contrast with the metasedimentary west shore, the east side of Hallett Inlet is a block of bolcanic deposits. It consists of numerous beds of basalt-andesite, basalt and tuff-agglomerate. The joint is concealed by a large south-flowing glacier at the head of the inlet.

The entire area is heavily glaciated. The cape is covered with highland ice from an elevation of 1,600 feet. Numerous ice walls reach to the inlet on the east side. The west bank is covered with cirques, valley glaciers and ice falls, many of which end in floating piedmonts.

Hallett Beach, lying beneath Cape Hallett on the northwest side, is a flat terminal moraine, roughly triangular, about one-half mile on each leg. The midsection is pierced by a lagoon from the inlet side which nearly bisects the beach. The gravelly surface sedimentation has been integrated with scattered boulders by deposits of penguin guano and organic remains. The beach supports a population of approximately 200,000 penguins.

Chapter X—Photography

The staff photographic allowance consisted of 8 enlisted personnel and 2 officers, being distributed throughout the task force on the various icebreakers and the *Arneb*. These plus the ships' companies, AirDevRon 6 and 5 construction battalion photographers totaled 24 and were considered adequate for obtaining the desired coverage but not adequate in regard to keeping up with the processing, filing, and administrative work involved.

Aerial coverage of ice in McMurdo Sound was obtained on a weekly basis or when a major change occurred. Motion picture documentary coverage in 16 millimeter color was considered to be adequate, a total of 144,350 feet being in the NPC film library. Stills in color and black and white were obtained of operational interest in addition to views for Fleet Home Town News and technical projects. Panoramic series from the surface and air were taken of many geographical areas, such as Cape Hallett, the Knox coast area, Marble Point in McMurdo Sound, etc.—these photographs will be of particular interest to the Hydrographic Office. Approximately 8,450 black-and-white and 1,467 color stills of the operation are now on file at the NPC. This is in addition to the trimetrogon coverage obtained by AirDevRon 6.

Emphasis was again placed on the importance of individual ships vigorously pursuing Home Town News coverage through adequate photographic supervision, with less importance being placed on individual ships cruise books, scrapbooks, etc.

On operations such as Deep Freeze, which are of such wide interest, all public news releases, especially when supplemented by photographs particularly of the Home-Town News variety, are of great benefit to the Navy recruiting program.

Most of the ships of the task force with authorized photographic laboratories were not administering the laboratories in accordance with OpNav Instruction 3150.6. In order to benefit the Navy in general, all negatives and prints should be forwarded promptly in accordance with OpNav Instruction 3150.6 and not held aboard ships for preparation of scrap books, albums and cruise books, before they are forwarded.

Deep Freeze I and II motion-picture footage has been used extensively for TV and theater releases by: Walt Disney Productions, Columbia Broadcasting System, MGM, NBC, and Lawrence Welk. CHINFO is currently producing two 28-minute films, one on Deep Freeze I and one on Deep Freeze II. The Bureau of Yards and Docks is producing two films for training and public interest on the Seabee's activities during Deep Freeze I. Task Force 43 has been authorized to produce five technical photographic reports on the establishment of bases during Deep Freeze II. These films will greatly benefit the Navy and Department of Defense in the fields of education, recruiting, and public relations.

There has been a constant flow of still-picture releases in newspapers, magazines, trade papers and service publications. Stills are also being used for training purposes by various Navy activities for cold weather operations. There were 39 feature releases, 27 spot news releases, and 9 color releases carried by 250 newspapers and magazines on Deep Freeze II at the time of this report.

Shipboard radar cameras, type CRZ–6, were not dependable, consequently radar photographic coverage which would have been very useful to the Hydrographic Office was not obtained. Complete, detailed technical report on these cameras will be forwarded to the bureaus concerned.

Chapter XI—Special Projects

The special projects described in annex D of CTF–43 Operation Plan No. 1–56 were accomplished. Due to the poor condition of the

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airfield at McMurdo, the airborne geomagnetic survey was limited to the New Zealand and en route areas with deferral of inland Antarctic flights.

Detailed reports of these projects are obtainable from the agencies involved. Bureau of Ships reports required of the ships were made as listed in annex D of the operation plan and contain recommendations too numerous to list here. However, major recommendations concerning hull and engineering are recorded in the chapter of this report dealing with ship operations.

As much as possible was accomplished in special projects with ships assigned to the task force. The number and extent of such projects were necessarily limited because of lack in transportation equipment, ship space requirements, and time spent in the operating areas. Much more could be accomplished in the field of special projects if these limitations were removed.

Elsewhere in this report assignment of a ship for hydrographic purposes is proposed. This ship would conduct on-the-spot studies in oceanography, hydrography, ice, high latitude navigation and charting. Assignment of special projects to this ship also would be mutually beneficial and would free other ships of circuitous routing to accomplish such projects.

Chapter XII—Medical and Dental

HEALTH ASHORE

A doctor and 2 corpsmen were stationed at both Little America V (73 men) and McMurdo air facility (93 men). Insomnia or "big eye," characterized by loneliness and mild depression, was noted in both camps particularly during the dark months of May through July. One case of paranoid schizophrenia developed, initiated by the loneliness of isolation. One case of irrascible behavior was noted, believed to be due to major pathology in the central nervous system. Both of these cases were suspected months before by the medical officers, but the personnel were retained because of high motivation to "winter over." These cases initiated a psychiatric screening project covering both military and civilian personnel by a Bureau of Medicine and Surgery team of psychiatrists to prevent recurrence of psychiatric casualties in Deep Freeze II, and to produce criteria for future selection of personnel for polar duty.

The predominant medical condition treated continues to be relatively afebril upper respiratory infections, epidemic with influx of new personnel to groups long isolated, aggravated by close living conditions and by overheating of living spaces with resultant extremely low relative humidities.

Traumatic deaths and injuries are the most serious problem. Instant death to 3, death in hours to a fourth, and critical injuries to 4 more men resulted from a P2V crash while making a GCA approach in marginal weather on October 18, 1956. One case of drowning occurred on January 14, 1957, when a weasel carrying six men went through the bay ice off Hut Point. Numerous fractures, lacerations, sprains, etc., call for special training of medical officers in surgery and anesthesiology.

Morale in general depends on food and comfort, competent leadership, workload, news and mail from home, and recreation. Recreational alcohol contributed to morale by releasing tensions and inhibitions. It also creates innumerable morale problems through intoxication, favoritism in dispensing, thievery, etc. Control of alcohol consumption by medical officers during camp isolation, and operation of club bars during summer influx of large numbers of personnel seems the best answer to this problem.

