JOINT ARCTIC WEATHER STATIONS

FIVE YEAR REPORT

1946-1951

JOINT CANADIAN -UNITED STATES ARCTIC WEATHER STATION PROGRAMME

A REVIEW OF THE ESTABLISHMENT AND OPERATION OF THE JOINT ARCTIC WEATHER STATIONS AT EUREKA, RESOLUTE, ISACHSEN, MOULD BAY, AND ALERT AND A SUMMARY OF THE SCIENTIFIC ACTIVITIES AT THESE STATIONS 1946-1951

Compiled by

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and

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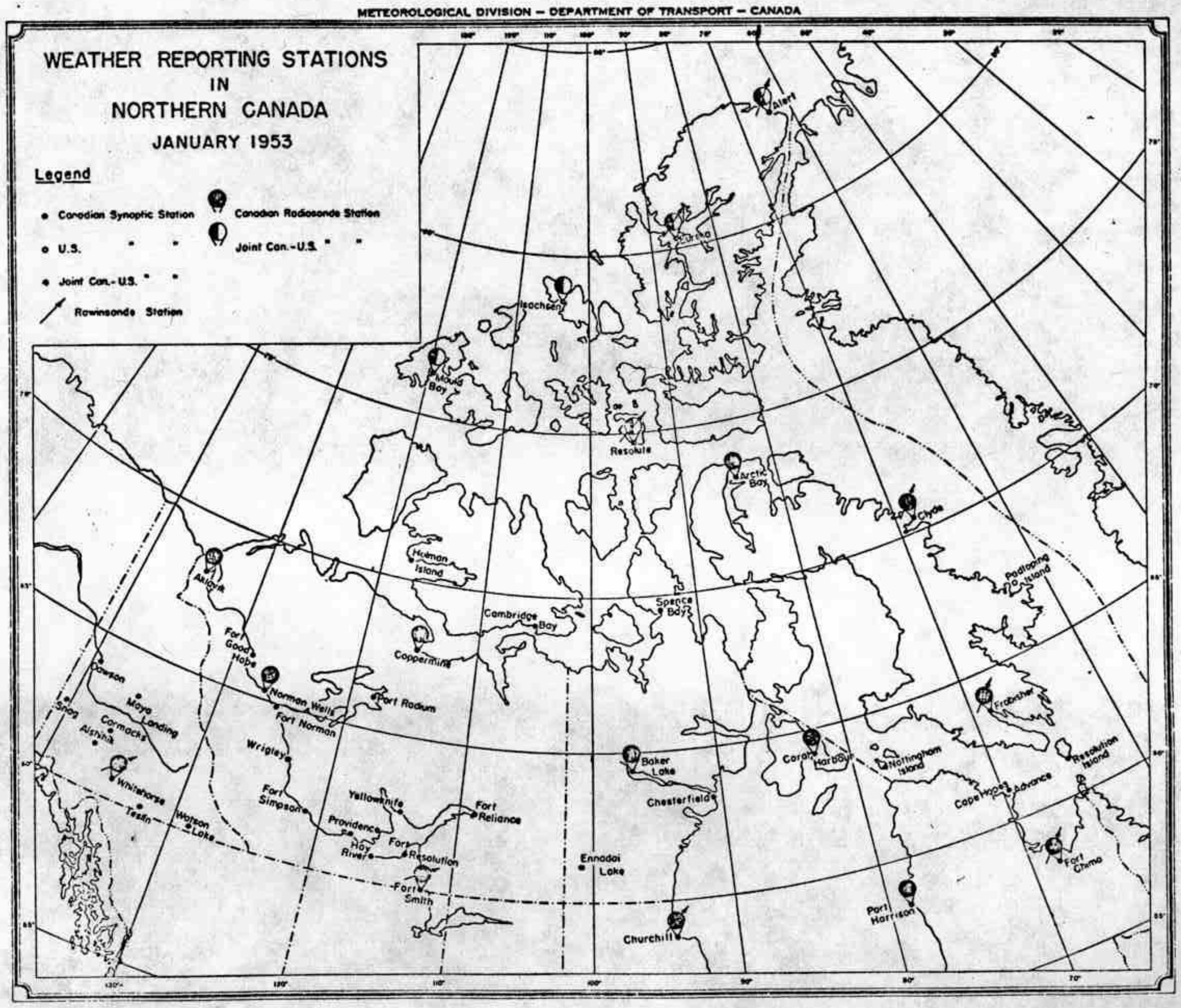
METEOROLOGICAL DIVISION — DEPARTMENT OF TRANSPORT — CANADA
WEATHER REPORTING STATIONS
IN
NORTHERN CANADA
JANUARY 1953
Legend
Canadian Synoptic Station
U.S. " "
Joint Can.-U.S. " "
Rawinsonde Station
Canadian Radiosonde Station
Joint Can.-U.S. " "
Alert
Eureka
Isachsen
Mould Bay
Resolute
Arctic Bay
Clyde
Padloping Island
Holman Island
Aklavik
Cambridge Bay
Spence Bay
Coppermine
Fort Good Hope
Norman Wells
Fort Norman
Port Radium
Dawson
Mayo Landing
Snag
Carmacks
Aishihik
Whitehorse
Teslin
Watson Lake
Wrigley
Fort Simpson
Yellowknife
Fort Reliance
Providence
Hay River
Fort Resolution
Fort Smith
Frobisher
Baker Lake
Coral Harbour
Nottingham Island
Resolution Island
Cape Hopes Advance
Chesterfield
Ennadai Lake
Churchill
Port Harrison
Fort Chimo

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Chapter 1

INTRODUCTION

A basic requirement for progress in the science of meteorology is a thorough knowledge of circulation of the atmosphere over the world as a whole. In order to obtain this knowledge, weather reports are needed from a large number of stations, distributed at intervals across the earth.

Prior to World War II, observations from the Canadian Arctic were very meagre. Some meteorological data were available from the records that were kept by expeditions that attempted to find the North West Passage. However, these observations were inadequate for accurate climatological work for the following reasons: the records rarely extended over a period longer than a year; observations in the different localities were usually made in different years and consequently, are not strictly comparable; many of the instrumental observations were made with instruments whose correction factors were unknown or unrecorded; the observations were nearly all made on shipboard or along the coasts with very few observations from the interiors of the islands. Additional information was obtained during the First Polar Year, from 1882-83 but this too provided short period records only.

The first stations of a permanent nature in the Canadian Arctic Islands, at which meteorological observations were taken were those established by the R.C.M.P. in the 1920's such as Craig Harbour, Pangnirtung, Pond Inlet, Bache Peninsula and Dundas Harbour. At about this same time, observations were also undertaken at some of the posts of the Hudson Bay Company, namely, Arctic Bay, Cambridge Bay, Clyde River, Coral Harbour, Fort Ross and Holman Island. The development of radio communications in the late 1920's brought about the establishment of stations at Nottingham Island, Cape Hope's Advance and Resolution Island by the Marine Radio to provide navigational aid to shipping in Hudson's Bay and Straits and to take meteorological observations as well.

During World War II, stations were established on Baffin Island at Frobisher and Padloping Island by the U.S. Air Force, to provide weather information for aircraft ferrying operations across the North Atlantic. An emergency landing strip was maintained at Frobisher, also. In addition to the stations which had been established on the southern Arctic islands, a requirement still existed for a network of stations on the more northerly islands, to obtain not only meteorological information but other scientific observations such as magnetic and ionospheric observations, and to provide air navigational aids and emergency landing fields for flying operations in Arctic regions.

Initial Plans - Shortly after the close of World War II, Colonel Charles J. Hubbard began to arouse interest in the United States and Canada for the establishment of a network of Arctic stations. His plan, in broad perspective, envisaged the establishment of two main stations, one in Greenland and the other within the Archipelago, which could be reached by sea supply. These main stations would then serve as advance bases from which a number of smaller stations would be established by air. The immediate plans contemplated the establishment of weather stations only, but it was felt that a system of weather stations would also provide a nucleus of transportation, communications and settlements which would greatly aid programmes of research in many other fields of science. It was recognized that ultimate action would depend on international co-operation since the land masses involved were under Canadian and Danish control.

Approval for the project as basically outlined was given by Congress in the United States under Public Law 296, 79th Congress, an excerpt from which is quoted below.

"Concerning the establishment of meteorological observation stations in the Arctic region of the Western Hemisphere for the purpose of improving the weather forecasting service within the United States and on the civil international air transport routes from the United States.

"Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that in order to improve the weather forecasting service of the United States and to promote safety and efficiency in civil air navigation to the highest possible degree, the Chief of the Weather Bureau, under the direction of the Secretary of Commerce, shall, in addition to his other functions and duties, take such action as may be necessary in the development of an international basic meteorological reporting network in the Arctic region of the Western Hemisphere, including the establishment, operation, and maintenance of such reporting stations in co-operation with the State Department and other United States governmental departments and agencies, with the meteorological services of foreign countries and with persons engaged in air commerce.

"Approved February 12, 1946"

The basic project as outlined by Colonel Hubbard assumed a distribution of approximately ten stations at intervals of about five hundred miles between Banks Island and Peary Land. Two general locations were under consideration for the control depots, one in the vicinity of Winter Harbour on Melville Island and the other near Thule, Greenland. All the locations which were considered for the smaller stations were included within circles of five hundred mile radius, drawn with either Thule or Winter Harbour as centre.

Previous experience had indicated that large aircraft could be landed on Arctic ice surfaces in winter, using wheels where the snow was light or skis where the snow was heavy. Since protected waters will generally freeze smooth, it was believed that suitable ice runways could be found within close proximity of almost any given Arctic coastal location.

The plan of action required that surface ships would proceed to the central base locations during the summer months. The following winter, the stations would be built up and preparations made for spring activities, to establish the out-lying satellite stations by air when flying conditions in the Arctic are most favourable. The exact location of a satellite station would be determined by a preliminary reconnaissance by means of light aircraft equipped with skis. After the site was chosen and a suitable landing strip located on the ice, the station personnel and supplies would be flown in with heavy transport aircraft on wheels.

It was planned that the re-supply of the main stations would be conducted annually by surface ships during the summer navigation season, and that the satellite stations would be re-supplied by air annually during the spring flying season. Mail deliveries were to be accomplished by means of air drop to the smaller stations whereas landings would be made at the main bases when possible. Medical advice was to be provided by radio with emergency evacuations by air if necessary.

<u>1946 Operations</u> - When approval for the Arctic project had been given by U.S. Congress, Canada was approached to work out a suitable basis of co-operation between Canada and the United States in the Arctic. A meeting of Canadian and United States representatives was held in Ottawa on May 18, 1946 to discuss United States proposals to establish weather stations in the Canadian Arctic. The United States representatives pointed out that it was desired to commence the project in the summer of 1946 with the establishment of two main bases, one in north-western Greenland and one in the central Canadian Arctic. These stations would carry out meteorological functions and act as supply points for smaller stations, which would be established later. The station to be built in Canada would, it was hoped, be established on Melville Island close to Winter Harbour.

If Canadian approval was obtained, it was proposed to procure supplies and personnel immediately. The ships would be loaded and would sail not later than July 15. Aerial reconnaissance would be carried out in the Melville Island area, followed by similar reconnaissance of Banks Island, northwest Ellesmere Island, Prince Patrick Island and Axel Heiberg Island. Melville Island was to be reached by ship not later than August 20.

It was felt in Canadian circles that a large scale project of this kind would require careful examination in view of its many implications and a decision was not reached in Ottawa by the time that the ships were loaded and ready to sail in Boston that summer. In the meantime, the United States had reached an agreement with Denmark whereby a station would be established by the U.S. Weather Bureau at Thule, Greenland and consequently, the U.S,. Weather Bureau decided to proceed with this phase of the operation in July, 1946 and to postpone activities in the Canadian Arctic area until a decision was obtained from Ottawa.

Canadian Participation - On November 23, 1946, the Interdepartmental Meteorological Committee submitted a recommendation to the Cabinet Defence Committee in Ottawa for the establishment of weather stations in the Canadian Arctic. This recommendation brought out the desirability of extending our meteorological knowledge of conditions prevailing in the Canadian sector of the Arctic, especially with a view of accumulating sufficient surface and upper air meteorological data to determine the feasibility of carrying on scheduled air operations across the Arctic. According to the International Meteorological Council, stations for this purpose should be located no more than three hundred to five hundred miles apart in order to secure sufficiently precise data to prepare pressure maps. Moreover, observations over a minimum period of five years would be required.

It was felt that observations from the Canadian Arctic, which was then a meteorological blind spot, would increase our knowledge of the circulation of the earth's atmosphere and permit an extension of the period of reliability of weather forecasts. This was of special importance to Canada and the United States since their weather is dominated to a large extent by outbreaks of Arctic air. It was proposed that emphasis should be placed initially upon the establishment of a regular observational programme and secondly, upon the investigation of Arctic meteorological problems. The recommendation put forward the proposal that nine Arctic stations be established during the years 1947-49 according to the following time table.

Year	Proposed Stations-Arctic	Transportation
1947	l. Winter Harbour, Melville Island	By ship from Halifax.
1947	2. Cape Kellett, Banks Island	By H.B.C. Supply Boat from Fort Ross; or by R.C.M.P Boat St. Roch from Aklavik; or by schooner from Aklavik; or by plane from Aklavik; or by Plane from Port Radium and Coppermine.
1947	3. Grant Land Area	By ship from Halifax to Winter Harbour then by air.
1948	4. Barrow Strait	By ship from Halifax
1948	5. Cambridge Bay	As No. 2

1948	6.	Prince Patrick Island or Borden Island	By air from Winter Harbour Island
1949	7.	Sverdrup Islands	By ship from Halifax to Winter Harbour then by air.
1949	8.	Simpson Peninsula	By air from Coral Harbour or Baker Lake.
1949	9.	Bache Peninsula	By ship from Halifax.

The Canadian Cabinet considered and approved on January 28, 1947, the Interdepartmental Meteorological Committee's recommendation for a Joint Arctic Programme with United States including the establishment of nine Joint Arctic Weather Stations during the three-year period 1947-49 inclusive. When this approval was received, a meeting was held between Canadian and United States representatives at Ottawa on February 27, 1947, to reach technical agreement on a detailed plan for the project.

It was agreed that as a tentative programme, the following should be the division of responsibility for 1947-48:

a) The Canadian Government would provide the Officer-in-Charge, the pay and the subsistence of half the staff and all permanent installations including installations at adjacent air strips which would be the property of the Canadian Government.

b) At the request of the R.C.M.P. representative, a separate building should be supplied for the use of the R.C.M.P. officer at Winter Harbour. Periodic visits to the other stations could be made on the monthly air mail flight.

c) The United States would bear all other costs including equipment, transportation, fuel and Arctic supplies.

The decision was made that these arrangements would be subject to periodic review and that it would be desirable to assess the results of the programme as a whole at the end of five years in order to determine the need for the continuation or extension of the programme.

The United States Government representatives further brought out that the United States staff at a station should be in charge of a senior United States official, who would be subject to the policies and administration of the Canadian Officer-in-Charge but who could report to the U.S. Weather Bureau on technical matters.

Both Canadian and United States representatives were of the opinion that immediate action was required to get the Arctic Project under way and it was agreed that the plan for 1947-48 should be implemented at once. These plans included the establishment of the following stations:

a) A station in the Eureka Sound area on Ellesmere Island to be established by air from Thule, Greenland in April, 1947. This station was to replace the one which had been previously planned for the Grant Land area because it was felt that the terrain in the Grant Land region was too difficult. It was pointed out that there were mountains up to 14,000 feet which resulted in bad orographic weather and that fiords were deep and dangerous. These conditions also applied to the north coast of Nansen Sound and Greeley fiord. The terrain on Axel Heiberg Island was also extremely rugged whereas in the Eureka Sound area, the land was comparatively low, with broad flat areas from Mokka fiord to Stor Island. The terrain in the vicinity of Schei Island was also believed to be quite suitable.

b) A station to be established at Winter Harbour in the summer of 1947 by sea supply. The installation of a station at Cape Kellett on Banks Island should be postponed, but that the supply plan for 1947-48 should include provision for a station in the Banks Island area for 1948-49.

Arrangements were made with the Post Office whereby Canadian post offices would be established at each Joint Arctic Weather Station.

It was pointed out that all persons at the Joint Arctic Weather Stations would be subject to the applicable laws of Canada and the Northwest Territories. More specifically, the following requirements were outlined:

a) The Game Laws

All the new weather stations would be in the Arctic Islands Game Preserve and under Section 48 of the Game Regulations, no persons except Eskimos can hunt, trap, trade or traffic without special permission. No musk-oxen can be taken at any time by any one.

Section 40 of the Game Regulations provides that no auto-loading firearms may be taken into the Northwest Territories. A footnote points out that under the Criminal Code, no person shall carry a revolver unless he holds a permit from the Commissioner of the Royal Canadian Mounted Police. The possession of automatic pistols is prohibited.

It was recognized that wolves might be killed at any time and that if it became necessary to shoot the occasional polar bear in self defence or for protection of the stations, this would not be considered an offence against the Game Regulations. Reports on such incidents, however, should be made to the nearest R.C.M.P. officer.

b) TheScientists and Explorers Ordinance

Under this Ordinance, any scientist attached to any of the stations or expeditions must obtain a 1icence~from the Commissioner of the Northwest Territories at Ottawa. This would apply to biologists, geophysicists, etc., who are supernumerary to the weather station staff. Weather station operators and meteorologists would not be required to obtain a licence under this Ordinance.

c) The Archaeological Sites Ordinance

No one may excavate archaeological sites or export any archaeological relics without a licence from the Commissioner of the Northwest Territories. This Ordinance would apply to all personnel at the stations or on any of the expeditions as well as to any supernumerary scientists attached thereto.

Chapter 2

ESTABLISHMENT OF STATI0NS

Eureka, N.W.T.

Planning- The establishment of a station in the Eureka Sound area was planned in general terms during 1946 and a large proportion of the necessary supplies were taken to Thule, Greenland and placed in storage pending a spring operation.

Reconnaissance - The first reconnaissance of Eureka Sound was flown on September 8, 1946, by aircraft from Thule, Greenland. At that time the ground surfaces were bare below 1,000'. The most remarkab1e circumstance observed was the fact that Eureka Sound itself was open water. It was estimated that there was some 10 per cent of ice cover remaining in the Sound in the form of pans and small pools of loose fragments which would present no problems to an icebreaker. This reconnaissance approached the Sound over Raanes Peninsula. Unfortunately, the visibility prevented observation of ice at the juncture of Eureka Sound and Norwegian Bay. Reconnaissance proceeded north to approximately Depot Point at which place it was necessary to turn back. In general the country adjacent to Eureka Sound was found favourable for the establishment of a weather station. Much or the land was rough rising to 2,000' or 3,000', but it seemed propitious compared to the usual mountainous character of these Arctic islands and especial1y by comparison to the Ellesmere Island range in the east and the high mountains of the backbone of Axel Heiberg Island .

A second reconnaissance over Eureka Sound was flown on March 25, 1947. This flight followed the ful1 length of the Sound northward to Cape Stallworthy and returned at low altitude for detailed observation of possible locations. The northern portion of Eureka Sound appeared the most satisfactory. Further north, in Nansen Sound, there was more snow and more difficult weather, presumably owing to inflowing air directly from the Polar Sea. The Grant Land Coast was extremely bold and rugged and offered no satisfactory weather station location. The Axel Heiberg coast in this northern portion was very flat near the water and appeared as if it might be soft and treacherous in the summer months.

The most satisfactory location appeared to be in Slide fiord on the Ellesmere Island side. This fiord strikes off from Eureka Sound proper at right angles toward the east with bold headlands protecting the entrance and is surrounded by low, rolling country for many miles. Within the fiord the ice was quite smooth. On the north side, which is the lee side from the prevailing northwesterly winds, were several good camp locations close to the shore line, and as two rivers promised fresh water

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in summer, it was decided to attempt the installation of the new weather station there. The coordinates of this station were found to be 80° 00’ 00" N., 85º 56’25" W.

Station Establishment – On April 7, Easter Sunday, the initial entry landing was made on the sea ice of Slidre fiord. Representatives of Canadian and United States Weather Services made a physical reconnaissance of the area and a suitable site was selected on the north shore of Slidre fiord, just to the eastward of one of the large streams coming down from the valley. The movement of supplies for the weather station into Slidre fiord was commenced from Thule, Greenland, on April 8. Aircraft and crews were provided by the U.S. Army Air Force as a Task Force from the Troop Carrier Command under direction of the Strategic Air Command.

Arrangements for a rapid operation had been made at Thule by prior segregation of the cargo into priority lots suitable for loading into the aircraft. It was found that cargo discharge from the aircraft at Eureka Sound could be rapidly accomplished and it was normal for aircraft to complete two flights per day. The airline distance from Thule is approximately 360 miles. The ice in Slidre fiord was found to be 80" thick during the airlift. All aircraft operated on wheels and approximately 50 per cent of the total tonnage was carried by a C-82. This latter aircraft is especially well adapted to operations of this nature because of the ease of loading and discharging cargo. An airborne tractor and sleds had been provided at Eureka Sound for the movement of supplies from the landing strip to the camp-site. It was normal to avoid the necessity for heating aircraft engines by stopping only one motor for a short time.

Supply levels for food, fuels, and other consumable stores delivered by this aircraft were estimated to be adequate for more than 400 days. The entire 110 tons of supplied were handed off the aircraft and moved to the station site by the permanent station staff of six men who also undertook the erection of temporary buildings and commencement of the weather observing programme at the same time. Five buildings were erected and the permanent station facilities installed in the period April 15 to June 21, without any curtailment of the regular meteorological programme.

Jamesway huts were uses for temporary buildings throughout the first months of the establishment of the station. These are prefabricated units 16’ x 16’ and may be increased in length in increments of 8’. They consist of insulated plywood floor panels which support semicircular ribs. A thick, heavily insulated, weatherproof blanket is stretched over the ribs. The ends consist of the same type of insulating blanket into which doors and windows are fitted. These buildings are of inestimable value in providing temporary shelter for personnel at the time of initial entry to the station. They can be erected in a few hours and may be maintained at a comfortable temperature regardless of outdoor weather.

The station personnel landed at Slidre fiord at 11 a. m. with one of these buildings on board. By 7 p. m. the building was up and heated, radio equipment and facilities for weather observations were in operation and hot meals were available for personnel.

Airstrip Construction - A land airstrip was considered very desirable in the event of medical emergency and to provide against the possibility that ice would not freeze smooth in the fiord near the station every year. Accordingly, two small airborne tractors, an airborne roller, harrow, grader and hydraulic pan were airlifted to the station in May. The six men at the station constructed an airstrip during July, at the same time maintaining full weather observations and radio schedules at the station.

Summer Sea Supply - An icebreaker reached the Eureka weather station on August 9, 1947. This ship brought some permanent buildings, additional equipment, a year's supply of consumable stores, and two additional men for station staff. Work was immediately begun on erection of the permanent buildings and all were completed prior to the dark period and cold weather of winter. Additional buildings were added in subsequent years to provide more space and additional facilities.

Resolute, N.W.T.

Planning- The establishment of the main weather station in the central part of the Canadian Arctic Archipelago was planned for the summer of 1947. A preliminary reconnaissance in 1946 had indicated that the vicinity of Winter Harbour on Melville Island would be a satisfactory location. On July 16, 1947, the cargo ship U.S.S. Wyandot, preceded by the icebreaker U.S.S. Edisto, set sail from Boston bound for Winter Harbour with the personnel and supplies for the new station on board. The personnel consisted of eight Canadians and eight Americans, as well as an R.C.M.P. constable. The supplies included tractors, heavy airstrip grading equipment, power generators, pre-fabricated housing, fuel oil, clothing, food and emergency rations, as well as meteorological and other scientific equipment. It was estimated that the supplies were sufficient to permit the station to exist for a minimum period of two years without further re-supply.

Reconnaissance - An aerial reconnaissance of the ice conditions on the route to Winter Harbour was carried out on July 24. Since this flight indicated that ice conditions appeared to be favourable in Barrow Strait and Viscount Melville Sound, it was decided to examine the ship route toward Winter Harbour by driving the Edisto as far to the west as possible. Clear water was found in Barrow Strait as far west as Griffith Island where the pack was entered. At about 100º W longitude, the broken pack showed less and less open water and larger areas of unbroken sheet ice. As further progress was made westward, the open water narrowed into leads then the leads became more and more infrequent , so that it was necessary for the Edisto to back up and ram the ice frequently. The ship could make slow headway where the ice was uniform, but she was stopped by the pressure ice which was from eight to twelve feet thick.

At about lO8º W longitude , the ship was stopped by heavy ice. It was evident that it would be impossible to escort the Wyandot to Winter Harbour until conditions improved considerably and the Edisto returned to Dundas Harbour to await an improvement in ice conditions to the west.

Leaving the Wyandot at anchor at Dundas Harbour, the Edisto started west on August 15 for a second reconnaissance. Heavy ice was again encountered in Viscount Melville Sound and the Edisto suffered damage to both propellers which reduced her to half power. In view of the lateness of the season and the damage to the ice-breaker, it was felt that there was not much hope of the cargo ship reaching Winter Harbour that summer.

Alternate Site - The question of an alternate location for the weather station became of prime importance. A survey was carried out on the south shores of Bathurst and Cornwallis Islands and in the Radstock Bay area on Devon Island. The most satisfactory alternate site was at Resolute Bay on Cornwallis Islands for the following reasons:

1. It offered the best possibility for airstrip construction and representative weather observations.

2. Its more westerly situation as compared to Devon Island was central to the Canadian Arctic Archipelago for the support of further Arctic operations, and approached the western areas of special meteorological interest.

3. It was believed to be readily accessible by cargo ship, even in a difficult ice year.

Approval for the new site was given by both Canadian and United States governmental agencies and unloading operations were begun on August 31.

Station Establishment - The rapid approach of winter pointed up the need for haste. Eight LCM-type landing barges churned the water between the ship and the shore around the clock, and all the cargo amounting to approximately 3,200 tons was discharged in six days. The station site was selected at a point one quarter of a mile from the beach with a fresh water lake 1,500 feet to the west. A suitable airstrip site was located 2 1/2 miles inland. The Royal Canadian Air Force established a base at the Resolute airstrip in 1949.

The Resolute weather station is located about 500 yards from the shoreline of Resolute Bay on the southern side of Cornwallis Island at latitude 74° 41' 03" N, longitude 94° 54' 17" W.

The erection of the station buildings was carried out by weather station staff and a group of U.S. Army personnel with some assistance by work parties of U.S. Navy crew members. Airstrip construction was begun simultaneously by a detachment of U.S. Army engineers. The construction operations were handicapped to some extent by the weather as temperatures dropped below freezing and snow began to fall. However, the outer shells of three prefabricated wooden houses, five Quonsets and several Jamesway huts were erected by September 12, and on September 13, the ships departed from Resolute.

There was not sufficient time or sufficient warehouse space to store all the supplies indoors and recurring blizzards soon covered all the outdoor caches with deep, hard snow drifts. Thus, during its first winter of operation, the Resolute station was plagued by a shortage of many items. The supplies were there, but it was impossible to find them in the snow drifts.

Two unfortunate accidents occurred the first winter which caused a serious drop in morale at the station. One of the Canadian radio operators was critically injured when he was severely mauled by a polar bear within the camp area the last week in October. He was evacuated by air and recuperated in a hospital in Montreal. The second major accident occurred when a Canadian radiosonde technician was electrocuted on December 7.

Recreation- Opportunities for recreation are limited at Resolute, as well as at the other Joint Arctic Stations. Some outdoor sports such as skiing, hiking and fishing provide occasional relaxation. A comparatively extensive library is also available at each station, but the most popular hobby is photography. The U.S. Weather Bureau furnishes a minimum of photographic equipment such as an enlarger, printer, drying plates, developing trays, chemicals and so on, and a nominal amount of photographic printing paper.

lsachsen, N.W.T.

Planning - When the Resolute station was established in the summer of 1947, additional supplies were carried in at the same time for two new stations which were to be established in the spring of 1948. On the basis of the most desirable spacing for these stations, tentative target areas had been selected on Ellef Ringnes Island and the southern portion of Prince Patrick Island with the exact sites to be determined by reconnaissance.

The new stations were to be established by air according to the procedure which had worked so well at Eureka. Suitable sites would be selected where a smooth ice surface would permit the landing of large transport aircraft on wheels. The operation was scheduled for April and May for at that time of year the ice cover in the Arctic is sufficiently thick to bear the weight of heavy aircraft, good flying weather may be expected, and there is nearly continuous daylight in these regions.

Reconnaissance - An aerial reconnaissance of Ellef Ringnes Island, discovered in1900 by members of the Sverdrup expedition, was carried out on March 27. F1at areas in the vicinity of Cape Thorstein were first examined. These appeared to be extensive river deltas and it was anticipated that they would be soft and muddy in summer. The flight continued along the south side of the western peninsula of Ellef Ringnes Island without finding a satisfactory location. The best station site was located in a small bay near Deer Bay. To the east were the flats of a broad delta which might provide a landing strip location in case a better one were not possible on one of the table plateaus of the higher ground. Three ponds were in the vicinity and a stream in a deep ravine promised a potential source of fresh water. To the south a ridge of rock ran into the bay as a long narrow point. Near the southern end of this point, there appeared to be a suitable landing area where the wind had scoured the ice free of snow in large patches.

A second reconnaissance of this area was made with a ski-wheel aircraft and a successful landing was made on the ice. An area of smooth ice was located nearby where larger transport aircraft on wheels could land. The station site is located at latitude 78° 46' 40" N, longitude 103° 31' 40" W, close to the spot where Stefansson and two companions came ashore in May, 1917, suffering from scurvy.

Station Establishment - The first three station personnel were flown in on April 3 with emergency rations and shelters consisting of Jamesway huts. Flying was hampered to some extent by reduced visibility in blowing snow, but by April 13, approximately 84 tons of supplies had been delivered to the station site. The bulk of the supplies were carried in U.S. Air Force C-54 aircraft but two loads of bulky grading equipment were carried in with C-82 aircraft, commonly known as "the flying box car". By April 2l a total of l69 tons had been airlifted to the station which completed the operation except for the delivery of a few miscellaneous items at a later date.

The initial station complement was to be six men, three Canadians and three U.S. personnel. An additional U.S. mechanic was included to assist with airstrip construction during the first summer. It was found that seven men were required permanently to maintain efficient operations and the staff level has been kept at this figure. However, the ratio has been changed to four Canadians and three U.S. personnel in order to effect an equal division of staff in the whole Arctic Project since Mould Bay is being staffed with three Canadians and four U.S. personnel.

The station staff erected all the buildings in the camp throughout the spring and summer of 1948. These were as follows: five Jamesway huts, three tents and one prefabricated wooden building. Two additional prefabricated wooden buildings were supplied in 1949.

Mould Bay, N.W.T.

Reconnaissance - The initial aerial reconnaissance of Prince Patrick lsland, discovered by the McClintock expedition in l852, was begun on March 23, 1948, in Intrepid Bay. An attempt was made to examine Green Bay but fog and turbulence prevented any careful survey. The flight continued around Manson point and to the head of Mould Bay. This bay is 25 to 30 miles long. Reconnaissance proceeded down the west side of Mould Bay without finding any suitable areas and turned north again into Walker Inlet.

A reconnaissance on April 5 located a suitable site on the east side of Mould Bay, about 15 miles from Crozier Channel at latitude 76° 14' 16" N , longitude 119° 20 ' 28" W. The shore line adjacent to the ice landing area consisted of hard gravel ridges bounding a broad low valley with an extensive delta at the mouth.

Station Establishment - The initial landing was made on April 11 with three station personnel and basic supplies. Communications were established that same evening with a small portable radio giving voice contact with Resolute. A tractor was delivered on April 12, as well as some gasoline and other supplies. On April 13, another load of station supplies was delivered. The airlift activity to Mould Bay was intensified on April 15 when six loads were flown in. Thereafter, the airlift continued without a pause until April 19 when all the supplies were in except for some bulky grading equipment that was taken in on April 25. The establishment of the station at Mould Bay presented a slightly more difficult problem than at Isachsen in view of its greater distance from Resolute; namely, 500 miles as compared to about 350 miles. However, 170 tons of supplies were carried into Mould Bay in 32 flights without incident.

The airlift was carried out from Resolute simultaneously with the establishment of the lsachsen station by the Atlantic Division of the Air Transport Command of the U.S. Air Force. The scale of the operation may be judged from the fact that following aircraft were assigned to it: 5 C-54, 2 C-82, and 2 C-47. Supporting equipment included snow removal machinery, aircraft heaters, maintenance parts, temporary shelters, food and Arctic supplies. Approximately 100 military personnel, as well as about 25 civilians, were transported to Resolute to accomplish this mission.

Staff - The staff establishment at Mould Bay was identical in numbers to that at Isachsen the first year, with three Canadians, three U.S. personnel and an additional U.S. mechanic on a temporary basis for airstrip construction. The permanent staff establishment was later raised to seven, four

Canadians and three U.S. personnel.

The station was seriously short-staffed for the entire first year since the U.S. Executive Officer was evacuated in May, 1948, on medical grounds and there was not sufficient time to send in a replacement before the ice landing strip became unusable. In spite of this staff shortage, the station carried on a full weather observing programme in addition to a heavy work load in station construction.

Alert, N.W.T.

Alert, the newest of the Joint Arctic Stations is situated on northern Ellesmere Island, near the most northerly point of land in North America, at latitude 82° 30' 06" N, longitude 62° 19' 47" W. The choice of the name "Alert" for the weather station was a fitting one for it serves as a reminder of the expedition which made the greatest contribution towards an accurate survey of this coast.

In 1875, the Nares expedition, consisting of two ships, the Alert and the Discovery, wintered on the north coast of Ellesmere Island. The Discovery made her winter quarters at Discovery Harbour, where Greely later established Fort Congor. The Alert forced her way farther northward until difficult ice conditions brought her to a halt in latitude 82° 24' N . , near Cape Sheridan. Numerous sledge trips were made from the ship during the winter to survey and map the north coast of Ellesmere Island and the northeast coast of Greenland.

Reconnaissance - The preliminary reconnaissance for a weather station site on the north coast of Ellesmere Island was carried out by icebreaker in the summer of 1948, and some supplies were left cached on Cape Belknap such as fuel, emergency rations, temporary shelters, and a small tractor. A photo reconnaissance flight during the summer of 1949 indicated conditions in the area very similar to those in the summer of 1948.

The reconnaissance in 1948 was carried out both by helicopter and on foot, and it appeared to be conclusive that the best weather station location on the north coast of Ellesmere Island was on Cape Belknap for the following reasons.

1. Suitable exposure for weather observations.
2. Possibility of access by icebreakers.
3. Possibility of airstrip construction on land.
4. Favourable camp site with fresh water.
5. Potential ice landing surfaces for spring operations.

Station Establishment - The establishment of Alert was originally scheduled for the spring of 1949, but other commitments of the U.S. Air Force made it necessary to postpone the project until 1950. Aircraft of both the

Royal Canadian and United States Air Forces took part in the operation in 1950. The initial landing was made on Easter Sunday to take in a survey party and three station personnel. As soon as the tractor could be started, it was used to improve the landing area on the ice and the remainder of the supplies were ferried from Thule in a round-the-clock airlift.

Alert is the most northerly post office in the world. Canadian post offices have been established at all the Joint Arctic Stations and mail deliveries--often by parachute drop--are made at intervals throughout the year.

An unfortunate accident occurred at the Alert station on July 31, 1950. An R.C.A.F. Lancaster was making a mail drop there when one of the parachutes fouled the tail assembly and caused the aircraft to crash. All the personnel on board were killed including Col. C.J. Hubbard whose efforts and enthusiasm had been largely instrumental in initiating the Joint Arctic Weather Station Programme .

Staff - The Alert station permanent staff complement consists of eight men, four Canadians and four U.S. personnel. Additional help was provided for the initial construction period in the spring and summer of 1950 by the assignment of a Canadian carpenter and three U.S. personnel for airstrip construction work.

Reconnaissance of Bridport Inlet

1948 Reconnaissance - The original plans for the Joint Arctic project called for the establishment of the main station in the vicinity of Winter Harbour on Melville Island in 1947. Severe ice conditions in the western Arctic that year necessitated the choice of an alternate site for the main station, Resolute Bay being the final choice. However, it was still felt that a surface weather observing station was required on Melville Island to bridge the wide gap between Resolute and Mould Bay, and a reconnaissance of the Bridport Inlet area was made by the ice-breaker USS Edisto in 1948.