At Little America, where bathing was convenient three or more times per week, dermatologic conditions dominated the cases reporting for sick call; whereas at McMurdo where men bathed every 7 to 10 days skin afflications were rare. This suggests that too frequent, hot, soapy bathing in excessively dry atmosphere is detrimental to good health.

No major problems of frostbite or freezing have arisen on Deep Freeze I or II. In general, the practice of medicine in an Antarctic camp is not unlike that in an isolated north woods lumber camp.

HEALTH AFLOAT

There were no unusual health problems in ships except for 1 case of epidemic meningitis which occurred on the *Atka* in December 1956. This was expertly isolated and treated. The crew was given sulfadiazine prophylaxis which helped prevent contagion; and information was controlled so that there was no panic among task-force personnel or their dependents.

SANITATION

Naval air facility, McMurdo Sound, because of its location on a relatively snow-free volcanic hill, continues to have the problem of ready, potable, and dust-free water supply, particularly during summer months. Heads utilized halved oil drums which when full of excrement are dumped on the sea ice. Washing and head facilities are crowded during the summer months. Messing facilities are similarly overcrowded, with slowup in serving, eating off wet hand-washed dishes, and limitation of variety and palatability of menus. Though esthetically below Navy standards there have been no occurrences of gastrointestinal infections resulting therefrom. Foods have been adequate in quantity and quality even during the summer. During stepped-up summer aviation activity sleeping accommodations are crowded. Though a danger, this has not affected health markedly in the past.

Little America has no fresh-water problem, but has the problem of fecal stalagnites in the heads which have a deep typical Chick Sale arrangement. This has been effectively combated by well-placed blasting charges at appropriate intervals.

PERSONNEL

A doctor should be assigned to any isolated group of men in polar regions, and a corpsman in addition for every 33 or more men. In the summer of 1957 for the 7 bases of Deep Freeze II 9 volunteer doctors were given special training in surgery, anesthesiology, psychiatry, ophthalmology, emergency dentistry, and cold-weather medicine. By September two doctors had lost their enthusiasm and were assigned to task-force ships. In October a third doctor developed cold feet and had to be replaced with a volunteer who got only 6 weeks training prior to departure. All training was accomplished in Chelsea and Newport Naval Hospitals, Boston City Hospital, and at Davisville, R. I. Three corpsmen were trained in X-ray, laboratory, anesthesia, and O–R technique. The corpsmen were assigned to Weddell Sea, Little America, and McMurdo bases. Prior to departure in March 1957, one additional volunteer corpsman from the task force was assigned to each of the latter stations. The presence of the VX–6 surgeon to assist the McMurdo doctor on the first fly-in undoubtedly saved some lives in the P2V crash.

MEDICAL MATERIAL

Resupply for Little America and McMurdo, and supplies for Byrd, Pole, Weddell, Knox, and Adare bases, costing approximately $84,000, were designated by the force surgeon and ordered by MCB special. These were inspected, divided, and crated by the MCB corpsman, and painted black on all but one side. This latter was invaluable in helping to prevent freezing of most supplies and assisted in ready identification. In spite of this, excessive damage occurred to rubber, plaster of paris, biologicals, formalin solution, and hydrogen peroxide from freezing. These must be given special handling in the future. Shortages in Little America and McMurdo supplies from Deep Freeze I noted were chapsticks, foot powder, covered instrument X-rays, carpenter toolkits, keratolytics, and silver nitrate. The six-drawer cabinets with door-storage space obtained by the CB's for medical spaces were considered excellent.

MEDICAL FACILITIES

At Little America and Naval Air Facility, McMurdo, medical spaces have been found adequate. At the smaller bases, small medical spaces have perforce limited medical supplies and equipment so that physicians must utilize considerable ingenuity.

MEDICAL TRANSPORTATION

The helicopter is unquestionably the preferred mode of casualty transportation, providing one is available, weather conditions are favorable, and distance is not too great. Of surface vehicles, the Tucker Sno-Cat seems best able to furnish fast, heated, tracked, and sufficiently commodious transportation of up to four casualties for airstrip ambulance service.

SURVIVAL MATERIAL

The Deep Freeze I survival ration utilizing Coman-Gutenko pemmican was replaced with the Army ski-troop ration modified to provide in ounces: Meatbar 16; starch and carbohydrates 17½; cocoa and chocolate 5; dried fruit 1½; dehydrated flavors and drinks 2¼; and heat tablets, vitamins, matches, toilet paper, waterbag and chewing gum 2%. Total weight with packaging 45 ounces per man/day. This provides an estimated 5,700 calories, +5 percent.

The planes of VX-6 carried Army shelter tents as survival shelter which can hardly be considered suitable protection from the Antarctic elements.

The Bausch and Lomb G-15 neutral-gray glass, which can be ground to average prescriptions and to bifocals, with double-gradient density inconel metallic coating in a light gold-filled aviator-type goggle proved most effective and popular with all hands.

Experiments when flying in 97 percent "whiteout" disclosed that the B. & L. Kalichrome yellow shooting glass, also ground to prescription and metallic coated for protection from actinic rays, increased visibility of horizon from 10° to 120° and materially increased contrast in snow and ice detail for all observers. Had this discovery been made a year earlier and had all pilots been so equipped, the P2V might not have crashed at McMurdo in October 1956.

Medical and dental personnel aboard *Glacier*, *Arneb*, *Staten Island*, *Northwind*, *Wyandot*, and *Hespelen* were considered adequate, except that absence of a dentist in the *Northwind* would have been inconvenient for the Knox Coast group had plans not been changed. The force corpsman was assigned the *Greenville Victory*, Deep Freeze II corpsmen riding the *Merrell* and *Towle* down and Deep Freeze I corpsmen returning. These corpsmen rendered great services to their shipmates and to the task force.

Chapter XIII—Public Information

Despite news-significant world events which occurred during Antarctic operations, Operation Deepfreeze II was one of the most widely publicized naval operations in recent years.

Two officers and five journalists were assigned staff public information duties. Twenty-nine civilian media correspondents including all major outlets were accredited. Of these, 24 covered Ross Sea-Little America-McMurdo operations. Included were German, New Zealand, Australian, and Japanese nationals. Public information headquarters were set up at the task force office in New Zealand, but insufficient personnel to man both this office and billets in the Antarctic prevented stationing a permanent JO there.

The 18th Air Force unit included four public information officers, a civilian Air Force reporter, and photographic teams. They carried out a very active Air Force public information program. Based at Weedons, they occupied the Navy public information office at Christchurch and made Navy photo and news releases (flown and radioed from the Antarctic) in the absence of Navy public information personnel.

Via frequent Air Force flights from McMurdo to New Zealand, Navy film and tape recordings were airmailed to Washington. During periods of press copy backlogs, commercial press copy was flown to New Zealand and cabled to the United States commercially.

For maximum coverage of operations, journalists were assigned to Weddell, Knox, and Ross Sea group commanders. One journalist was assigned Little America-Byrd Station, one remained at rear echelon, Washington. They filed daily news or feature stories, made numerous tape recordings for national and hometown release and worked closely with Navy photographers.

The assistant PIO was stationed at NAF McMurdo most of the time. The staff PIO, reporting in New Zealand in advance of CTF 43 and TF units' arrivals, moved with correspondents to NAF McMurdo and with CTF 43 in various flagships in the Ross Sea. In New Zealand, USIS was serviced continually; personally and by mail and radio messages.

Each task force unit was advised to request their type commanders to assign a junior officer for the operating period to afford more complete coverage.

Fleet Home Town News Center performed an excellent job by special handling of thousands of hometown stories, features, photos and tapes. This was a tremendous morale booster to the task force.

Initial long delays in radio transmittal of press copy from naval air facility McMurdo, were alleviated by establishment of a radio-teletype to Balboa, C. Z. This eased transmission of press copy from McMurdo but copy filed aboard ships and at Little America still experienced long delays reaching McMurdo for retransmission. Correspondents were restricted to 500-word messages but were permitted in rotation to file an unlimited quantity. Until flights to New Zealand were suspended December 19, newsmen filed lengthy releases and film as "mailers." TV cameramen airmailed film to networks while it was still news. All copy was approved and handled by PIO.

Intense public interest in Deep Freeze, building up prior departure United States and continuing upon return, demanded utmost public information efforts. CHINFO, IGY, and OIC, United States Antarctic programs referred all Antarctic informational matters to the task force staff. PIO also produced the task force cruise book which was very well received by all hands and top Government executives.

Public information activities for Deep Freeze II are considered satisfactory overall.

Chapter XIV—Personnel and Administration

During this operation the staff of commander Task Force 43, was divided into five groups: Ross Sea group (accompanying CTF 43), Weddell Sea group, Knox Coast group, New Zealand advance echelon, and the echelon remaining at headquarters in Washington, D. C. Ships of the task force departed from various ports of the United States on various dates. The Weddell Sea group, *Wyandot* and *Staten Island*, met at Panama and then proceeded as a group. The Ross Sea-Knox Coast group met in New Zealand, proceeded as a group to the Ross Sea and then divided into two groups and proceeded on assigned missions.

Operational requirements prevented the *Curtiss* from proceeding to the Antarctic until December 27, 1956. This caused a shortage of transportation and berthing facilities as all commands and activities desired to have their personnel arrive as early in the season as possible. This was partially solved by airlifting approximately 150 personnel to New Zealand. Except for the *Curtiss*, other ships were necessarily overcrowded from time of departure New Zealand until arrival in Antarctica. Approximately 50 percent of the wintering-over personnel for Little America and McMurdo Sound bases were transported in the *Curtiss*. This reduced the time available for effecting relief of the Deep Freeze I wintering-over group. Deep Freeze II wintering-over personnel therefore received only minimum instruction and indoctrination from the personnel they relieved.

Government agencies—both inside and outside and the Defense Department—as authorized by CNO sent observers on this operation. As a limited amount of berthing spaces were available, only a small number of foreign observers could be accommodated. However, observers from Australia, France, Japan, New Zealand, Chile, and Argentina as authorized by CNO accompanied units of Task Force 43.

During Operation Deep Freeze I, varying ship schedules while in the Antarctic required frequent transfer of personnel, whereas during Deep Freeze II all commands were directed to issue individual orders to personnel to be deployed to the Antarctic. Having an individual set of orders for each man eliminated much confusion and enabled ships and bases in the Antarctic to transfer personnel on a moment's notice.

CHAPTER XV—CONSTRUCTION

During Deepfreeze II the following facilities were constructed:

Little America Station.—3 barracks; 1 latrine; 1 communications building; powerhouse—as added facilities to those already existing.

Byrd Station.—A 23-man IGY station consisting of barracks, messhall, shops, and scientific buildings.

Pole Station.—An 18-man IGY station consisting of barracks, messhall, shop, and scientific buildings.

Naval air facility, McMurdo.—1 barracks; 1 recreation building; one 250,000-gallon capacity gasoline storage tank; communications facilities—as added facilities to those already existing.

Weddell Sea.—The 39-man Ellsworth IGY Station consisting of barracks, messhall, shops, and scientific buildings.

Windmill Islands.—The 27-man Wilkes IGY Station consisting of barracks, messhall, shops, and scientific buildings.

Cape Hallett.—The 14-man Adare IGY Station consisting of barracks, messhall, shops, and scientific buildings.

(Refer to Y. and D. drawings No. 732,921 to drawing No. 733,111 inclusive, for station plans. As-built drawings are being prepared and will be distributed to those concerned later.)

Little America and naval air facility, McMurdo.—Construction was accomplished at operating stations with no features different from those detailed in Report of Operations Deepfreeze I.

Byrd Station.—Located at 80° S. 120° W. on the polar plateau at an elevation of 5,100 feet. Materials and personnel for constructing and outfitting the station were delivered by two tractor trains from Little America and by air lifts from Little America and naval air facility McMurdo. Construction was accomplished by 1 officer and 25 enlisted personnel of MCB (Special) during December 1956 and January 1957.

Pole Station.—Located at the geographic south pole on the polar plateau at an elevation of 9,275 feet. Materials and personnel for constructing and outfitting the station were airlifted from naval air facility, McMurdo. Construction was accomplished by 1 officer, 23 enlisted men, and 1 civilian during the period November 20, 1956, to January 4, 1957.

Adare Station.—Located at Cape Hallet. The site is composed of rock and beach sand, lying only a few feet above sea level and is surrounded by an Adelie penguin rookery. Materials and personnel for constructing and outfitting the station were delivered by ships. Unloading was an amphibious operation to the station site on the beach. Five officers and 125 men of MCB 1 supplemented by ships working parties were employed for unloading the ships and for construction during the period January 3, 1957, to January 10, 1957. Two officers and 30 men of MCB 1 and the wintering-over party, completed the construction by January 31, 1957.