At that time approximately 180 drums of 100/130 aviation gasoline were cached for the RCAF and about 50 packaged rations were deposited for emergency use. In 1948 rather favourable conditions were found at Bridport Inlet since the area was entirely free of ice permitting the EDISTO to enter the inlet.

1951 Reconnaissance - As Canadian government approval for the establishment of a surface weather and pilot balloon observing station on Melville Island had been obtained, the Meteorological Division, in anticipation of similar approval from the U.S. government, procured two prefabricated buildings for delivery by ice-breaker during the sea supply mission in 1951.

The ice-breaker U.S.S. Atka proceeded to the vicinity of Bridport Inlet in August, 1951, to find that a rather severe windstorm had driven heavy pack ice onto most of the adjacent beaches rendering it impossible in most instances to reach the beach with small landing craft. The channel between Dealy lsland and the peninsula northward was entirely choked with ice which prevented the USS Atka from entering Bridport Inlet as had been done in 1948. The Atka might have negotiated this ice, but due to lack of soundings it was considered hazardous for the ship to attempt an entrance under existing ice conditions.

The ice conditions enroute to Bridport were not severe. In fact very little ice was encountered east of Cape Cockburn, Bathhurst Island. In some areas the ice was unbroken, but a few substantial leads were found permitting the icebreaker to continue westward.

It was decided to take the initial supplies for the Bridport station on the deck of the ice-breaker since it would materially reduce the airlift during final installation of the station. The cargo, which occupied most of the deck aft from the wardroom, consisted of two new prefabricated buildings provided by the Canadian Meteorological Division, one used prefabricated building belonging to the U.S. Weather Bureau to be used as a storage building; and 200 drums of diesel fuel. There was also a small tractor with trailer to be used in beaching the supplies if required.

Representatives of the U.S. Weather Bureau and the Canadian Meteorological Division left the Atka by helicopter some 30 or 40 miles east of Bridport Inlet for the initial reconnaissance. New charts compiled from recent aerial photography by the R.C .A.F. had been carefully studied previously to determine the most level areas adjacent to suitable beachheads and possible weather station sites. The Bridport lnlet area was examined first from the air by helicopter to pick out locations that appeared suitable for airstrip construction and station development. From the aerial reconnaissance three out of five potential areas were determined to be unsuitable. Finally, the observers landed and investigated the two remaining areas on foot to gather more specific and detailed information concerning the sites. On the basis of the ground survey, a site lying about a mile and one-half from the beach-line and about eight miles east of Dealy Island was selected as being most desirable.

During the course of reconnaissance on foot around the area of Bridport Inlet, some old cart tracks were discovered along the eastern shore of the inlet which were still plainly visible though made about 99 years previously.

After about 25% of the total supplies had been landed, unloading was stopped when a shift in the wind brought heavy pack ice against the shore and effectively blocked the entrance at that point for landing craft. A second landing area was selected approximately two miles farther west and the discharge of supplies was immediately resumed. No further difficulty was encountered except for the very strenuous work of manhandling the supplies from the strandline up to secure terrain at a safe point above the ice line. Approximately 145 tons of supplies were landed at the two beachheads .

The first cache is about eight miles and the second cache about ten miles from the proposed weather station site. Much of the intervening route is strewn with numerous boulders which would be most difficult to traverse by tractor and sled. The easiest way to transport supplies to the proposed weather station site would be to have a tractor and sleds available in April and May and haul the supplies over the sea ice. In this way one D-4 tractor could haul three or four sleds in a train and carry five to eight tons of supplies at each trip. To move the supplies overland from either cache would require the construction of about four miles of roadway suitable for travel by tractor.

The reconnaissance of Bridport Inlet and caching supplies was completed on August 17th at which time the Atka proceeded to Resolute. While the Atka was at Bridport, a steady wind averaging 25 to 30 knots blew for about two days out of the northwest. This accounts for the surprisingly small amount of ice encountered on the return to Resolute and the trip was made in about 20 hours.

<u>Accessibility by Icebreaker</u> - Bridport Inlet can probably be reached by icebreaker between August 15 and September 15 during most years. Most of the ships which visited this area in earlier years arrived during the latter part of August when ice conditions had reached their minimum and summer winds had driven ice southward from the southern shore of the island. Except for the ice blocking the passage between Dealy Island and the peninsula northward, the inner inlet could have been reached in 1951 as it was in 1948. In 1950, the ice in the inner bay persisted until the latter part of August and it may be expected that the inner bay would not be clear of ice until after the 20th of August. It is noteworthy that although the inner bay this summer was practically free of ice, a great deal of broken pack ice had been driven into the southeast part of the bay and would have effectively prevented landing by small craft along most of the eastern and southern shores of the bay.

<u>Visit to Dealy Island</u> - A visit was made to Dealy Island to investigate an old stone hut and two cairns bui1t many years ago. The entire roof of the hut had caved in but all of the walls were still standing since they were made of fieldstone from the nearby area and were apparently erected by men familiar with rubble masonry. Numerous empty cases, boxes, barrels, etc., were found nearby, probably strewn by bears attempting to find food.

One of the large cairns on top of Dealy lsland was examined for records left by early explorers, but because of the limited time available a complete search could not be made and nothing was found. However, a record was made at the cairn giving some details of the 1951 Supply and

Reconnaissance Mission. The record, enclosed in a sealed can, was placed near the base of the largest cairn. A copy of the record left is included for general information:

16 August 1951

TO WHOM IT MAY CONCERN :

Commander Service Squadron FOUR in the icebreaker U.S.S. ATKA (AGB-3) arrived in the vicinity of Bridport Inlet on 14 August 1951, and discharged some 70 tons of prefabricated housing material and some 200 drums of Arctic diesel fuel.

The purpose of the visit to Bridport Inlet was to select a site for joint Canadian-United States weather station and to bring in some initial supplies.

The persons embarked in the ship were as follows: Commander Service Squadron FOUR with his staff of 13 officers and 37 enlisted. The U.S.S. ATKA ship's company consisting of 18 officers and 19l men. 3 observers from the United States Weather Bureau. 7 Canadian observers. 1 Oceanographer, U.S. Naval Technician.

Passage from Resolute Bay to Bridport was accomplished between the period 121600R and 141700R August. Ice encountered varied from 2 to 8 feet in thickness, but for the most part it was possible to follow leads. The ship was required to break through belts of ice on occasions which ranged from a few hundred feet to several miles across.

The site tentative1y selected for the new weather station lies approximately half-way between Bridport Inlet and Skene Bay but because of ice along the beach south of this site, initial cargo was landed on the peninsula which borders the southeast side of Bridport Inlet.

WALTER C. FORD,
Captain, U.S. Navy,
Commander Service Squadron FOUR and
Commander Task Group 49.2

J. C. JACKSON ,
Senior Canadian Observer.

R. B. KELLY,
Commander, U.S. Navy,
Commanding U.S.A. ATKA (AGB-3)

J .G. DYER ,
Senior U.S. Weather Bureau
Observer.

Chapter 3

STATION MAINTENANCE

Fire Protection - Fire protection is one of the very serious problems that is present at all of the stations. There are several factors that contribute to the seriousness of the problem as follows:

1. Inadequate source of quantities of water for quenching fires;
2. Impracticability of storing large containers of water without freezing;
3. The relatively low humidity and the tendency of combustible material to burn with great rapidity when once ignited in an environment of 1ow humidity;
4. The shortage of personnel to keep constant watch in and around buildings where stoves are in operation and combustible materials are kept.

The Joint Weather Stations have suffered two very costly fires, one at Eureka and one at Resolute. The fire at Eureka was started apparently from an overheated stove from which oil had dripped onto the floor. To give an example of the great degree of combustibility, the fire when first discovered was of fairly small proportions, but in the three or four minutes necessary for the initial observer to warn the rest of the camp, and get help, the fired had spread beyond control and comp1etely destroyed the main mess building and garage which were joined together. The fire occurred in December with prevailing temperatures approximately 35 degrees below zero F., and with the almost complete lack of water, it was utterly impossible to control the fire and the building and contents were a complete loss.

This fire placed the station in a very hazardous position. With the exception of a small emergency transmitter, the fire consumed all the radio equipment, the power generator and the weasel and tractor which were used to support the station by hauling supplies, ice and fuel. Due to the conscientiousness of the station personnel, synoptic weather reports were sent out each day on a sma1l radio transmitter operated with a hand crank at a considerable hardship to the personnel. Periods as long as l to 2 ½ hours were often required to transmit messages.

The USAF very generously agreed to arrange a special flight and provide on loan new generators and equipment which were available at Goose Bay. It required almost seven weeks, however, to get the material delivered into Eureka because of extreme cold temperatures which produced a 1ong series of mechanical failures to airplanes attempting to complete the mission.

The fire at Resolute was not as serious, but had somewhat the same circumstances surrounding its origin, and in fact, also resulted in a complete loss to the building and contents.

The system of fire prevention and protection which is now followed at each station is essentially as follows:

1. The OIC and EO of the station prepare a local fire prevention and watch program in which all hands participate.

2. Buildings which are the most likely fire-danger points are insulated on the interior with asbestos rock-board. Coal-burning stoves are generally used in buildings which are heated but not attended for periods of time because coal- burning stoves are considered to be safer than oil-burning ones.

3. Fire extinguishers of the CO-2 type are placed at practically all danger points. Carbon tetrachloride type fire extinguishers are also located at numerous danger points and automatic type extinguishers are placed in and around particularly hazardous points such as stoves; barrels of water containing calcium chloride mixture to lower the freezing point have been scattered at strategic points throughout the camp, and dry type extinguishers are also being procured.

4. A fire warning system has been procured for Resolute which uses a series of Thermisters located at numerous points in each building. This system functions when environmental temperatures exceed the safe points and operate the thermister circuit. This sounds a warning bell in the central point which is the operations building. In addition to the warning bell a locator dial indicates the location of the danger. A similar but a more simplified system is being procured for each satellite station.

5. Finally , a fire watch is kept at each station which consists of a physical inspection of all danger points at frequent intervals.

Waste Disposal - The waste disposal system at most of the stations is rather utilitarian and simple. Latrine wastes at all stations are treated in the same manner. That is, the waste is collected in empty fuel drums and hauled out on the Bay ice where it is finally dropped into the sea during the summer melting period. During the time when it is impossible to get out on the ice, the waste is dumped out near the beach and pushed to the bay by tractor.

Kitchen water waste is ordinarily collected in a receiving drum and then flushed out on the surface of the ground at occasional periods when there is sufficient waste to keep the pipe from freezing up. During the winter the outlet pipe will invariably freeze up if a small stream or trickle of water is allowed to pass through it. At the satellites the kitchen waste is usua11y collected in garbage cans and hauled away from the station with a sled. At some stations, such as Eureka and Isachsen, part of the waste water is saved for use in generating hydrogen. It is so difficult to obtain water that every method of conservation must be used. It is, therefore, necessary to save and re-use some of the waste water such as dish water, rinse water, etc., which has been found satisfactory for generating hydrogen. The soap helps to keep the chemicals solvent and makes it easier to clean the generator. Around most of the stations the ground is so porous that surface water disappears readily during the summer season and does not collect in pools or ponds as one might expect.

Empty food tins, packaging, etc., are usually collected and moved away from the station to be dumped on the bay ice or pushed into the sea by tractor. Combustible waste is burned in an incinerator.

Storage of Food and Refrigeration - Each station carries a minimum of approximately 12 to 14 months' food supply at all times. The plan is to have a safe margin of staple foods so that in case of emergency or failure of re-supplying the stations during any given year, the station could carry on until conditions improve with respect to transportation. Food, except for items susceptible to damage by freezing, is stored in non-heated buildings throughout the year. At present the storage facilities at practically all the stations are somewhat inadequate, but plans have been made to purchase another Quonset-type storage shelter for each satellite for the next procurement season. At Resolute it is believed one of the former transient buildings will become available for storage use, since military airlift personnel can be expected to be billeted at the R.C.A.F. quarters.

Certain types of food subject to damage by freezing are stored in warmed storerooms. This type of storage, however, is very limited at all of the stations, particularly the satellites. The foods which must be kept in warm storage are items such as evaporated milk, vinegar, catsup, canned asparagus, and certain fresh foods. Moreover, any food packed in glass containers is likely to be damaged or lost by freezing, and an attempt is made first to avoid procurement of food in glass containers and, if unavoidable, to store them in a warmed space.

Resolute has a 400 cubic foot reefer for storage of frozen meats and frozen products during the summer. The reefer is needed from about the middle of May until the end of September to keep frozen produce properly stored and preserved. During the rest of the year, freezing temperatures prevail and the reefer is not needed except for space. The Resolute reefer is used in the summer to receive the Resolute frozen produce and to store frozen supplies for Isachsen and Mould Bay, which are delivered to the satellites during the fall airlift, usually in early October. The capacity of the Resolute reefer is accordingly overtaxed during August and September and it is proposed that an additional reefer be procured and placed at Resolute to store satellite meats exclusively.

Current planning is for construction of permafrost type reefers at all the satellites. This involves the construction of a cubicle approximately 5' x 5' x 6’ buried deep into the permafrost or in a hillside with openings through the top. The entire top except the opening must then be covered with an overburden of 2 ½ to 3 ½ feet of dirt or an equivalent type of insulating material. Experience in other Arctic areas indicates that this type of permafrost reefer can provide temperatures of not more than 28 - 30 degrees F all through the summer as long as entry into the reefer is kept to a minimum and the reefer is kept closed most of the time. This reefer is intended to store fresh meats and produce during the summer. In the past, satellites have been supplied with fresh meats for nine months only and have had to do without fresh meat during the summer.

Fuel Storage and Distribution - Fuel for the satellite weather stations is still supplied in 53-gallon (U.S.) steel drums, but with the anticipated shortage of steel containers it may become necessary to start a programme of airlifting fuel oil in tanker planes to conserve steel. Resolute is in a very favourable position with respect to fuel storage since they now have five 15,000-gallon steel tanks which will hold more than a year's supply of oil. With Resolute's system, much valuable time is saved in unloading the ships because the oil can be pumped directly from the landing barges to the storage tanks and the numerous pieces of equipment and the personnel required to fill individual drums may be eliminated. Pipelines from the fuel tanks are arranged to bring fuel to the main distributing point in the station area where it can be pumped directly into individual tanks supplying furnaces, stoves, generators, etc. This system eliminates much of the arduous work required in digging out drums of fuel in the winter, hauling them to the camp and emptying drums one at a time.

During the Summer of 1951 one of these large tanks was delivered and erected at Eureka. It will greatly facilitate the resupply of fuel oil in the future.

It is hoped that at a future date the other three satellites can be benefitted through the same programme. There is already a tank available for Alert which has not as yet been delivered, but will very likely reach the station during the summer of 1952.

Specifications for Fuel Oil - The fuel oil used at the Arctic stations is of the best grade obtainable. It has been observed in past years that typical "Arctic-type fuel oil" is not satisfactory because of the low temperatures encountered at the weather stations. Ordinarily, Arctic-type fuel oil is graded pour point cloud point minus 40 degrees F. That oil is presumably satisfactory for general use where temperatures are not lower than minus 40 degrees F. In practice, it will not flow very satisfactorily at that temperature because some of the waxes begin to precipitate out in the fuel oil and soon start to clog small fuel lines, orifices, and filters. During the past 2 or 3 years it has been possible to obtain minus 60 degrees F pour point cloud point fuel of the following general specifications.

Oil, Fuel, Diesel Specifications

Viscosity at 100ºF.	2.35 c/s	Appearance	Clear
P .M. Flash	148ºF.	Color	1 ASTM
Cloud Point	Below (-60)ºF.	BS & W	0.0%
Pour Point	Below (-60)ºF.	Sulfur	0.092%
Corrosion	Negative	Distillation	90% 548°
Conradson Carbon	0.03	E.P.	611º
	Diesel Index 53.2		

This oil has proved very satisfactory and has almost eliminated the difficulties encountered previously. The latter fuel is somewhat more expensive, but in the long run pays for itself by saving time and maintenance problems.

Operation of Mechanical Equipment

Power Generators - Resolute is equipped with International UD-9 generators developing l8.75 KVA. The power at Resolute is 220 Volts alternating current 60 cycles per second. This amount of power was ample for the initial operation of the station but added facilities included in the station's activities gradually caused a shortage of electrical energy to develop. To control this situation positive measures had to be taken to avoid excessive use of electric lights, hot plates, and miscellaneous electrical appliances used in different parts of the station. By this means it has been possible to get by on the power avai1able with the present generators. During the summer of 1951 new and larger generators were sent to Resolute which will take care of the power requirements, possibly for the next two years at least. The latest generators sent into Resolute have an increased capacity of 33%. It will still be necessary, however, to observe conservation of electrical power by elimination of unnecessary lights and appliances.

The power problem at the satellites is of a more complex nature since they use both AC and DC power. Alternating current is used for the usual lighting, rawin operation and power tools. The DC power primarily of 30 Volts is used for most radio equipment and also for lights. The foregoing situation requiring dual power arose from the initial need to conserve fuel costs and airlift tonnage at the satellites. Initially all the radio equipment at the satellites was airborne type operating at 28-30 Volts DC. This is still largely the case although a few 110 Volt AC receivers have been furnished the various satellites. DC power is furnished from direct current, gasoline-driven and wind-driven generators at each station. The 110 Volt AC is furnished by a Witte 7 ½ KVA generator.

An added requirement for additional power has arisen at each satellite owing to an increase in facilities and instrumentation. It is, therefore, possible that within the next year or two, at least two of the satellites will be converted to use of alternating current power exclusively. The other satellites will likewise be converted at a later date as equipment and means become available. The use of a dual power source at the satellites has caused a certain amount of inefficiency and a great deal of inconvenience although it has helped cut down the requirement for a large airlift of fuel oil.

Tracked Vehicles - The principal mobile equipment at all the stations is tracked vehicles such as Caterpillar tractors, International tractors, etc. This is essential since initially there are no roads at the stations, and secondly, in beaching supplies over rough beach terrain, no other motive power is as suitable as tracked vehicles. At Resolute , the prime movers are model D-7 Caterpillar tractors equipped with dozers, winches, etc. Other types of tracked vehicles at Resolute are TD-9 forklifts and Weasel personnel carriers.

The satellites have all been supplied with TD-9 tractors which are about one-half the weight of the D-7 tractor. The size limitation at the satellites was brought about by the requirement that equipment must be airlifted or delivered in LCVP-type landing craft. Although a TD 9 tractor is somewhat smaller than is desirable, it has proved to be a most valuable tool for hauling supplies, preparing runways, removing snow from ice strips, and in doing a variety of duties around the stations. As a matter of fact, a bulldozer is perhaps the most valuable single tool or piece of equipment at the weather stations aside from the instrumentation and facilities for maintaining personnel.

The two main problems associated with mechanical equipment at the stations are first, the provision of sufficient equipment, and second, the estimation far enough in advance of the necessary spare parts which will be required. Due to the fact that delivery of supplies to the stations is very infrequent it becomes increasingly important that suitable spare parts in sufficient quantities are available for maintaining equipment. This necessarily requires that a large and expensive inventory of spare parts for mechanical equipment be maintained at all times. Insofar as possible, an attempt is made to standardize types and makes of equipment at all stations.

Wheeled Vehicles - When a station is initially installed there is little or no need for wheeled equipment because there are no roads over which the equipment can operate. Without the availability of roads, wheeled vehicles become very inefficient and subject to serious mechanical troubles. For the foregoing reasons wheeled vehicles were not placed at any of the stations the first year. During the second year of operation at Resolute, a jeep was made available, and since then, several 6 X 6 trucks and an additional jeep have been procured. This was largely the result of the construction of a suitable gravel road between the weather station and the airstrip about 2 3/10 miles distant. Since the construction of the road, the wheeled vehicles have more than proved their worth by expediting the transportation of supplies and gravel and other building materials between the beachhead and the airstrip.

None of the satellites have any wheeled vehicles and it is not likely that wheeled vehicles will be procured in the near future, except possibly one for Alert. The other satellites do not have suitable roads for wheeled vehicles of any type, but Alert has a road of 1 ½ miles which is in good shape and can be brought up to required standards by use of a grader.

It is noteworthy that tracked vehicles require less mechanical maintenance than wheeled vehicles for a given number of hours of operation. This is no doubt due to the greater durability and rugged construction of tracked vehicles which results in less mechanical failure and breakage.
As an example, the heavy D-7 Caterpillar tractor equipment appears to be nearly immune to troubles from operation in excessively low temperatures as long as correct fuel oil is available so that it passes through lines, pumps, and injectors at extremely low temperatures.

During the first year of operation at Resolute when sufficient shelters were not available for equipment, one D 7 type tractor was run approximately ten weeks without stopping during February, March and April. This was done to eliminate the requirement for preheating a tractor before starting, which is necessary if it is stopped overnight in low temperatures. No maintenance difficulties were experienced with this tractor after the ten weeks of operations as described, and the same tractor is still in use and operating four years later without having had any major repairs.

Chapter 4

METHODS OF RE-SUPPLY

Summer Sea Supply Mission

General Plan - Supplies required for operation and maintenance of the Joint Arctic Stations have been transported annually by the summer sea supply mission comprising a task group of U.S. Navy ships supported by R.C.A.F. reconnaissance aircraft and crews. The complement of vessels normally used for this mission has included one or more cargo vessels, including one of the LST type, an oil tanker, two or more icebreakers including a U.S. Coast Guard icebreaker. Cargo destined for Eureka and Alert is delivered by icebreaker if ice conditions permit, or is otherwise offloaded at Thule; cargo destined for Isachsen and Mould Bay is offloaded at Resolute with the Resolute cargo. The satellite cargo at Thule and Resolute is transported by airlift to final destination at a later date.

Loading Procedures - Supplies and equipment are assembled for shipment during the year in the U.S. Weather Bureau warehouse at the South Boston Annex of the Boston Naval Shipyard. Here shipments are received, divided into allotments for each station, packaged, marked with identifying codes and colours, and shipping documents are prepared. Cargo is separated into groups by station of destination and by class of item as follows:

1. Food
2. Fuel, Lubricants, Anti-Freeze, etc.
3. Household Furnishings and Supplies
4. Kitchen Furnishings and Tableware
5. Clothing and Personal Items
6. Medical, Recreational and Trail
7. Special Services (Firefighting, Photo, Surveying, etc.)
8. Office Equipment and Supplies, Forms, Books, etc.
9. Meteorological Equipment and Supplies.
10. Radio Equipment and Supplies
11. Tools and Small Hardware
12. Stock Builders' Supplies
13. Stoves and Service Units
14. Electrical System
15. Lumber and Millwork
16. Building Units
17. Antennae and Accessories
18. Vehicles, Boats, Heavy Equipment, Machinery and Accessories.

These code numbers are used for ease in handling and ready identification in the field. Each package is identified by a distinguishing colour marking for each station. Coded markings also identify station and in addition, indicate class of item and box number within the class which serves as a key to shipping document which identifies contents of the package. Food and other items shipped by Canadian Meteorological Service to Boston are processed with U.S. Weather Bureau shipments. A staff of two men is maintained by the U .S. Weather Bureau for operation of the Boston Warehouse. Their duties include procurement of supplies, arranging the handling of cargo when received and in movement from warehouse to ship. From late May until the ships are loaded in July, assistance in the work at the warehouse is obtained from students and replacement personnel assigned for Arctic duty.

Ships are loaded by Boston Naval Shipyard personnel during the early part of July and depart Boston about July 15. Icebreakers carry no general cargo from Boston but sometimes carry Arctic fuel oil in ships' tanks for delivery to Alert and Eureka.

Schedules - Cargo vessels proceed from Boston to Halifax, Nova Scotia, where additional supplies for the Joint Stations and for related Canadian establishments are loaded. Fuel oil is loaded on the tanker either at a United States port or at Halifax, depending on joint procurement arrangements of agencies of United States and Canada involved. The Task Group proceeds to Thule, offloading Eureka and Alert cargoes either onto icebreakers if a trip is planned to one or both satellites, or at Thule to be held in storage for later airlift delivery. When ice conditions permit, usually around mid-August, the Task Group proceeds to Resolute to discharge remaining supplies. The cargo vessels then return south, but the icebreakers may remain to perform special additional duties such as reconnaissance investigation of ice and new sea routes.

Unloading Procedures **-** General cargo is loaded from the cargo vessel onto large sleds in LCM’s which carry the cargo to the landing beach near the station. The loaded sleds are pulled from the LCM onto the beach with tractors. At Resolute, fuel oil is pumped into pontoon tanks on LCM's which discharge at the beach by pumping into large storage tanks. A sufficient quantity of oil is included for Isachsen and Mould Bay. Fuel oil shipped via icebreaker tanks for Alert and Eureka is loaded into drums at Thule for later airlift if not delivered directly to the station. Since unloading time is usually limited and uncertain due to frequent changes in ice conditions, cargo is moved as rapidly as possible when unloading operations begin and is frequently left in the beach area for later delivery to storage caches. Isachsen and Mould Bay cargo is stored in warehouses provided for the purpose by the R.C.A.F. at the Resolute airstrip. Alert and Eureka cargo is placed in outside storage with maximum possible protection. It is hoped that inside storage space will be available at Thule for this purpose in the future.

Cargo - A large variety of items is included in the supplies provided to the Arctic stations each year since everything required for living and working in the Arctic must be included. In addition to supplies consumed in ordinary living, there must be protective supplies such as medical and firefighting equipment; stocks of spare parts must be maintained so that a1l equipment may be kept in operation, including meteorological equipment, electric power generators, radio communication equipment, and mobile equipment. Tractors and grading equipment are required at all stations for construction, maintenance, and snow removal on roadways and airstrips; at the satellites the weather station has full responsibility for this function. Average cargo for one year of operation, not including special items such as building structures or fuel tanks is approximately fifty tons of general cargo and ten thousand gallons of fuels for each satellite; for Resolute weather station it is approximately three hundred tons of general cargo and forty thousand gallons of fuels.

Problems of Ice Navigation

Although navigation of Navy icebreakers is the responsibility of Navy personnel, the following brief notes on ice navigation may be of value for planning purposes of the Weather Services since it is desirable to know what can be expected under various circumstances.

Continuous Sheet Ice - Large areas of unbroken sheet ice are found in summer throughout the waters of the Canadian Arctic islands and Baffin Bay. This ice is formed wherever there was open water in the previous fall, or more commonly, where sheets of ice have remained over from year to year without wholly disintegrating and without being crushed into pack. The residue of the previous sheet is refrozen as new sheet. This is believed to be the history of the great areas of such ice found in the middle of Melville Sound, where it is probable that open water seldom exists to any large extent.

Sheet ice may reach a thickness of six to nine feet in a winter, depending on temperatures and currents. In Slidre Bay, 102 inches was measured in 1947. This is believed to be approximately a maximum thickness for undisturbed freezing during a season. During the summer the ice melts both on the top and the bottom. The thaw waters on top form a pattern of pools with irregular islands of the original ice surface between them. In the late summer these thaw pools average about l8 inches deep, and the adjacent ice area projects 6 inches to a foot above their surface. By reason of these pools there is, therefore, a difference in the thickness of the ice of about two feet under the pools and under the adjacent ice areas. When broken by an icebreaker the line of cleavage follows through the majority of thaw pools in the direction of the crack.

During the melting on the upper surface, the bottom is also melting at what is probably a fairly uniform rate all over. Finally the bottoms of the thaw pools go through to the water beneath and than spread laterally. This process may be hastened by the presence of dirt on the ice surface which absorbs the Sun's heat and drills down into the ice. It is important to note that the presence of quite numerous holes through an ice sheet does not necessarily indicate that it is in an advanced state of deterioration. These holes may have been seal holes or the result of impurities on the surface. This ice may still be 6 feet thick on the average, and of substantial hardness.

It is very difficult to judge the thickness of sheet ice from observation (especially aerial) of the surface only. One point which can be observed is the amount of surface area which has been occupied by thaw poo1s, compared to the amount still remaining as white ice. If the thaw-pools represent the majority of the surface, (since the ice is necessarily thinner under them) it follows that the average thickness of the sheet is less than if the surface ice areas are in the majority.

Another feature, although difficult to observe, is the amount by which the surface ice areas project above the level of the water in the pools. It is presumed to be true that at least in the latter part of the summer the ice is sufficiently porous and there are sufficient holes and cracks so that the water level in the pools is the same as the water level of the sea on which the ice is floating. The amount of ice above water bears a relationship to the amount below water. The ice areas are shaped like mushrooms, being undercut all around the edges. If the ice areas are quite sharply rounded on top and the lip at the edge is some inches above the water in the pools (indicating substantial ice above water) it is probable that the average ice is quite thick since there must be a bulk of ice below water for flotation. This is certainly so if the ice areas cover a majority of the surface. On the other hand, if the ice areas are flat and their lip is close to the water level, then the ice may be thin if the ice areas cover a minority of the surface.

The USS EDISTO could not maintain headway under full power in sheet ice averaging more than 5 ½ to 6 feet thick and was stopped by ice of about this thickness in Melville Sound in 1947. As this limiting thickness is approached, progress is very slow. The icebreaker is not necessarily in any danger of being trapped, since she can always break through a short distance of much thicker ice by backing and ramming. Moreover, there is the broken line of her own track on which to retreat. In exposed areas the occurrence of very thin continuous sheet ice is extremely rare, since the surface is usually broken by natural forces as soon as it becomes weak. It should, therefore, be assumed that wherever continuous sheet ice is observed, it will not be profitable to attempt passage in an icebreaker (WIND CLASS). This sheet ice may persist in protected water, or may be found in sizeable floes during the process of breaking up.

If there is some kind of lead through the ice, even very narrow and hardly more than a line of breakage with a little element of slackness, the ship can make progress in sheet ice averaging up to 6 feet in thickness. Progress is slow and occasionally it may be necessary to back and ram at points where the crack is tightly closed.

<u>F1oes of Sheet Ice</u> **-** As the general ice surface begins to break up, large areas of sheet ice move from their original position and become what are described as floes. These floes are mixed with other broken ice to form pack ice.

The performance of the icebreaker in sheet ice which has become floe ice depends a great deal on the size of the floes. It is a good generality that as long as there is any slackness around the ship or open space into which she can push the ice, then she can keep going. If the floes are small enough to be split open under the ship and the sections pushed into surrounding areas of slack ice, it is quite possible to pass through floes which may be 6 to 8 feet thick. However, if the floes are so large that the ship becomes embedded, she will be stopped by a thickness of about 5 feet. As a very general figure, it may be estimated that an icebreaker of the Wind Class should not attempt to break through thin floes of sheet ice (excepting very thin rotten ice less than 4 feet) more than 500 yards in least dimension, nor a thick floe (6 to 8 feet) more than 200 yards across. It is better to go around them.

It is important to realize that floes of sheet ice are usually thinner around the edges than in the middle. Therefore, the breaking of a floe may be attempted on the basis that it is fairly easy to enter the ice, but as the middle part is reached the ship may be stopped and forced to back and ram.

It should be noted that large flat floes are sometimes encountered which are not the result of simple freezing (giving sheet ice) but which are formed from consolidated pack. This ice is usually hummocky on top. It may be as much as 20 feet thick and is probably impenetrable by the icebreaker even in floes of small area.

From observations during early operations it was felt that considerable reliance could be placed on the color of the thaw pools as a measure of the ice thickness beneath. There is no question that the color varies from a light aquamarine blue on dense thick ice to darker shades as more and more of the darkness of the water underneath penetrates through thinner ice. These shades grade from pure light blue, to steel b1ue, to grey and finally almost black when the bottom goes out of the pool altogether. Occasionally rotting ice will show brown pools where marine life has come up from underneath and stained the water.

The colors do not, however, provide an accurate measure of the ice thickness. This may be because of the difficulty of distinguishing between slight variations of shade with the unaided eye, or perhaps the presence of overcast or the color of the sky has an effect by reflection. In any event, with close observation of the colors in 1947, it was found impossible to determine any distinct difference in shade in the pools on ice varying from 3 to 8 feet in thickness. About the best that can be said for color determination is that if the pools are light blue, the ice is very thick, if steel blue the ice may be from 3 to 8 feet and only if very dark, or brown can one be sure the ice is really thin. It will then have numerous holes through it.

Pack Ice **-** Pack is usually referred to either as loose or close (depending on the percentage of ice to water in the surface cover), or light or heavy (depending on the average thickness of the pieces of ice which make up the pack).

Light loosepack does not slow up an icebreaker to any great extent**.** It is generally possible to maintain a straight course at good speed, only deviating from time to time to avoid the heavier pieces.

Light closepack may give an icebreaker trouble. She should be able to maintain headway in quite close broken pack averaging up to 5 feet in thickness. Her speed will be reduced, however, and she cannot break by shock the large pieces which may be encountered. She must begin to pick her way carefully, choosing the places which are most slack and most broken. Such pack is likely to have occasional pools of open water (these are sometimes called polynias, which differentiates them from thaw pools.) The ship will then work from polynia to polynia. However, there can be occurrences of very close, dense, crushed ice with sufficient body to stop the ship. This is difficult to penetrate since there is nothing to be gained by backing and there is nothing to ram. Fortunately, such occurrences are rare and are usually found where an area of crushed ice is caught between two areas of pack moving against each other**.**

There are two aspects of heavy pack ice which are very important to navigation. The first is that a pack may have a certain percentage of ice to water, but in one case the slackness is distributed through the pack while in another it may be concentrated in scattered polynias. In the latter case the ice between polynjas may be so dense as to stop the ship. The second and most important characteristic of heavy pack is whether it consists of fairly small but heavy pieces or whether it is composed mainly of large floes of sheet ice with irregular leads and polynias between them**.**

If the ice is broken up and the slackness well distributed, ice-breakers can probably make satisfactory progress in 90% heavy pack. If the heavy pack is denser than 90% coverage, she probably cannot proceed with sufficient success to make it worthwhile. She can back and ram to extricate herself from difficulties, but progress by this method is negligible. Furthermore, backing is dangerous to the propellers**.**

The type of pack which gives the most trouble, but which may still be successfully navigated, is heavy pack up to about 90% ice and containing many large floes. It was previously stated that an icebreaker should not attempt to penetrate a thick floe more than 200 yards across. In heavy pack all the floes must be assumed to be thick (6 feet or more) and most of them are more than 200 yards across. It is, therefore, essential for the ice navigator to realize that he must go around the floes and not attempt to keep a straight course. The success of ice navigation in close heavy pack depends directly on the skill with which the greatest line of weakness is exploited. This is the first rule for the navigator.

Very often the following of the greatest line of weakness will lead the ship so far from her desired course that she loses the profit of progress. In fact sometimes she may get turned around in exactly the wrong direction. It may be necessary to abandon a good line of weakness for a more difficult one in order to improve the heading. In any event one must remember that it is out of the question to steer by the compass. One must steer by the ice.

The line of weakness may be a lead, or only a crack through the pack with open water varying from 2 or 4 feet in width to several yards. If it approaches the width of the ship's beam, progress is practically unhindered except when the lead is tortuous and the ship cannot maneuver to follow it. She will follow it herself, almost regardless of the helm, by bouncing from side to side. If she cuts into the pack at the side, the ice breaks toward the open water and forces her back to the lead. This maneuvering presents a great hazard to the propellers, however.

The line of weakness may be a series of polynias with areas of close broken ice between them. By following from one polynia to another the ship gains enough headway in each to attack the next area of close ice with her full force.

The line of weakness may be only the fracture between two large floes. This presents the least chance for progress although the question of whether the ship can maintain headway depends on the closeness of the fracture, the weight of the two floes, and the distance to be traversed.

The selection of the best line of attack depends directly on conditions a few hundred yards ahead and may well depend on conditions several miles ahead. For this reason the ice navigator must be able to see in advance. The use of aircraft to examine conditions far in advance is a very great asset and a helicopter carried by the icebreaker is excellent for this purpose.

A characteristic of pack which has not been mentioned is the occurrence of old pressurized floes. These are referred to by some ice navigators as "paleocrystic" ice. These floes may have a single pressure ridge in them and rise above the general ice level 4 to 8 feet. They are always deep under the pressure ridge. They do not have the regular pattern of thaw pools on them and what thaw water is present appears light blue. Small pressurized floes can be broken if the ship has enough headway to strike a heavy blow. However, a great deal of time is lost in trying to break through these pressurized pieces. If there is slack water around they can be pushed aside, but on the whole it is best to avoid them if at all possible.