Wilkes Station.—Located in the Windmill Islands off the Budd Coast. The site is bare ground and rock with no snow cover during the summer. Materials and personnel for constructing and outfitting the station were delivered by ships as an amphibious unloading operation. The station site is contiguous to the beach unloading site. All planned buildings and structures except tunnels were constructed. Three officers and 90 men of MCB 1 supplemented by the wintering-over party and ships' working parties unloaded the ship and completely constructed the station during the period February 1, 1957, to February 16, 1957. Although topographical conditions did not require the use of the truss foundations at this site, the trusses were used to speed erection since they required less levelling than mud sills would have.

Ellsworth Station.—Located in the Weddell Sea on the Filchner Ice Shelf at 77°43′ S. and 41°7.3′ W. at an elevation of 115 feet. Materials and personnel for constructing and outfitting the station were delivered by ship unloading directly to 18-foot-high shelf ice. Tractors and sleds were used for hauling cargo 2 miles over a trail with a 5 percent grade. No crevasses were present along the trail, but constant vigilance and maintenance were required to keep it usable. Three officers and 91 men of MCB 1 supplemented by the wintering-over party and ships' working parties unloaded the ships and constructed the station during the period January 29, 1957, to February 11, 1957. The construction was 90 percent complete upon departure of the ships.

Chapter XVI—Morale and Recreation

Reports received from ships participating in Operation Deepfreeze II have indicated high morale among shipboard personnel. Despite cramped living quarters, erratic mail schedules and nondelivery of mail, lack of adequate space for outside recreation, personnel accepted the situation along with exigencies of sudden changes of plans as a part of the job. The unique aspects of an Antarctic expedition generally interests all hands as a challenge, overbalancing the slight feeling of depression which normally accompanies groups of personnel exposed to limited facilities.

Among many of the factors contributing to the high level of morale among the personnel, the leadership displayed by officers and leading petty officers stood high. Lesser factors, not necessarily in the older of their respective value, are informally recorded for future consideration in operations of this nature.

The presence of representatives of the major press media of the United States and the recording of events for individual hometown consumption by newspapers, radio, television, and magazines gave personnel the feeling that they were a member of the team. Although amateur radio facilities cannot be operated from United States Navy ships, those ships of the task force which operated at Little America and McMurdo Sound were able to make use of the shore-based radio amateur facilities—both for handling radio messages as well as talking directly home by radiophone patch. This service was free of charge and personnel not making use of the privilege felt secure knowing that the service was available should they need to use it for important or emergency matters. Great interest was observed in hobby shop material, amateur photography, amateur painting, movie attendance, etc., which were generally available to all personnel. Many personnel exhibited a keen interest in rock collecting and visiting penguin rookeries when the circumstances permitted.

Personnel were particularly enthusiastic in visiting the various ports of call designated for recreation, always receiving the utmost in hospitality. They presented a positive and friendly relationship toward the foreign country concerned. Dispatches, letters and even articles in newspapers spoke of the exemplary conduct exhibited by Task Force 43 personnel.

The presence of observers, both military and civilian-foreign and domestic, is believed to have had considerable influence on the personnel. An attitude of cooperativeness and willingness to assist the accompanying observers was prevalent. This spirit of "Can Do" also appeared mutual between members of the United States Coast Guard and MSTS ships participating in Operation Deep Freeze II.

Church services were always well attended.

CHAPTER XVII

Ship itineraries

U. S. S. *BROUGH* (DE-148)

Port	Arrived	Departed	Port	Arrived	Departed
Newport, R. I.		Sept. 8	Dunedin, New Zealand	Dec. 22	Dec. 29
Panama, C. Z.	Sept. 13	Sept. 13	Ocean Station	Dec. 31	Jan. 14
Dunedin, New Zealand	Oct. 3	Oct. 9	Dunedin, New Zealand	Jan. 16	Feb. 8
Campbell Island	Oct. 10	Oct. 10	Campbell Island	Feb. 9	Feb. 9
Ocean Station	Oct. 12	Oct. 30	Ocean Station	Feb. 11	Feb. 25
Dunedin, New Zealand	Nov. 1	Nov. 12	Dunedin, New Zealand	Feb. 27	Mar. 2
Campbell Island	Nov. 14	Nov. 14	Callao, Peru	Mar. 20	Mar. 25
Ocean Station	Nov. 16	Nov. 28	CHOP COMDESLANT	Mar. 25	Mar. 25
Campbell Island	Nov. 29	Nov. 29	Panama, C. Z.	Mar. 29	Mar. 30
Dunedin, New Zealand	Nov. 30	Dec. 6	Newport, R. I.	Apr. 5	
Ocean Station	Dec. 10	Dec. 20			

U. S. S. *GLACIER* (AGB-4)

Davisville, R. I.		Sept. 10	Clark Island		
Panama, C. Z.	Sept. 24	Sept. 26	Vincennes Bay	Jan. 31	Feb. 17
Valparaiso, Chile	Oct. 3	Oct. 5	Melbourne, Australia	Feb. 26	Feb. 28
McMurdo Sound	Oct. 28	Nov. 5	Port Lyttelton	Mar. 6	Mar. 10
Little America V	Nov. 7	Nov. 8	Callao, Peru	Mar. 29	Apr. 3
Port Lyttelton	Nov. 16	Dec. 7	Cristobal, C. Z.	Apr. 7	Apr. 8
Wellington	Dec. 8	Dec. 8	Ciudad Trujillo	Apr. 11	Apr. 14
Port Lyttelton	Dec. 9	Dec. 10	Boston, Mass	Apr. 19	
McMurdo Sound	Dec. 20	Jan. 15	CHOP COMSERVLANT	Apr. 19	Apr. 19

Ship itineraries—Continued

U. S. S. *ARNEB* (AKA-56)

Port	Arrived	Departed	Port	Arrived	Departed
Davisville, R. I.		Oct. 27	Clark Island		
Norfolk, Va.	Oct. 28	Nov. 2	Vincennes Bay	Jan 31	Feb. 17
Panama, C. Z.	Nov. 8	Nov. 11	Sydney, Australia	Feb. 23	Mar. 13
Wellington, New Zealand	Nov. 30	Dec. 10	CHOP COMPHIBLANT	Mar. 14	Mar. 14
McMurdo Sound	Dec. 23	Dec. 28	Melbourne, Australia	Mar. 15	Mar. 18
Cape Hallett	Dec. 29	Jan. 10	Capetown, Union of South Africa.	Apr. 4	Apr. 9
McMurdo Sound	Jan. 12	Jan. 15	Davisville, R. I.	Apr. 29	

U. S. S. *WYANDOT* (AKA-92)

Port	Arrived	Departed	Port	Arrived	Departed
Davisville, R. I.		Nov. 9	Buenos Aires, Argentina	Feb. 27	Mar. 4
Panama, C. Z.	Nov. 16	Nov. 19	Rio de Janiero, Brazil	Mar. 9	Mar. 14
Valparaiso, Chile	Nov. 26	Nov. 30	CHOP COMSERVLANT	Mar. 14	Do.
Punta Arenas, Chile	Dec. 5	Dec. 7	Norfolk, Va.	Mar. 28	
Chica Bay, Weddell Sea	Jan. 26	Feb. 10			

U. S. S. *ATKA* (AGB-3)

Port	Arrived	Departed	Port	Arrived	Departed
Seattle, Wash.		Nov. 1	Cape Hallett	Feb. 12	Feb. 12
Pearl Harbor, T. H.	Nov. 9	Nov. 13	McMurdo Sound	Feb. 14	Feb. 25
Wellington, New Zealand	Nov. 26	Dec. 10	Port Lyttelton	Mar. 3	Mar. 5
McMurdo Sound	Dec. 20	Dec. 28	Wellington, New Zealand	Mar. 6	Mar. 14
Little America V	Dec. 29	Jan. 21	Pearl Harbor, T. H.	Mar. 27	Mar. 29
McMurdo Sound	Jan. 22	Jan. 28	CHOP COMSERVPAC	Mar. 27	Mar. 27
Little America V	Jan. 29	Feb. 6	Seattle, Wash.	Apr. 5	
McMurdo Sound	Feb. 7	Feb. 10			

U. S. S. *NESPELEN* (AOG-55)

Port	Arrived	Departed	Port	Arrived	Departed
Norfolk, Va.		Oct. 27	Melbourne, Australia	Jan. 27	Jan. 29
Panama, C. Z.	Nov. 2	Nov. 5	McMurdo Sound	Feb. 7	Feb. 18
Papeete, Tahiti	Nov. 21	Nov. 24	Dunedin, New Zealand	Feb. 24	Feb. 29
Port Lyttelton	Dec. 4	Dec. 9	Callao, Peru	Mar. 18	Mar. 20
McMurdo Sound	Dec. 20	Jan. 2	Panama, C. Z.	Mar. 26	Mar. 27
Little America V	Jan. 4	Jan. 10	CHOP COMSERVLANT	Mar. 27	Do.
McMurdo Sound	Jan. 11	Jan. 15	Norfolk, Va.	Apr. 3	

U. S. S. *CURTISS* (AV-4)

Port	Arrived	Departed	Port	Arrived	Departed
San Diego, Calif.		Dec. 27	Port Lyttelton	Feb. 17	Feb. 17
Port Lyttelton	Jan. 12	Jan. 14	Wellington, New Zealand	Feb. 18	Feb. 18
McMurdo Sound	Jan. 21	Jan. 28	Auckland, New Zealand	Feb. 20	Feb. 25
Little America V	Jan. 29	Feb. 6	Sydney, Australia	Mar. 1	Mar. 6
McMurdo Sound	Feb. 9	Feb. 10	San Diego, Calif.	Mar. 25	
Cape Hallett	Feb. 12	Feb. 12	CHOP COMAIRPAC	Mar. 25	Mar. 25

U. S. S. *STATEN ISLAND* (AGB-5)

Port	Arrived	Departed	Port	Arrived	Departed
Seattle, Wash.		Nov. 3	Punta Arenas, Chile	Feb 25	Feb. 26
Panama, C. Z.	Nov. 16	Nov. 19	CHOP COMSERVPAC	Feb. 26	Feb. 26
Valparaiso, Chile	Nov. 26	Nov. 30	Talcahuano, Chile	Mar. 2	Mar. 14
Punta Arenas, Chile	Dec. 5	Dec. 8	Callao, Peru	Mar 19	Mar. 21
Chica Bay, Weddell Sea	Jan. 26	Feb. 10	San Diego, Calif.	Mar. 31	

USCG CUTTER *NORTHWIND* (WAGB-282)

Port	Arrived	Departed	Port	Arrived	Departed
Seattle, Wash.		Nov. 8	Port Lyttelton	Feb. 21	Mar. 2
Pearl Harbor, T. H.	Nov. 16	Nov. 18	Little America V	Mar. 9	Mar. 10
Wellington, New Zealand	Dec. 2	Dec. 10	McMurdo Sound	Mar. 12	Mar. 12
McMurdo Sound	Dec. 23	Dec. 28	Cape Hallett	Mar. 13	Mar. 14
Cape Hallett	Dec. 29	Jan. 10	Sydney, Australia	Mar. 22	Mar. 28
McMurdo Sound	Jan. 12	Jan. 24	Seattle, Wash.	Apr. 19	
Wellington, New Zealand	Feb. 1	Feb. 20			

Ship itineraries—Continued

USNS *GREENVILLE VICTORY* (TAK-237)

Port	Arrived	Departed	Port	Arrived	Departed
Davisville, R. I.	----------	Nov. 14	Clark Island, Vincennes Bay	Jan. 31	Feb. 17
Panama, C. Z.	Nov. 20	Nov. 23	CHOP COMSTSLANT	Feb. 23	Feb. 23
Port Lyttelton	Dec. 10	Dec. 13	Wellington, New Zealand	Feb. 24	Mar. 1
McMurdo Sound	Dec. 20	Dec. 28	Panama, C. Z.	Mar. 16	Mar. 16
Little America V	Dec. 29	Jan. 10	Guantanamo Bay, Cuba	Mar. 18	Mar. 19
McMurdo Sound	Jan. 11	Jan. 16	Norfolk, Va.	Mar. 21	----------

USNS *PRIVATE JOSEPH F. MERRELL* (TAK-V4)

Port	Arrived	Departed	Port	Arrived	Departed
Davisville, R. I.	----------	Oct. 25	Little America V	Jan. 29	Feb. 6
Panama, C. Z.	Oct. 31	Nov. 3	McMurdo Sound	Feb. 7	Feb. 25
Port Lyttelton	Nov. 20	Dec. 10	Port Lyttelton	Mar. 3	Mar. 5
McMurdo Sound	Dec. 20	Dec. 28	CHOP COMSTSPAC	Mar. 5	Do.
Little America V	Dec. 29	Jan. 21	San Francisco, Calif.	Mar. 25	----------
McMurdo Sound	Jan. 22	Jan. 28			