Old floes of pressurized ice were found in Norwegian Bay which were sometimes a mile or more across. Their surface was hummocky and distinctly dirty. They were estimated to be 20 feet thick or more on the average. The icebreaker cannot do anything to ice of this weight except chip off little pieces around the edge. It is essential to circumnavigate such floes although they may force the ship 5 or 10 miles off course. It then becomes imperative to know whether the line of weakness around a large floe leads to improved conditions or whether it may be a trip into dense pack. The use of a helicopter is practically an essential for this type of ice navigation.
The principal hazards and mistakes in ice navigation in heavy pack may be summarized as follows :

1. Losing the line of weakness. It is often a nuisance to twist and turn to follow leads and breaks, and the ship is allowed to plow into dense pack. Or she may be forced away from the line of weakness by the action of the ice. But it may take her an hour to work through a floe which she could go around in ten minutes.

2. Choosing the wrong general line of attack. If the navigator does not know where his line of weakness leads, he may find himself going in the wrong direction altogether or be trapped in heavy pack.

3. Tackling ice which is too heavy for the ship. If pack which is too heavy for the icebreaker is penetrated by dogged perseverance, her progress will be so slow that it must be finally abandoned. It is then very difficult to turn around, although the ship can probably retreat in her own track. The ship is in grave danger of damaging a propeller under these circumstances.

4. Poor Visibility - This is the most serious hazard to ice navigation. Unless one can see ahead one cannot tell where to go and will probably get into more trouble all the time. In poor visibility it is much better to wait for clearing weather than to attempt to proceed.

5. Impatience - Ice navigation cannot be hurried. Not only must one wait for good visibility, but against heavy pack it is better to wait for an opening than to attempt to force one. Pack ice is always in motion. It changes constantly with the winds, tides and currants. An impassable barrier one day may be open the next.

6. Damage to Ship - It must be remembered that the propellers of an icebreaker are not invulnerable. It is dangerous to swing sharply where the stern of the ship will be brought against the edge of a heavy floe. Backing in heavy pack is especially dangerous and should be done slowly and only when absolutely necessary. Often the ship will slide back by herself if given time. If a propeller is damaged in heavy pack , the ship may have difficulty in extricating herself. When working in heavy close pack, some ice is always forced under the hull and damage may occur to propellers.

Airlift Operations

Spring Airlift - The basic plan for re-supply of all satellite stations is by airlift during the spring of the year, in late April or early May. This is considered the logical time of the year for such operations since the weather and ice landing surface conditions for aircraft are most favourable. Supplies in storage at Thule and Resolute are moved by air to the satellites during this period; fuel oil is loaded from bulk storage into drums for delivery to the stations. Although Alert and Eureka may receive their supplies by icebreaker, there is no certainty that this can be accomplished in any particu1ar year, therefore, supplies are procured for all satellites on the basis of delivery by spring airlift. The bulk of items required for use at satellites from spring 1952 through spring 1953, for example, were shipped in the summer of 1951 and procurement was initiated for some items of supply as early as the fall of 1950. It is evident that the period of time elapsing between planning of procurement and actual use of supplies results in inevitable discrepancies between actual needs of a station and regular annual supply, arising from unforeseen changes in consumption and in program. Such situations are rectified by shipment by air from U.S. and Canada at spring airlift time or at other times of the year. If Alert or Eureka are reached by icebreaker in a particular year, then spring airlift operations for that station are very much reduced in scale, including only mail and certain items not delivered by summer sea supply mission because they are not suitable for long period storage.

Other Airlift Operations - Second in importance to the spring airlift is the fall airlift when a limited quantity of urgently needed items, fresh food and mail are delivered to the satellites after airstrip surfaces become sufficiently frozen to permit landing of heavy aircraft. Personnel replacement movements are made usually during spring and fall airlift operations. In addition to spring and fall airlifts, emergency supplies and mail deliveries are made to satellites by parachute in a mid-winter drop, usually in December, and by a mid-summer drop, usually in July. Special flights are made at other times of the year as needs arise and facilities are available to make them.

Responsibilities - At the present time, airlift operations from Resolute to Isachsen and Mould Bay are the responsibility of the R.C.A.F. who also conduct flights to Alert and Eureka as circumstances require. Regular airlift operations from Thule to Alert and Eureka are the responsibility of the U.S.A.F. Mail and cargo shipments other than the summer sea supply shipments destined for Eureka and Alert proceed via U.S.A.F. to Thule, Greenland. Mail destined to Isachsen, Mould Bay and Resolute is routed via R.C.A.F. to Resolute.

Chapter 5

PERSONNEL

Division of Duties (Classification of Staff) - In accordance with the basic agreement between the United States and Canada, the staffing of the joint stations is on an equitable basis, that is, each country provides half the personnel to operate each station. In the staffing of Isachsen and Mould Bay where the staff consists of seven men each, one station comprises four Canadian and three U.S. personnel, while at the other there are three Canadian and four U.S. citizens.

At all of the stations the Official in Charge is a Canadian. The senior U.S. representative, who is responsible for the activities of U.S. personnel and the administration of U.S. interests on the station, is designated as an Executive Officer.

Basically the Canadian and U.S. Positions are as follows:

Canadian:	Official in Charge Radio Operators Meteorological Observers Cooks
United States:	Executive Officers Radio Technicians Meteorological Observers Mechanics Supply Clerk Cooks

Official in Charge - The Official in Charge has the responsibility for the overall administration of the station, the safety and security of the personnel and station, the scientific programme with transmission of data, the preparation of reports, records and recommendations for improvement of station facilities and the maintenance of morale and discipline on the station.

Executive Officer - The Executive Officer is responsible for the administration and welfare of the U.S. personnel and accountability of U .S. property. He is also responsible for amicable international relationships of his U.S. subordinates with Canadians and Canadian authorities He supervises the operation and maintenance of mechanical equipment, including radio transmitters and radiosonde equipment. At regular intervals he submits reports and recommendations to the Chief of the Arctic Operations Project of the U.S. Weather Bureau.

Meteorological Observers - The meteorological observers carry out the observational programme according to standard procedures of both the Canadian Meteorological Division and the U.S. Weather Bureau.

Radio Operators - The radio operators are responsible for operating the station communications equipment. They also participate at times in taking weather observations.

Radio Technicians - The radio technicians provided by the United States are responsible for the maintenance of the radio equipment. They are also required to assist in the transmission of messages and station maintenance duties as required in addition to their official duties.

Chief Mechanic - The Chief Mechanic is responsible for the maintenance and repair of generators and power system and all mobile equipment. He is experienced in the use of power tools including lathe, drill press, welding equipment, etc. He must be able to supervise the duties of the general mechanics engaged in maintenance of the station utilities including construction, repairs or operation of equipment. He is responsible for the maintaining of stock records of machine supplies and spare parts.

General Mechanic - The general mechanics are experienced in the operation of heavy equipment such as D-7 and TD-9 diesel tractors, fork lifts, and gasoline engines. Their duties also include the maintenance of camp utilities including fuel system, water supply, snow removal, trash and waste disposal, etc.

Supply Clerk - The supply clerk maintains inventories, stock records and shipping documents. He is also responsible for keeping records of accountable properties issued to personnel and maintains a store house of miscellaneous supplies.

Cooks - The cooks selected for the stations have previous professional experience in cooking for small groups of people. They are proficient in baking bread, pies, cakes, etc., and preparing menus of balanced diet. They are required to maintain records of food consumption and a running record of the food inventory.

Selection of Personnel - In considering the selection of personnel for Arctic assignments whether they be Canadian or U.S., there are certain factors to be followed in trying to find the right man. In general, the following qualities are found to be the most important considerations in the evaluation of an individual:

1. Technical Ability
2. Personality
3. Enthusiasm
4. Physical Fitness

Of the four above categories, the most difficult to determine by interview or from letters of recommendation is a man's personality.

If one were to select an individual for an extended journey into the wilderness, personality would be of equal importance to the other three categories. Little of this same importance is lost where the hardship of isolation and boredom will bring out the best or the worst in a man's character. Quite understandably, however, in Arctic stations where turnover is yearly and forty or fifty men are to be screened, the problem of selecting for the right personality is most difficult. With a few exceptions, personnel at the joint stations have been able to get along together remarkably well. Experience gained over the past five years has provided a pattern to follow in the selection of qualified personnel and although a few undesirables have been hired on occasion in spite of careful screening procedures, definite progress has been made in the better selection of personnel.

Health and Recreation

The health of the men at the Arctic Stations has been remarkably good. This is attributed in part to the comparatively high standard of living. Quarters are the best obtainable, offering each individual the maximum degree of privacy practical on these small stations. Dietary standards have been arrived at after years of study and practical application and as a result the food supplied affords well-balanced meals. .In addition, the stations are almost entirely free of disease bacteria, being hundreds of miles from the nearest settlement. However, as a result of living in the relatively germ-free areas of the north, the individuals lose an immunity to the usual communicable diseases and, therefore, are easily susceptible to virus infections occasionally introduced by transient personnel.

Probably the most common ailment is dental trouble. By joint arrangement between the two countries, a dentist is assigned to the Arctic stations to participate in the spring re-supply mission. If time permits, he visits each station; otherwise, personnel are flown to Resolute for treatment. Early in 1951, an amateur radio operator in the United States relayed instructions from a local dentist to the Alert station where the cook was suffering from toothache, and a successful extraction was performed by station personnel.

Field-type medical kits are located at each of the stations. These include tooth extracting equipment, sulfa drugs, penicillin, plasma, etc., and medical instructions.

Procedure for Obtaining Medical Aid - The following procedure has been developed to obtain medical assistance for personnel at the Joint Arctic Stations with the minimum possible delay.

1. Immediately on occurrence of i1lness or injury, etc., the Officer-in-Charge will prepare and dispatch a radio message in standard Wireless Consultation form as specified by the Canadian Department of National Health and Welfare.

2. If the station considers that evacuation by air may possibly be necessary, the following information must be added at the end of the message.

2.1 Landing place available--whether land airstrip, ice airstrip, bay or lake.
2.2 Length and width of runway.
2.3 Condition of runway surface (give details).
2.4 Available hours of daylight daily.
2.5 Landing facilities for day and/or night landings.

3. The above message will be addressed for action to:

Chief R.C.A.F. Medical Officer,
North West Air Command,
R.C.A.F., Edmonton.

and information copies sent to:

Controller TO, and
Reichelderfer, WBC via DO.

4. If evacuation is recommended by Chief R.C.A.F. Medical Officer, the stations will be advised, and all stations will stand ready and willing to assist in every possible way.

5. Information copies of all messages sent to R.C.A.F. from stations in connection with the emergency will be sent to:

Controller TO, and
Reichelderfer, WBC via DO.

6. It must be realized by personnel originating messages from the stations, that accuracy is most essential in all statements. The doctor's diagnosis and decision as to the necessity for evacuation is to a great extent dependent on the accuracy with which the patient's condition is reported in these messages. Further, the lives of Search and Rescue crews and the safety of aircraft are involved in the event evacuation is considered necessary by the Medical Officer.

<u>Accidents</u> - Although health in general has been excellent there have been serious medical situations requiring evacuation.

An attack by a polar bear resulted in severe injuries to a radio operator necessitating evacuation from Resolute in the fall of 1947. An aircraft, fortunately at Resolute, carried out the evacuation.

In the spring of 1948, the Executive Officer at Mould Bay was evacuated by C-47 aircraft. Diagnosis in the field indicated a heart ailment of unknown seriousness.

In the fall of 1950, a mechanic at Eureka who was suffering from an infected finger was evacuated by the R.C.A.F., received medical attention at Fort Churchill and was returned to Eureka a month later.

Another mercy mission was flown by the R.C.A.F. during the spring of 1951. A Mould Bay airstrip construction workman was taken ill with an ulcerated stomach condition and was evacuated to a hospital in Winnipeg.

Recreation - Living in a remote part of the world offers the Arctic employees ample opportunity to engage in a hobby whether it be skiing, photography, collecting fossils, rocks or Arctic flowers, or just hiking. There are games, music and books for those who seek their pleasures indoors. Complete darkroom facilities are to be found at each station for the use of camera enthusiasts and a still camera is part of the station equipment. Each station has been provided with a record player and every year the size of the record libraries increases. In addition, short wave radio receivers are on hand for entertainment purposes.

Animal life abounds at most of the stations. Polar bears, muskox, caribou, wolves, white fox, Arctic hare and the lowly lemming are to be found and although the bears and wolves are inclined to be dangerous, the study of all of the animals is most interesting. Bird life includes ravens, tern, eider ducks, sanderlings, knotts, ptarmigan, brant and jaeger among others.

Games in variety are to be found in the recreational supplies. Chess, checkers, and playing cards are always favourites; fishing supplies, table tennis sets and softball equipment are also furnished, as well as guns and ammunition for target practice. Libraries are well-stocked and include many volumes of early Arctic expeditions as well as other educational and fictional reading.

Chapter 6

METEOROLOGICAL PROGRAMME

Surface Observations

Eight daily synoptic observations are taken at 3-hourly intervals at all Joint Arctic Stations. The observations are commenced simultaneously at all the stations at the following times in GMT; namely, 0215, 0515, 0815, 1115, 1415, 1715, 2015 and 2315. The observations are taken in accordance with instructions contained in Manobs, the manual of standard procedures and practices for weather observing and reporting in Canada. The observations which are taken at Alert, Eureka, Isachsen, and Mould Bay are transmitted by radio to Resolute. The entire weather collection is then relayed by radio from Resolute to Edmonton where the observations are put on the teletype circuits which feed into the forecast centres across Canada and United States. These observations are also made available to European centres by means of radio teletype from New York to Paris.

Hourly Observations - The programme at the Joint Arctic Stations does not require routine hourly reports at the present time. However, hourly observations are taken and transmitted when requested by the office at the departing point of an aircraft for the station concerned. A permanent record is kept of all reports so taken.

Techniques - The instruments and techniques used in taking weather observations at the Joint Arctic Stations are the standard ones which are used at all Canadian stations. However, in order that the best possible observations may be made under Arctic conditions, additional precautions are taken. The elements which require special care are listed in the following paragraphs.

Temperature - The following procedure is adopted in order that the thermometer readings will not be affected by the presence of the observer.

1. The instrument shelter is approached from the leeward side.

2. The thermometers are not handled while the readings are being taken.

3. The thermometers are read as quickly as possible after the door of the instrument shelter has been opened.

4. The observer does not come any closer to the instruments than is necessary for accurate observation of the scale and holds his

breath for a few seconds while the reading is made.

5. If conditions are such that frost is forming on the thermometers, they are wiped with a clean, dry cloth about fifteen minutes before each observation.

6. When the temperature drops below -39ºF, the freezing point of mercury-filled thermometers cannot be used. During such periods, the air temperature is measured by means of thermometers filled with alcohol or a mercury-thallium alloy, and the maximum temperature is obtained from the thermograph chart.

Visibility - Observations of visibility, particularly during the Arctic night, are of great practical importance for aircraft operation in Arctic regions. A light installed at the top of the antenna mast serves for visual observations of oblique visibilities under various conditions of Arctic weather. Other lights near the station may also be used for visibility markers.

For non-instrumental visibility observations during the Arctic night, the number of degrees from the horizon that stars of moderate brightness (third degree magnitude) can be seen is noted. The normal eye is capable of seeing stars of the first six magnitudes. If stars of moderate brightness can be observed within about 6º of the horizon, the visibility is usually unlimited.

For daylight observations of visibility, prominent station and natural markers are chosen, and the distance from the station to several of the near ones is measured.

Clouds - At stations north of the Arctic Circle, observers must become proficient in recognizing cloud types under conditions of semi-darkness. Cirrus-type clouds, which are composed of ice crystals, form at much lower altitudes than they do in temperate zones and are often observed as low as 5,000 ft. or less. Convection is weak and clouds are mainly of the sheet or stratus type rather than any form of cumulus.

Low powered ceiling projectors have been supplied to the Joint Arctic Stations in order that cloud heights may be determined during the dark period.

Precipitation - Precipitation in the Arctic is chiefly in the form of snow. The measurement of the amount of snowfall is a difficult problem anywhere and especially so in the Arctic where drifting is considerable. During periods of high winds, the air is filled with blowing snow to such an extent that it is often difficult to tell whether snow is actually falling or not. However, newly-fallen snow is usually a shade whiter than the old drifting snow and will show up if the drifts are examined carefully. There is no method at present by means of which an exact measurement of the amount of snowfall can be obtained. However, a good approximation is the average of a series of measurements of the depth of freshly fallen snow in a level semi-sheltered area.

Care of Instruments - The instrument shelter may fill with snow during severe storms of blowing snow. In such cases, the thermometers may not indicate true air temperature owing to the insulating effect of the snow and the lack of venti1ation. The accumulation of snow in the shelter may be prevented by covering the shelter with canvas for the duration of the storm. If the station is located in an area where winds of moderate speed are frequent, a canvas cover is not advisable since it reduces the free circulation of air in the shelter. Instead, the floor boards may be cut out of the shelter entirely and a special shelf constructed for the thermograph.

It is difficult to ensure the continuous operation of the clock mechanism in instruments such as a thermograph during extended periods of low temperatures. The clock may be oiled lightly with a high quality low temperature oil, but it is often preferable to clean all the oil from the mechanism and permit it to run dry.

Disposition of Records - All surface weather records are kept in duplicate at the Joint Arctic Stations. One copy is kept on the station and the other copy is forwarded to the Head Office of the Meteorological Division in Toronto. The records are microfilmed in Toronto, and a microfilm copy is forwarded to the United States Weather Bureau in Washington.

The surface weather observations which have been taken at the Joint Arctic Stations are given in appendices to this report.

Station Identification - The meteorological call letters and international index numbers of the Joint Arctic Stations are given in the following table:

Station	Call Letters	Index Number
Alert	LT	082
Eureka	EU	917
Isachsen	IC	074
Mould Bay	MD	072
Resolute	RB	924

Ceiling Measurements - Resolute Airstrip and Weather Station - Comparative ceiling measurements were taken simultaneously at the Resolute airstrip and weather station on three occasions in 1949. The station elevation is about 55 feet a.s.l. whereas the airstrip is about 190 feet a.s.l.

The following observations were made:

Date	Time	Ceiling Airstrip	Ceiling Weather Station	Wind
June 27	2130 CST	200 ft.	400 ft.	SW 4
July 19	0900 CST	500 ft.	1,000 ft.	NNW 18
July 20	1030 CST	500 ft.	840 ft.	NNW 20

Although these observations are not conclusive, they suggest that the height of the summer stratus at the Resolute airstrip may be expected to be at least 200 feet lower than at the weather station.

Optical Phenomenon at Resolute - On the evening of June 2, 1948, at about 2215 CST, a shallow bank of fog rolled over Resolute Bay from the northwest and continued on towards Barrow Strait. When the fog bank was well south of the station, a brilliant multiple fog bow consisting of seven separate arcs was observed. A theodolite was used to make some angular measurements of the arcs, but the display lasted for only a few minutes and the three innermost arcs faded before readings could be taken.

At first each bow showed appropriate rainbow colouring, red on the outer edge and violet on the inner, but they soon became diffuse and appeared white with a slight reddish glow on their outer edges. At the time of the observation, the elevation and azimuth of the sun were approximately 9° and 333° respectively. Azimuth readings were taken of the intersections of each portion of the arc with the horizon as closely as possible. These readings are given in the table below.

Azimuth Readings of Intersections.
of Arcs with Horizon

	Arc 1	Arc II	Arc III	Arc IV
East	112.5	117.0	120.7	123.8
West	194.5	190.0		183.5

Mean angular separation of arcs in degrees

I-II	II-III	III-IV
4.5	3.5	3.0

The theory of the formation of supernumerary rainbows is fully covered in Chapter III of "Physics of the Air" by W.J. Humphreys. The angular separation of supernumerary rainbow maxima varies inversely as the size of the drops causing them. If the rough assumption is made that sunlight is monochromatic with a wavelength near the middle of the visible spectrum, the tables on pages 492-493 of "Physics of the Air" provide an approximation for the size of the fog droplets, namely 0.03 mm. radius.

Upper Air Observations

Pilot Balloon Observations - Two pilot balloon observations are made daily at all the stations whenever weather conditions permit. These observations are recorded and coded for transmission by radio according to the instructions contained in Manobs. The pilot balloons are released within one-half hour of 0900 and 2100 GMT. However, at lsachsen and Mould Bay, where there is no radio direction-finding equipment for obtaining upper winds from a radiosonde ascent (rawinsonde), the pilot balloons are released at the time of the radiosonde flight, within one-half hour of 0300 and 1500 GMT.

Helium is used for inflating the balloons at Resolute, but at all the other stations hydrogen is used. Whenever hydrogen is used, all necessary precautions are taken to guard against static electrical discharges, owing to the explosive nature of this gas when mixed with air in proper proportions.

All pilot balloon flights are followed as long as the balloon is visible since it is desirable to obtain the winds at all levels up to the maximum possible altitude.

During cold weather, moisture from the observer's breath condenses on the eye-piece and objective lenses of the theodolite. It is then necessary to keep a clean dry cloth handy to wipe the frost from the lenses. The eye-piece cap is removed in order to make the lens more accessible.

Optimum conditions for obtaining pilot balloon flights to high altitudes occur in the spring months at the Joint Arctic Stations. During the summer and early fall the high frequency of low cloud reduces considerably the number of days per month when a flight above 3,000 feet may be obtained. In the winter dark period the main limiting factor is the brightness of the light which is carried by the pilot balloon. Small flashlights are sometimes used. The dry cell type of battery is not satisfactory for this since it loses its strength very rapidly at low temperatures. A type of wet cell battery, which is activated by soaking in water prior to the flight, has given satisfactory results. However, many of the observations are taken with the aid of a candle which is carried aloft by the balloon in a paper lantern.

Radiosonde and Rawinsonde Observations - The observation, rapid transmission and accumulation of upper air data constitutes one of the main commitments of the Joint Arctic Stations. Except during occasions of extremely unfavourable weather or some unforeseen emergency, every attempt is made (a) to accomplish a successful release, (b) to obtain the maximum possible altitude, and (c) to ensure reliable data.

The releases are made within one-half hour of 0300 and 150O GMT. As the radiosonde transmitter is carried aloft by a balloon, it transmits pressure, temperature, and humidity data to a receiving station on the ground. At Alert, Eureka and Resolute, additional equipment is available to permit tracking the radiosonde transmitter by means of radio direction-finding equipment as it is carried aloft. Thus, with this rawinsonde equipment, it is possible to compute the wind at various altitudes even when the sky is obscured by low clouds.

By basic Canadian-United States agreement, the upper air records from the Joint Arctic Stations are processed by the U.S. Weather Bureau and U.S. Weather Bureau procedures and instructions, as given in their circular P, apply in making the observations.

In order to ensure reliable data, it is necessary that station personnel perform periodic specific calibration of the radiosonde ground equipment. One person who has received instruction in calibration procedure is assigned to each Arctic station. This person has the responsibility for the maintenance and calibration of radiosonde and rawinsonde equipment. An electronic technician has been appointed by the U.S. Weather Bureau to visit each station periodically and perform major maintenance on the equipment if necessary.

An upper air ascent is seldom missed at any of the stations. In general, the only occasions when a flight has been missed have been times of extremely severe weather or when all available personnel have been required for urgent loading or unloading of aircraft during a re-supply period. Weather conditions do not normally prevent a successful release. However, during periods of high winds, turbulent eddies near the surface may smash the transmitter against the ground before the balloon has risen to a sufficiently high altitude.

The upper air observations which have been taken at the Joint Arctic Stations are given in an appendix to this report.

Chapter 7

SPECIAL SCIENTIFIC PROJECTS BY WEATHER STATION PERSONNEL

Low Level Air Temperature Measurements

Resolute - In order to obtain data which may be used in the study of inversions, the occurrence of fogs, visibilities, and associated Arctic phenomena, measurements of the temperature profile In the lower levels of the atmosphere were begun at Resolute on September 6, 1948.

Three ceramic type resistance thermometers were available for this study and were mounted on one of the radio masts at heights of 6 ft., 36 ft., and 72 ft. above the ground. The thermometers were shielded from direct solar radiation by means of specially fabricated shields which also served as mounts for the thermometers. The cables from the thermometers were led to an indicator box located in the operations building of the weather station, one hundred feet from the radio mast.

The observations were begun with two readings daily. These were increased to four per day on November 1, 1948.

It was noted during the winter that the calibration of the thermometer at the 36 ft. level appeared to be changing. A check thermometer was mounted at the 36 ft. level for comparative readings and a correction factor was determined for the original thermometer. However, since the correction factor did not remain constant, it is felt that the temperature readings at the 36 ft. level must be treated as doubtful.

The observations were discontinued on August 12, 1949, when the thermometers ware required for another purpose.

Alert - An installation for the measurement of the temperature profile at low levels in the atmosphere, similar to the one at Resolute, was put in at Alert in the summer of 1951. Thermohms were mounted at the following heights on the wind charger tower; 6 in., 2 ft., 4 ft., 8 ft., 16 ft., 32 ft., and 45 ft., above ground level. Eight observations daily were begun on June 11, 1951. In addition, hourly observations were taken on August 11, 23 and 29 when conditions of clear skies and light winds prevailed.

Tables of Low Level Temperature Readings - The low level air temperature readings which were taken at Resolute and Alert are included in the tables that are appended to this report.

Permafrost Drilling and Soil Temperature Measurements at Resolute

Drilling Programme--1948 - In August, 1948, a drilling programme was carried out at Resolute to locate a suitable site for a future seismological station. When this had been completed, shallow holes were drilled about 100 feet north of the weather station operations building and ceramic resistance thermometers were inserted at the following depths:

1. surface

2. 4 inches
3. 8 inches
4. 18 inches
5. 39 inches
6. 60 inches

Two thermometers were also placed in a disturbed soil pit at depths of 17 inches and 34 inches. Unfortunately, it was discovered that the elements in both thermometers in the disturbed soil pit and in the thermometer at the 4 inch level were damaged, and no readings were obtained from them. The cables from the thermometers were led to an indicator box in the operations building.

Daily readings were begun on September 6, 1948. These were increased to twice daily on November 12 1948, another thermometer was installed at the four inch level on August 13, 1949. On August 24, 1949, the thermometer at the 39 inch level developed an instrumental error and the readings at this level ware discontinued as of that date.

<u>Drilling Operations--1950</u> - In 1950, it was decided to extend the scope of this investigation and attempt to obtain information from much greater depths. It was hoped that a maximum depth of 1,000 feet could be reached. This project made possible by the joint efforts of the U.S Weather Bureau, the Meteorological Division of the Department of Transport, and the Dominion Observatory.

On August 20, 1950, a 1,000 ft. capacity diamond core drill with its accessories was landed at Resolute from the U.S.S Whitley cargo ship attached to the Task Force servicing the Joint Arctic Stations. The equipment was loaded on sleds and hauled to the station where it was installed at a point one hundred and fifty feet north-northwest of the east side of the operations building. The choice of this site enabled the, elements to be placed in fairly typical ground and at the same time the recording apparatus could be permanently located in the nearby operations building.

During the following weeks, a drill shelter, 12 feet long, 9 feet wide, and 8 feet high made from dunnage, was erected on a sled. This shelter, which was later covered with tar paper, was designed to accommodate the drill engine, a water pump, a water heater and a space heater. A

28-foot steel pipe tripod was set up for hoisting and lowering the rods and the remaining equipment was uncrated and made ready for immediate operation. Two new water pumps and a new drill engine were carefully run in to avoid delay when the drillers arrived.

Two drillers arrived on August 20, and at once turned their attention to the problem of water for use in the drill hole. Since a continuous supply of hot water was required at the rate of about 500 gallons per hour, it was decided to try and pump the water to the drill from a fresh water lake 1,500 feet west of the station. The water pump, rated at a thousand gallons per hour and powered with a four-cycle Briggs and Stratton gasoline engine, proved quite adequate for pumping to the drill site whose elevation was about 45 feet above the lake. A 1,500-foot line made up of 25-foot lengths of flexible steel hose was laid from the drill to the water pump which was, housed in a wooden shelter at the lake. This system delivered plenty of water, but the day after it was started the weather turned cold and the water quickly froze in the steel hose.

An attempt was made to heat the line by using an arc welder as an electrical heater where the steel pipe and another conductor were the heating coil. This method was quite successful when applied to individual lengths, but it could not be used over the whole line since rubber gaskets in the hose couplings insulated consecutive lengths from each other. Since it proved to be impractical to heat the water in the hose, and in view of the work involved in draining 1,500 feet of the line each night, it was decided to utilize a tank and haul water to the drill site as required.

A 1,000-gallon metal tank mounted on a tractor-drawn trailer was used for hauling water. This tank was also required at intervals of three or four days to supply water to the weather station and as a result, it was necessary to suspend drilling operations owing to lack of water during these periods. On other occasions, the tractor was required elsewhere which also resulted in a suspension of drilling activities on account of lack of water.

Two pumps were required at the drill site. One was used to pump water from the main tank through an oil-fired heating coil into a 45-gallon drum. The second pump took heated water from the drum and forced it into the drill hole. When drilling was interrupted, the water from the heating coil outlet was diverted back into the main tank to avoid wasting water.

The entire programme called for the installation of six individual temperature elements in separate holes as well as the installation of a cable one hundred feet in length and another one thousand feet in length with temperature elements distributed along the length of each cable.

<u>Drilling Procedure</u> - To begin each hole, a 2½ inch pipe was driven to bedrock with a 350-pound hammer. It was found in each case that the overburden was approximately 6 feet thick and consisted of frozen gravel.

Penetration through the last 18 inches was slow owing to the rock-like hardness of the permafrost. The bedrock was limestone with occasional faults and cracks. When the drill penetrated beyond one of these faults, the loose rock particles would cave in and cause a blocking of the drill hole when the rods were withdrawn. Such caving was prevented by the insertion of a 1½ inch casing. If caving occurred below the casing quick drying cement was forced into the hole. This cement prevented further caving and could be drilled easily. The hole was E size with a diameter of 1½ inches and recovered core with diameter 15/16 of an inch.

The deeper holes could not be completed in one continuous stretch of drilling since there was not sufficient staff for 24-hour duty. Thus, it was necessary to provide some means of preventing the residual water in the hole from freezing from one day to the next. As an initial experiment, fuel oil was pumped into the hole. The casing was then capped with plugs. This method did not prove to be satisfactory for the water which was left in the hole did not mix with the oil. As this residual water froze, the resulting increase in volume caused the oil to act as a hydraulic ram and the casing was pushed out of the hole to a height of four inches.

An ethylene-glycol type antifreeze was tried next with good results. When drilling was discontinued for the day, antifreeze was pumped in and no freezing was noted in the hole the following day. It was found that a little over four gallons of antifreeze were required for 100 feet of drill hole. The antifreeze was salvaged by forcing it out of the hole with a plunger consisting of a plugged rod. It was found that from the time that the plunger was withdrawn until the drill was inserted, enough frost formed in the hole to cause the rods to stick.

On September 14, the antifreeze was emptied from a hole drilled to 128 feet. When the core barrel was inserted it began to bind and it was decided to pull it up. Ice formation caused the rod to stick again at the 70-foot level and it was not possible to budge it. In an attempt to save the hole and salvage the equipment in it, the casing was pulled out, a shoe-bit was attached, and drilling was begun with the casing over the imprisoned rods. However, the water supply tan out when the casing had been drilled to 38 feet, and as the tractor was not available for hauling water, operations had to be discontinued.

On the following day, the casing was re-drilled from the surface to a depth of 55 feet. The great strain on the casing caused the threads at the couplings to begin to give and it was necessary to withdraw the casing and abandon the hole.

After the loss of the hole at 128 feet, it was decided to discontinue the practice of salvaging the antifreeze. The antifreeze was merely flushed out with the water as drilling was resumed. Holes were drilled to depths of 6 ft., 11 ft., 23 ft., 30 ft., 50 ft., and 103 ft. with little difficulty. All the core was recovered

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for the 103-foot hole. Thermometer cables and temperature elements were inserted at the following depths:

1. surface
2. 5 feet
3. 10 feet
4. 21.5 feet
5. 28 feet
6. 50.5 feet
7. 98 feet

The first six temperature elements consisted of high resistance ceramic thermistors encased in protective copper jackets sealed to lead-out cables. These elements were installed about 140 ft. north-northeast of the operations building with two feet between each hole. The surface element was mounted on an adjustable arm so that it could be placed immediately above the ground or snow throughout the year.

The 100-foot cable contains 18 thermistor elements. Fifteen of them are spaced at 5-foot intervals from the surface to 70 feet and the remaining three are at 80 feet, 90 feet, and 100 feet respectively. A 200-foot lead-in cable connects the temperature elements to an indicator box in the operations building. Before the cable was lowered into the hole that had been drilled to 103 feet, a test was made with a weight on a strong line to ensure that there were no obstructions in the hole. However, when the cable was lowered, it was stopped at a depth of 98 feet by ice or cave-in.

After each temperature cable was installed, the casing was withdrawn to avoid any possibility of the temperature readings being affected by the conduction of heat through the metal. While the hole was still warm from the drilling activity, a pipe wrench was clamped to the casing and tied to a heavy rope leading over the sheave wheel on the tripod to the winch drum. A second pipe wrench was used to rotate the casing while the winch applied tension through the rope which finally hoisted the easing up over the temperature lead-out.

After the individual temperature elements had been put down in the shallow holes, BXL lead-in cables were spliced to each lead-out conductor. Each soldered joint was covered with two alternate layers of electrician’s rubber and friction tape. The joints were then bound together with another layer of the rubber tape which was itself covered completely with friction tape. An 8-inch copper tube was slipped over the splice and filled with hot tar, making the joint both rigid and waterproof.

Deep Hole Drilling - The equipment was moved on September 22 to make a second attempt to drill to 1,000 feet. The tractor was not available for hauling water as it was required for other station duties and actual drilling operations were delayed until September 25. A depth of 94 feet was reached on September 26. Numerous delays were experienced from

September 27 to September 29 since the water hauling equipment was not available to permit continuous drilling. Moreover, one of the water pumps broke down on September 28. Nevertheless, a depth of 150 feet was reached on September 29.

On September 30, as the drilling progressed beyond 150 feet, the difficulties caused by ice formation increased rapidly. Although the time required to pull out the rods, extract the core and re-insert the drill was only about 10 minutes, on one occasion ice formed in the hole from 110 feet to 150 feet during this period. In view of this handicap and the difficulty of maintaining a continuous supply of water at the drill site, it was decided to discontinue drilling operations when a depth of 188 feet had been reached. The hole was filled with antifreeze and the casing was plugged. It was hoped that the antifreeze would keep the hole open until the following summer when drilling could be resumed.

Drilling 0perations--1951 - A further attempt to drill to a depth of 1,000 feet was made during the summer of 1951. Additional drilling equipment such as drill rods and drills, as well as an improved hot water boiler were provided by the Dominion Observatory. Two drillers and two experienced driller's helpers arrived at Resolute during the first week in July to carry out this project.

An adequate supply of water for the drilling was obtained by pumping water directly from the lake and drilling operations were carried on around the clock. The rate at which water was used at the drill site was about 400 gallons an hour.

Drilling operations wore first begun with the hole that had been left filled with antifreeze from the previous summer. However, this hole was lost when a cave-in occurred at the 31-foot level. The main difficulty during the drilling operations was found to be with the equipment. As drilling proceeded to greater depths, the water that was circulated had to be heated to a correspondingly higher temperature. The valves and the plungers of the pump did not stand up too well under heat and pressure and breakdowns occurred frequently.

A second hole was started and had reached a depth of 385 feet when a breakdown occurred in the pump. Drilling was stopped immediately, but the water in the hole froze so rapidly that some of the drill rods were frozen into the hole before they could be pulled out and the hole was lost.

Out of a total of 7 holes which were drilled during the period from the first week in July until August 20, five holes were lost. Three were lost due to cave-in, another owing to breakdown of the pumping equipment and the fifth was lost when mud formed at the bottom of the hole and there was not sufficient pressure in the line to wash the mud up to the surface.

Two holes were completed, one to 307 feet and the other to 453 feet. Thermistor elements were lowered into each of these holes and regular

observations are being taken. The hole that was drilled to 453 feet was completed in four days and a greater depth could have been reached, but so much drilling equipment had been lost in the other holes that insufficient drill rods were on-hand to progress any further.