USNS *PRIVATE JOHN R. TOWLE* (TAK-240)

Port	Arrived	Departed	Port	Arrived	Departed
Davisville, R. I.	----------	Oct. 19	CHOP COMSTSLANT	Feb. 2	Feb. 2
Panama, C. Z.	Oct. 25	Oct. 28	Port Lyttelton	Feb. 3	Feb. 6
Melbourne, Australia	Nov. 19	Nov. 22	Panama, C. Z.	Feb. 21	Feb. 24
Wellington, New Zealand	Nov. 25	Dec. 10	Norfolk, Va.	Mar. 1	----------
McMurdo Sound	Dec. 20	Jan. 28			

Operation Deep Freeze II: Outstanding occurrences

OCTOBER 1956

Oct. 16------ First Navy aircraft (R5D) arrives McMurdo Sound from New Zealand.

Oct. 17------ Navy P2V crashed on arrival with following fatalities: Lt. D. W. Carey; Capt. R. A. Hudman, USMC; M. D. Marze; C. S. Miller.

Oct. 22------ First Air Force Globemasters (C–124) arrive McMurdo Sound.

Oct. 26------ First Air Force Globemaster flight over South Pole, with Maj. Gen. C. E. McCarthy as pilot. First airdrop at South Pole.

Oct. 28------ U. S. S. *Glacier* arrives McMurdo Sound, earliest surface penetration of icepack in history.

Beardmore Support Station established, opening way for flights to South Pole.

Oct. 31------ Navy R4D (Bu. No. 27418) makes first aircraft landing at South Pole. Crew: George J. Dufek, Rear Admiral, USN; Capt. Douglas Cordiner; Lt. Comdr. Conrad Shinn, pilot; Capt. William Hawkes, copilot; Lt. John Swadener, navigator; John Strider, AD2; Dearney Aville, WYA). Landing at 2034, remaining 45 minutes and then returned to McMurdo Sound with a stop at Beardmore Station for refueling. Flight was accompanied by Air Force Globemaster (Maj. C. J. Ellen, pilot) of the 52d Tactical Squadron, which orbited overhead during landing.

NOVEMBER 1956

Nov. 6------- Byrd Station Advanced Reconnaissance Party departs Little America under Maj. Merle Dawson, United States Army.

Nov. 12------ Byrd Station Advanced Reconnaissance Party reached crevassed area at base of Rockefeller Plateau, approximately 170 miles from Little America.

Glacier, en route McMurdo to Campbell Island, encountered iceberg approximately 208 miles by 60 miles at 63°50′ S., 174° 40′ E.

Operation Deep Freeze II: Outstanding occurrences—Continued

NOVEMBER 1956—continued

Nov. 20	Two Navy R4D delivered first 8 construction personnel and 11 dogs to South Pole, headed by Lt (jg) R. A. Bowers, CEC, USN First R4D landed at 0043. Position 8 miles from Pole. USAF commenced airdrop of approximately 500 tons of materials and supplies for South Pole Station.
Nov. 24	Pole construction party moves to location of South Pole, using dog teams.
Nov. 25	T/Sgt R. J. Patton, 1st Aerial Port Squadron, makes first parachute jump at South Pole—(jump made from 1,500 feet at 25 below zero).
Nov. 26	Two Navy R4D land additional 10 men. USAF Globemaster successfully drops 7-ton tractor at Pole.
Nov. 27	Light vehicles of Byrd Station Advanced Reconnaissance Party reach Rockefeller Plateau.
Nov. 29	Lt (jg) John Tuck designated military leader of South Pole Base.

DECEMBER 1956

Dec. 1	Max Kiel Airfield dedicated at Little America. Remainder of construction party plus Dr. Paul A. Siple, Deputy Officer in Charge, United States Antarctic Programs, arrive South Pole.
Dec. 5	Heavy tractor train departs Little America for Byrd Station under CWO Victor Young.
Dec. 6–8	Navy P2V–7 lands successfully at Pole but is unable to take off because of defective engine. Repairs were effected on spot and plane returned to McMurdo Sound.
Dec. 7	Weddell Sea Group departs Puntas Arenas.
Dec. 11	Heavy tractor train safely across crevassed area at base of Rockefeller Plateau.
Dec. 14	CTF–43 determines to establish joint US–NZ IGY Station at Cape Hallett rather than Cape Adare.
Dec. 17	Byrd Station Advance Reconnaissance Party arrives at station site (80° S., 120° W.), 632 miles from Little America, elevation 5,100 feet. Trail named Army-Navy Drive.
Dec. 18	TF–43 ships, led by icebreakers *Glacier* and *Atka* and including the cargo ships *Merrill, Towle, Greenville Victory* and Tanker *Nespelen*, clear the icepack and enter Ross Sea.
Dec. 19	*Northwind* and *Arneb* arrive off Cape Hallett but ordered to McMurdo Sound to deliver emergency equipment.
	Last of USAF Globemasters depart Antarctica for New Zealand, because of fuel shortage and poor runway conditions, having delivered approximately 60 percent of scheduled material—503 tons to South Pole, 27 tons to Beardmore Station, 36 tons to Byrd Station, with 12 tons to trail party along route.
Dec 22	Weddell Sea Group stopped by ice at 70°–29° S, 11°–41° W.
Dec 23	Ships commence off-loading, using *Glacier* to ferry materials within 9 miles of NAF, McMurdo. Heavy tractor train arrives Byrd Station.
Dec 24	Weddell Sea Group proceeding slowly off Cape Norvegia.
	Lt. Harvey Speed makes first aircraft landing at Byrd Station, using same Navy R4D as made first landing at South Pole.
Dec 25	Weddell Sea Group stopped in ice 70°–47° S., 12°–06° W.
	Damage reported to tips of propeller blades on *Wyandot.*
	Northwind and *Arneb* arrive McMurdo Sound. 8 men of construction party withdraw from Pole Station.
Dec 26	*Glacier* completes ferrying high priority cargo and opens channel for other Task Force ships to approach McMurdo.
Dec 27	*Northwind* and *Arneb* depart McMurdo Sound for Cape Hallett.
	Atka, Greenville Victory, and *Merrell* depart McMurdo Sound for for Kainan Bay.
Dec 28	Weddell Sea Group proceeding through open leads.
Dec 29	Weddell Sea Group gains open water adjacent to ice shelf.
	Captain McDonald and Captain Ronne visit United Kingdom Royal Society Base at Halley Bay, by helicopter.