A requirement still exists to complete the drilling to the 1,000 foot level. It is hoped that this would permit the determination of the depth of the permafrost layer in this region. In the opinion of the drillers who took part in the operations in the summer of 1951, the following additions and improvements to the present drilling equipment at Resolute will be required to complete the project:

1. Four drillers and two drillers' helpers. Four men are not sufficient to carry out around-the-clock operations efficiently.
2. Five hundred feet of drill rods in addition to those already at Resolute.
3. A steam boiler.
4. A duplex high pressure steam pump.
5. A special grease for the drill rods that will stand up under extreme heat.

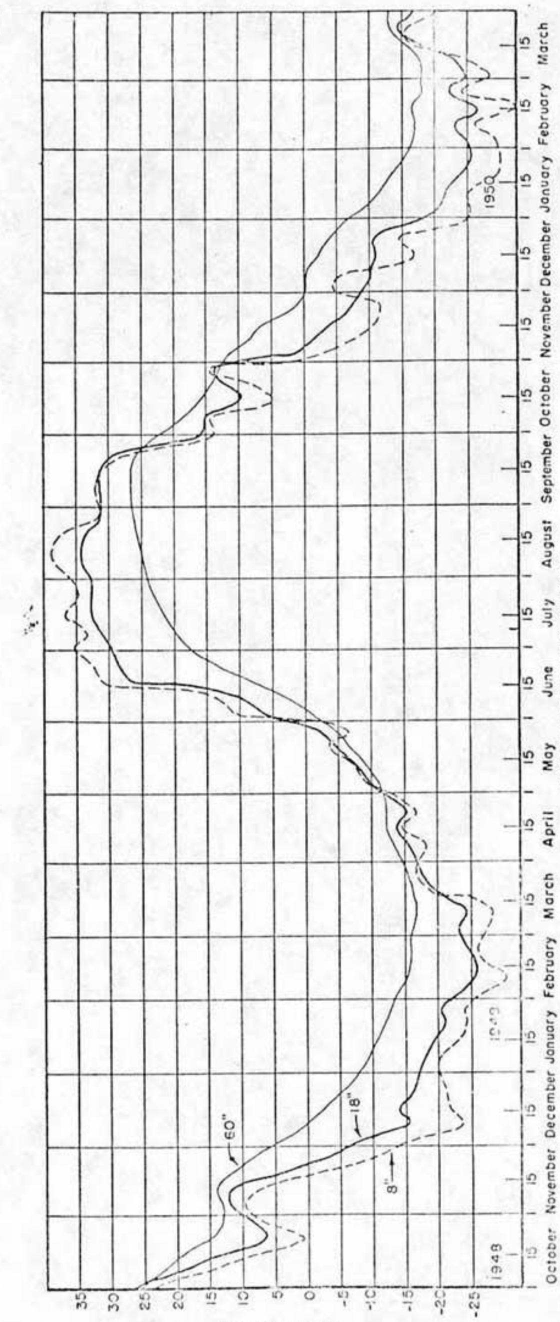
<u>Soil Temperatures at Resolute</u> - Tables of the soil temperature readings which have been made at Resolute since September, 1948, are appended to this report. Running graphs of the soil temperatures at weekly intervals at the 8 inch, 13 inch, 60 inch, and 50.5 foot levels are given on pages 55 and 56 to provide a pictorial description of the annual temperature regime at various depths. Graphs of the instantaneous temperature profile from the surface to 98 feet are also given for December, 1950, and June, 1951, on pages 57 and 58.

A thorough analysis of the temperature observations has not been made as yet. However, the graphs bring out a number of interesting features.

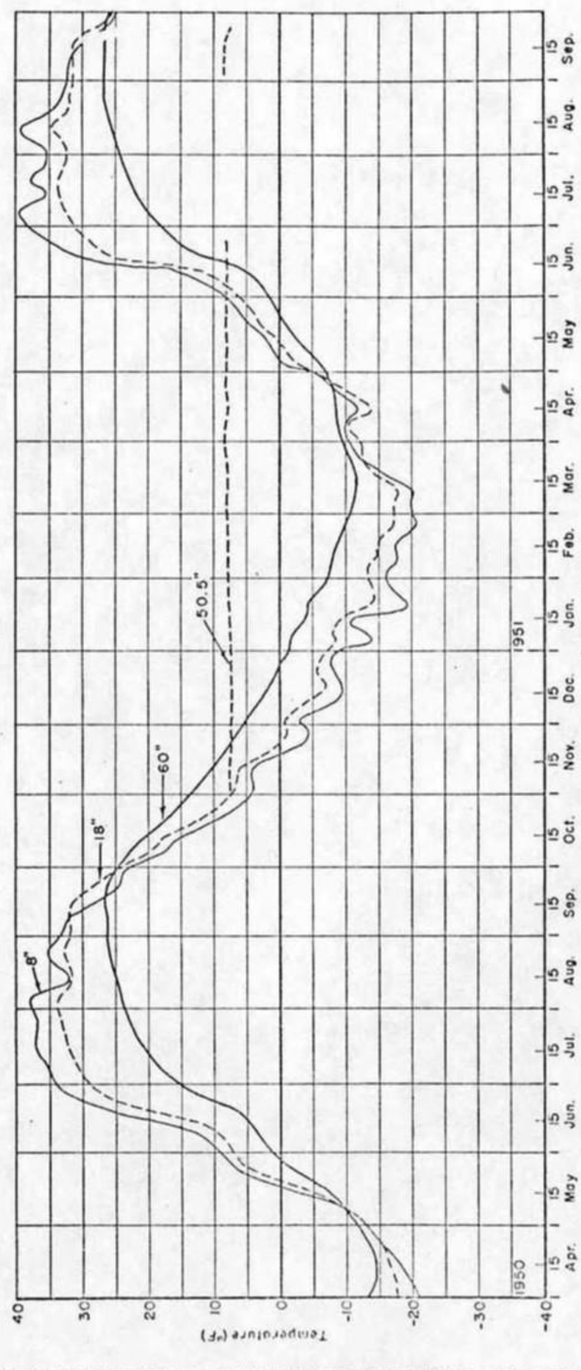
1. The temperatures at the 8 inch level show short period fluctuations which reflect the fluctuations of the air temperature above the surface. However, these fluctuations from ambient air temperatures are rapidly damped out with increasing depth and are practically negligible at the 60 inch level.

2. There is a marked lag in seasonal temperature changes with depth. For example, the temperatures at the 8 inch and 18 inch levels reach a maximum about the second week in August, whereas the temperature at the 60 inch level continues to rise until mid-September. The temperatures from the surface to the 60 inch level fall at varying rates after mid-September, so that by the last week in September there is a reversal in sign of the temperature gradient.

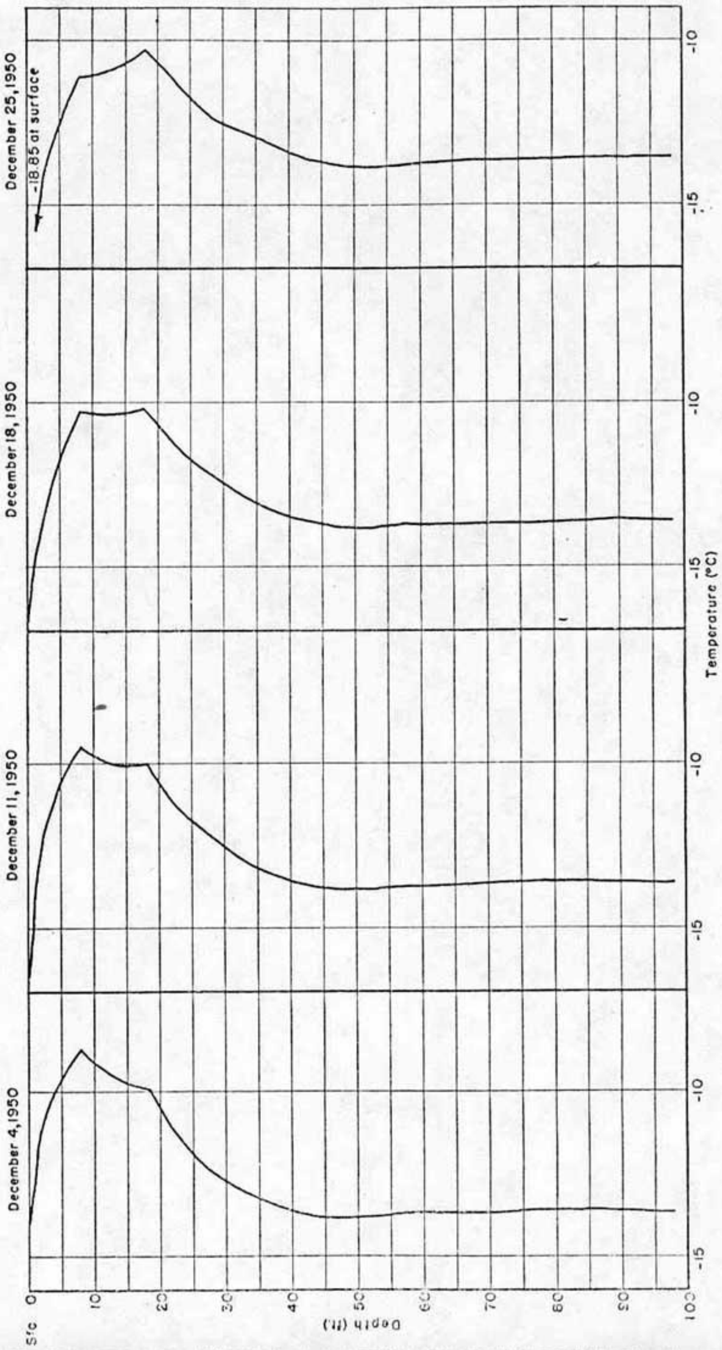
3. The temperatures in the layers near the surface begin to rise in



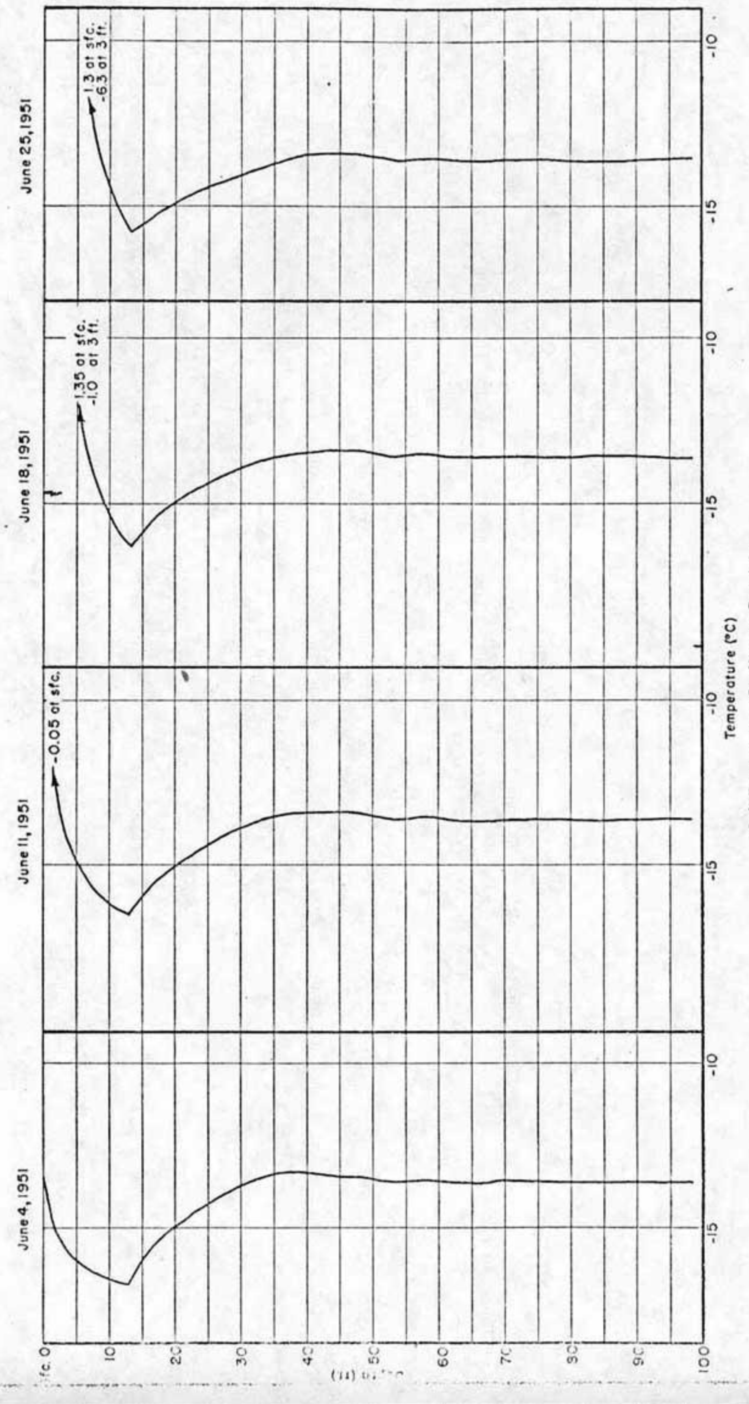
Soil Temperatures at Resolute



Soil Temperatures at Resolute



Soil Temperature Profiles at Resolute



Soil Temperature Profiles at Resolute

early March, and about May 1, there is again a reversal in sign of the temperature gradient from the surface to the 60 inch level.

4. From about August 25 to September 15, the temperatures within 18 inches of the surface remain near the freezing point, indicating that the complete freezing of the water in the active layer takes about three weeks.

5. The temperature at the 98 foot level remains practically constant throughout the year.

6. The layer from 50 feet to 98 feet is nearly isothermal.

7. Seasonal temperature changes are perceptible to near the 50 foot level, but the lag at this level amounts to about six months.

Tidal Observations

Prior to the establishment of the Joint Arctic Stations, tidal records for Arctic Canada were very inadequate. In the western Arctic, there was a brief record of observations taken near the Mackenzie River Delta. In the eastern Arctic, a number of temporary stations had been set up from time to time in Hudson Strait and around Southampton Island when hydrographic surveys were in progress. For the remainder of Arctic Canada, it was necessary to rely on spotty readings taken with the aid of improvised equipment by various expeditions.

A tidal observing programme was initiated at the Joint Arctic Stations to obtain additional information concerning Arctic waters. The necessary equipment was provided by the Canadian Hydrographic Service. Most of the observations were obtained with a simple tide scale consisting of a wooden scale graduated in tenths of feet, mounted vertically on a wooden platform. The instructions specified that the tide scale was to be installed in the spring as soon as the first patches of open water appeared near the shore. The most preferable type of location is a deep pool near the mouth of a river surrounded by sand bars which would provide some protection from drifting ice. Unless the ice is driven by great force, it simply goes aground on the sand bars and does not disturb the tide scale. Furthermore, the mouth of a river is generally ice free far in advance of other locations and thus permits an earlier beginning of tidal observations.

Some of the difficulties which arise when tidal readings are made in Arctic waters may be judged from the following account of experiences at Resolute in the summer of 1949. The site for the tide marker was chosen at a point near the mouth of a small creek where a wide shore-lead had formed by the second week in July. The location was surrounded on three sides by gravel bars, and it was found that throughout the summer these bars provided sufficient protection that the tide marker was dislodged by ice on a few occasions only, although there were numerous large blocks of ice in the vicinity almost continually. Whenever the marker was shifted by ice, it was reset as closely as possible in its previous location. A geodetic bench mark on the beach nearby was used as reference. On August 16, 1949, a huge block of ice upset the marker and it was not possible to re-erect it until August 22. On August 28 drifting ice tore the marker from its platform and it was found on September 4, two miles from its original location.

Readings were made with a telescope mounted beside the door of the operations building in the camp area. Since there was continuous daylight during the summer, it was necessary to visit the beach only when visibility was poor or when drifting ice obscured the marker. An attempt was made to obtain several readings near each high and low tide with a few intermediate readings. This could not always be done for occasionally other duties interfered with the tidal observations or the marker was obscured by fog, snow or drifting ice.

Recording Tide Gauges – Recording equipment to provide continuous observations of Arctic tides has been provided to the Joint Arctic Stations by the Canadian Hydrographic Service. The only station at which satisfactory results have been obtained with this type of instrument to date is at Mould Bay where a very complete record of tides has been obtained for the period July 18 to September 19, 1951. It is interesting to note that the tide gauge continued to function until September 19 in spite of the fact that there were l½ inches of ice surrounding it. The float in the gauge crushed the ice and kept it in a slushy condition.

An attempt was made to obtain observations with this equipment at Resolute and Isachsen. Unfortunately, when the gauge was assembled at Resolute, it was found that the spindle for the clockwork drum was too large and the instrument would not function. A replacement is being provided for this equipment.

The automatic tide gauge at Isachsen was installed on the bay ice in October, 1950. The float chamber for the gauge consisted of a pipe which was frozen in the ice and filled with fuel oil to prevent water freezing in the pipe. However, there was not enough pipe on hand to provide a sufficiently great pressure head so that the fuel oil would displace all the water from the pipe, and after three days of operation the gauge was rendered inoperative by water freezing in the pipe.

Tide Records - The tidal observations which have been taken at the Joint Arctic Stations are given in an appendix to this report. A thorough analysis of the results is being made by the Hydrographic Service of Canada. However, it may be noted from the records which have been taken to date that the highest tidal ranges which have been experienced at the various stations are approximately as follows:

Alert - 2 feet
Eureka - 1 foot
Isachsen - 1½ feet
Mould Bay - 1¾ feet
Resolute - 6 feet

The following general features of the Resolute tides may also be noted:

1. The spring tides occur approximately one day before to two days after a new and full moon.
2. The neap tides occur approximately one day before to three days after the moon's quarters.
3. There is an inequality in range between the two tides of the day and the intervals of time between successive high tides and successive low tides do not remain constant.
4. The minimum range, which occurs at the neaps, is less than half the maximum range, which occurs at the springs.

Ice Thickness Measurements

The systematic recording of sea ice conditions is an important phase of the scientific programme at the Joint Arctic Stations. The basic observations are as follows:

1. Periodic thickness measurements at representative points. In general, weekly observations are required. However, this has not always been possible at all the stations with the staff available.

2. Date and circumstances attending the fall freeze-up.

3. The record of the ice deterioration from the beginning of the spring thaw until the final break-up during the summer.

Special long-handled chisels are used for cutting holes in the ice in order to obtain ice thickness measurements. This involves a considerable amount of work when the ice is several feet thick and an improved measuring device was constructed at Resolute in the fall of 1949. The new

Resolute ice thickness measuring installation consists of a 9-foot length of 3-inch pipe which is embedded in the ice with approximately three feet of its length projecting above the upper surface of the ice. This pipe is filled with fuel oil which displaces the water from the pipe so that no freezing occurs in it. The thickness measuring device consists of a twenty-foot length of 3/8 inch pipe with two arms of 3/8 inch pipe about 11 feet long hinged to its lower end. The two arms are prevented from opening out to an angle greater than 45 degrees by short lengths of chain attached to the main supporting pipe. This measuring rod is lowered into the 3-inch pipe with the arms folded. When the tips of the arms have passed below the lower end of the 3-inch pipe, the weight of the arms causes them to open outward to the extent of the chain. When the rod is then raised, the arms butt against the lower surface of the ice and the ice thickness may be read from graduations along the main pipe stem. A cross bar at the top end of the measuring rod prevents it from falling through the 3-inch pipe and it is left in place throughout the winter. Occasional comparative measurements are made of the thickness of ice on fresh water lakes nearby.

A preliminary analysis has been made of the ice thickness measurements which were taken at Resolute from September, 1947, to May, 1948. The readings were taken at a point near the centre of the bay about one half mile from the shore where the water depth is approximately 35 feet. A measurement was attempted on June 7, 1948, but the hole could not be completed owing to rapid seepage of water and slush after a depth of 2 feet had been reached. The bay first froze over solidly on September 20. Slush ice formed in the bay on September 11, but this was all blown out a few days later by strong northerly winds.

Since many of the bays on Arctic islands are ice-free for at least part of the summer, the ice which covers them during the winter is for the most part new ice which forms after the fall freeze-up. It is expected that the ice observations taken at the Joint Arctic Stations will permit a determination of the extent of variation of the rate of accretion of this new ice from year to year near various islands in the Arctic and how this rate is affected by such factors as depth of snow cover, severity of winter and so on.

It is suggested that the cycle of ice formation from freeze-up to break-up follows a pattern somewhat as follows. When the ice first forms in September, the thickness increases rapidly for a few days. When a layer of several inches thick has formed, this acts as a partial insulator and the rate of increase drops slightly. During this period the ice surface is still receiving some radiation from the sun during the day. However, after the beginning of November, when the sun no longer rises above the horizon, no solar radiation is received and the rate of increase rises. After the sun begins to rise above the horizon in February, the rate of increase again falls off until sufficient solar radiation is received that the ice begins to melt. This appears to occur early in June at Resolute.

The total accumulation of bay ice in any winter depends to a certain extent on the date of freeze-up since an early freeze would mean a longer ice growing period. The rate of ice accretion at any time depends upon the ice thickness and the temperature difference between the water surface and the air. A severe cold spell will cause a higher rate of accretion if it occurs in the fall while the ice is still relatively thin than a similar cold snap later in the winter when the ice is relatively thick.

Since it was not expected that the amount of ice accretion at Resolute would vary widely from year to year, the graph of thickness measurements taken in the winter of 1947-48 and the ice thickness measurements for the fall of 1948 were used to make an estimate of the total ice accretion at Resolute for the winter of 1948-49. On December 29, 1948, it was estimated that the ice thickness should be about 61 inches on March 1, 1949 and that the total ice accretion for the winter should be about 77 inches. This forecast was found to be reasonably close to the truth, for the ice thickness was measured as 60 inches on March 1 and as 75 inches on June 12, 1949.

An interesting feature of the ice observations taken in 1950-51 is that the bay ice accretion at Alert, the most northerly of the Joint Arctic Stations was markedly less than at Resolute. The reason for this has not been determined as yet.

A record of the ice observations which have been made at the Joint Arctic Stations is given in an appendix to this report.

Sea Ice Reports - Resolute, N.W.T.

June 24th, 1950 - Ice reconnaissance flight reports Smith Sound ice-free to latitude 79°N. Kennedy Channel, Lincoln Sea and west around tip Ellesmere many tidal cracks. North shore of Jones Sound to northern tip of North Kent Island free of ice. Norwegian Bay a few open spots mainly frozen with old ice embedded. Area north of Cornwallis cracked and ready to break up.

June 27th, 1950 - Ice in Resolute Bay land fast with numerous tidal cracks. Many thaw pools persist on bay ice although beginning to flow through cracks. Some candling apparent in surface layer. Barrow Strait clear of ice with exception of small pans of drift ice. Ice breaking off outer edge Resolute Bay ice pack with tidal and wind action. Creek started to flow about three days ago.

July 5th, 1950 - No significant change in the extent of bay ice. Shore cracks widening but no shore lead. Surface bay pools run off through numerous holes and cracks. Ice estimated sixty four inches thick.

July 11th, 1950 - Bay ice has more cracks than before, but still remains as solid pack. Another large piece broke off pack at mouth of bay last Wednesday evening. Since then large drift pans visible in strait and with proper wind has plugged solid into the bay moving out later. Shore ice broken free and tide action apparent last two days. Large areas of open water visible between Cape Martyr and Griffith since last Tuesday.

July 18th, 1950 - Three-quarters of the ice in bay broken up and moved out into Strait Saturday last. Since Saturday midnight, high winds developed and shifted such that ice pans have choked up major portion of bay again, however, requiring only shift to Northwest wind to clear bay of ice entirely. Some indication that bay ice nearly solid vicinity 1947 landing area.

July 26th, 1950 - All ice moved out of bay overnight. Considerable drift pans visible in Barrow Strait when wind from south and southeast.

July 16th, 1951 - Shore lead North Star Bay to vicinity Cape York Greenland broadening and clearing of floes. Lancaster from Coral Harbour July 10 reported almost solid ice except for large lead about ENE-WSW near Cornwallis Island, frequent breaks along shore. Lancaster which departed Resolute July 13 reported considerable open water along South shore and as far as Devon Island, also some open water along east coast of Cornwallis.

August 4th, 1951 - Resolute Bay ice free except three-tenths of ice at entrance brought in by recent wind shift. Six-tenths ice extending in V-shape from E corner Cornwallis to Somerset. Seven-tenths ice along east shore Cornwallis.

August 15th, 1951 - Light easterly winds and incoming tide filled Resolute Bay with ice Friday, August 10 and forced ships to withdraw. Two days with winds north-west about 10 m.p.h. failed to move ice out and renewed southerly winds yesterday moved in more and larger ice floes. Fresh westerly winds this afternoon cleared ice from west side of bay which is now 60 percent free of ice with many leads out to channel.

August 21, 1951 - Bay and channel ice free.

Sea Ice Reports   Eureka, N.W.T.

July 9th, 1947 - Ice conditions in fiord and sound not noticeably change from last report. Deterioration of ice slowly progressing.

July 15th, 1947 - Ice in Slidre Fiord and Eureka Sound beginning to break up. Leads changing daily in size and direction. Thickness of ice in fiord thirty inches.

July 15th, 1947 - The ice in the fiord and in Eureka is separating at the cracks and drifting around in large floes, which are being crushed together and against the shores, greatly hastening their breaking up. In the fiord large expanses of open water, some more than a mile wide, and in the area of the Sound that can be seen from the station somewhat smaller leads are visible. It is not safe just yet to attempt to make soundings as a change of wind might crush the tiny boat and maroon the men on an ice floe. Ice appears to be remarkably thin now, but this may only be at the edges of the floes.

August 1st, 1947 - Deterioration of the ice in Slidre Fiord began about May 25th, and soon afterward saucerlike depressions began to appear all over the surface of the ice, each containing some water. On May 30 water began flowing down the previously dry river beds as the snow in the hills began to melt. This water soon melted the ice at the river mouths and formed large pools locally. Almost immediately cracks in the ice parallel to the short axis of the fiord began opening up with their beginnings in or near the pools formed at the mouths of the rivers. The volume of water running into the fiord from the hills at this time was increasing daily, and the river mouth pools began widening and melting the ice cracks. Throughout the period of ice deterioration, the sun was bright and warm and as soon as pools of water formed in the saucer-like depressions in the ice surface, the sun's heat warned them and the ice beneath the pools began rotting rapidly. By June 5 the ice surface was too badly pitted to permit further aircraft landings. The river of melted snow water increased steadily in volume until a maximum was reached on approximately June 13th, then began drying up slowly. By June 20th, the influence of the sun and the influx of warm drainage water had opened the shore leads sufficiently so that the ice was floating freely. The whole mass soon began moving slightly until the winds and tides and movement was easily noticeable from the changing width of the shore leads and cracks. This motion continued until July 9 when the wind changed direction to south said blew strongly. The ice mass moved to the north shore and began breaking up at the edges and separating into large segments. The following day the wind went back to west and the segments separated, opening leads approximately a mile wide where previously there had been only eight foot wide cracks. It was evident that the sun had decreased the thickness very considerably, and the ice segments drifted about with the winds and tides, breaking up into small pans rapidly. On July 20, the broken-up ice moved out of the fiord leaving it entirely free of ice. At this time, the ice pans were no more than a few feet in thickness, and except for small amounts of old ice that appeared later when the ice was driven back into the fiord none of these pans exceeded three feet of solid ice.

July 5th, 1948 - Ice cover vicinity of station unbroken except for a few widely separated cracks. Surface everywhere covered by shallow pools.

Shore lead averages one hundred feet wide. First evidence of movement seen yesterday when twenty foot lead running south from station to opposite shore closed up and ice edge advanced slightly toward beach.

<u>July 12th, 1948</u> - Ice from station to eastern end Slidre Fiord has broken up and drifted eastward. One-fifth to one-half fiord is ice free. Ice in Sound remains fast and solid except for a few narrow cracks.

<u>July 18th, 1948</u> - Slidre Bay is clear and southward movement of bergs observed July 17.

<u>June 16th, 1949</u> - Average thickness of ice is five feet eight inches. Surface of ice is soft and spongy to a depth of six inches and there are a number of pools of fresh water forming on the surface and melted to a depth of ten inches. Still solidly connected to the shore except in the vicinity of creeks.

<u>July 8th, 1949</u> - Ice in Slidre Fiord now free from shore and beginning to move. Average thickness four feet six inches. Ice in Eureka Sound still solid.

<u>May 17th, 1950</u> - No leads or cracks have been observed in either Slidre Fiord or Eureka Sound. Snow beginning to melt in sheltered locations. Low hills surrounding weather station are windswept and considerable areas of bare ground visible on them. Average snow cover six to seven inches. Ice thickness measured in Slidre Fiord 99 inches and in Eureka Sound 100-inches. Surface of Eureka Sound very rough due to floe ice freezing in.

<u>May 21st, 1950</u> - No significant change in conditions since last report. No leads or cracks have appeared in fiord. No water running in creeks.

<u>May 26th, 1950</u> - Snow melting slowly but no pools of water in creek as yet. No cracks or leads visible in fiord,

<u>May 30th, 1950</u> - One ice crack visible running across fiord in vicinity of station. Continued freezing temperatures prevented any thawing of snow during past five days.

<u>July 5th, 1950</u> - No significant change in ice conditions in Slidre Fiord. Thickness of ice is between four and five feet. Shore lead about one hundred and fifty feet wide.

<u>July 11th, 1950</u> - No significant change in ice conditions in Slidre Fiord during past week. Thickness of ice estimated at between thirty and forty inches.

<u>July 18th 1950</u> - Crack in ice running across fiord from station vicinity opened to width of one hundred feet on July 12. This is first indication

of ice movement. Ice thickness estimated two to three feet. Shore lead about two hundred feet wide. No open water or ice movement has been observed in Eureka Sound from vicinity of station.

July 25th, 1950 - Main ice sheet in Slidre Fiord now moving freely with wind and tide. Ice rotten with many holes through it and floes breaking from edges. Thickness of ice estimated less than 12 inches in most places with some places up to 20 inches in thickness.

August 1st, 1950 - Approximately twenty-five per cent of Slidre Fiord now ice free and remainder of ice moving about freely. Eureka Sound appears to be still ice covered and no breaks or open water can be seen in it from station vicinity.

August 8th, 1950 - During past week there were indications of ice breaking up in Eureka Sound and strong winds pushed ice into Slidre Fiord until fiord now approximately 90 per cent covered with ice, Member of staff on climbing mountain August 10 reports considerable open water could be seen in Eureka Sound south of Slidre Fiord but north of fiord no open water could be seen.

August 14th, 1950 - Slidre Fiord is now entirely free of ice except for few icebergs and some small floes near shores. Considerable open water can be seen in Eureka Sound at mouth of Slidre Fiord.

August 21st, 1950 - Slidre Fiord now free of ice and open water can be seen in Eureka Sound although believe there is some floe ice on east side of Sound.

August 29th, 1950 - Slidre Fiord covered by approximately 20 per cent floe ice. Considerable floe ice visible in Eureka Sound at mouth of Slidre Fiord.

September 12th, 1950 - Fiord began freezing over on September 5 and ice now about 1½ inches in depth. Floe ice not exceeding 15 per cent of area mostly along shore and there should be no difficulty in selecting site for aircraft landing strip in spring. Two-large icebergs grounded 400 yards west of camp assure us ample fresh water for winter. Lake approximately twelve miles northeast of station visited September 11 and find surface smooth and even with ice depth of 3 inches.

August 6th, 1951 - Report on ice deterioration: large fields of pack ice in Eureka Sound. Slidre Fiord entirely free from pack as of July 27, except for area of 10 per cent at the southerly limits of fiord.

August 13th, 1951 - Large amount of scattered pack In Slidre Fiord driven in by wind shift. Broken fields of pack in Eureka Sound with 7 per cent open water.

August 21st, 1951 - Slidre Fjord is clear of pack ice except for scattered remnants. Eureka Sound appears to have open water from station to Axel Heiberg Island as judged from station limits.

August 27th, 1951 - Slidre Fiord clear of ice. Eureka Sound also clear as much as may be seen from station.

September 3rd, 1951 - Slidre Fiord clear of ice except for remaining pack ice driven ashore by northwesterly winds from Eureka Sound. Eureka Sound clear of ice as seen from station area.

September 10th, 1951 - Slidre Fiord and Eureka Sound clear of ice. Fiord commenced to sludge and pancake over with new ice on September 10, but was cleared by westerly wind.

Sea Ice Reports - Mould Bay, N.W.T.

June 21st, 1948 - Ice condition near station as follows: depth 70 inches covered with six to fourteen inches snow. Small pools fresh water from melted snow along shore.

June 27tha 1948 - Entire bay covered by large pools of water caused by melting snow and overflowing streams. Ice rapidly deteriorating. Top 3 to 6 inches honey-combed surface. Large leads forming near shore.

July 16th, 1948 - No major changes in ice condition vicinity this station. Fifty to sixty inches porous ice with few narrow leads. Ice broken away from shore with lead approximately 10 yards long completely around bay.

July 18th, 1948 - Sea ice in vicinity of station does not appear to be more than one year old and was 72 inches thick during latter part of April. No movement of sea ice in Mould Bay and Crozier Channel.

June 16th, 1949 - No cracks or signs of breaking up. Water on surface at base of hill near end of ice air strip site. Snow depth over one foot average with no signs of surface melting. Temperatures above freezing for past two weeks only. Ice frozen to ground one half mile from base of hill east of station.

June 16th, 1950 - River started flowing and pools were forming on bay ice by June 18.

June 26th, 1950 - Sea ice melting at river mouth four hundred yards maximum width by a mile long. No large leads but ice shows small cracks. No movement of ice. Ice shows tendency to candle at water edge.

July 5th, 1950 - No significant change in ice condition except for slight increase in area of water at river mouth.

July 18th, 1950 - No apparent change since last report. No new significant cracks or leads observed from station.

July 24th, 1950 - No apparent change in general ice condition since last report. Slight increase in water area along Mould Bay in immediate vicinity of camp.

August 1st, 1950 - No apparent change in ice condition. Slight enlargement in area of water along bay shore. Small pieces of ice floating along bay shore observed.

August 8th, 1950 - No apparent change in ice condition since last report.

August 14th, 1950 - Slight enlargement of open water along bay shore due to a large number of small pieces breaking from mass during recent wind storm. No apparent change in the position of main mass itself.

August 21st, 1950 - No apparent change in ice condition since last report.

August 29th, 1950 – Slight increase in area of water along bay shore with numerous pieces floating ice. Approximately 2 to 3 miles of ice-free water at the head of bay. No change in position of ice mass in the rest of bay.

September 7th, 1950 - No apparent change in ice conditions since last report.

September 13th, 1950 - No apparent change in ice conditions.

September 21st, 1950 - Fresh ice in bay frozen to a depth of seven inches.

June 7th, 1951 - Ice strip serviceable, one crack, raised two inches across strip. Rotting in form of triangular small cracks and air bubbles, occasional very shallow pools.

June 10th, 1951 - Stream one mile east of camp flowing at approximately 1 gallon per minute.

June 11th, 1951 - Small rivulets in camp area. Pot holes on strip surface. Surface rotted to three inches.

June 12th, 1951 - Ice measured at 87 Inches. Ice surface porous to four inches. River beginning to flow. Ground thawed to two inches where free from snow.

June 13th, 1951 - Ice 85 inches thick. River beginning to flow out over ice. River temperature plus 0.2°C. Temperature of thawed earth plus 7°C. Creek beginning to flow at 4:00 p.m.

June 14th, 1951 - Bay ice near mouth of river has 18 inches water cover. Strip unserviceable. Temperature 32°F.
June 15th, 1951 - Water flowing everywhere

June 18thy 1951 - River water on ice has cut hole in bay ice near ice foot and in deep water, flooded areas of ice surface beginning to drain. Beyond flooded areas surface drainage system beginning to form. Fresh melt streams forming on ice. Fresh water temperature 32°F. Temperature in ice measuring hole, which is now draining melt water and made up of a mixture of salt and fresh water, 31.5°F. River melt water 34°F. Temperature 5 feet above ice surface 35°F.

June 20th, 1951 - Temperature 38°F. Surface drainage system formed.

June 22nd, 1951 - Drainage streams on ice have deepened up to two feet in places. Temperature remains at 31.5°F. in measure hole.

June 28th, 1951 - Open water extends to strip edge near mouth of river. River temperature 35.4°F. Temperature five feet above ice 47.5°F. Temperature in deep surface crack (3 feet) 31°F., brackish water.

July 4th, 1941 - Lead across bay five miles north and up bay from camp.

July 5th, 1951 - Shore leads observed in Crozier Channel. Open water near mouth of river at camp 150 by 200 feet in deep water and away from ice foot. River flow is decreasing.

July 8th, 1951 - Temperature 45°F. Strip cut in half by open water 200 feet side. Ice 30 inches thick 100 feet south of open water, 52 inches 1000 feet from south end of strip. Some pressure noted in Crozier Channel. Shore leads increasing in size. River flow greatly decreased.

July 9th, 1951 - Shore lead in front of camp greatly decreased in size. South end of ice strip has numerous cracks extending full thickness of ice. Ice thickness 30 inches near leads and open areas on strip tapering to 52 inches at over 150 feet from open areas which have relatively warm water from river drainage. Surface of strip rough with scattered rises and depressions.

July 11th, 1951 - River temperature near mouth 41.8°F.

July 22nd, 1951 - Strip site still not clear of ice. Two leads near head of bay extending full width of bay.

July 25th, 1951 - Under force of strong west wind ice at strip site has broken from main body and drifted to ice foot. Strip site open. August 2nd 1951 - Leads increasing in number in bay, strip open.

August 3rd, 1951 - Brackish water still in shore leads. Pressure by main body of bay ice noted 1½ miles south of camp on east shore of bay. No leads noted in channel. Pressure area of considerable size off Manson Point in Channel. Bay ice 60-70 per cent water surface in form of pools and leads.

August 4th, 1951 - Ice in front of camp breaking. Lead has formed 75 yards west of strip. Main body bay ice stationary. Lead area shifting.

August 7th, 1951 - Temperature bay water 34°F. (taken 200 yds. from shore, depth of water over 30 feet)

August 8th, 1951 - Ice beginning to break slightly under any wind. Surface rotted with many leads, main body ice still solid. Estimated maximum thickness 40 inches.

August 11th, 1951 - 11 p. m. wind from west 43 m.p.h. Ice moving in on shore in solid mass, pressure on N.W. Hill, very high tide.

August 14th, 1951 - Maximum wind 52 m.p.h. last night. Many new leads have formed. Strong pressure near N.W. hill.

August 15th, 1951 - Water froze in hydrogen drums last night.

August 16th, 1951 - Ice in puddles around 1/8 inch thick in morning.

August 17th, 1951   NE wind, ice moving out of bay

August 18th, 1951 - Bay clear of ice. Average thickness pan 2 feet, maximum thickness 40 inches. Pools froze last night ¼ inch.

August 21st, 1951 - South wind. Pack ice in bay.

August 22-3, 1951 - Wind E20-30 m.p.h. Temperature minimum 22°F. on 23rd.

August 24th, 1951   Temperature bay water 31.8°F. Bay clear. Wind NNE to N at 20 m.p.h.

August 26th - September 4th - Bay open and ice free.

August 26th, 1951 - Intrepid Inlet open; Crozier channel open 10 miles off shore with numerous leads extending full width of channel. After ice went out the salinity of the bay water increased greatly on the surface levels.

August 27th, 1951 - Channel pack ice, 30 per cent open water vicinity Intrepid inlet. Mould Bay, Intrepid Inlet appeared to be open. Many leads and stretches of open water extending to Eglinton Island.

August 29th, 1951 - Wind SE at 18 m.p.h. Wave action breaking grounded ice along shore of Mould Bay, causing loose ice in bay to deteriorate quite rapidly.

August 30th, 1951 - Wind has veered from SSE to SSW to NW since noon. Maximum velocity 38 m.p.h. from south. Bay still open.

September 3rd, 1951 - Temperature 30°F. Trace of snow on ground. Ground not frozen. Bay and channel both open, practically no drift ice observed in either area. Ice observed, however, along western shores of Eglinton Island estimated to extend five miles west from shore.

September 5th, 1951 - Temperature 31°F., wind E 20-25 m.p.h. Ice closing in on shore in channel. Area from Manson Point to Disappointment Point beginning to receive pressure.

September 6th, 1951 - Wind E 30 m.p.h.

September 7th 1951 During night beginning 11 p.m. September 6th, ice observed through fog, moving in to bay; morning of 7th pack ice filled the bay. 1-2 inches snow on ground. Temperature 32°F. wind gentle from south.

Period August 28th - September 9th - Temperatures remained almost constant at 30°F. accompanied by very low overcast. Ground damp and unfrozen. Permafrost level on strip one foot to eighteen inches.

Sea Ice Reports - Isachsen, N.W.T.

June 23rd, 1948 - Head of bay and ice strip covered with six inches water.

June 23rd, 1948 - Runoff from streams in progress. Sea ice thickness 78 inches covered with 6 - 8 inches water in places and 6 - 8 inches candled or deteriorated ice. Tidal and other cracks deteriorating.

July 15th, 1948 - About 30 feet open water around edge of bay. No leads.

August 1948 – The bay ice gradually deteriorated and melted back from the shore to distance of 100 feet. Cracks appeared in the same ice that was water-covered in the spring and by the 12th of August were quite noticeable with pools of water on the ice. About the same date, movement of ice was noticed in windy weather, and a large area of clear water 4,000 feet by 4,500 feet was at the head of the bay. This area of clear water changed shape as the wind moved the ice, By the 20th of August a strip of clear water 10,000 feet in length could have been obtained suitable for landing a float plane of the size of a Canso. Unfortunately, ice began forming about the same time which would have made a float plane landing rather risky. However, the remainder of the bay and as far out to sea as one can see remains inert. The oil drums used as airstrip markers are still in the same place.

A lead was noticed out to sea from the point of land south of the bay on the 20th of August.

June 27th, 1950 - Majority of snow covering on ice now thawed. Ice covered with large number of thaw pools and runoff water. Tide cracks now thawing and runoff water going underneath ice in these cracks. Surface of ice quite solid although first six inches has candle. Water 8-10 inches deep on area where carbon black spread in thaw experiment.

July 5th, 1950 - No significant change in ice conditions. Run-off water diminishing and ice covered with new snow. Very little thawing during last week.

July 11th, 1950 - Little change in ice conditions during last week. Strip of water extends around shore line 20-40 feet wide on both sides of bay. No observation has been made away from general camp area.

July 19th, 1950 - Ice conditions this station unchanged. Thawing of surface continues but no leads visible.

August 1st, 1950 - Little change in ice conditions during last week. Examination of ice surface one mile off shore on July 30 revealed only small thaw pool areas in ice formed last fall. Old ice of last summer deeply marked with large thaw pools and channels on ice surface. All pools except largest covered with approximately 1/8 inch new ice after below freezing temperatures of past few days. Only lead visible is small break at stream mouth on opposite side of bay near delta strip.

August 15th, 1950 - Entire body of ice in bay moved to southeast August 10. Ice observed to be forced up on shore also at crack across middle of bay. Clear area of water off campsite shore widened to 100-300 feet with large pans grounded ice. Considerable ice movement from 10th to 12th although temperatures below freezing during most of period. Thaw pools on ice surface observed on 13th covered with 1½ inches new ice.

August 29th, 1950 - Little change in ice conditions this station. Large amount of grounded pan ice in clear water area. Entire area now frozen over with thin layer new ice.

September 4th, 1950 - Bay bare, completely frozen over September 4th.

June 8th, 1951 - Delta strip unserviceable, ice in bay 105 inches thick. No sign of deteriorating to date.

August 10th, 1951 - Bay ice continuing to deteriorate. 50 per cent open water in north and bay. Effect of wind on ice movement pronounced.

August 17th, 1951 - Hole-in-Fog Bay open west shore, north end to Sock Point ½ mile wide. Previously small pan ice jammed against west shore. No other open water in vicinity.

August 24th, 1951 - Ice condition vicinity station same as of August 17. Near shore open despite prolonged fresh easterly winds. Except for rare drifting pan, pack frozen firm. Slight occasional freezing of open water, thawing with sun.

September 8th, 1951 - Bay ice frozen fast in position of August 31. Split in pack approximately two miles opposite station ½ mile wide, 3 miles long. Moderate pressure ice between this shore and split. Sock Point shore lead approximately ¼ mile wide, one mile long from base of point southward.

September 14th, 1951 - Ice condition same as of September 8 except thickness young ice now average eight inches.

Sea Ice Reports - Alert, N.W.T.

July 2nd, 1950 - Open water channel one mile wide approximately two miles north of point behind pack Ice extending east and south.

July 11th, 1950 - East of the point, channel open approximately five miles wide. Begin to notice tide in the bay.

July 18th, 1950 - Leads on the coast are all closed.

July 26th, 1950 - Inlet all clear of ice, also all along the coast open water about one mile wide.

August 5th, 1951 - Very little sign of ice deterioration. Thawing very slowly due to low temperatures. Occasional leads open 5-10 miles from station but close very rapidly depending on wind and tide. Shore leads extend from 50-200 feet. Inlet is entirely free of ice.

August 13th, 1951 - Several leads visible from station at the present time. Other conditions same as in previous reports.

August 20th, 1951 - No marked change from previous report. Leads open and close depending on wind conditions.

August 28th, 1951 - No change in ice conditions from previous report.

September 2nd, 1951 - Ice conditions unchanged. New ice forming on bay and then breaking up due to wind conditions.

September 10th, 1951 - Bay and shore leads covered with thin layer of new ice, no leads visible.

July, 1951 - The bay adjacent to the station had completely broken up by the end of the month though a number of small floes continue to drift back and forth in accordance with the prevailing wind. The main pack to the north and north-east of the station still appears to be stationary and although occasional small leads can be observed, these close again at short intervals. Observations from surrounding hills have established the existence of an open channel of water along the Greenland coast. The most recent survey proved Robeson Channel to be open though traced with southward moving floe ice.

October, 1951 - On August 14 and 15, strong gales forced the pack ice towards the east and on several occasions during this period the sea was clear of ice as far as the visual horizon. However, the dispersals were of short duration and slight variations in the wind direction brought the ice back to the shoreline. It is extremely doubtful whether the ice-breaker could have found entry to the station even if they had attempted to do so as originally planned. The longest period free from ice was not more than twelve hours. At this time a strong, 50-knot gale was blowing and the presence of large, loose floes, some more than 100 feet thick, would have made the situation very hazardous for any ship. At any event, it would not have been possible to handle small boats for the transfer of cargo to the shore. New ice has been forming in the adjacent bays for over two weeks but variable temperatures and winds have thwarted any permanent freeze-up.

Ice and Sea Water Temperatures

In order to provide additional basic data in the investigation of the physical processes associated with the formation, dissipation, movement and general characteristics of sea ice, observations are taken at Resolute and Eureka of the temperature gradient existing from the surface of the sea ice throughout the layer and into the water below during the life cycle of the bay ice from fall freeze-up to spring break-up. These observations were begun in the fall of 1948 at Resolute and the fall of 1949 at Eureka.

The temperature measurements are made at the ice surface and at depths of 2 inches, 6 inches, 1 foot, 2 feet, 4 feet and 7 feet below the top of the ice. The thermometer elements are mounted on a board with their spacing as given above. After the ice is sufficiently thick in the fall to permit walking over it, this board is installed vertically in a hole in the ice and is allowed to freeze in. The thermometer cables are connected to an indicator box on the surface which is housed in a small shelter to provide protection from drifting snow.

When an attempt was made to chop the thermometer installation at Resolute out of the ice in June, 1949, two of the thermometer elements were damaged and two were lost so that only three thermometer elements were available for ice temperature readings during the winter of 1949-50. Replacement elements were provided in 1950 and a complete programme was carried out during the winter of 1950-51. In the spring of 1950 and 1951 no attempt was made to chop the thermometer installation out of the ice. The installation was recovered by securing an empty fuel drum to the supporting board as a float and permitting the ice around the installation to thaw.

The ice temperature measurements which have been made at Eureka and Resolute are given in an appendix to this report.

Lake Water Temperatures at Resolute

The temperature profile in the fresh water lake west of the Resolute weather station was investigated on June 20, 1951. The lake depth at the point where the temperature readings were taken is 28 feet. A correction of -2.7ºF was made to the thermometer readings since the thermometer for melting ice was read as 34.7. The following readings were obtained.

Depth (ft.)	Thermometer Reading (ºF)	Corrected Temperature (ºF)
Surface	34.7	32.0
5	35.0	32.3
10	35.8	33.1
20	36.3	33.6
27	36.6	33.9

It was felt that in the fall the temperature should be somewhat higher and might approach 39ºF, which is the temperature of maximum density of fresh water. It was realized that the effect of the permafrost at the level of the lake bottom might bring about a somewhat lower equilibrium value.

On November 9, 1951, further temperature measurements were taken in the fresh water lake to the west of the weather station, with the following results:

Depth (ft.)	Temperature (°F).
5	32.1
10	32.1
15	32.6
20	32.9
22½	33.2 (bottom)

These temperatures are not much different from those found In June (in fact they are slightly lower). This would seem to indicate that the lake fails to freeze solid only because of the release of the latent heat of fusion and the insulating effect of the ice layer on the surfaces.

Since the ratio of the latent heat of fusion of water to ice to the specific heat of water is 80:1, the freezing of a 4” thickness of ice will raise the temperature of the whole lake by about 1°C, if we assume an average depth of about twenty-five feet. The fact that the maximum density of water is about 39°F means that the heat of solidification actually is distributed throughout the volume of the lake.

The ice thickness on the lake increases by roughly one foot per month. Thus the temperature of the whole lake is raised through 1°C. about every ten days. Furthermore, since the ratio of the volume to the total area of the surface of the water of the lake is of the order of 10:1, the heat given out by a cubic foot of water cooling 1°C. is available for dissipation through each square foot of surface of the water mass every day.

Observations of Arctic Snow Characteristics

A special programme to study Arctic snow characteristics was begun at Resolute in 1948 under the direction of the Associate Committee on Soil and Snow Mechanics, National Research Council, Ottawa. The purpose of these observations is to describe the characteristics of the snow cover at the time of observation by means of such measurements as the specific gravity, hardness, grain size, shape of crystal, snow temperature and so on.

During the period that there in snow on the ground, daily observations of the snow cover are made at a test site where the ground is relatively flat and the exposure is semi-sheltered. A completely exposed area is not suitable for a test site since such open areas are often swept completely bare during periods of high wind. A location too close to a building is not desirable either since large drifts form near any obstructions.

A more detailed set of observations is made at weekly intervals. For these observations it is necessary to dig a test trench to ground level and make observations of the properties of each layer in which the snow differs in hardness or crystal structure from the layers adjacent to it. After the observation is completed, the trench is filled in and its location marked with a stake in order to avoid digging another trench in the same place at subsequent observations.

On January 9, 1950, a change was made in the data to be recorded at the daily and weekly observations. Prior to that date, the following data were recorded at each daily observation.

1. Air temperature in degrees Centigrade.
2. Total depth of snow in inches.
3. The average diameter of the surface snow crystals in millimetres.
4. The shape of the surface snow crystals according to Table 1.
5. The average wind speed for the 24 hours preceding the observation.
6. The total precipitation for the 24 hours preceding the observation.
7. The total number of hours of sunshine during the 24 hours preceding the observation.

TABLE 1

CLASSES OF SIMPLE SNOW FLAKES

Class A - All types' of needles with either flat pyramids or truncated pyramids at their ends.

Class B - Thin hexagonal plates.

Class C - Hexagonal plates with various form of small notches in their sides or short extensions at the six points of the plate. Structurally, they are almost as strong as Class B flakes.

Class D - A wide variety of flakes that are somewhat weaker structurally than Class C flakes.

Class E - A wide variety of flakes structurally weaker than Class D flakes while their six points may not be fairly solid. They are joined to the hub of the flake by relatively weak arms.

Class F - Flakes with six slender rays without branches.

Class G - Similar to Class P flakes but with one or two pairs of slender branches on each ray.

Class H -- Similar to Class G but each ray has many delicate branches. All extremely feathery flakes are of this class.

Prior to January 9, 1950, the following observations were taken when a test trench was dug at weekly intervals.

1. Total depth of snow cover.
2. A description -of the form of the snow surface.
3. Air temperature in degrees Centigrade.
4. The depth in inches to each layer boundary from the surface.
5. The temperature in each snow layer in degrees Centigrade.
6. The hardness of each snow layer expressed in grams per square centimetre.
7. The average diameter in millimetres of the grains in each layer.
8. The shape of the snow grains in each layer according to Table 1.
9. The free water content of the snow in per cent.
10. The specific gravity of the snow in each layer.
11. A description of the snow in each layer.

After January 9, 1950, the following data wore recorded at the daily observations.

1. Total depth of snow in inches at the test area.
2. The number of tenths of surface area that is snow covered.
3. The shape of the surface snow crystals according to Tables 2 and 2a if snow is falling at the time of observation, or according to Table 3 if snow is not falling at the time of observation.
4. The average diameter in millimetres of the snow crystals in the surface layer.
5. The condition of the snow surface according to Table 4.
6. The depth of snow which has fallen since the observation of the preceding day.
7. The dry bulb temperature in the thermometer screen at the time of observation.
8. The maximum and minimum air temperature for the 24 hours preceding the observation.
9. The average wind speed and prevailing wind direction during the 24 hours preceding the observation.
10. The average relative humidity and average cloud amount for the 4 synoptic observations preceding the snow observation.
11. The total number of hours of sunshine during the day preceding the day on which the snow cover observation is made.
12. The type and amount of precipitation which has fallen since the preceding observation.
13. Any additional pertinent information such as notes on drifting and blowing snow, thawing, etc., is given in a separate "Remarks" column.

After January 9, 1950, the following observations were made at weekly Intervals.

1. The total snow depth at the test area depth gauge in inches.

2. The total water equivalent of the snow cover.
3. The air temperature in degrees Centigrade.
4. The form of the snow surface according to Table 4.
5. The shape of the snow crystals in each layer according to Tables 2, 2a and 3.
6. The average diameter of the snow grains in each layer.
7. The specific gravity, hardness and snow temperature for each layer and the depth at which these observations are made.
8. The free water content in each layer when the snow temperature is near 0°C.

TABLE 2

TYPE OF PARTICLE

Code	Term
1	Plates and combinations of plates with or without very short connecting columns.
2	Stellar Crystals and parallel stars with very short connecting columns.
3	Columns and combinations of columns.
4	Needles and combinations of needles.
5	Special Dendrites.
6	Capped Columns.
7	Irregular Crystals.
8	Graupel.
9	Sleet.
10	Hail.

TABLE 2a

ADDITIONAL CHARACTERISTICS

Code	Remarks
m	Broken crystals of type 1, 2, etc.
r	Rimed crystals of type 1,2, etc., but not sufficiently rimed to be classed as Graupel.
f	Clusters of Type 1, 2, etc., crystals.
w	Wet or partially melted crystals of Type 1, 2, etc.

TABLE 3

Code	Remarks
a	Stars or Plates close to their original form.
b	Feltlike structure. Needles Or columns close to their original form and snow in transformation with fragments of stars, etc., present

c Rounded grains of settled snow, grains rounded by abrasion during drifting, graupel, sleet and hail.
d Settled snow grains having crystal facets.
e Depth hoar (generally cup shaped crystals.)

TABLE 4

SURFACE CONDITION

Code	Description
op	Smooth
or	Rain erosion
os	Sun erosion
ow	Wind erosion
ox	Sun or rain crust
oy	Wind crust
oz	Film crust
ov	Surface hoar

Snow Crystal Replicas

A test programme to obtain replicas of Arctic snow crystals was carried out at Resolute during the winter of 1949 and 1950. The method consists of preserving the form of the snow crystal by the use of a plastic solution of one to two per cent of Formvar 15-95 dissolved in ethylene dichloride. This solution was provided by the General Electric Research Laboratory.

The solution is kept outdoors in cold storage as well as a supply of small squares of black cardboard. When the snow is falling and it is desired to collect specimens of the snow crystals, one of the cardboard squares is exposed outdoors until a number of flakes have settled on it. The cardboard is then brought into the cold storage room and a glass rod is used to place a drop of the solution on any wanted specimens. In about 15 minutes the ethylene dichloride evaporates, completely and a plastic replica of the snow flake is left-on the cardboard. The cardboard may then be taken indoors for examination.

Whenever specimens are obtained, a record is made of the date, time, air temperature, wet bulb temperature, wind direction, wind speed and gustiness, cloud type and height and any other pertinent remarks. The length of time that the card is exposed is also recorded.

Some difficulty has been experienced in mailing the replicas to Head Office for examination since the fragile replicas seem to be very easily damaged in transit. It is planned to make further tests with a stronger solution to determine whether replicas can be obtained that will stand up more readily for mailing.

Arctic Test of U.S. Navy Model, TDM-1, Automatic Weather Station

Content of Report - This report will attempt to describe some defects and weaknesses in the TDM-1 automatic weather station noted during almost five months of continuous operation, and to suggest improvements. The period of operation begins August 1, 1951, and continues to the middle part of December. This evaluation will be made in view of the kind of service for which this station was designed. It is supposed to be a completely self-operating radio broadcaster of several kinds of basic weather data and to require maintenance no oftener than at intervals of two months.

Log of Automatic Station - A detailed log, covering installation and maintenance of the station, is available at the Arctic Project of the U.S. Weather Bureau for inspection. It may be seen from the log that nine maintenance visits were made as a result of breakdown or malfunctioning of the station. Three of these were caused by the partial failure of a single part - a weak motor. (The motor was finally replaced on the third visit.) Two trips were necessary to correct mechanical adjustments. Three were made to replace defective parts in the transmitter. (Two failures of the keying relay, one failure of the meter on/off switch.) One visit was caused by engine failure. Most of the trips, other than these nine, were made for the purpose of changing the thermograph chart. Maintenance performed during these extra trips may have prevented additional failures of the station.

Housing - The house which contains most of the working parts of the station had been assembled by others several years before, so nothing can be said about any problems of assembly that may have been encountered. At the time the station was re-activated, the house was found permanently attached to a large, heavy tractor sled. This seemed to be a satisfactory arrangement so it was left on the sled during moving and at the final installation. The sled is heavy enough and broad enough to give the structure sufficient stability to withstand winds of considerable force without need for guy wires or ballast. At the present site it has experienced winds bf over fifty knots without being disturbed. The insulation of the house seems to be adequate. A record of the engine running time during two months does not show that the engine has had to start for house heating. Of course, the engine runs about 25% of the time to make the scheduled hourly transmissions.

One defect has been noted which may have been the cause of two or three failures of the station. The joints of the house are not tight enough to keep out snow during high winds. Snow entering joint cracks near the transmitter may have caused shorting of the high voltage circuit. It is significant that all transmitter failures have occurred during high winds. It is believed that the joints could be made snow-tight by use of an adhesive during assembly or by caulking on the outside after assembly.

A weak point in house design from the standpoint of Arctic operation, is the air intake opening and, to a much lesser extent, the air exhaust opening. The problem of blocking of the air intake opening by drifting snow is one that appears to have no easy solution. Lack of ventilation is almost certain to cause engine overheating and premature power plant failure. Freezing of the air intake louvers while in a closed position is another cause for failure of the house ventilation system. Unless the problem of ventilation can be solved by change of design, it seems likely that the TDM-1 system will never be reliable for Arctic use.

Power Plant - The engine appears to be capable of good service if there is adequate ventilation and maintenance is performed at necessary intervals. This requirement for engine maintenance seems to be the factor limiting the length of time the station can run without attention. The manufacturer specifies that the engine crankcase should be drained and refilled with fresh oil after 100 hours of operation. This is on the instruction plate attached to the engine. The U.S. Navy instruction book says nothing about changing oil but says that oil level should be checked every two months and oil added if necessary. If the manufacturer's instructions are followed and the station transmits hourly, the period between oil changes is a little less than three weeks. If 3-hourly transmissions are made, the engine should run about 120 hours in two months, but additional running time may be necessary for house heating. This is a variable factor depending on outside temperature and wind.

The fuel consumption rate of the engine has been found to be 0.21 gallons per hour. At this rate a full tank of fuel, 80 gallons, should be sufficient for 380 hours of engine operation. Loss of water from the cells of the battery has been found to be rapid, possibly because of the low humidity of the warm air inside the station. After one month of operation, the level of the electrolyte in the battery was found to be far below the top of the plates. A single 12-volt aircraft type battery has been used during this test.

The position of the engine is not good. It is difficult, if not impossible, to remove the flywheel for inspection or adjustment of the magneto breaker points because of the small amount of clearance between the flywheel and the house ventilation air intake filter. The filter must be removed and even then the space is limited. It is difficult to drain the oil because the drain plug is too close to the floor. The oil drain cock is too shall. Draining the crankcase takes about twenty or thirty minutes.

Engine Controls - There has been no trouble with any of the engine controls, except for one failure of the programme contacts, S-1102, in the automatic on/off control unit. This may have been due to faulty initial adjustment but probably was caused by a disturbance of the adjustment when the programme disc was set up for hourly transmissions, which was done just before the trouble appeared.

Keying Control Unit - Operation of this unit has been satisfactory. However, since the accuracy of the transmitted data depends to a large extent on the characteristics of the 6J5 relaxation oscillator, it would be desirable to re-design the circuit to allow use of standard tubes without special consideration for individual tube characteristics.

Rectifier Power Unit - This unit has been satisfactory.

Transmitter - Three failures of the station have been caused by defective parts in the transmitter. The keying relay K-103, has failed twice. It is recommended that the keying system of the transmitter be revised so as to eliminate the need for breaking the high voltage plate and screen circuit. Also all unnecessary switches such as meter switch, S-101, and modulation switch S-102, should be removed for circuit simplicity.

Circuit Selector - This has not been a major source of trouble, although the adjustment of the micro-switch actuating levers is quite critical and is not easily accomplished. One rotor replacement has been necessary. The relays are difficult to reach for cleaning. High relay contact resistance would affect accuracy of transmitted data.

Electrical and Mechanical Construction - The electrical and mechanical units of this equipment are not easy to service. Servicing time may be important when the station is used in the Arctic, unless living accommodations are available at the site. One improvement would be to make the individual units more easily removable by use of cables and multi-pin connectors for inter-unit wiring. The panel cabinet should be weather proof. Electrical circuits should be simplified as much as possible. The panel cabinet should have shelves or brackets to support each unit. Relays should be of the hermetically sealed, plug-in type wherever possible. Tube sockets of better quality should be used.

Weather Instruments - All weather instruments have operated without failure except the humidity unit. The case of this unit fills with snow during severe storms of blowing snow. This could be easily corrected by sealing the case.

Antenna Mast and Antenna - The masts are sturdy but difficult to erect. This is unimportant except at locations where a speedy installation is desirable. The antenna system is satisfactory although it may be difficult to get the transmitter to load properly unless specified dimensions for the antenna and counterpoise are closely followed. For Arctic installations where frequency changes from day to night are of little advantage, it would be better to use a single frequency and doublet antenna. The transmitter output circuit would have to be modified slightly to work efficiently into a balanced antenna like the half-wave doublet.

Accuracy of Transmitted Data - The greatest source of error appears to be the timing of the pulses. Two different observers will seldom arrive at identical values when timing the same transmission and, some means of recording the transmissions would be highly desirable. This could be done with an inking-type telegraph tape recorder where the tape is pulled by means of a synchronous motor driven by a frequency-regulated power source. Such a device would eliminate the human error in timing the pulses.

Conclusion - The automatic weather station is suitable for use at Arctic sites that can be easily visited throughout the year by a maintenance technician. It is likely to require servicing at periods more frequent than every two months. Living accommodations must be available at the site because of the time required for making some kinds of repairs and subsequent testing of the station after repairs have been made. Some accurate means for recording the transmitted pulses should be developed.

Salinity of Sea Water

During the first part of 1950 two hydrometers, together with nomographs and instructions for their use, were forwarded to each Arctic station for obtaining readings of the density and salinity of the sea water in the vicinity. A programme was proposed whereby readings would be taken once each week until it was determined whether or not there were significant fluctuations. Depending upon the degree of fluctuation, the frequency of continued reading was then left to the discretion of the station personnel. Such readings are possible only during the summer season and then only when ice and weather conditions do not present too great a hazard to the observer.

During the fall of 1951, a small number of salinity and density measurements were received from two of the stations - Eureka and Mould Bay. Receipt of more extensive data will be quite valuable inasmuch as this type of information is practically non-existent for the areas involved. Without salinity and density measurements of the sea water, no conclusions on theoretical grounds can be reached regarding water currents. Furthermore, the freezing temperature of sea water is dependent upon its salinity. The importance of this knowledge in forecasting the accumulation and thickness of ice can be readily seen.

Analysis of Sea Water Sample from Resolute

A sample of sea water was obtained from Resolute Bay and forwarded to McMaster University, Hamilton, Ontario, for analysis.

The results to date are most interesting. All sulphate samples are, in general, enriched in S^{34}. However, the enrichment of sea water sulphate varies by a significant amount from location to location. The sample from Resolute Bay has the highest enrichment of heavy isotopes whereas samples from off the west coast of Mexico have the lowest enrichment. In other words, there seems to be a correlation between latitude and S^{34} content of sea water sulphate. If the enrichment of S^{34} in SO_4 is due to the exchange reaction

$$S^{32}O_4 + H_2S^{34} = S^{34}O_4 + H_2S^{32}$$
$$K = 1.07 \text{ at } 25°C$$

then the enrichment will depend on the temperature. The variations found in sea water are of the order of magnitude expected from the variations in temperature reported, O°C at Resolute Bay, 30°C off the coast of California and Mexico.

Atmospheric Refraction

Atmospheric refraction tables have always been considered uncertain for small angular altitudes. In fact, authoritative works on navigation have suggested that altitudes less than ten degrees be not used for this reason. On the other hand, there are many times, especially in polar regions, when the only objects available in the sky for navigation purposes are at low altitudes. For example, in the Arctic the sun and moon are generally low in the sky and for intervals of several months the sun may not reach an altitude as great as fifteen degrees.

For these reasons a programme to measure atmospheric refraction at angular altitudes less than ten degrees from elevations near sea level was undertaken by Prof. Charles H. Smiley of Brown University.

Prof. Smiley and his associates carried out the observations in tropical and temperate zones. He also provided the necessary instruments, namely sextants and chronometers, to the stations at Resolute, Eureka and Alert in order that observations might be taken in Arctic regions.

The basic observations are measurements of the vertical diameter of the sun at low angular elevations. The direct image of the sun is placed alternately above and below and in each case, tangent to the reflected image. The flattening of the sun gives the measure of the differential refraction and by integrating downward, one can obtain the refraction at successively lower altitudes.

Observations were taken at Resolute in February and November of 1950, but the observations programme has not yet been begun at Eureka or Alert. Some difficulties were encountered in making the observations at Resolute. For the major portion of the winter, there is open water in Barrow Strait which is an active source of fog and low stratus. This fog obscures the horizon and makes it a practical impossibility to obtain sunrise or sunset times with any precision. Furthermore, due to the nature of the land marks, the sea horizon may only be obtained toward the southeast, while in all other directions hills obscure the horizon to several degrees. Attempts were made to overcome this difficulty by taking observations about a mile south of the station, but with little success owing to fog, drifting snow and cloud.

The observations which were taken at Resolute are given in the tables which are appended to this report. The tabulated readings are sextant readings taken in pairs when the solar images are at upper and lower tangency.

Solar Radiation

Solar radiation measurements are currently being taken at Resolute and Eureka to determine the amount of solar energy received at those locations. The amount and distribution of the solar radiation which is intercepted by the earth are the primary generating causes of the physical activities that determine weather and climate. Data from Resolute and Eureka supply information from a large area from which no previous observations are available. These data are invaluable in contributing to "the solar radiation picture" for the North American continent.

Resolute and Eureka measure the total solar and sky radiation received on a horizontal plane at the earth’s surface. The equipment consists of an Eppley thermoelectric 180° pyrheliometer which converts the radiation falling upon it to an electromotive force which in turn is used to make a continuous tracing on a non-integrating type Brown recorder using a strip-chart. One roll of chart paper will last 30 days with continuous day and night operation. The paper contains time lines to show each ten minute interval. At Eureka it was found that the Brown recording equipment created too great a drain on the station's a.c. power supply, so a Leeds and Northrup Micromax recorder was installed to operate from the 32 volt d.c. station current. The records obtained, however, are comparable with those of a standard 110 volt installation.

Solar radiation records from the Arctic are forwarded to the U.S. Weather Bureau where they are evaluated and prepared for publication. Due to the inaccessibility of the Arctic stations, it is not possible to publish the data monthly in the "Climatological Data - National Summary" as other radiation data are published. However, it is planned to put out a supplement to this publication containing one year's solar radiation data from Resolute and Eureka as data become available. This may be put out as a supplement in itself, or as an addition to the yearly summary booklet, depending upon the time of year the data are ready for publication.

Chapter 8

STATIONS ESTABLISHED AT RESOLUTE IN ADDITION TO THE WEATHER STATION

Resolute Magnetic Observatory

A magnetic observatory was established at Resolute in 1948 by the Dominion Observatory for the purpose of studying long and short term variations in the earth's magnetic field adjacent to the north magnetic pole area.

The observatory was housed in a prefabricated building of non-magnetic construction and equipped with a set of three saturable core recording magnetometers as well as additional recording instruments of conventional type. Two absolute instruments are also part of the observatory equipment and are used to standardize the records.

One geophysicist is employed full time to service the magnetic instruments, develop the photographic records and transmit necessary reports to Ottawa.

The magnetic data furnish immediate control for all ground and airborne magnetic surveys of the Canadian Arctic and correlation with ionospheric disturbances. The observatory at Resolute was established as a temporary magnetic observatory, but after one year's operation it became apparent that the results were so significant as to warrant its continuation on a permanent basis.

The following magnetic data have been determined for Resolute:

Mean Location Magnetic Pole 1950	74 ºN 100° W
Location Resolute Bay Mag. Obs.	74.7ºN 94.9ºW
Magnetic Elements Epoch	1950.5
Declination	101° 28' W
Inclination	89° 03.5'
Total Force	57900
Vertical Force	57890
Horizontal Force	975

The nearest approach of the momentary position of the magnetic pole to the magnetic observatory was at 1900 GMT July 21, 1950, when it reached a point two miles southwest of the magnetic observatory.

There is a definite indication, even during the single year 1950, that the mean position of the magnetic pole is shifting slowly northward. From January to December the dip increased at Resolute from 89º02.4’ to 89º04.5’.

During this same period the declination changed from 103º0.8' W in January to 100º24.0’W in December. In both dip and declination the change was steady through the year.

Resolute Seismograph Station

The need for seismograph stations in the Canadian Arctic is two-fold; first, to provide information on the seismicity of the region, and second, to fill one of the largest blank areas in the seismograph network of the world.

The Dominion Observatory, Department of Mines and Technical Surveys, in recognition of this need, sent an observer on the cargo ship U.S.S. Wyandot during the summer of 1948 to investigate the possibility of installing a seismograph station at Resolute. Since he reported favourably, a special meeting of the Seismic subcommittee, Associate Committee on Geophysics, National Research Council was held in the spring of 1949 to discuss the instrumentation of the station. The recommended equipment was assembled during the following winter and was flown to Resolute by the R.C.A.F. Air Transport Command during the spring of 1950. A seismologist from the Dominion Observatory proceeded to Resolute by air in July of that year and the station was in routine operation by September, 1950. The R.C.A.F. and the Weather Station co-operated to make this rapid installation possible.

The station is under the constant supervision of a seismologist who interprets the records daily and signals all pertinent data immediately through the channel of the D.O.T. Ionospheric Station. These are received in Ottawa and relayed to Washington where they are used by the Coast and Geodetic Survey for the determination of epicenters. Complete interpretation of the records is sent out by mail and bulletins giving these data are distributed by the Dominion Observatory to all interested parties.

Little evidence of seismicity in the area adjacent to the station has been found, but it is almost impossible to exaggerate the importance of the station in teleseismic work. Because of its position, it provides triangulation with any other pair of stations in the northern hemisphere. Continuing studies are also being carried out on the microseisms recorded at the station with a view to learning about their possible value in weather forecasting.

Resolute Ionospheric Station

The Telecommunications Division of the Department of Transport established the Ionospheric Measurement Station at Resolute during the summer of 1948 as part of a joint Canada-United States programme for the study of radio wave propagation. The station is for the purpose of measuring the electrical and physical characteristics of the ionized layers in the upper atmosphere which are responsible for long-range radio transmissions. These measurements provide a great deal of information concerning the physics of the upper atmosphere.