Operation Deep Freeze II: Outstanding occurrences—Continued

DECEMBER 1956—continued

Dec 30	McMurdo Sound, *Nespelen* and *Towle* unloading directly on sea ice about 5 miles from station. *Arneb* moored to fast ice at Cape Hallett; *Northwind* breaking channel to station site. Pole Station reported 85 percent complete. Comdr. W. F. Flynn relieves Comdr. H. W. Whitney as C. O. Antarctic Naval Bases at Little America. Eight of permanent military party arrive Pole Station.
Dec 31	*Glacier* estimated to have broken more than 32 million tons of ice to this date. Weddell Sea Group: Captain McDonald and Captain Ronne and others visited British Commonwealth Shackleton Station and Argentine General Belgrano Station by helicopter.

JANUARY 1957

Jan. 1	Byrd Station commissioned. Cape Hallett Group—*Northwind* and *Arneb*—beginning Dec. 31, caught in 3-day gale by blowing pack ice. Resulting damage: *Arneb* holed along waterline from ice pressure; *Northwind*, 1 propeller blade lost. Weddell Sea Group beset in ice near Gould Bay. Sea ice broke out of Kainan Bay, forcing search for a barrier ramp to permit unloading. *Nespelen* completes off-loading of 540,000 gallons of aviation fuel.
Jan. 2	*Northwind* and *Arneb* commence amphibious operation to off-load cargo at Cape Hallett.
Jan. 3	Unloading of ships on barrier at Kainan Bay commenced.
Jan. 5	H. M. N. Z. S. *Endeavour* arriving McMurdo Sound with Sir Edmund Hillary aboard. *Nespelen* arrives Little America. Last construction personnel leave Pole Station.
Jan. 6	Shrine of Our Lady of the Snows dedicated to memory of Richard Williams at McMurdo. Advance reconnaissance party and heavy tractor train return to Little America.
Jan. 8	2 additional scientists flown to South Pole Station bringing population to 11 men and 1 puppy; 11 sled dogs return McMurdo.
Jan. 9	1 additional scientist flown to South Pole Station. All Cape Hallett cargo off-loaded.
Jan. 10	*Staten Island* and *Arneb* depart Cape Hallett for McMurdo Sound for inspection of damage; leave construction personnel to complete station at Cape Hallett. Announce P2V-7's will return New Zealand for solution of inherent ski weakness.
Jan. 11	New Zealand IGY-Scott Station relocated from Butter Point (across McMurdo Sound from NAF McMurdo) to Pram Point (2 miles from NAF). United States Navy construction personnel assist New Zealanders in establishing station. Commander Task Force 43 directs Weddell Sea group not to proceed westward and to establish station along coast where operationally feasible. Weddell Sea group: Shift in wind opens water areas and group proceeds westward at 13 knots. 18th Air Force presents flag to Christchurch Cathedral.
Jan. 12	*Glacier* rendezvoused with *Greenville Victory* and *Nespelen* and cleared way for both ships to unloading area at McMurdo. Commander Task Force 43 modified order of Jan. 11 to Weddell Sea group to permit westward progress until stopped again by ice. Knox Coast group (Task Group 43.6) reconstituted as follows: *Glacier, Arneb, Greenville Victory* with Capt. Gerald Ketchum as commanding officer, and Capt. C. W. Thomas, USCG, as chief staff officer. Ross Sea group (Task Group 43.4) reconstituted as follows: *Atka, Curtiss, Nespelen, Brough, Merrell, Towle, Northwind* with Rear Admiral Dufek as commander, task group. Thirteen construction personnel evacuated by air from Byrd Station.

Operation Deep Freeze II: Outstanding occurrences—Continued

JANUARY 1957—continued

Jan. 13	Weddell Sea group reached open lead along ice shelf after *Wyandot* had been holed by pack ice. P2V–7 depart McMurdo for New Zealand. *Arneb* and *Northwind* arrive McMurdo Sound.
Jan. 14	McMurdo Sound: *Weasel*, off main ice trail, breaks through ice about 100 yards off Hut Point. Ollie B. Bartley, CD2, became entangled in radio antenna and drowned in 30 feet of water; other 5 passengers rescued.
Jan. 15	Knox Coast group (*Glacier*, *Arneb*, *Greenville Victory*), plus *Nespelen*, depart McMurdo. Weddell Sea group searching for site in area 75° 26′ S., 58° 22′ W.
Jan. 17	Weddell Sea group unable to reach Bowman Peninsula, due to ice. Furthest point reached 75° 135′ S., 61° 15′ W. Remaining P2V–7 departs McMurdo for New Zealand.
Jan. 17	Lt. Comdr. D. W. Canham relieved by Lt. R. E. Anderson as officer in charge, NAF McMurdo Sound.
Jan. 20	Scott New Zealand Antarctic Base commissioned by Capt. H. Reugg, Administrator, Ross Sea Dependency, with Rear Admiral Dufek, Commander Task Force 43, present. New Zealand ensign raised on flagpole used by first Scott expedition.
Jan. 21	U. S. S. *Curtiss* with IGY and Navy wintering-over personnel aboard arrived McMurdo Sound. *Atka* and *Merrell* en route Little America to McMurdo.
Jan. 22	Weddell Sea Group moving westward through heavy pack; Capt. F. Ronne, scientific and military leader, proposed placing base Gould Bay. *Atka* and *Merrell* arrive McMurdo.
Jan. 23	Dedication of Amundsen-Scott IGY South Pole Station held at NAF McMurdo Sound. Participants: Dr. Lawrence Gould (US–IGY), Dr. Henry Wexler (US–IGY), Dr. Albert Crary (US–IGY), Dr. Trevor Hetherton (NZ–IGY), Dr. Kaare Rhodal (US–IGY) representing Norway; Rear Adm. George Dufek (USN) and Capt. William Dickey (USN). Commander, Task Force 43 (Admiral Dufek) shifted flag to *Atka*. *Northwind* departed McMurdo for New Zealand for repairs.
Jan. 26	Knox Coast Group (Task Group 43.6) enters pack ice en route Vincennes Bay; fails to reach site on first attempt. Dr. Harry Wexler, chief scientist for IGY Antarctic program; Dr. Albert Crary, deputy chief scientist, and party arrive Little America by air.
Jan. 27	Weddell Sea Group select site at 77°43′00″ S., 41°07′30″ W., approximately 35 miles northwest of Argentine General Belgrano Station; unloading commenced.
Jan. 28	U. S. N. S. *Towle* completed unloading and departed McMurdo Sound, homeward bound via Christchurch, New Zealand. U. S. S. *Atka*, *Curtiss*, *Merrell* en route McMurdo Sound to Little America.
Jan. 29	U. S. S. *Atka*, *Curtiss*, *Merrell* arrive Little America.
Jan. 30	Heavy tractor train (8 D–8 tractors, 14 sleds) depart Little America for second run to Byrd Station. Knox Coast Group, site for station selected at Clark Island (actual 66°15′27″ S. 110°34′45″ E.) by U. S. S. *Glacier*: *Arneb* holed while transiting pack. Change of personnel Little America completed by helicopter.
Jan. 31	U. S. S. *Nespelen* departed Melbourne for McMurdo. Cape Hallett Station completed. Knox Coast Group reached Clark Island, Vincennes Bay.