The actual operation of the station is under the direction of the Telecommunications Division with the data being analyzed by the Radio Physics Laboratory, Defence Research Board, and further correlation with similar world-wide data by the Central Radio Propagation Laboratory, United States Bureau of Standards, Washington. The station consists of a laboratory building, living quarters and smal1 buildings for housing special radio receiving equipment. Accommodation is also provided for magnetic observation equipment and staff of the Department of Mines and Technical Surveys as part of their programme of geomagnetic observation.

Chapter 9

ARCTIC BUILDINGS

Foundations

To appreciate the problem of installing foundations for permanent heated buildings in the Arctic islands, it is first necessary to understand the action of the active layer and the reaction of the permafrost level in the ground over which a permanent heated building is erected. The depth of the active layer of earth, that layer which thaws in summer and re-freezes in winter, varies throughout the islands and is generally between one and three feet. Beneath this active layer lies permanently frozen ground which is frozen to undetermined depths.

Prior to installation of the first two Joint Arctic Weather Stations, little information was available regarding suitable types of foundations, chiefly because few permanent fully heated buildings had been erected in this area previously. However, such information as was available indicated that the action of the active layer on foundations and the reaction of the permafrost level were factors which required careful consideration before a foundation was selected for buildings.

Active Layer - Generally the action of the active layer is to gradually force any large solid masses such as rocks, foundation posts, etc., upward until they are on the surface. This may take several years but the forces causing the movement are very considerable and the weight of a building is insufficient to counteract them. This action is the same as that of ground frost on fence posts with which almost everyone is familiar. The building foundation must be so constructed that the active layer cannot exert such force upon it if the structure is to remain stable and have a reasonable life expectancy.

Permafrost Level **-** The erection of a permanent heated building tends to depress the level of permafrost immediately beneath the building while having little or no effect on the immediately surrounding ground. In summer, ground water drains into this sub-surface depression and over a period of years, the level of the ground beneath the building tends to rise above that of the surrounding grade due to an increase in volume by addition of water. This rise is for the most part very uneven which would tend to create a very unstable condition in any foundation and impose severe stresses on parts of the building.

Post-type Foundation - With these difficulties in mind, it was at first thought that it would be best not to disturb the permafrost level.

Accordingly, when the Eureka station was being constructed, the first buildings were erected on posts high enough to permit an air space beneath the building. To overcome the action of the active layer, the foundation posts were set well down into permafrost. Air was allowed to pass under the building during the winter to completely freeze the ground and to carry away the heat transmitted downward through the floor. In the summer when the building was not being heated to any appreciable extent, the building was banked with gravel so that the building acted as an insulator of the ground beneath and prevented depression of the permafrost level. During the first summer it was observed that this scheme actually raised the level of the permafrost and decreased the depth of active layer beneath the building.

Two buildings were set up on posts, one a permanent type and the second a temporary building. For comparison purposes, two other temporary buildings with fully insulated floors were erected directly on grade, on mud sills. These latter buildings were small and had a life expectancy of only two years.

The three temporary buildings were erected in April. The one on a post foundation was a Quonset hut of tropical design provided by the U.S. Weather Bureau from war surplus. Although additional insulation was added, the building was poorly insulated, particularly in the floor. It immediately became apparent during the cold weather of that spring that the passage of air beneath the floor was causing a greater heat loss from the building than had been anticipated, thus making the building very hard to heat in low temperatures and rendering it uncomfortable for the occupants. It was evident that the post type of foundation was not satisfactory unless the floor of the building was well insulated.

During the early summer (June and July) of 1947, it was noticed that the permafrost level rose sharply above that of the surrounding ground wherever the ground was covered by any insulating material and fell beneath any area where the surface had been disturbed in any way. This effect was much more pronounced than had been expected, particularly at the airstrip site where a large surface had been levelled and rolled.

Depression of the permafrost level occurred beneath the two temporary buildings erected on mud sills to the extent that floors became uneven and had the buildings been of rigid construction, corners would have opened up.

These observations were made over the short period between April and August of 1947 with a view to determining the most suitable type of foundation for subsequent buildings at Eureka and for the larger and more numerous buildings to be erected at the base station which was to be installed in August and September of that year.

Gravel Pad Foundation - Prior to this experimentation, the mud sill and gravel pad or mud "floating" type of foundation had been avoided because of the possibility of rocks being pushed up by action of the active layer and other uneven heaving of the ground due to frost action. Now, however, it was realized that it would be possible to place a layer of dry gravel over the surface upon which the building was to be erected and raise the permafrost level almost to the surface of natural grade, thus eliminating the difficulties which beset floating foundations in southern latitudes.

A layer of load-bearing gravel about 1 ½ times the natural depth of the active layer, if placed over natural grade, causes the level of the permafrost to rise to the point where a very stable foundation is achieved. Such a layer of gravel acts as an insulator to prevent thawing due to sun and warm air on the surface of the ground, insulates the ground from heat transmitted through the floor of the building and at the same time, provides a dry, easily handled bedding for foundation sills.

The Resolute station area is completely covered with good load-bearing gravel beneath which lies some bedrock. Hence it offered very good natural resources for the gravel pad type of foundation. As a result of the observations at Eureka and some local experimentation at Resolute prior to erection, all but two of the Resolute station buildings were constructed on gravel bed foundations. Similarly, buildings subsequently erected at Isachsen, Mould Bay, Alert, and Eureka, were also built on "floating" foundations.

Comparison of Gravel Pad and Post Foundations - At station locations other than Resolute, load-bearing gravel is scarce and it was only with great difficulty that sufficient dry gravel was obtained upon which to set the station buildings as the earth at these stations consists mostly of tundra and silty soils. Further investigation of post type foundations was indicated as the results of the Eureka tests showed that post foundations, if properly installed beneath a suitable building, form a very stable foundation.

The post type of foundation has certain desirable features which the floating foundations does not have; namely,

1. If the building is set on posts, it offers little obstruction to drifting snow, hence removes the necessity of "digging out"' buildings after each windstorm.

2. Being elevated, it provides excellent "head" for disposal of waste water from the building.

3. It provides ready access to fuel intake lines from outside tanks, waste drains, etc ., which require occasional servicing.

Personnel at Mould Bay, N.W.T., erected one of the regular permanent buildings on a post type foundation such that the floor of the building was approximately three feet above natural grade. A temperature profile taken in the building, when compared to temperatures taken in a similar building on a gravel bed foundation under similar conditions, indicates that additional heat loss from the building owing to the free air space beneath it, is not significant and that it is possible to maintain the building at a comfortable temperature at all times. Furthermore, the level of permafrost was not disturbed and the maximum depth of the active layer beneath the building during the summer of 1950 was fourteen inches, which is normal for this area.

Comparison of temperature profiles taken in this building with those taken in a building on a floating gravel bed foundation at Resolute indicate that the temperature gradient in the two buildings between the floor and the seven foot level is very nearly the same for both buildings; namely, about two degrees per foot on the average.

These results indicate that in the erection of future buildings in Arctic areas where silty soils exist and load-bearing gravel is scarce, post type foundations with a free air space below the building should be considered.

The posts should be set well down in the permafrost to ensure a firm footing. In windy areas it might be necessary to provide cables with which to anchor the building to the foundation to prevent excessive wind sway.

Prefabricated Buildings

History- Pursuant to a Cabinet decision of the 28th January, 1947, recognizing the need for establishing weather stations in Canadian Territory in the Arctic, to be operated jointly by Canada and the United States, it was agreed that Canada would supply materials for the erection of all permanent buildings and that some of these buildings would be shipped north during the Summer of 1947.

Inasmuch as public announcement of Canadian plans was only made on March 4, 1947, and the United States Weather Bureau had previously investigated thoroughly sources of supply of special prefabricated Arctic buildings, it was considered expedient to take advantage of the preliminary work undertaken by the U.S. Weather Bureau and to purchase a number of buildings from Timber Structures Incorporated. This Company had forwarded an offer to supply the specially designed and prefabricated buildings to U.S. Weather Bureau Specifications.

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The question of prefabricated buildings versus regular type buildings had already been considered. It had been concluded that due to the remoteness of these stations, the short period each year during which building was feasible and the difficulties involved in transporting skilled carpenters and in erecting regular type buildings, prefabricated buildings would be less expensive and more efficient. Furthermore, the ease with which prefabricated building components can be adapted to space and weight specifications for sea and air shipment made them preferable to regular type buildings for Arctic use.

Design - Six buildings were purchased from Timber Structures Incorporated and carried north on the summer sea supply ships of 1947. Of these, one was erected at Eureka and three were erected at Resolute, while the other two were placed in storage at Resolute for later airlift to Isachsen and Mould Bay in spring, 1948.

The walls, roof and floor of these buildings consisted of 4' x 8’ prefabricated panels with interlocking joints to render the building weatherproof. The panels were made up of studding frame, covered on both sides with plywood sheet and insulated in the enclosed space with spun glass insulation. Special knocked-down roof trusses were provided to hold up the roof panels.

These prefabricated wooden buildings proved adequate for Arctic use. It was possible to maintain comfortable temperatures indoors even in the severest winter cold spells. At Resolute, thermostatically-controlled oil-burning furnaces with a circulating fan were used in the main buildings. The third building at Resolute and the building at Eureka, N.W.T., were heated with oil-burning space heaters of about 60,000 BTU per hour capacity.

Timber Structures buildings, while entirely adequate for Arctic use, had one major disadvantage from the standpoint of the Canadian Meteorological Service; namely, they could not be purchased in Canada.

In view of Canada's shortage of U.S. dollars and the large amounts of money involved, it was necessary to locate a Canadian firm which could supply additiona1 Arctic buildings. Accordingly, eleven Canadian companies were contacted and each was invited to submit a quotation on buildings to the specifications supplied. Most of the companies were not in a position to undertake construction of these special buildings and the field was narrowed to two large suppliers who were both willing and capable of supplying them. Of these, the Prefabricated Homes Company was chosen as supplier for Arctic buildings in 1948.

The buildings supplied by Prefabricated Homes Company were similar in design to those of Timber Structures with the exception that they incorporated many improvements in design of roof trusses, ventilators, insulation, etc., that were written into the specifications as a result of experience at Eureka and Resolute, N.W.T.

Evaluation - Subsequent temperature comparisons between a Timber Structures Company building and one supplied by Prefabricated Homes Company indicated that both types were very suitable. The Prefabricated Homes building tended in this test to have a slightly lower heat loss factor than the other building. However, in neither of these buildings was it possible to maintain conditions of relative humidity above 40%.

Condensation- During the coldest periods in winter, there is a certain amount of condensation and frost formation on the interior of outside walls. This is particularly noticeable in buildings which are heated with a simple space heater and in which water vapour is added to the air by heating of water, etc. Even in buildings where little moisture is added to the air other than that which is dried out of clothing and bedding (excluding laundry moisture), condensation and frost have been observed to form on the inside of exterior walls. This has not been serious in the case of most weather station buildings as the frost and condensation have formed only on the interior surface of the prefabricated panels and not within the insulation. It is, however, undesirable and messy when temperatures moderate as the frost melts and the water runs down the walls to the floor, requiring mopping up. Condensation and frost formation generally occur between the floor and the 4 foot level and around windows and doors.

Relative Humidity - The relative humidity of the air in Arctic buildings in winter is undesirably low and tends to remain low even when moisture is added to the air artificially. It is believed that the moisture added to the air is extracted by condensation on the lower part of the walls. This low relative humidity, which is often as low as 10%, is detrimental to furniture, buildings, and comfort of personnel, yet it is difficult to overcome in buildings in the Arctic.

Heating Systems - In buildings heated with a circulating hot air furnace, condensation and frost formation are very considerably less than in buildings where the air is not circulated with a fan. At Resolute, rooms for personnel were partitioned off and ceilings added, yet no serious condensation was noticed. It appears that condensation and frost formation are caused by warm moist air stagnating in the area near the inside surface of walls.

The use of thermostatically-controlled circulating furnaces tends to reduce condensation and frost formation and to raise relative humidities. It is felt that with careful location of the hot air outlets and cold air returns and a reasonably high rate of air circulation, warm air could be made to scrub the walls almost continuously, thus preventing stagnation of the air and consequent formation of condensation and frost.

In the circulating furnace installations made to date in the Arctic weather station buildings, no cold air return ducts were installed and the location of the hot air duct outlets was not made to any specific design, yet the problems of condensation and low relative humidities were partially overcome.

Ceilings - In general, the use of full ceilings in weather station buildings has been avoided because roof panels of all buildings were insulated. Where ceilings have been installed, such as in living and sleeping quarters, hallways have been left without ceilings to permit warm air to circulate. No difficulties have been encountered with condensation or frost on the underside of the roof panels.

At the Ionospheric and R.C.A.F. stations at Resolute, full ceilings have caused formation of condensation and frost which melts in the spring, and the water seeps through the ceilings.

Experimentally, a full ceiling has been installed in the addition to the Operations Building at Resolute. This addition has uninsulated roof panels, the insulation being applied on the upper surface of the ceiling. The attic thus formed is being watched for condensation and frost formation.

Comparisons - A comparison of the Timber Structures and the Prefabricated Homes buildings for condensation and frost formation shows the Prefabricated Home buildings to be slightly superior. In the Timber Structures buildings, frost formed heavily on nail heads, around windows, ventilators and doors, and on the lower part of walls near the floor. Prefabricated Homes buildings, although subject to some of these same troubles, were not affected to nearly the same extent. Nail heads showed little tendency to frost up. Doors, windows and walls frosted only to a limited extent.

Structurally, both types of buildings were found to be more than adequate.

Special Buildings - Additional buildings involving special design problems such as a floorless power-house garage with two 12’ x 12’ overhead recessing doors, a warehouse with similar features, and other buildings with half floors were successfully designed and prefabricated to Weather Services specifications by Prefabricated Homes Company Limited, and these have stood up well under Arctic conditions.

Modifications - As a result of experience, numerous modifications have been incorporated in the newer buildings.

1. Lever handles have been substituted for knobs so that doors may be easily opened with heavily mittened hands.

2. Windows have been set higher and glazing and frames improved for Arctic use.

3. Ventilators, roof trusses, and panel joints have been improved.

4. For cleanliness, insulating value and resistance to wear, a floor covering of battleship linoleum for all living quarters and operations building floors has been written into specifications.

Experimental Hut at Alert, N.W.T.

Late in 1949, the Department of National Defence (Army) requested the co-operation of the Meteorological Division in testing the Army Prefabricated Hut, Mark III**.** This building had already been through preliminary testing and the design had been altered as a result of the tests on two prototypes, Mark I and Mark II. Arrangements were made to transport and erect a Mark III Hut at Alert, N.W.T., the most northerly Joint Arctic Station, in the summer of 1950**.**

The hut was erected and occupied by the weather station personnel in the fall of 1950. After a series of tests had been carried out with the hut for the Department of National Defence, the hut was left at Alert on indefinite loan for the use of the weather station.

Chapter 10

PROJECTS BY TRANSIENT SCIENTIFIC PERSONNEL

Introduction - Since it is desirable that the Joint Arctic Stations be utilized to obtain as much scientific data concerning the Arctic as possible, it has always been the policy of the Meteorological Division, Department of Transport, and the U.S. Weather Bureau to provide accommodation at these stations for visiting scientists insofar as facilities permit.

In order to ensure that the limited accommodations are utilized to derive the maximum possible benefit, a procedure for the processing of applications to visit the Joint Arctic Stations was formulated at a meeting of Canadian and United States representatives held in Ottawa on January 4, 1949.

It was agreed:

a) that the following procedure is to be followed in respect of requests from United States agencies (other than permanent Weather Bureau and Service personnel) for permission to undertake scientific investigations at Joint Weather Stations:

i) The agency wishing to visit a Canadian Arctic weather station will first ascertain from either the United States Weather Bureau or the Meteorological Division whether adequate accommodation is available for the proposed visit.

ii) If accommodation is available, the request will be referred to the United States State Department.

iii) The State Department, when satisfied that the scientist concerned is reliable from the security point of view and that his work is of sufficient importance to warrant his being given some of the very limited accommodation available, will forward the request through State Department channel to Canadian authorities.

iv) The request will then be referred to the Advisory Committee on Arctic Research for coordination with other research projects.

v) In the final stage, the request will be referred to the North West Territories Administration for issuing of a license.

b) that the procedure outlined in subparagraphs (i), (iv), and (v) above will be followed in respect of applications of this kind from Canadian agencies; and

c) that the present policy of not charging transient personnel for meals and accommodation be continued, providing the periods of such visits are of a reasonably short duration.

Wildlife Survey of Slidre Fiord Area

A biological investigation of the wildlife of the Slidre Fiord area on Ellesmere Island was conducted from April 19 to August 23, 1951, by John S. Tener, mammalogist for the Districts of Franklin and Keewatin, Canadian Wildlife Service, Department of Resources and Development, Ottawa Ontario.

Three different investigations were carried on simultaneously for the Department of Resources and Development. The principal project concerned the study of muskoxen to determine their numbers, available food supply, relation to predators, mortality factors, and life history.

At the request of the Northern Administration and Lands Branch, a general investigation of the zoological resources of the area was conducted to determine whether it would be practicable for the Northern Administration and Lands Branch to move Eskimo families from Arctic areas where resources are insufficient to the Slidre Fiord region, which is now without Eskimos. This survey was also intended to provide information for the personnel of the Weather Station concerning the resources that were available in the event that they were isolated for a lengthy period.

Zoological and botanical specimens were collected for the National Museum of Canada. Fifty plant specimens, parasites, invertebrates, fish, twenty-one mammals and thirty-six birds were obtained.

The weather station facilities were extended to the mammalogist by the Department of Transport.

National Museum of Canada Investigations

During the three-year period ending in 1951, the National Museum of Canada carried out investigations at three of the Joint Arctic Weather

Stations; Resolute, Mould Bay, and Alert. At the first of these, the work was archaeological and consisted of the excavation and study of old Eskimo sites. It was continued through three summer seasons. At the other two stations, the work was chiefly biological, devoted mainly to the collecting of zoological material for record, study and exhibition. The National Museum wishes to gratefully acknowledge the courtesies which its officers received at these stations and to express its thanks for the wholehearted cooperation given by everyone concerned. The following report on the above investigations was prepared by Dr. F.J. Alcock, Chief Curator of the National Museum.

Resolute Bay - The work at Resolute Bay was a project sponsored jointly by the Bureau of Ethnology of the Smithsonian Institution at Washington and the National Museum of Canada. The former supplied the services of Dr. Henry B. Collins, Jr. of its permanent staff; the latter furnished help in the way of field assistants, field equipment, and in making arrangements with the Royal Canadian Air Force for the transportation of the officers to and from the field. In 1949 the assistant was Dr. J.P. Michea who at that time was on the staff of the National Museum of Canada. In 1950, Mr. W.E. Taylor, a student specializing in anthropology at the University of Toronto, assisted Dr. Collins, and in 1951, Mr. Taylor worked alone, completing the details of certain phases of the work. A preliminary report by Dr. Collins, entitled “Excavations at Thule Culture Sites near Resolute Bay, Cornwallis Island, N.W.T.” appeared in the Annual Report of the National Museum of Canada for the Fiscal Year 1949-50, pp. 49-63. A second report “Archaeological Excavations at Resolute, Cornwallis Island, N.W.T.” summarizing the findings made during the summer of 1950, is included in the Annual Report of the National Museum of Canada for 1950-51 and a comprehensive final report is being prepared.

At Resolute are four abandoned village sites consisting of stone and whalebone house ruins which represent the largest concentration of old Eskimo remains on Cornwallis Island. In addition, tent rings, cairns, fox traps and other evidence of temporary occupancy are known at many places along the coasts of the island. The objective, in connection with the work, was to obtain a representative sample of material from each site in order to show the relationships of one site to another and to reveal a full picture of the culture of each site during the time it was occupied. Excavation was carried out on selected houses of each of the four sites. In 1949 some 1,100 specimens were collected all of which proved to be typically Thule. Many of the objects, particularly harpoon heads are identical with types from Thule-Punuk sites in Alaska, and this is true also of the samples of pictographic art which were discovered. In 1950 some objects of the older Dorset culture were also found. It is known, therefore, that there are three stages of culture represented at Resolute – Dorset, early Thule, and developed Thule. The first two were probably represented by only one or two families who lived there for short periods. The third or last stage lasted longer, perhaps for a century or more, and during this period the population may have numbered in the hundreds.

Mould Bay - A two-man biological expedition, jointly sponsored and financed by the Smithsonian Institution, Washington, D.C., and the National Museum of Canada, investigated the birds and mammals of Prince Patrick Island, N.W.T., in the period April 19 to October 12, 1949. Personnel consisted of Charles 0.Handley, Jr., who represented the Smithsonian Institution, and Stuart D. MacDonald, of the National Museum of Canada. With headquarters at the meteorological station at Mould Bay, the party was able to work the peninsula between Mould Bay and Crozier Channel, as well as the east coast and parts of the west coast of Mould Bay.

Mr. MacDonald secured for the National Museum of Canada an excellent collection of 207 birds, 122 mammals, a small collection of plants, some animal parasites, and a few fossil invertebrates. He made detailed notes on local distribution, numbers, habits, and habitats of the birds and mammals, made water color representations of the evanescent colors of the soft parts of some of the birds, and took habitat photographs. The fine collection of mammals and birds obtained is a valuable addition to the study collections of the National Museum of Canada. Because Prince Patrick Island wildlife populations have been heretofore unrepresented in museums, it is expected that taxonomic study of this material will shed additional light on the relationships of the animal populations represented in this collection to those inhabiting other parts of the world. Similarly, previous to this expedition we had almost no information on the kinds of animals, their numbers, and their interrelationships from that remote part of Canada. Distributional data secured provide northwesternmost corner-posts for the North American ranges of the species found to occur there.

Mr. MacDonald published a summary report of this expedition (1951, National Museum of Canada Bull.123, Annual Report of the National Museum of Canada for the fiscal year 1949-50, pp. 131-132). Mr. Handley (1950, Wilson Bull. vol. 62, no. 3, pp. 128-132), as a result of his observations on Prince Patrick Island and later study of specimens secured by the expedition, published an article on the relationship of Branta bernicla hrota (Muller) and Branta bernicla nigricans (Lawrence), concluding that these are not just races of the same species but actually two different species.

Alert - In the, period April 16 to September 30, 1951, Mr. Stuart D. MacDonald collected biological material and data for the National Museum of Canada on northern Ellesmere Island, N.W.T. While there he made the Alert Meteorological station his headquarters. With emphasis on a study of birds and mammals, MacDonald covered thoroughly the country within a ten-mile radius of the station and as well, visited a number of ponds and lakes somewhat beyond that area. In June he made a trip to the Ellesmere Ice Cap via Wood Creek. The latter was visited again in August.

Specimens collected and brought back include 73 birds, 30 mammals, 41 lots of invertebrates, and a plant collection of 63 numbers. In addition he made notes on habitats, food, behaviour, voice, numerical status, local distribution, reproduction, phenology, and, as well, prepared a description of the country he visited. Habitat photographs were taken and water color reproductions were made of some of the soft parts of birds. The information and collections secured are from a biologically little known part of the country and are, therefore, welcome additions to our knowledge of Arctic wildlife. Taxonomic studies of the specimens secured are to be made shortly, and it is expected that the information secured by this expedition will be published in due course.

Geological Survey - Cornwallis Island

The Geological Survey of Canada has long considered the northern and western parts of the Canadian Arctic Archipelago as a region of potential source of fuels, coal, oil and natural gas. Authorization to use the facilities of the Resolute Weather Station permitted the field geologists of the Department of Mines and Technical Surveys to start in 1950, on Cornwallis Island, an extended study of the stratigraphy and structure of sedimentary measures. The study of air photographs had revealed areas of inclined strata on Cornwallis Island and nearby a belt of gently folded strata crossing Bathurst Island, a major geological feature which was unknown till recently.

The geologists, living at the station till navigation became possible, studied and mapped in detail the disturbed strata of the vicinity. In the summer of 1950, when there was enough open water to permit the use of a 22-foot canvas canoe, the survey party set out to circumnavigate Cornwallis Island, and completed the journey in a month. In 1951, journeys were made up the east and west coasts of the Island over a period of two months.

During these field trips, scientific observations were made along the coasts. They consisted of general geological observations, surveys of structural sections and the measuring of stratigraphic sections. Substantial palaeontological collections were obtained and a study was made of marine beaches, of features of post-glaciation of the land, and of the physiography of the coast. Other sundry observations were made on tide, sea ice movement, fauna and flora. Some traces were found of former expeditions such as a note left by a party for Sir John Franklin which was found on the east coast. Near Cape Phillips, on the north coast, many thousand feet of strata containing abundant graptolite fossils produced a most interesting scientific record.

Final results of the geological surveys which have been made from Resolute have not been compiled yet. They will eventually be published in the official reports of the Geological Survey of Canada. As a preliminary synopsis, many thousand feet of strata have been tentatively identified as ranging from Upper Ordovician to at least Middle Silurian, locally folded and faulted. Solid bitumen material was found disseminated in some strata along the north coast of Cornwallis Island.

The following notes were made by T.A. Harwood, Defence Research Board, during the canoe trip around Cornwallis Island in July - August, 1950.

East Coast - Barlow Inlet is seven miles north of Cape Hotham. This inlet is a marked feature at the southern end of the east coast. The highest hills recorded by corrected aneroid barometer were 700 feet on the south side and 750 feet on the northern bluffs with a level surface sloping gently inland to the northwest.

The coast northward from Cape Hotham to Kanes Inlet (Snowblind Bay) is formed by hills sloping to the sea. To the north of Kanes Inlet these sloping hills give way to cliffs. These cliffs continue northward to the southern entrance of Helen Haven where from here on to Cape Phillips the hills become more rounded, the coast lower and the strand line wider. North of Decision Point the many streams which pour into the sea are all fronted by current formed spits of sand and gravel.

Depot Point is ten miles north of Barlow Inlet. There is a conspicuous hill about 800 feet high to the west of this point on the top of which is a stone cairn supporting a 20-foot mast. At three places along this coast to Kanes Inlet the coastal escarpment is pierced by valleys, through which small streams run to the sea.

Decision Point is 3 miles north of Helen Haven, a low shingle point extending, leeward from the foot of a prominent rounded hill. The maximum altitude of the coastal hills and interior plain is here 425 feet. From this point the coast trends away to the northwest.

Abandon Bay is a shallow bay at the mount of a verdant valley. On the north side of this bay about 500 yards from the cliff may be seen an overturned boat abandoned by Penny in 1851 on his return from Cape Becher.

Murdaugh Island, which should have been clearly visible, could not be seen. It seems likely that it does not exist and that ice pressure ridges on a submerged shoal have given the illusion of an island.

Cape Phillips is a prominent headland which marks the N. E. corner of Cornwallis Island.

North Coast - The present charts of this coast originally mapped by Goodsir and Marshall are vague and inaccurate. The Arctic Pilot Vol. III states that the above party took no observation for position. However, by correlating the position of Abandon Bay given by Goodsir with the observed position of this bay obtained by Penny, and tracing the capes northward and westward from here, it seems likely that Goodsir and Marshall only reached the western end of what is now known to be Cornwallis Island. This being so, it is not difficult to understand why Cornwallis was shown connected to Bathurst Island on
Goodsir's map. This error was not corrected until the discovery of the fate of the Franklin Expedition in1856, from whence it was shown that the Erebus and Terror had circumnavigated the Island in 1845.

It is thus difficult to tie up any position on Goodsir's chart with the present charts and Canadian Topographical Maps and for this reason names of bays and capes mentioned here are taken from the Canadian Topographic Series, 8 mile sheet 58 N.W. and N.E.

Stuart Bay is assumed to be a small bay at the mouth of the second river west of Cape Phillips. Cape Gell on the western side of this bay is perhaps the most dominant topographic feature on the north coast. Two cairns and some barrel staves and hoops were found on this point.

Inland from Cape Phillips to Cape Gell the interior plain appeared nowhere to exceed an altitude of 560 feet (height of the peneplain).

Cape Austin, the northwesternmost tip of Cornwallis, is very low and is formed by a series of lagoons separated by raised beaches. Two cairns had been erected on this point.

From this point the coast turns south. Little Cornwallis is visible to the west at a distance of some 4 to 5 miles. The strait between Cornwallis and Little Cornwallis could, in heavy weather or blowing snow, be taken for a bay between two points of land.

West Coast - The shore had not been previously visited by any party and is only very poorly delineated on the present Canadian Topographic Series 8 mile sheets.

The strait between 1ittle Cornwallis and Cornwallis is approximately one mile wide. The west coast of McDougal Sound from one mile south of Cape Austin to Cape Airy is composed of rounded hills without cliffs. It is deeply indented by five bays all of which, on the 20th of August, were blocked by the previous season's ice. None of these, bays have yet been named.

A combination of current, which here appears to set to the north and southwesterly winds which are prevalent, sends the floe ice up McDougal Sound where it forms pressure ridges on all the points.

From Stanley Head, a round hill on the south side of the southernmost bay, the coast runs southward for seven miles without a break to Cape Airy. Immediately to the east of Stanley Head is a conspicuous hill, almost a peak, which makes it the best landmark on this coast.

South Coast - Pioneer Bay is a wide shallow bay with a low foreshore.

Intrepid Bay lies east of Cape Rosse where the shore line becomes considerably higher so that both sides of the bay are steep. The entrance to Intrepid Bay is about 5/8 miles wide. No grounded ice was observed in the inlet on August 20th, 1950.

From Claxton Point, a long conspicuous rocky point, 6 miles to the east of Cape Rosse, the coast is broken by points and capes into a succession of bays which include Becher Bay, Allen Bay and Resolute Bay.

Sheringham Point is a striking cape with features that are seen from inland as well as from the sea.

Allen Bay lies between Sheringham Point and Martyr Point. It is wide and shallow and contains numerous small islands. The bay is difficult and dangerous to approach and affords no shelter for vessels. It is the breeding ground for numerous walrus at its western end.

Resolute Bay lies between Cape Martyr and Prospect Hill and is open to the south and shallow. A channel into the bay has been found through the shoal water across its mouth which at high tide allows a ship drawing 20 feet to enter the bay itself. It is usual, however, for ships to anchor off the harbour in Barrow Strait.

This bay affords no protection from southerly and southeasterly winds. A current entering from the east carries ice into the bay, sometimes even against the wind.

Assistance Bay, which lies about 5 miles east of Resolute Bay, is open to the southeast, south and southwest.

Cape Hotham forms the southeast corner of Cornwallis Island. From here the coast turns due north. This cape and the east coast of Cornwallis Island are formed by the rapid change in dip of the flat lying limestone beds west of here. A tremendous rock slide has taken place at the very tip of Cape Hotham and it is believed that many submerged rocks must be close to the surface for some distance offshore.

Current and Ice Conditions - Wellington Channel. The current in Wellington Channel sets southward along the east coast of Cornwallis Island with a maximum speed at the flood of 1.5 knots. This current stops, and in some places is reversed, at about 2 hours before low water. Ice is carried by this current into all the bays and coves on this coast.

Queen's Channel (Maury Channel). Here the ice was observed to move through the straits at over 3 knots (measured) on a rising tide, but on the ebb tide, the current slackens to about half a knot at low water. A steady stream of ice pouring out of Penny Strait into Maury Channel was carried to the east into Wellington Channel by this current. A large volume of ice passed through Maury Channel during 10 days of observation. Despite this, the channel was never blocked and was navigable at all times.

McDougal Sound. The current along the east shore of McDougal Sound and the Strait between Big Cornwallis and Little Cornwallis Islands sets continually to the north, slacking only at the bottom of low water. The current on the flood appeared to be about 2 knots.

In general, all remarks covering ice conditions in Wellington Channel and Queens Channel contained in Arctic Pilot Vol. III seem to be borne out. There is no doubt that the strong tidal currents in Queen’s Channel keep that channel open until very late in the fall, and open it up very early in the spring. Furthermore, whilst some pack ice was observed from the air in Maury Channel on July 14, open water extended from a line from Dundas and Baillie Hamilton Island, through Queen's and Penny Straits to a latitude of 77° N. Through the summer of 1950, latitude 77° N appeared to be the northern limit of open water.

Detailed ice reconnaissance reports of this area, Wellington Channel and Queen's Channel, were observed to be valueless after a period of 24 hours. It would seem that in areas where the tidal currents are strong and where the channels are affected by the prevailing winds, aerial ice reconnaissance must be continuous, particularly if it is being carried out for small unstrengthened vessels.

The following tidal observations were taken at various points on Cornwallis Island.

Position	**High or Low Water**	**Time Zone -6 90th Meridian**	**Date 1950**	**Map**	**Approximate Range**
Barlow Inlet	Low	2:00 p.m.	July 25	8 mile C.T.	3.2 ft.
Barlow Inlet	High	7:30 p.m.	July 24	8 mile C.T.	
Barlow Inlet	High	9:05 p.m.	July 25	8 mile C.T.	
15 miles N of Barlow Inlet	High	4:00 p.m.	July 26	8 mile C.T.	3.7 ft.

Position	High or Low Water	Time Zone -6 90th Meridian	Date 1950	Map	Approximate Range
Kanes Inlet By sights 75°02½' N 93°33' W	Low	7:40 p.m.	Aug. 1	8 mile C.T.	6.2 ft.
Helen Haven By sights 75°18' N 93°41' W	High	5:50 p.m.	Aug. 6	8 mile C.T.	
6 miles W. Cape Phillips Maury Channel N. Cornwallis	High	9:30 p.m.	Aug. 8	8 mile C.T.	5 ft.
4 miles east of Cape Austin	Low	9:00 p.m.	Aug. 17	8 mile C.T.	
New Strait 75°29' N 96°20' W	Low	10:30 p.m.	Aug. 18	4 mile sheet	4½ ft.
Muskox Bay 75°10' N 96°30' W	Low	11:15 p.m.	Aug. 19	4 mile sheet	4½ ft.
Between Intrepid Bay & Pioneer Bay	High	12:00 p.m.	Aug. 19 and 20	8 mile sheet	5 ft.

C.T. Canadian Topographic Series Barrow Strait West and Barrow Strait East 2 sheets
4 mile sheet – A preliminary sheet prepared as a base map.

Northern Insect survey Investigations

The following reports are a resume of the investigations of the Northern Insect Survey at Resolute, Cornwallis Island, in 1949, and at Alert, Ellesmere Island in 1951. The report on the Resolute survey was prepared by Messrs. E.H.N. Smith and W.E. Butler, and on the Alert survey by Mr. P.F. Bruggemann. This Survey is a joint project with the Division of Entomology and Botany, Science Service, Department of Agriculture and the Defense Research Board, Department of National Defence. The Survey was inaugurated in 1947 and its main objectives are:

1. To study the distribution, relative abundance, ecology and systematics of northern biting flies.
2. To obtain a better knowledge of the total insect and plant species of Northern Canada.
3. To obtain specimens for the Canadian National Collection of insects and for the herbarium of the Division of Botany.

Northern Insect Survey at Resolute, N.W.T. 1949

Introduction - The success of this survey was made possible through the cooperation of Mr. C.P. McNamara, Defence Research Board, Department of National Defence; the R.C.A.F., U.S.A.F., and the Canadian Meteorological Division and U.S. Weather Bureau for transportation and accommodation arrangements. Assistance at Goose Bay Labrador, was given by G/C J.A. Vernor, R.C.A.F., Col. J. Auton, U.S.A.F., and their staffs.

The work at Resolute, Cornwallis Island, was made possible through the assistance of station personnel and Const. H.H. Aime, R.C.M.P.

On June 2, Smith and Butler travelled by train from Ottawa to Montreal accompanied by Mr. W.B. Schofield of the Division of Botany and Plant Pathology. On June 3 they were flown by the 426th Transport Squadron of the R.C.A.F. Air Transport Command from Dorval, Quebec, to Goose Bay, Labrador, arriving in the afternoon.

From June 4 to June 20, while awaiting transport to Resolute Bay, they made familiarization trips in the area. On June 20th they were flown to Resolute by the United States Military Air Transport Service.

At Resolute, they began their summer's work, which continued until August 8. They were accommodated in a Jamesway hut first, then in an insulted plywood building with the laboratory in the same room in each case.

On August 8, they left Resolute and flew to Goose Bay, Labrador, by United States Military Transport Service via Thule, Greenland. At Thule a number of insects were collected.

The Area - Resolute is situated on the south coast of Cornwallis Island at latitude 75° in the Central Canadian Arctic. The terrain consists mostly of a coastal ridge of low mountains which separates a narrow coastal plain from the higher ground inland.

The Rain survey area between Resolute Bay and Allen Bay is quite rolling except for a 600foot elevation to the southwest at Cape Martyr. There are as many as ten beach lines with several ponds along each of them. A chain of lakes extends across the area draining to the southeast into Resolute. Upper Silurian limestone rock is exposed in most of the area with weathering not as extensive near the base of the mountains where the rocks are fairly large and sharp.

Most of the vegetation is located in three small marshes. Some of the lakes and pools have vegetation along their margins. Several small rapid rivers empty into Resolute, Allen Bay to the west and Assistance Bay to the east. By the end of the summer many of the ponds in the area had dried up leaving thick muck in some locations.

The Soil - There is very little soil in the area. Polygonal soil formation was observed in some places. The rock is mostly upper Silurian limestone and it has broken down to a fine powder by weathering in some places. The lack of much vegetation shows a marked deficiency in some of the plant requirements.

On the coastal plain near Allen Bay there is a sandy slope 100 feet long and 50 feet at the widest point.This slope is devoid of vegetation.

The greater part of the area consists of heavily fossilized limestone rock varying in size from two feet to small fragments and averaging about six inches. Vegetation is just beginning to find a foothold in some places. A few glacial orratics were scattered about the area.

Permafrost was beyond two feet on higher points of land and at four inches just below the moss in the marshes; the average is believed to be about 18 inches.

Soil samples were taken for the Division of Bacteriology, Department of Agriculture.

Vegetation - The area is very sparsely vegetated. The three small marshes have most of the vegetation in them, mosses predominate. Also present are several species of Saxifrage, Carex, grasses, Papaver radicatum and other plants. Papaver radicatum is the highest plant on the island, in some places it grows to the height of six inches. In the pools and streams of the marshes there are a number of algae.

The exposed slopes and ridges have either no vegetation or scattered clumps of Saxifrage oppositifolia, Parrya arctica, Draba alpina, and a few other small plants. The less exposed places have, in addition to the above mentioned plants, Salix arctica which has typically prostrate branches with shoots no higher than two inches.

Some the lakes and ponds in the area have vegetation on their margins and along drainage lines to the water. The main plants found here are Carex aquatilis var. stans. Alopecurus alpinus and several mosses.

A more detailed report of the flora is being prepared by the Division of Botany and plant Pathology.

The following is a list of the more abundant plants with their observed dates of flowering.

Saxifrage oppositifolis	June 21
Salix arctica	(June 21 in flower)
	(July 13 in fruit)
Ranunculus sulphureus	July 2
Dryas integrifolis	July 2
Eriophorum angustifolium van triste	July 5
Saxifrage flagellaris	July 13
Saxifrage nivelis	July 13
Saxifrage cernua	July 13
Saxifrage Hirculus	July 13
Papaver radicatum	July 13
	(July 18 – at peak of bloom)
Saxifrage caespitosa	July 18

Detailed Survey Of Biting Flies - The survey party arrived in the area on June 20, 1949, and a continuous search was maintained for any species of biting flies. None were located up to the time of departure on August 9, 1949.

Some of the men in the camp claimed they were present in previous years, but this is believed to be erroneous. Midges were very numerous the last half of July and it is believed these were mistaken for biting flies. In one case it was definitely found that a small midge had previously been considered a black fly.

Mosquito Breeding Areas - There were numerous pools in the area and many appeared capable of supporting immature stages of mosquitoes. One typical pool was 50 feet across end varied in depth from 12 inches in the centre to 3 inches on the margins. As the season progressed, the pool became shallower. Corex ap. and mosses were on the margins and the water contained different algae. Midge larvae were in the pool all summer, and crustaceans such as Cyclops and fairy shrimp were also present.

Blackfly Breeding Areas - There are quite a number of swift streams in the area; at certain times they contained midge larvae, but no other insect life was ever discovered in them. Midge pupae were also observed and collected from the undersurface of rocks in the streams, but no blackfly pupae were ever among them.

Other Insects - From this area insects belonging to four orders were collected.

Diptera - In the order Diptera, 627 of the family Chironomidae, 284 of the family Muscidae, and 232 of the family Tipulidae were collected and mounted. The Chironomidae and Muscidae were very numerous in the area during the month of July; the Tipulidae population was very small throughout the entire season.

Trichoptera - In the order Trichoptera, 11 specimens were collected and mounted. These were all found on July 17, one of the warmest days of the season.

Lepidoptera - In the order Lepidoptera, six specimens were collected and mounted, unspread. These are all adult Lepidoptera, the only ones seen during the entire season. Immature species were, brought back, three for rearing and one preserved in alcohol.

Collembola – In the order Collombola, a number of species were preserved in alcohol.

Arachnidae, Acarina -Two vials of spiders and two vials of mites were collected.

Ectoparasites - No ectoparasites of mammals and birds were found in the area. The dogs were checked, but appeared to have no fleas at any time during the summer. Numerous lemming burrows were found, especially among the Eskimo ruins. Trap lines were set out but nothing was ever caught. Lemming skulls were collected, also jaws, from owl regurgitations, but it is believed that it is a low year for the lemming population in the area as the regurgitations were quite old. Bird nests of Eastern Snow Buntings and Common Eider Ducks were checked for fleas, but only insects of the order Collembola were found. Only one fox was seen in this area all summer; no other animals were seen. Indications of the presence of polar bears and muskoxen were found, but the animals were never seen.

No blood serum was collected in the area as there are no mosquitoes and the population of animals and birds is very small.

Since the insect population is so small and no biting flies are in the area, insects have little effect on life in the camp.

Northern Insect Survey at Alert, N.W.T. – 1951

Introduction - Mr. P.F. Bruggemann spent the time from April 14 to September 30, 1951, at Alert weather station, Ellesmere Island, N.W.T., making biological investigations for the Northern Insect Survey, a project sponsored jointly by the Dominion Department of Agriculture and the Canadian Defence Research Board.

It gives the writer great pleasure to express his gratitude to the officials of the United States Weather Bureau and of the Meteorological Division of the Canadian Department of Transport, who, by their kind permission to use the facilities of the weather station at Alert, made it possible not only to spend nearly six months in a hitherto almost inaccessible region, but also to perform the necessary, duties without any of the difficulties and hardships usually inseparable from work in extreme northern latitudes. Thanks are also due to the United States Army Air Force and the Royal Canadian Air Force and to the officers and personnel of the weather stations at Resolute and Thule, who helped to make the journey to and from Alert enjoyable. Last, but by no means least, it must be said that the generous help and manifold kindnesses of the members of the staff of the Alert weather station contributed in great measure to make this past season memorable and productive.

General Survey of District - The writer was most fortunate to have during his stay at Alert a very delightful companion, Mr. Stuart MacDonald of the National Museum of Canada, Ottawa, who was engaged in collecting birds and mammals and both freshwater and marine invertebrates. Since the writer's main interest centred on insects and plants, our respective fields were complementary, which led to fruitful cooperation without any competition. As Mr. MacDonald is contributing a report on his activities, no observations on wild life will be mentioned in the present one.

At the time of our arrival, the surrounding country was still covered with an almost unbroken blanket of snow. The first few weeks were, therefore, utilized for a general survey by means of excursions on skis.

The country in the vicinity of the station is a much dissected plateau which slopes to the north-northeast from about 500 feet to 250 feet and then more sharply down to the sea. Above it, to the southwest, rises a chain of rounded, elongated hills which runs approximately from west-southwest to east-northeast and ends in two prominent elevations. The higher one, Mount Pullen (? named after the Reverend Pullen,
Chaplain of the Nares Expedition), rises to 1650 feet, almost due south of the station, some five and one-half miles distant. The more easterly one, 1250 feet high, bears no name on the latest map, but was called "Dean" by the Nares people. Together they form a conspicuous landmark, and from the top of Mount Pullen, where there is a small cairn, a considerable area of northeastern Ellesmere and northwestern Greenland is visible.

The coast line near the station is rather irregular and forms a number of inlets and bays of varying sizes and shapes. Between Mushroom Point and Black Cape, gently sloping beaches occur which show a series of well preserved ancient shore lines. West of Cape Belknap the hills rise more abruptly from the sea and, at the entrance to Colan Bay, form steep cliffs.

Beyond and south of Colan Bay the general elevation increases and the plateau merges into the foothills of the United States Range. The northern end of this, consisting of a jumble of snow covered peaks and short ridges, forms the skyline to the west.

he rocks apparently consist exclusively of slates and shales of presumably early palaeozoic age. As can be readily seen in the numerous ravines and canyons which the melt-water streams have cut into the plateau, the strata have bean severely and intricately folded and frequently stand vertical. The strike in all areas examined is very uniform and runs approximately to east-northeast. No easily recognizable fossils were found in the rocks examined.

The strata vary greatly in hardness and only the softer shales appear to disintegrate readily into a stiff, fast-drying clay and silt. The beds, of clay which accumulate on gentle slopes and more or less level areas, lead to the development of small tracts of rather barren polygon soil. Most of the finer silt particles are carried away by the large amount of runoff water resulting from the melting of the snow, which takes
place with astonishing speed during the second half of June.

It soon became clear in the course of these preliminary investigations that, at least during April and May, the immediate neighbourhood of the station is, except for a few foxes and lemmings, practically devoid of wild life, nor was it promising from a botanical point of view. Thus it seemed of advantage to extend the work over a larger area.

The high mountains in the west, in the clear Arctic air seemingly so near, but actually over 30 miles distant had been beckoning ever since our arrival at Alert. Expectations of finding in the deeply cut and sheltered valleys of the streams which drain this area, a greater abundance of wild life and a richer plant growth provided the main reason for carrying out the plans to explore this region.

It had been impossible to study the reports of the Nares Expedition before leaving Ottawa. Therefore, we did not know that a sledge party under Lieutenant Egerton, accompanied by Captain Feilden, the naturalist of the expedition, had made an entirely unsuccessful attempt to reach Mount Cheops during the second half of May, 1876. This pyramid-shaped peak is easily recognizable for the station. Not so Mount Grant, which had been chosen as a possible ultimate goal. During the only visit to the top of Mount Pullen, from where this might have been possible, no effort was made to identify this, supposedly highest, mountain of the northeastern part of the United States Range.

Close study of the available maps (which revealed considerable discrepancies as regards the position of Mount Grant), made it apparent that the easiest route, and probably the only possible one, would be up the valley of Wood Creek. Consequently, after a preliminary exploration of the shortest practicable way to the east shore of Black Cliffs Bay, we started in the evening of June 7 on skis, one pulling, the other pushing, a sledge of 250 lbs. gross weight. The load consisted of camping equipment, guns, ammunition, etc., and provisions for seven days. The weather station provided the loan of a convertible toboggan sledge and a reversible two-man, lightweight tent, without which the trip would not have been possible. Both items ware found very serviceable. Unfortunately, no snowshoes could be found and these were greatly missed on several occasions.

Pulling the sledge over two ridges, each about 200 feet high, turned out to be rather hard and unaccustomed work. Crossing Colan and Black Cliffs Bays on the rough and deeply snow-covered ice was equally laborious. Thus it was midnight before a tiny island in Black Cliffs Bay, about three quarters of a mile from Wood Creek Delta was reached. Lieutenant Egerton called it “Oopik Island" on account of the numerous pellets left there by snowy owls. It was almost entirely free of snow and appeared to be a favourite spot for shorebirds and waterfowl. The maturing it receives has resulted in abundant plant growth and it was, therefore, of considerable interest botanically.

Wood Creek emerges at the head of its delta from a short, narrow gorge, at the upper end of which a partly ice-covered, nearly vertical rock wall, some 20 feet high, formed the first serious obstacle. After some step cutting and reconnoitering the prospects for a mile upstream, load and sledge were hoisted up and the journey resumed. In the space of the next mile and a half, the stream has cut a very irregular course through the rocks. The vertical walls of the several short gorges show the excessive folding of the. rather thin-bedded strata very well. While similar exposures occur at a few places higher up in the valley, most of the slopes are covered with scree and even a trained geologist probably would have difficulties in attempting to determine sequence and thickness of the formations. All outcrops examined were quite similar to those seen in the vicinity of the station, e.g. in the ravine of Parr Creek.

Above these series of gorges, the main stream, as well as a tributary joining it from the south, has dug a wide valley through an ancient gravel outwash plain. The nearly level remnants of its surface stand at approximately 250 feet above sea level and it was probably laid down when the elevation of the entire region was considerably lower than at present. Shortly before going into camp at 1000 hours on June 6, after having made good some 14 miles, the first flowers of the purple saxifrage, *Saxifraga oppositifolia*, were discovered on the south-facing valley slope.

After about 10 hours' rest the journey was resumed and led at first along a rather narrow and tortuous section of the valley. The weather, which had been partly overcast with occasional fine snow, now began to clear. The increasing insolation accelerated the melting of the snow and a few small pools of open water formed in the creek bed. Generally speaking, the depth of snow in the valley was less than anticipated. However, in some of the narrower parts, deep, hard-packed and steep-sided snow drifts were difficult to negotiate.

About six miles farther on, the valley began to broaden again and from here to the next camp, a number of recent muskox tracks were crossed. However, only a single animal was seen, standing on a low steep-sided hill, which rose from the floor of the valley. This provided the only opportunity during the whole summer to obtain photographs at close range. The old bull objected to this, however, and made a short charge which resulted in no more serious consequences than a precipitous retreat of the over-ambitious photographer.

The high valley sides which rise generally in well-defined steps to several hundred feet above the watercourse had so far restricted the view to no more than a mile or two. Only when near Camp II, a quarter of a mile below the point where the two main branches of Wood Creek unite, one or two of the higher peaks near Mt. Grant became visible at times.

After a twelve-hour rest at Camp II, sledging was resumed at 2210 hours on June 9. Following the north branch of Wood Creek, the going became more and more difficult. The floor of the valley, here rather wide and fairly straight, consists of nearly level, boulder-strewn gravel flats. Into these the melt-waters have cut channels to a depth of a few feet, which wander from side to side and branch frequently. They retained a fair covering of snow, while the higher portions were almost bare. It was not always possible to pick out the right way and more than once a promising lane ended up against a barrier of bare rock.

The gradient along the whole length of the stream is gentle and very uniform. The only exceptions are the waterfall at the head of the delta and a rather insignificant step about half way between the main fork and the mouth. The average rate of rise was found to be even less than anticipated: 1220 feet for the first 28 miles and 700 feet for the remaining 6½ miles to the foot of the nearest tongue of the ice cap.

After struggling along for another 3½ miles, it was decided to abandon the sledge and make a dash on skis, at least as far as the foot of the ice cap, packing only tent and provisions for two snacks. Accordingly, at 0500 on June 10, the final phase of the journey began. From here on, the aspect of the valley changes greatly. At Camp III, where the sledge was left, both sides are still of about equal height. The south wall, formed by the edge of an extensive, much cutup plateau, which extends far to the south along the east front of the icecap rises to about 2000 feet. On the other side short ridges and sharp peaks of black slate tower over 3000 feet above its floor. After rounding a corner of this plateau, where the valley is considerably constricted, it widens out again and trends more to the south. One branch of it appears to end at the foot of a distant large glacier, which is badly crevassed. The other shorter one, runs nearly straight towards a narrow tongue of ice which descends through the gap between two ridge-like peaks.

After four hours of travel, Camp IIIa was established at the foot of the glacier on a well vegetated, gravelly flat. The next hour and a half were used in having lunch, making notes on the plants, and collecting specimens of these, as well as of the flies and midges which were flying in some numbers in the bright sunshine, and which had been noticed for the first time at Camp II.

Closer examination of the ice tongue revealed that its actual foot was buried under an enormous, exceedingly steep snowdrift. Higher up, the ice was bare and appeared quite smooth and free from any cracks or crevasses. Without having made definite plans, we began to ascend a steep, conical hill flanking the south shoulder of the ice. The cliff-like summit of it forced a traverse of the shoulder facing the glacier. There was not a sign of bergschrund and as the steadily decreasing gradient made it just possible to scramble up the hard-packed snow slope, the ascent was continued towards the edge of the icecap. This, however, appeared to be receding farther and farther, until in the end, after four hours' climbing, it was conquered.

The view it afforded amply repaid for the effort expended; as far as the eye could reach, a slightly undulating plain of glittering white extended to the west and southwest, dotted here and there with groups of nunataks, whose partly bare slopes stood out in strong contrast with their surroundings. In the far distance, a massive white peak was silhouetted clearly against the dark-blue sky. Fond imagination took it to be Mount Oxford. But the closest group of nunataks, perhaps ten miles away, held the greatest surprise; among the pointed summits appeared a mound, immaculately white, of perfectly hemispherical shape, which resembled nothing more than the cupola of an observatory, and which looked so artificial that it seemed to be entirely out of place among its angular neighbours in this silent waste of snow, ice and rock. A lone fox track bore mute witness to the fact that it was not quite devoid of life.

To gain a still better vantage point, the climb was continued for a few hundred feet to the lowest point of the ridge-like summit of the mountain to the south of the glacier. There was neither sufficient energy nor time left to attempt its very peak about a mile away and hundreds of feet higher. The next hour was devoted to rest and the taking of a series of overlapping pictures front north-northwest through east to south, comprising most of the northeast corner of Ellesmere Island from Markham Inlet past Cape Union down to Lady Franklin Bay and Lake Hazen, as well as a considerable portion of northwest Greenland.

It is much regretted that no surveying instruments of any kind wore taken along, because not only the identity of Mount Grant remains in doubt, but the delineation of the upper course of Wood Creek and of the eastern part of the icecap appears to be incorrect on the maps.. According to aneroid readings, which were carefully corrected with the aid of air pressure records at the station, the elevation of the highest point attained is 4800 feet, while that of Camp IIIa is 1920 feet, and the total distance travelled since leaving the station amounted to 37 miles.

At 2220 hours on June 10 Camp III was reached after 24 consecutive hours on the trail. After a well earned rest, the weary trek home began. The snow was softening and beginning to disappear rapidly and it soon became clear that in order to avoid serious difficulties, no time was to be lost. While on the outward journey, the very gentle slope had caused the optical illusion of going downhill, now the heavy sledging had the opposite effect: the trail seemed to be going uphill all the time. In a few places deep pools had to be detoured by going over the bank, which necessitated backpacking or cutting a groove for the uphill sleigh runner into the steep snow slopes. The waterfall was negotiated just in the nick of time and a last camp made at the head of the delta. The remaining nine nightmarish miles over soft snow on Black Cliffs Bay, across the partly bare 200-foot saddle into Colan Bay and through water and deep slush on the Dumbell Lakes were finally overcome when at 1050 hours on June 13 the station was reached.

During the next two weeks the snow melt proceeded rapidly and by June 25 the country was practically bare. Plants were coming into bloom and several species of insects, mainly two-winged flies, were on the wing in considerable numbers. The ground had become quite soft during this period, making walking very tiring. However, the soil dried with astonishing rapidity and by the end of the month travel on foot had become easy. As none of the more productive collecting spots were closer than about four miles from the station, a great deal of walking was necessary; in the month of July alone, the writer travelled 246 miles.

The first impression, that the vicinity of the station was rather barren, was fully confirmed now, and by the middle of July, it became clear that, in order to find the majority of the plant species which had been recorded for this region, it would be imperative to go farther afield. Accordingly, plans were made for a second trip to Wood Creek. As the chances to reach the creek by boat seemed very remote, the only alternative, to walk around the head of Hilgard Bay, was explored during two excursions. The first, a round trip of 27 miles, on July 20=21, showed that it was comparatively easy to reach at least the head of the bay. The second one of 36 miles on July 25-26, during which a few miles of the valley of the creek entering the head of Hilgard Bay were explored, extended to near the south corner of Egerton Lake and to within six miles of Wood Creek, and showed this route to be feasible. While both trips were somewhat disappointing as far as botany is concerned, they yielded rich insect collections.

On August 1-2, during a 34 mile journey, Cape Sheridan, Floeberg Beach and Black Cape were visited. At Cape Sheridan, where Peary wintered in the "Roosevelt" in 1905-06 and again in 1908-09 during his attempts to reach the Pole, there stands a cairn, erected by Peary on a low hill east of the stream which here enters the sea. The large wooden cross which once overtopped it has blown down. It bears on a
copper plate the following inscription:

In Memory of
Ross G. Marvin
Cornell University
Aged 31
drowned April 10th 1909 45 miles
north of Cape Columbia
returning from 86° 38’ N. lat.

Above this cairn, farther inland and on prominent hills, stand two more, the one to the northwest, presumably built by Peary, bears a large wooden cross on which is only carved: - R - . The other one, to the southeast was erected by Nares in 1876. Of its flagstaff only the lower part still stands. Below the "Alert" cairn, on a spur of the hill, lies the lone grave of Niels Christian Petersen, the Danish interpreter of the Nares Expedition who died here in 1876. Below this again is “Floeberg Beach" where H.M.S. Alert, one of the two ships of the Nares Expedition, wintered in 1875-76. Two heaps of coal ashes, piles of hand-forged barrel hoops, bits of wood and broken crockery tell of the first visitors to these shores. "Floeberg Beach" lived up to its name: nowhere else along the coast were the floes as large or numerous nor as tightly packed as here. A few miles farther east the frowning cliff of Black Cape bears a group of small cairns. Neither here nor at Cape Sheridan did a cursory examination reveal any containers which might hold documents. The cairn erected in 1948 by United States Navy personnel west of the creak at Cape Sheridan, was only seen from a distance. The cold wind which drove ragged sheets of fog across the landscape kept insects in hiding and the hope of finding one or the other of some still missing plant species which Captain Feilden had collected around Floeberg Beach proved vain.

Bad weather, which had hampered work continuously during the entire season, delayed the start of the second excursion to Wood Creek until August 10. On the following day after a 20 mile walk in 15½ hours, each carrying a 65-pound pack, MacDonald and the writer arrived at Wood Creek about 2½ miles above its mouth. During the following days the country south of the creek was explored from the camp set up here. Unfortunately, it was impossible to cross the fast-flowing, deep stream and, what was still worse, the weather which had been splendid during the first day, deteriorated rapidly bringing frequent rains which turned to snow at levels above 500 feet, and high winds. Insect collecting soon became nil, but the botanical results were most gratifying. Not only were some of the missing, previously recorded species found, but also several which are new for the region and represent some considerable range extensions.

With provisions running low and the weather showing no signs of improvement, it was decided on August 14 to return directly to the station instead of camping for a day at the east shore of Hilgard Bay as originally planned. We left at 1100 hours and had to battle a southwesterly gale all the way to the head of Hilgard Bay. Here the wind most perversely switched to the northeast, thus still impeding instead of aiding our progress, To make matters worse, it soon brought rain which later turned to snow. By the time the station was reached, at 2300 hours, the ground was white.

This snowfall marked the unexpectedly early - the writer is tempted to add "unusually early" – beginning of winter. While it was possible to collect a few more midges, which were emerging from the still unfrozen lakes, by picking them off the snow, and to dig out some grasses, the all-too-short collecting season had come to an end.

Results of the Entomological Investigations - Most of the Arctic expeditions brought home valuable collections of plants, mammals and birds, but few paid attention to insects. Among the notable exceptions is the Nares Expedition. Its naturalist, Captain Feilden, was the first, and as far as the writer is aware the only one who made a collection of insects in the region under discussion. The results of his work have been published by McLachlan, who lists a total of 45 species from Ellesmere Island. Of these, however,
only 24 (including 5 Mallophaga), had been taken or observed north of 81° 50'.

As mentioned elsewhere in this report, the summer of 1951 was rather unfavourable for insect flight. It was not only more than two weeks shorter, but also considerably cooler than that of the preceding year. The monthly mean for July 1951 was only 36.3° as against 39.9°. The writer was, therefore, very gratified to learn that his material comprised a total of 41 species of insects, exclusive of Mallophaga
which were collected by Mr. MacDonald. It is likely that this number would have been still greater had the season been more favourable. Several species were apparently prevented from emerging by the onset of winter. As the material has not been worked over, only a few remarks of general interest will be made concerning the insect fauna.

Butterflies and moths are among those insects which are most likely to attract attention. Of the former, ten specimens of a small fritillery, Boloria polaris, were taken. (For a number of these, as well as of moths and some other insects, the writer is indebted to Mr. MacDonald and members of the staff of Alert weather station). The first one seen was captured at half past one in the morning of July 10.

The larvae of a fair-sized, heavy-bodied moth, Byrdia groenlandica, resemble the familiar "woolly bears" and are easily seen on saxifrage and Arctic willow. They require several seasons to mature and are heavily parasitized by two-winged flies. From a great number collected, only four adults were reared.

Two species of bumble bee were found. The first of these hardy insects was seen flying on June 12 and later on some were observed to gather pollen and nectar on a sunny slope, while the air temperature stood at 30.5°. Four other species of hymenoptera, all parasites of other insects, were taken.

Along the shores of the Dumbell Lakes and Hawkins Lake, a long series of trichoptera was collected, which constitutes a range extension of more than 5½ degrees in latitude for this order.

On August 24 the writer captured an immature German cockroach, Blatella germanica, in the kitchen. Later on numbers of adults, including, females with egg containers, were noticed. This infestation must sure1y be the farthest north record for this cosmopolitan species.

The diptera are the best represented group with 27 species. This order supplies here as elsewhere in the Arctic the largest numbers of individuals. As soon as the continuous sunshine warms their winter quarters, they emerge and swarm in sheltered places or sun themselves on rocks or the walls of buildings. And at the end of the short summer, after the first snow has covered the country with a fresh mantle of snow, midges continue to emerge from the yet unfrozen lakes in such numbers that they cover the water and darken the snow along the shores. On calm sunny days they can become a decided nuisance by flying into one's eyes, cars, nose and mouth, but they do not bite like mosquitoes. Only one species of mosquitoes, Aedes nearcticus, occurs at Alert. Fortunately, they do not appear in great numbers and fly only when the air temperature exceeds 42°, which does not happen frequently. While one of the mechanics complained that the back of his neck became inflamed and itchy as the result of mosquito attacks, the writer did not feel the slightest pain when bitten nor did he experience any after-effects of numerous bites. In spite of the protracted and painstaking search, no larvae or pupae of mosquitoes were found.

Several species of blowflies as well as of tachinide, which are parasites of other insects, were found.

Results of Botanical Investigations -The area investigated extends from 61°15’ W to 65°W and from 82°25’N to 82°32 N. It is part of one of the northernmost land masses in the world. Ellesmere Island reaches about 40 miles farther north at Cape Columbia and only the extreme point of Greenland exceeds this by 25 miles.

Considering this high latitude, the flora of the vicinity of Alert weather station is astonishingly rich. Captain Feilden, the naturalist of the British Arctic Expedition under the command of Sir George Nares, 1875-76, found in this district a total of 33 species of flowering plants. Collections made by members of later expeditions, i.e. Perry, 1905-06 and 1908-09, and McMillan 1920, added 21 species, and the writer was fortunate enough to discover another 18, thus bringing the number of species of vascular plants known to occur in Northeastern Ellesmere Island to 72.

The comparative richness of the flora (which is the sum total of different kinds of plants) is, in these high latitudes no indication of a similarly luxuriant or even abundant vegetation (which term refers to the visible display the plants make collectively.

In April, when the writer arrived at, Alert, the country gave the impression of a dreary waste of ice, snow and rocks. Only closer inspection revealed a few withered blades and heads of grasses and widely scattered small groups of empty poppy seed pods barely overtopping the surface of the snow. Here and there, windswept, bare mounds serve snowy owls, and later falcons, as perches. These places are also frequented by foxes which visit them for the same purpose for which our city dogs use hydrants and signposts. The liberal manuring that these spots receive results in a rather luxuriant growth of grasses and several other kinds of flowering plants which are sufficiently hardy to survive the continuous exposure to low temperatures and cutting winds during the long winter.

In the immediate vicinity of the station, the general impression of barrenness persisted even after the snow had disappeared. The, often very stony, polygon soil supports only a scant vegetation which, moreover, tends to congregate in the cracks. These give some measure of shelter and provide a better supply of the all-important moisture than the fast-drying, rounded hummocks, but also hide the plants from casual view.

Some of the gentler north-facing slopes of the hills along the coast support a rich growth of saxifrage.This produces such a profusion of bloom that whole hillsides glow with a purple sheen. It is a sad thought that nobody is there to enjoy this splendour which renews itself from year to year.

Only a few small and widely scattered areas provide all the conditions necessary for the establishment of a more or less luxuriant, closed vegetation, i.e. an association of plants growing so close together as to cover the ground completely. The main requirements appear to be, in ascending order of importance:

1. a certain measure of fertility and depth of the soi1, which depends on the composition of the rocks from which it has been derived;
2. a sufficient amount of snow cover, which is influenced by the topography and the direction of the prevailing winds;
3. an ample and continuous supply of moisture. According to the source of this, these areas can be divided conveniently into three groups:
a. margins of shallow ponds (Ravine Pond, a small pond near Cape Belknap, ponds above Hawkin’s Lake);
b. margins of sluggish streams (tributary of Ravine Creek in the gap between Mount Pullen and "Dean");
c. flats or gentle slopes below persistent, slow-melting snow drifts (foot of Mount Pullen and "Dean", slope east of Jolliffe Bay, slope between Jolliffe and Colan Bays, flat along, south side of Hawkin’s Lake.) The localities in brackets are those visited.

The composition of the plant communities which occupy these areas varies so much from place to place that it is difficult to group them according to assemblies or to correlate these latter with different habitats. To do this would require a far larger collection of data than could be gathered in one short season. At a rough estimate, the patches of closed vegetation occupy only a small fraction of one per cent of the total
area investigated.

The great variability in composition of the plant associations runs parallel with the discontinuous, and in cases extremely localized, distribution of most members of the flora. Only about 25 per cent are found in widely scattered, smaller or larger groups, while the remainder is made up of those which were seen in only one or two localities. To this last group belong not only small, inconspicuous and therefore easily overlooked species, but also some rather large and showy ones. Elevation by itself does not appear to have much influence on the vegetation in high-Arctic regions. The writer found, for instance, a rather large well vegetated area at the head of one of the main branches of Wood Creek nearly 2000 feet above sea level and some 25 miles inland near the foot of a tongue of the ice cap. It supported a plant community very similar in composition to those seen near the mouth of the stream at less than 200 feet. It is, therefore, to be expected that many, if not all, of the sheltered valleys in the interior are as well vegetated as the coastal regions.

That the 1951 season was shorter, if not considerably shorter than usual, may be deduced from the fact that not even the earliest flowering plants ripened seeds, except odd individuals growing in very favourable spots, that many did not even set seed, and that practically all the grasses had barely reached the flowering stage when they were buried by the first fall of snow.

As the material collected at Alert has not yet been worked up completely, it is not possible to give a list of the species at the present time. A paper on the flora and vegetation of the district by the writer in collaboration with Mr. J.A. Calder of the Division of Botany, Dominion Department of Agriculture, is in preparation and will be published in the near future.

Geographical Investigations at Eureka, N.W.T.

Introduction - The following report was prepared by Pierre Gadbois who spent the time from April 19 to August 24, 1951, at Eureka, N.W.T., making geographical investigations sponsored jointly by the Geographical Branch, Department of Mines and Technical Surveys and the Northern Administration and Lands Branch, Department of Resources and Development. The writer travelled with J.S. Tener of the Canadian Wildlife Service who was engaged in biological investigations in the Slidre Fiord area.

The names used in the following report have been approved by the Canadian Board on Geographical Names. Eastwind Lake was named for the U.S. vessel which successfully resupplied Eureka.

The Limits of the Surveyed Area - The extent of the area surveyed was determined to a certain extent by the hydrographic network draining into Slidre Fiord. Because of the nature of the geographical work to be done, the areal extent of the survey was necessarily that of the available photographs and maps. The only usable map was one prepared by the Surveys and Mapping Branch of the Department of Mines and Technical Surveys, at a scale of two inches to one mile. The contour lines of this map show a vertical interval of 50 feet except in the vicinity of the airstrip where it is 25 feet. The northern and southern coverage of this map includes the heights of land; to the west, it is limited by Eureka Sound and to the east it includes only a small part of the Slidre River system. The geographical survey was limited to this coverage.

Physical Processes in the Surveyed Area - The dendritic pattern of the hydrographic network indicates the imperviousness of the soil and the unconsolidated nature of the materials through which the streams are cutting. Slidre River is the only stream with sufficient importance to be called a river. It flows into the fiord at its eastern extremity. All other streams are mere creeks with such a small volume that they dry up completely by the middle or the end of July, after which they flow sporadically for short periods of time varying with the volume and duration of summer precipitation. The yearly precipitation being of the order of four to five inches, it can be deduced that the regime of these streams is not much influenced by it, but is affected mostly by the melting of the winter snow. Black Top Creek and other small streams, however, have their source at small snowfields on top of high ridges, but the volume they thus acquire is not sufficient to provide for losses caused through evaporation and some infiltration. The result is that these also dry up completely before reaching their mouth. The larger Slidre River has not been traced to its source, but is believed to rise in the mountains bordering Canon Fiord; if such be the case, the larger volume of water in this river would be explained by the presence of more extensive snowfields in these mountains. The sporadic streams have a power of erosion and accumulation only over a short period of the summer and this prevents them from grading their profile considerably, the result being that most of them follow a rather steep incline. In the spring, they become torrents, rushing down to the fiord and incising their valleys deeply into the soft unconsolidated sediments over which they flow. Their aggrading power is great only in the spring when they are able to build comparatively wide deltas. Good examples are those of Station Creek and Remus Creek. This period of sedimentation depends upon the volume of the stream which, as we have mentioned, is mostly influenced by the amount of winter snow covering the ground. When this snow has entirely melted away, the flow of these streams diminishes gradually until completely dry. In regions of temperate climate, sedimentation will occur at various break-points in the gradient of a stream because of the resulting change in the flow speed, but here it is somewhat different. The point of sedimentation regresses from the mouth to the source, at a rate proportional to that of the change in volume with a resulting reduction in the power of carrying sediments. In the later part of summer, there is barely sufficient water at the very source of most streams to force a downward movement of coarser sediments through the process of solifluxion. In the early spring, these deposits left along the entire course of the. stream will be washed further down until they will ultimately reach Slidre Fiord where the tidal currents will probably disperse them.

Fosheim Peninsula is an exceptionally low region having a counterpart in Western Ellesmere Island only in the more southerly Bjorne Peninsula, south of Baumann Fiord. This depressed area is a sedimentary plain eroded by glaciation, uplifted and finally heavily dissected. There is no evidence of a general Quaternary glaciation of the area. It would rather appear that small lobes have moved down from a northern icefield, cutting their paths through the sedimentary plateau and leaving their imprint in the form of these lower plains bordered by high ridges which would be remnants of the same plateau. On this plateau, consisting mostly of soft rocks and unconsolidated sediments, the subsequent normal erosional processes have erased the clear-cut path of the glaciers by joining the plain and the plateau with a smoothly inclined slope. This did not happen, however, where there were intrusions of harder igneous rocks which were able to resist the effects of normal erosion to a considerable extent. These hard rocks, where they apparently were cut by glaciers, have remained as steep walls flanking the sedimentary plain.

It is not, of course, inferred that the igneous rocks were not affected by erosion, but that the effects were different because of the harder nature of these rocks. For example, the top of high doloritic ridges such as that of Black Top Ridge of the Sildre Fiord area was covered with a sheet of mantle rock originating from the bedrock lying underneath. This regolith was formed through the purely mechanical process of frost action. There appears to be no chemical alteration, or almost none, and soil does not develop beyond the stage of coarse rocks. Wherever the surface is sloping, there is a downward movement of the mantle rock by solifluxion, but elsewhere, on level ground, this residual cover remains as such indefinitely and its elements will reduce in size through the constant work of erosion upon it. When the slopes are perpendicular, or nearly perpendicular, the massive rock is jointed and broken off the main mass, rolling down to form huge talus slopes at the foot of the hills and leaving the more resistant rocks standing in a typical buttresses and recesses formation.

Other consolidated rocks are conspicuous in the area, the most common one being sandstone which is usually sculptured by the wind into all kinds of odd shapes and forms. The most prominent of these sandstone ridges stands 750 feet high, on the south shore of the fiord. Other rocks observed consisted of shale and some limestone outcrops that were unmasked from the thick layer of silt and clay by gullying.