Operation Deep Freeze II: Outstanding occurrences—Continued

FEBRUARY 1957

Feb. 1	U. S. Navy ship *Towle* returned to Commander Sea Transportation Service, Atlantic.
Feb. 2	TF-43 medical officers visit Little America III and IV to obtain food samples for scientific testing.
Feb. 3	U. S. Coast Guard cutter *Northwind* drydocked at Wellington, New Zealand.
	U. S. Navy ship *Towle* arrives Port Lyttleton.
Feb. 5	U. S. S. *Atka* and U. S. Navy ship *Merrill* departed Little America for McMurdo.
	U. S. S. *Curtiss* en route Sulzberger Bay, Cape Colbeck.
Feb. 6	U. S. Navy ship *Towle* departs Port Lyttleton for United States.
Feb. 7	U. S. S. *Atka* and U. S. Navy ship *Merrill* arrived McMurdo from Little America.
	U. S. S. *Nespelen* arrives McMurdo from Melbourne.
Feb. 8	CTF-43 shifts flag ashore to NAF, McMurdo Sound.
Feb. 9	First Globemaster (C-124) returns to McMurdo from New Zealand.
	U. S. S. *Curtiss* arrives McMurdo Sound. Weddell Sea Group (TG43.7) unloading completed.
Feb. 10	Globemaster (C-124) flights to Pole Station resumed Knox Coast Group (TG43.6). Cargo unloaded.
Feb. 11	U. S. S. *Atka* and U. S. S. *Curtiss* depart NAF, McMurdo for Cape Hallett.
	Weddell Sea Group (TG43.7), Ellsworth Station commissioned and turned over to winter party of 39 men, including 10 scientists led by Capt. Finn Ronne.
	U. S. S. *Staten Island* and *Wyandot* depart for United States.
Feb. 12	Second heavy tractor train arrives Byrd Station. Navy R4D completes transfer of 5 scientific and 2 military personnel to Amundson-Scott South Pole ICY Station.
	U. S. S. *Curtiss* departs Cape Hallett for United States by way of Port Lyttleton, N. Z.
Feb. 13	Air Vice Marshall Kay, RNZAF and party arrive at McMurdo Sound.
Feb. 14	CTF 43 shifts flag to U. S. S. *Atka*.
Feb. 16	Adm. Jerauld Wright, Commander in Chief, U. S. Atlantic Fleet, arrives McMurdo Sound. Wilkes Station commissioned by CTG 43.6 and transferred to wintering-over party of 10 scientists, 17 Navy personnel, led by Dr. Carl Eklund and Lt. (j. g.) Donald R. Burnett.
Feb. 17	Admiral Wright accompanied Air Force C-124 flight over South Pole; also aboard was Sir Edmund Hillary, leader, New Zealand traverse party, who carried on reconnaissance of his intended route.
	TG 43.6 (U. S. S. *Glacier*, U. S. S. *Arneb*, U. S. Navy ship *Greenville Victory*) departs Wilkes Station for United States by various routes.
	TG 43.7 (Weddell Sea group) clear of all pack ice on return journey.
Feb. 18	USAF C-124's recommence air drops to Byrd Station, Adm. Jerauld Wright aboard.
	Admiral Wright and staff depart McMurdo Sound for Christchurch, New Zealand.
	U. S. S. *Nespelen* departs McMurdo Sound for United States.

Operation Deep Freeze II: Outstanding occurrences—Continued

FEBRUARY 1957—continued

Feb. 19	Pole Station reports temperature of 40 below with 15- to 20-knot winds.
	TG 43.7 (Weddell Sea group) dissolved.
	U. S. S. *Glacier* directed to assist Japanese IGY survey ship, ice-bound since Feb. 17 at 68–22S, 38–11E.
	Glacier to proceed via Melbourne for fuel.
	U. S. Coast Guard cutter *Northwind* undocked, Wellington.
Feb. 20	CTF–43 recommends Dr. Andrew Assur, physicist from SIPRE for Navy's highest civilian award; Dr. Assur directed restoration of ice runway at McMurdo Sound.
	USAF C–124's complete airdrop of supplies to Byrd Station; in all, 240 tons were dropped in 17 sorties.
	U. S. S. *Glacier* at Melbourne, fuelling.
	Japan's ship *Soya* making some progress in ice.
	U. S. Coast Guard cutter *Northwind* arrives Port Lyttleton.
	USAF C–124's complete airdrop to South Pole Station; in all, 760 tons were dropped; 65 sorties at the Pole.
Feb. 21	Beardmore Camp disestablished.
Feb. 22	USAF Globemasters (C–124's) commence departure, McMurdo Sound for New Zealand.
	CTF–43 departs McMurdo Sound for New Zealand and United States.
Feb. 23	Support phase of Operation Deep Freeze II officially over; ships and aircraft depart McMurdo Sound.
	U. S. S. *Atka* and U. S. Navy ship *Merrell* depart McMurdo Sound for United States; last USAF Globemaster departs McMurdo.
	Last scientists flown to Pole Station by Navy R4D. United States wintering-over parties—221 service personnel, 70 scientific personnel.
Feb. 27	U. S. S. *Arneb* enters shipyard, Melbourne, Australia.
Feb. 28	U. S. S. *Glacier* departs Melbourne, Australia, to go to help of *Soya Maru*, beset in ice. Mission was later called off as unnecessary.

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