Geology of the surveyed area - Many of these rocks were fossiliferous and the following list is extracted from a report on these fossils made by the Geological Survey of Canada, Department of Mines and Technical Surveys: (the asterisks mark the fossils extracted from rocks in situ):

Caninia sp.
* ‘Chaetotes’ sp.
Fenestella sp.
Fusulinid foraminifera - not yet determined.
Geinitzella ? sp.
Geinitzella columnaris ? Schlotheim
Notothyris ? cf. N. polaris Tschernyschew & Stepanov
Polypora pustulata ? Toula
Productus (Linoproductus sp. ?)
Productus cf. P. uralicus Tschernyschew
Productus cf. P. weyprechti ? Toula
Punctospirifer sp.
Siphonophyllia sp.
Siphonophyllia sp. cf. S. callophylloides Holtedahl
Spirifer sp.
* Spirifer sp. probably Spirifer rockymontanus group
* Spirifer cf. S. fasciger Keyserling
Spiriferella sp.
* Spiriferella cf. S. parrayana Toula
* Spiriferella ex. gp. S. saranae
Syringopora sp.
Syringopora sp. cf. S. ramulosa Goldfuss
Timinia sp.

The following comments on the fauna and on the stratigraphy were also supplied by the Geological Survey of Canada:

> These fossils, where recognizable, are typical of the Permo-Carboniferous fauna described by various workers from the Arctic Islands and Northern U.S.S.R. Spiriferids of the Spiriferella saranae group are especially characteristic of Arctic fauna and are well represented in this collection. The productids are too poorly preserved for accurate identification, but they clearly belong to groups normally associated with this fauna.
>
> A similar fauna occurs in the Urals and Timan in the so-called Schwagerina horizon; in the older literature this horizon was regarded as of high Upper Carboniferous age. It is not considered to be Lower Permian and current North American usage would make these beds roughly equivalent in age to the Wolfcamp and possible lowermost Word formations of Texas.

Despite poor preservation, the Arctic Permian affinities of the fauna can be established beyond question. It is not possible to make any detailed comment on the stratigraphy since many of the fragments were presumably collected as loose boulders and may be glacial drift, the collection is nevertheless of considerable palaeontological interest.

Another part of the writer's collection was also identified and commented upon by the Geological Survey of Canada as follows:

Lot A (in situ, from undisturbed horizontal strata uncovered by a deep gully approximately one and a half miles north of Slidre Fiord.)

*Arenaceous shale. No organic remains were observed.

Lot B (in situ, same location as that of Lot A, shale.)

*Aucella keyserlingi (d'Orb.)
* Aucella cf. volgensis Lahusen
* Aucella cf. crassicollis Keyserling
* Aucella sp, indet. (? ce. corneus Sowerby)
* Scalaria cf. clementina d'Orb

Lot C (In situ, same location, sandstone.)

* Aucella cf. volgensis Lahusen
* Aucella cf. terebratuloides Lahusen
* Lima sp. indet. (the same form as in lots F and G.)

Lot D (From a stratum of weathered clay shale, in a gully near the source of the eastern branch of Station Creek.)

Aucella ex. gr. volgensis Lahusen
Astrate sp. indet.

Lot E (Same location as that of lot D, loose.)

Numerous inorganic concretions, rolled pieces of unfossiliferous rocks, fossil wood. Among these former, two reworked fragments of Acrotheuthis ? indet. And a large gastroped (genus and species indet.)

Lot F (From the northeastern extremity of Slidre Fiord, 100 feet above M.S.L., boulder of sandstone.)

Aucella ex. gr. volgensis Lahuson

Pecten (? Camptonectes) sp. indet. (? cf. praecinctus Spath.)
Lima sp. indet. (the same form as in lots C and G.)
Anomia ? sp. indet.
Ostrea sp. indet.

Lot G (In situ, from sandstone ridges at northwest extremity of Slidre Fiord.)

* Lima sp. indet. (the same as in lots C and F)
* Pelecypod (genus and species indet.)

Lot H (Weathered shale outcrop, three miles above the mouth of Station Creek.)

Indeterminate shall fragments (* pelecypod)

Lot I (Black Top Ridge at the latitude of Eastwind Lake, shale.)

* Aucella ex. gr. okensis Pavlow
doubtful cast of an indeterminate ammonite (? may be an inorganic concretion).

Lot J (Same location as that of Lot I)

Indeterminate ammonite probably of Late Mesozoic affinities.

Lot K (In situ, high ridge at the southwest extremity of Slidre Fiord.)

Finely grained, light coloured sandstone. No organic remains seen.

"The age of Lots A, H, and K, cannot be determined due to the lack of identifiable fossils."

"Lots B, C, D, and F, are all believed to be of an early Lower Cretaceous (i.e. Lower Neocomian) age. In terms of finer international standard stages their age is about Valanginian. The possibility of an Infravalanginian age is considered for Lots C, D, and F. Lot B seems to be somewhat younger than the rest and hardly could be of an Infravalanginian age."

"Lot G does not contain any reliable index forms. It contains, however, the same species of Lima sp.indet. as lots C and F. Also the rock (light yellow sandstone) is identical with the rocks of both latter lots. Therefore, it appears virtually certain that Lot G is of the same early Lower Cretaceous age as the other two lots above mentioned."

"The reworked fossils of Lot E appear to be likewise of an early Lower Cretaceous age. They, however, were definitely collected on the float and would conceivably be brought by glaciers from elsewhere."

"Lot I seems to represent a different and somewhat older fauna as compared with the lots above mentioned. The thick-shelled, coarsely and sparsely ribbed Aucella ex. gr. okensis Pavlow are, as far as the writer is aware, characteristic of an Infravalanginian (Lower Cretaceous) zone immediately below that with A. ex gr. volgensis-keyserlingi. It is, however, not as yet clear whether or not Aucella ex. gr. okensis Pavlow are restricted to this zone or may also occur in younger beds and in the rocks of the uppermost Upper Jurassic (Upper Portlandian) age. At the present time the age of. Lot 1 can only be determined as Lowermost Cretaceous (? Infravalanginian) to Uppermost Jurassic (Upper Portlandian) age. The former age is, however, considered much more probable. Poor preservation of fossils in this lot makes the age determination ever more tentative."

"The age of Lot J can only be determined as Mesozoic. It seems, however, that it is of late Mesozoic age as well."

"Lots B, C, D, E, F, and G, represent a typical boreal assemblage of the early Lower Cetaceous (Lower Meocomian) fauna. This is practically the same fauna as the Lower Neocomian faunas of northern European Russia, Siberia, Russian and Norwegian Arctic Islands, Greenland, Alaska, Canadian Arctic archipelago, Northwest Territories, British Columbia and Vancouver Island. This indicates the penetration of the Neocomian borea1 sea above mentioned into parts of Canada. It seems rather probable that all the Canadian areas previously mentioned represented parts of one and the same sea basin of the early Neocomian times."

"The above applies also to Lot I, except that this latter seems to be of somewhat older age than the rest."

"Similarity of facies of Ellesmere Island, Prince Patrick Island and N.W. Territories (Richardson Mountains) is also remarkable."

Description of the Surveyed Area - Located in northwestern Ellesmere Island, Fosheim Peninsula is limited by Eureka Sound to the west, Greeley Fiord to the north, Canon Fiord to the east and finally, Bay Fiord to the south. The neck of this peninsula extends from the extremity of Canon Fiord to that of Bay Fiord.

As already stated, the surveyed area was the watershed of Slidre Fiord which is a deep indentation in the northwestern part of Fosheim

Peninsula. This body of water has a length of sixteen miles and a width varying from one and a half to two and a half miles. Its orientation is roughly northwest-southeast. At the very end of the fiord there is an extensive area of low-lying ground, including Romulus Lake, apparently a former extension of the fiord which would have receded upon the uplifting of the land mass. The braided lower bed of Slidre River covers a great proportion of this low ground, where it builds its delta. For the 1ast two and a half miles of its course, this river varies from half a mile to one mile in width. Water flows over the entire width only in the early spring when the volume is still swelled by the melt-water of the area drained by it. By the middle of summer, the actual water course is reduced to a few hundred feet in width and it meanders all over this wide flood-plain. Nearly six miles above its mouth, it has cut deeply through the sedimentary layers and its cut-bank slope is a 50-foot vertical wall of unconsolidated materials. At this point the river branches off in two, one branch flowing in from the east and the other from the south and southeast.

Slightly more than two miles southwest of the confluence of Slidre River lies Romulus Lake, two and a half miles long, in the same general orientation as that of the fiord. It has a width of half a mile in its centre and of one mile in its eastern and western sections. This lake is of salt water and it is, as we have said, presumably a remnant of the fiord before it, receded to its actual limits. Although no exact measurements were taken, it is believed that this lake lies below the level of the fiord and that it is fed underground by it. The presence of ice in the month of July suggests that this lake must be quite deep. The south bank of Romulus Lake rises rabidly to more than 300 feet. It is mostly of clay and numerous gullies have cut deeply into it. The north side of the lake opens on the low sandy plain. The whole country east of this point is very low and relatively flat and from a height of 250 feet, one can see to the very foot of the snow-covered mountains bordering Canon Fiord.

The south shore of Slidre Fiord diminishes progressively in height from west to east, that is from 2000 feet on top of the old peneplain to some 250 feet in the lower, more eroded plain. This plain is broken by numerous gullies where creeks flow sporadically and by a 750 foot sandstone ridge located nearly ten miles east of Eureka Sound. This ridge is a typical cuesta formation, a monocline dipping gently to the east-northeast. Gullying has played an active part at the foot of this ridge while the harder sandstone at the top was greatly sculptured by the action of the wind. No fossils were found in these rocks. At the very edge of the ridge a very old formation was observed with the shape of a perfect sphere of sandstone, seven to nine feet in diameter and slightly flattened in its axis. This sphere, probably a concretion, had been eroded out by the wind from the softer rocks in which it was buried and it was standing on a pedestal like a big scale terrestrial globe. A later flight over this area revealed a great number of these spherical concretions, still almost entirely buried in sandstone.

The north shore of the fiord is somewhat similar to the south shore although it has a more diversified relief. The most prominent feature here is Black Top Ridge which, as already mentioned, is an igneous intrusion in sedimentary strata. This ridge is a monocline, probably part of a syncline that was eroded away by glaciation, and it dips gently to the east. The face of this ridge is quite steep, with an incline reaching over 25%, extending from, the mouth of Remus Creek for a distance of six or seven miles to the northwest then to the northeast beyond the latitude of Eastwind Lake and towards the opening of Canon Fiord. The ridge is more than six miles wide. It is incised by deep valleys and, in areas protected from the wind, there are some alpine meadows where a certain amount of Arctic vegetation succeeds in growing. The maximum height of this ridge has been determined as 3050 feet. A great part of the top, above 2600 feet, is covered with snow throughout the year. From the very top there is a magnificent view of the surrounding region including Greely Fiord with the glaciers flowing into it, Canon Fiord and its bordering mountains, a great part of Eureka Sound and of Nansen Sound leading into the Arctic Ocean.

At the foot of Black Top Ridge, there are slightly folded sand stone ridges leading to a four or five mile wide plain of unconsolidated clayey material. Six miles north-northeast of this lies Eastwind Lake, a refuge for ducks and loons. It is small and shallow, approximately one and a half miles by less than half a mile. All kinds of aquatic plants and some invertebrates live in it. The gentle slopes leading to this lake are covered with Arctic heather.

West of the low-lying plain above described, the land rises gently through a series of slightly folded sandstone ridges to the top of the peneplain which falls abruptly towards Eureka Sound and the entrance to Slidre Fiord. Elsewhere along the shore of the latter, except at the three main creeks, the shoreline rises sharply to three or four hundred feet and then gently to height of land.

<u>Eskimo ruins at the north shore of Slidre Fiord</u> - Although no special study was undertaken on former Eskimo sites in this area, a number of artifacts were collected at two different points on the north shore of Slidre Fiord near its eastern extremity. These were submitted to the National Museum of Canada for identification and the following comments were given:

There are three specimens which obviously belong to the Dorset culture, consisting, of one harpoon foreshaft of antler, and two worked fragments of antler.

> Two other specimens are obviously from the Thule culture; they are a broken harpoon head of ivory, and a handle made from the bone of a whale.

Five other specimens are probably from the Thule culture, including a whetstone, the handle of a scoop made from antler, and antler wedge, a rod of ivory, and an arrowhead of antler.

The remaining ten fragments are debris left over from the making of other tools and implements. Seven of these are of antler, two of bone, and one of ivory.

General Remarks - This short study on the geography of this area is very incomplete, being only a preliminary report. A detailed study is being prepared for the Director, Geographical Branch, Department of Mines and Technical Surveys.

The lack of any means of transportation other than a canoe was a handicap insofar as it limited the extent of the excursions that could be undertaken. The canoe was of very limited use because of the constant movement of ice in and out of the fiord. Snowshoes, skis, and a dogsled would have been most useful in the early part of spring. From Eureka Weather Station, one could easily have travelled to Axel Heiberg Island or up Eureka Sound to Nansen Sound or Greely Fiord, without too much difficulty. But it is felt that, under the circumstances, this survey has been very successful; the specific work assigned to the writer was completed, and a general geographical study was made.

This would not have been possible without the generous assistance of the United States Weather Bureau, the Meteorological Division of the Department of Transport and the United States Army Air Force to whom the writer wishes to express his grateful thanks.

Chapter 11

RADIO COMMUNICATIONS

Initial Plans - The overall plan for the Joint Arctic Project required the establishment of a communications system which would permit the regular transmission of weather reports from the Arctic Stations to forecast centres on the mainland. In order to accomplish this, the main station in the Arctic network was to act as a control station and collect the reports from the smaller or satellite stations. The entire weather collections would then be relayed by the control station by radio to a centre on the mainland.

It was envisaged that the following radio facilities would be required at the main station.

1. A high frequency channel to the mainland.
2. A 1ow frequency alternate to the mainland.
3. A high frequency channel for working the satellite stations.
4. A 1ow frequency alternate for working the satellite stations.
5. Transmitting and receiving equipment.
6. Radio operators and technicians.

Additional facilities would also be required to provide navigational aids for aircraft operations, such as a suitable frequency for working aircraft, a radio beacon, and, if possible, a D/F navigational aid and blind approach system.

The communications installations at the satellite stations would not be as elaborate as that of the main station. However, each satellite station would require a high frequency channel to the main station, a low frequency alternate, transmitting and receiving equipment, a channel for working aircraft and a radio beacon. It was felt that the smaller stations would require a radio staff of two men only.

Call signs and frequencies were tentatively approved for the Joint Arctic Network by the United States Interdepartmental Radio Advisory Committee in 1946. It was proposed that the radio network would terminate initially at Fairbanks, Alaska, with a parallel connecting circuit through Canadian facilities that would be designated later. This plan was later changed to the effect that the main outlet for the Joint Arctic network would be through Norman Wells rather than Fairbanks.

Initial Frequency-Assignment - Prior to the establishment of the first

Joint Arctic Station at Eureka, the following frequency assignment was made:

Point-to-Point Frequencies	Air-Ground Frequencies
170.5 kcs.	3452.5 kcs.
460 kcs.	4220 kcs.
3390 kcs.	6355 kcs.
5597.5 kcs.	
7560 kcs.	
10645 kcs.	
11925 kcs.	

A call sign of CHS was assigned to Eureka, to be used on both air-ground and point-to-point frequencies. A frequency of 201 kcs. was assigned for the radio beacon with identification MNU.

The same point-to-point frequencies as given above were assigned for the main control station at Resolute and also the same air-ground frequencies with additional VHF frequencies of 116.1 mcs. and 126.18 mcs. The point-to-point and air-ground call sign of CHW was assigned to Resolute. A beacon frequency of 391 kcs. was assigned to Resolute with the identification MNW.

When the stations were established at lsachsen, Mould Bay and Alert, each one was assigned the same air-ground and point-to-point frequencies as Resolute and Eureka. Radio call signs, beacon frequencies and beacon identification were assigned to the new stations as follows:

Call Sign	Beacon Frequency	Identification
Alert CHV	203 kcs.	LT
Isachsen CJ6L	240 kcs.	IC
Mould Bay VD2K	230 kcs.	PK

Change in Beacon Identification - In order to conform to the general pattern across Canada where the beacon identification and meteorological call sign of the station are identical, the beacon identifications at Eureka, Mould Bay and Resolute were changed on March 1, 1951. The radio beacon frequencies and identifications for the Joint Arctic Stations as of December, 1951, are as follows:

Station	Beacon Frequency	New Beacon Identification
Eureka	201 kcs.	EU
Mould Bay	230 kcs.	MD
Isachsen	240 kcs.	IC
Resolute	391 kcs.	RB
Alert	203 kcs.	LT

Changes in Frequency Asssignment - The air-ground frequency of 3452.5 kcs. was dropped from the authorized list early in 1950, as it was not being used. The additional 1ow frequency of 97 kcs. was authorized in February, 1950, to be used by Resolute as a replacement for 170.5 kcs. for working Norman Wells and Edmonton only. The frequency of 6355 kcs. was designated as the primary air-ground frequency with 4220 kcs. as a reserve frequency.

An additional frequency of 5840 kcs. was tentatively assigned to Resolute in August, 1950. However, it was found that reception on this frequency was poor at the satellite stations owing to considerable interference and this frequency was replaced by 5827.5 kcs. in October, 1951. The frequency of 97 kcs. was replaced by 131.75 kcs. in May, 1952.

Authorized Frequencies - The frequencies which are authorized and in use at the Joint Arctic Stations as of March 1, 1953, are as follows:

Point-to-Point Frequencies

131.75 kcs. (Resolute and Eureka only)
170.5 kcs.
460 kcs.
3390 kcs.
5597.5 kcs.
5827.5 kcs.
7560 kcs.
10645 kcs.
11925 kcs.

Air-Ground Frequencies

4220 kcs. (reserve)
6355 kcs.
116.1 mcs. (VHF)
126.18 mcs. (VHF)

Use of Amateur Radio - The use of station radio equipment for amateur radio transmissions has been authorized at all the Joint Arctic Stations. The fol1owing amateur radio cal1 signs have been assigned:

	Amateur Radio Cal1 Sign
Eureka	VE8MA
Resolute	VE8MB
Isachsen	VE8MC
Mould Bay	VE8MD
Alert	VE8ML

It was intended that the bulk of personal message traffic would be handled by amateur radio. However, provision was made that personal messages of an urgent nature would be accepted for transmission via official channels, if communications via amateur radio were not satisfactory.

This arrangement has been extremely successful and the bulk of personal message traffic from the stations at Resolute, Alert, and Eureka has been passed via amateur radio. As a matter of fact, over a considerable period of time, daily schedules were kept by Alert and Eureka with Mr. J. Surber, an amateur radio operator in Peru, Indiana, who relayed their personal messages.

Amateur radio transmissions are made chiefly on the 20-metre band, using both voice and CW. However, excellent results were obtained at Resolute, using a 50-watt transmitter on the l0-metre amateur band in the spring of 1948.

Weekly round-table discussions are held by the Joint Arctic Stations on the 75-metre amateur band to discuss mutual station problems and affairs.

Communications Equipment - Satellite Stat ions - The communications equipment at all the Joint Arctic Stations was procured from U.S. war surplus stock. As each satellite station was established, the initial radio contact with the control station was made by means of an SCR-694 transmitter. This is a small portab1e transmitter which can utilize power from a hand-cranked generator, and as soon as the station was better established, it was replaced by the more powerful BC-19l transmitter.

The BC-191 transmitter is part of the AN/VRC mobile equipment. This transmitter is not very satisfactory for permanent station use for the following reasons:

1. The output signal is unsteady, chirpy and generally bad.

2. The input power requirement is too high for ground battery installation.

3. They were designed for ruggedness and use with short random length antennae rather than for efficiency with suitable ground antennae.

4. They are inconvenient and slow when changing frequencies owing to the use of tuning unit drawers.

5. They are operated from a power supply of 12 volts DC which is not convenient to obtain from the 28-volt DC station battery installation.

The AN/VRC transmitters have been replaced by l0-channel Collins ART-13 transmitters which require 28 volts input power and thus fit the station main power source. The quality of their signal is far superior to that of the previous equipment. Their main disadvantage is that they were designed for aircraft use with short random length antennae and their input power requirement is too high.

The AN/VRC equipment included BC-3l2 and BC-3l5 type receivers. These were reasonably satisfactory, but lacked selectivity and sensitivity. Moreover, they required the inconvenient l2-volt DC power supply. These were replaced by BC-325 receivers at the same time that the change-over was made to the Collins ART-13 transmitters. The BC-325 receiver is similar to the BC-312, except that it is equipped with a 28-volt dynamotor. A BC-348 type receiver, which also operates from a 28-volt power source, has now been supplied to all the satellite stations.

The major difficulties with the initial radio installations at the satellite stations were the lack of standardization of equipment, the unsuitability of the equipment for the purpose, the over-supply of surplus spare tubes and lack of non-surplus ones, and the difference in in-put voltage required for the equipment and that of the main station supply.

The antennae which are used at the satellite stations are mainly straight wire antennae cut for frequency or half-wave doublets. In addition, both Eureka and Alert use whip antennae to a large extent, and limited use has been made of V-beam directional antennae cut for frequency and rhombic directional antennae.

Communications Equipment – Resolute - The transmitting and receiving equipment at Resolute consists of the following items:

Transmitters
6 T/4-FRC 400-watt transmitters
1 spare T/4-FRC transmitter
2 T/5-FRC 1000-watt transmitters
2 PP-l FRC rectifier units and 1 for maintenance
1 modulator MD-l/FRC
2 BC-797 transmitters
2 Wilcox 96-200C transmitters
1 Collins 32V-1 transmitter
1 radio transmitter/receiver SCR-694 in dismantled condition.

Receivers
4 RBA receivers
1 Hallicrafter SX-28 receiver
8 Superpro receivers

Installation of Racon Beacons - A racon beacon AN/CPN-6 was installed at the Reso1ute weather station in the spring of 1948 by the U.S. Air Force, but has been dismantled since then.

During the spring airlift of 1951, the R.C.A.F. supplied Rebecca type racon beacons to each of the Joint Arctic Weather Stations.

Reso1ute Antenna Array - The Resolute antenna system consists of 8 half-wave doublets cut for the fol1owing frequencies: 3390 kcs., 5597 kcs., 4220 kcs., 6355 kcs., 7560 kcs., 10645 kcs., 11925 kcs., l4200 kcs. There is also a Beverage long-wire antenna which is used for receiving, as well as an antenna for use with the low frequency beacon and another for use on 97 kcs. for point-to-point transmission. The half-wave doublets are strung between four 75-foot steel lattice towers which are arranged in the form of a parallelogram. The half-wave doublets are delta-matched to their transmission lines.

Establishment of Resolute Communications Station - The initial radio installation consisted of an AN/VRC-l emergency transmitter with which contact with Thule, Greenland was established on September 11, 1947.When the erection of the antenna system and the installation of the radio equipment had been largely completed in the early part of October, contact was made with Norman Wells on 214.3 kcs., and the regular transmission of synoptic reports began on October 23. The use of 214.3 kcs. was begun owing to a misunderstanding concerning the list of authorized frequencies. The use of this frequency was discontinued in November, 1947, and the frequency of 460 kcs. was used for low frequency transmissions instead.

Communications with Norman Wells on 214.3 kcs. did not prove too satisfactory, and on October 30, 1947, Resolute submitted a request to attempt to contact Edmonton direct on high frequency. Approval for this was given by the Telecommunications Division, and on October 31, tests were begun with Resolute on 10645 kcs. and Edmonton on 10920 kcs. Contact was made on the first try, and during the first week of the tests, 75% of the attempted contacts were successful.

Resolute as Net Control Station - The assumption of duties as net control station by Resolute was delayed by an unfortunate accident which occurred towards the end of October. One of the Canadian radio operators was severely mauled by a polar bear and had to be evacuated. As a result, the radio section was seriously short staffed until a replacement radio operator arrived just before Christmas. In the meantime, tests were continued with both Norman Wells and Edmonton to arrive at the most suitable procedures to be followed when Resolute took over net control. It was arranged that Normal Wells would cover the schedules between Resolute and Edmonton, and if Resolute were unable to contact Edmonton within 10 minutes of the scheduled time on high frequency, Norman Wells would take over and attempt to make contact on low frequency.

Trial collections of Eureka and Thule weather were begun on January 13, 1948, with satisfactory results, and shortly thereafter, Resolute began the regular transmission of weather reports from Thule, Eureka, and Resolute to Edmonton.

Prior to the date that Resolute took over duties as net control station, the weather reports from Eureka and Resolute had been collected by Thule, Greenland. Thule then routed these reports to Goose Bay, via the U .S.A.F. bases in western Greenland. When Resolute began the relay of these reports to Edmonton, no direct transmission of the satellite station weather reports was made to Thule. Since the forecast offices at the U.S.A.F. bases in western Greenland still requested these reports, it was necessary for the Thule station to monitor the weather collections made by Resolute. After Resolute collected the weather from Thule and Eureka, - and from Isachsen, Mould B ay and Alert after these stations were established - Resolute would contact Thule to pass the Resolute weather and to inquire whether Thule had missed any of the satellite transmissions. At this time, Resolute would make any fill-ins that were required and Thule would transmit this collection to the U.S.A.F. stations in western Greenland.

The weather collections were first made on 7560 kcs., but after the stations at Isachsen and Mould Bay were established, it was found that the collections could be made with less interference if the satellite stations were not on the same frequency as Resolute. A satisfactory cross-band arrangement was made whereby the satellites transmitted on 5597.5 kcs. and Resolute on 7560 kcs.

The T4-FRC transmitters at Resolute are not suitable for use on the same frequency as the station which is being worked. Break-in operation is difficult owing to a strong back wave from the transmitter oscillators feeding to the receivers. The transmitters are designed for remote operation. However, at Resolute they are located within the same room as the operating positions. The oscillator stage is not keyed, but operates continuously, and owing to the close proximity of transmitter and receivers, a steady signal is picked up by the receiver - regardless of the position of the key - which is strong enough to be quite objectionable and often effectively obscures a break-in signal from the station with which Resolute is in communication.

During the winter months, Resolute uses a frequency of 3390 kcs. in transmissions to the satellites, but in the summer when radio conditions are less stable, both 3390 kcs. and 7560 kcs. are used, depending upon reception conditions. At times, reception is poor on both of these frequencies, whereas a frequency near 5300 kcs. appears satisfactory.

A frequency of 5840 kcs. was tentatively assigned to Resolute by the Telecommunications Division in August, 1950. However, this frequency did not prove very satisfactory and a replacement for it was requested by Resolute. Four alternatives were offered by the Telecommunications Division; namely 5775 kcs., 5827.5 kcs., 5925 kcs., and 5945 kcs. These frequencies were monitored by Resolute over a test period, and it appeared that 5827.5 kcs. was the most suitable . This frequency was later approved by the

Telecommunications Division as an additional authorized frequency for Resolute to replace the tentatively assigned one of 5840 kcs.

Radio Schedules - The following table lists the radio schedules which are kept by the Reso1ute weather Station radio. The radio schedules of the various satellite stations can also be determined from the same table. The following abbreviations are used in the table:

RS	-	radiosonde observations
RW	-	rawinsonde observations
PB	-	pilot balloon observations
MT	-	6-hourly synoptic observations
TH	-	3-hourly synoptic observations

RESOLUTE RADIO SCHEDULES

Station Worked	Time (GMT)	Type of Traffic
Edmonton	0030, 0630, 1230, 1830	MT
"	0330,0930, 1530, 2130	TH
"	0445, 1645	PB RS RW
"	1045, 2245	PB
Alert)	0000-0005,0600-0605,1200-1205,1800-1805-	MT
Eureka)	0300-0305, 0900-0905,1500-1505,2100-2105	TH
Isachsen)	0400-0445 , l600-1645	PB RS RW
Mould Bay)	1015-1045	PB (Eureka, Alert
Ice Island, T3)		and Thule)
Thule)	2215-2245	PB (Eureka, Alert)

Note: Administrative traffic handled on above schedules when weather transmissions completed.

Procedure for Making Weather Collections - The following procedure has been adopted by Resolute to accomplish the weather col1ections from the sate11ite stations most efficiently. At each of the weather col1ection schedules listed in the above table, Resolute calls the stations in order, beginning with Mould Bay and continuing with Isachsen, Eureka, Alert, Ice Island and Thule. As soon as contact is established with the station, the weather is collected. If any station does not respond to two calls, the next station is called, and the missed station must wait until the end of the collection before passing its weather. If the station does not answer after three or four more attempts at the end of the collection, the word 'RADNO' is placed after his identifying figures in the weather collection to indicate that no radio contact was made. After the weather collection has been made from the satellite stations, Thule is called and weather reports are exchanged. Thule intercepts the transmission from the satellite stations on 5597.5 kcs.

Thule has been designated as Assistant Control Station, and if Resolute does not collect the weather within a few minutes after schedule time, Thule will take over net control and collect the weather from the satellite stations, listening on 5597.5 kcs. and transmitting on his working frequency.

Stations worked by Resolute Radio - Direct contact has often been made between Resolute and other stations not directly in the Joint Arctic Network for passing message traffic, for example, Churchill, Cambridge Bay, Coral Harbour, Baker Lake, Arctic Bay, Frobisher, and Fairbanks. However, communications with these stations are on a non-scheduled basis and are usually maintained only when there is aircraft movement between one of these stations and Resolute.

Radio Blackout - On the whole, communications with Edmonton have been very satisfactory and schedules have been maintained with a consistency near 90%. Schedules are rarely missed except during periods of poor reception. These periods of radio blackout generally last for no more than a few hours, although some have lasted for as long as two or three days. The worst disruption of communications occurred in May, 1948, when a complete radio blackout was experienced from May 5 to May 16, except for one day in that period , May 13, when conditions were fair.

At the start of a radio blackout period, it is first noticed that Resolute is unable to hear the weaker signals of the satellite stations. Thule signals become quite fuzzy, but remain readable with difficulty.The signal from Frobisher becomes very strong temporarily at these times, thus indicating that the skip distance on 756O kcs. lengthens. As the blackout progresses, 7560 kcs. becom~es dead although 10645 kcs. Remains usable to Edmonton and Norman Wells for a slightly longer period.

During radio blackout conditions, low frequencies appear to be usable up to about 150 kcs. Very little success has been experienced at Resolute with the use of 460 kcs. during b1ackout periods whereas Norman Wells on 97 kcs. and Edmonton on 117 kcs. are generally heard with a strong signal at Resolute.

Use of Low Frequency at Resolute - Shortly after scheduled communications were begun between Resolute and Edmonton, it was realized that a suitable low frequency and a 1ow frequency transmitter of sufficient power would be required at Resolute if schedules were to be maintained during periods of radio blackout. The low frequency transmitter at Resolute is a Wilcox, model 96-200C, which is rated at about 2,000 watts. The earliest attempts to contact Edmonton and Norman Wells with this transmitter and a comparatively short antenna were not very successful in late 1947 and the early part of 1948. Sporadic contact was made with Norman Wells but not with Edmonton.

An attempt was made to improve the Resolute communications on low frequency in August, 1948, with the erection of a Beverage long wire antenna. This antenna is made up of 4,070 feet of Number 6 steel-core copper wire, supported on te1ephone poles in the camp area and on 4" x 4" poles beyond the Camp area and is beamed in the general direction of Norman Wells. Tests were made with the Beverage antenna and the Wilcox transmitter tuned to 460 kcs. with both Edmonton and Norman Wells, and a1though contact was established with Edmonton, the tests were not very satisfactory. During blackout conditions, no contact was possible with either station. It was believed that the Beverage antenna was not sufficiently long, and it has been used at Resolute mainly as a receiving antenna.

Since 460 kcs. appeared to be too high for satisfactory blackout communication, authorization was requested from the Telecommunications Division for the use of 97 kcs. Authorization was given in February, 1950, to utilize 97 kcs for transmission toEdmonton and Norman We11s only. This frequency has been assigned to the Department of National Defence, and it was stipulated that its use by Resolute should be on a non-interference basis with D.N.D. commitments. In May, 1952, the frequency of 97 kcs. was replaced by 131.75 kcs.

Tests that were made with Edmonton and Norman Wells by Resolute on 97 kcs. did not prove to be complete1y satisfactory, owing to the following limitations:

1. There is no correctly engineered low frequency transmitting antenna at Resolute.

2. The minimum out-put of the transmitter should be approximately 5 KW.

3. The Wilcox transmitter requires 3-phase power whereas the Resolute station is on single-phase power. The 3-phase generator for the Wilcox transmitter is located in an unheated garage. During the cold period, this generator requires pre-heating for anywhere from two to three hours before it can be started, which prevents the transmitter from being used on a moment's notice.

4. The Wilcox low frequency transmitter is located in the radio room and blocks out all radio receivers when in use. An increase in power would necessitate remoting the transmitter.

<u>Hours of Watch</u> - The Resolute radio maintains continuous watch on the frequencies 5597.5 kcs., 7560 kcs., as well as on the Edmonton frequency of 117 kcs. Continuous watch cannot be maintained at the satellite stations owing to a shortage of radio staff, except during period s of aircraft movement near the station.

Trafficic Other Than Weather Handled at Resolute Radio Station **-** A considerable amount of traffic is handled at Resolute other than weather transmissions. Especially during re-supply periods, such as the spring and fall airlifts, and the summer sea supply mission, there is sufficient radio traffic to require the full time of two operators, one to work the air-ground position and the other to work the weather and administrative message circuit**.** During the summer sea supply mission, there is frequently a third position in operation as well, to maintain communications with the supply vessels. In previous years, the U.S. Navy has provided an operator to stand watch on the ship-to-shore circuit during the sea supply mission, and the U.S. Air Force provided an operator to maintain air-ground watch during the spring airlift. At present, air-ground traffic is handled mainly by the R.C.A.F.

Administrative message traffic has been handled by the weather station radio staff for the R.C.A.F., U,S.A.F., transient scientists and representatives of other departments and organizations that have been temporarily based at Resolute.

Chapter 12

EVALUATION AND RECOMMENDATIONS

Evaluation - The initial recommendation of the Inter-Departmental Meteorological Committee for the establishment of the Joint Arctic Stations stated the purpose of the project as follows:

1. To extend the meteorological knowledge of conditions prevailing in the Canadian sector of the Arctic with a view to accumulating sufficient surface and upper air meteorological data over a five-year period to determine feasibility and, if possible, procedure for carrying on scheduled air operations in the Arctic.

2. To obtain meteorological data for the use of extended period forecasting with the object of extending the reliability of the forecast period from a few days to possibly a month.

This programme has not been accomplished in full as yet, but considerable progress has been made. Meteorological records are available from Eureka for 4 ½ years , from Resolute for 4 years, from Isachsen and Mould Bay for 3 years and from Alert for 1 ½ years. The analysis of these records is underway, and although they do not cover a sufficiently long period to provide accurate climatological means, they have indicated the need for considerable revision of the mean temperature and pressure charts for the Canadian Arctic which were in use prior to 1947.

Since the printed observations from the Joint Arctic Weather Stations are only now becoming available for study, it has not been possible to utilize them in meteorological research to a great extent. However, they were found to be indispensable during the preparation of the booklet entitled "Climate of the Canadian Arctic Archipelago" by R.W. Rae of the Meteorological Division, Department of Transport, which was printed in January, 1952.

The meteorological observations from the Joint Arctic Stations are used in the preparation of daily weather charts in forecast centres throughout North America and Europe. They are especially useful in Canada and the United States for providing advance warning of severe outbreaks of Arctic air. These observations assist materially in the drawing of accurate Northern Hemisphere weather charts which are used by the U.S. Weather Bureau in the preparation of 5-day forecasts.

The air operations during the establishment and re-supply of these stations have provided valuable experience concerning Arctic flight procedures.

The establishment of the Joint Arctic Stations has been a major step in pushing back Canada' s northern frontier. They supply weather data coverage for vast areas in the Canadian Arctic, serve as advance bases for scientists working on Arctic projects, and provide emergency landing fields for trans-Arctic air operations.

Recommendations - The Canadian Meteorological Division and the United States Weather Bureau recommend that the Joint Arctic Weather project be maintained on the following basis:

1. The stations which have been established at Alert, Eureka, Isachsen, Mould Bay and Resolute, should be continued as upper air and surface weather reporting stations and centres for other scientific activities.

2. A surface weather and pilot balloon observing station should be established at Bridport Inlet on Melville Is1and to complete the present Joint Arctic Weather Network.

3. The operation of the Joint Arctic Weather Stations should be improved through the continuance of a programme of gradual replacement of present equipment, instrumentation and installations by standardized equipment of most suitable design.