Documents on Canadian Arctic Sovereignty and Security

UNFURLING THE AIR FORCE ENSIGN IN THE CANADIAN ARCTIC

The 1922 Eastern Arctic and 1927-28 Hudson Strait Expeditions

P. Whitney Lackenbauer and K.C. Eyre

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Contents

Introduction: The Air Force and the Opening of the Canadian Arctic in the Interwar Period

> *The twentieth century advance into the Arctic owes more to the aeroplane than any other factor.*
>
> -- Terence Armstrong, (1958)[1]

Canadian armed forces have been involved periodically in the North since the days of the Klondike Gold Rush in 1898. The intensity and degree of this involvement have reflected the changing perceptions of the North as they relate to defence, sovereignty, and national development.

For its part, the Royal Canadian Air Force made its first forays into the North in the interwar years as an agent of national development. As this volume reveals, the early expeditions took place in what now would be called a "whole of government" context. The Department of the Interior approached the Air Board to send an aviation expert (Squadron Leader Robert A. Logan) on the 1922 Canadian Arctic Expedition to reconnoitre (without a plane) and discern the feasibility of operating aircraft in the Arctic. His comprehensive report painted a detailed picture of the conditions in Canada's Arctic Archipelago, conceptualized what contributions aircraft could make to northern development, and recommended which airframes could withstand the severe environment. Five years later, the RCAF gained its first Arctic flying experience when it deployed six aircraft into Hudson Strait area to conduct an aerial survey in support of plans to open Churchill as an ocean shipping port. Squadron Leader Thomas A. Lawrence's detailed report encapsulates the main results of the 1927-28 expedition, which marked the first concerted effort to use aircraft for ice and weather reconnaissance in the Canadian Arctic and produced significant insights into conditions along Hudson Strait. While often overshadowed by the exploits of bush pilots who opened the Canadian North, these landmark documents provide examples of how the Air Force has contributed to northern exploration and built "an enviable record of efficient arctic operations."[2]

* * *

[1] Terence Armstrong, *The Russians in the Arctic: Aspects of Soviet Exploration and Exploitation of the Far North, 1937-57* (Fair Lawn, NJ: Essential Books, 1958), 62.

[2] Moira Dunbar and Keith Greenaway, *Arctic Canada from the Air* (Ottawa: Defence Research Board, 1956), 480.

At the end of the Great War, Canadian attention again turned to the unresolved issue of sovereignty over the islands of the Eastern Arctic. There had been no official Canadian presence in the area since Captain J.E. Bernier's 1910 expedition (the third of his prewar patrols in the Coast Guard Ship *Arctic*), even though Dominion Astronomer Dr. W.F. King's 1904 commissioned study of the problem of sovereignty in the Arctic had concluded that Canada's claim was imperfect. Furthermore, strong rumours circulated in Ottawa that other nations were preparing to occupy sites in the "Canadian North." The Danes, long established in Greenland, were reportedly planning an expedition to Ellesmere Island, an area they regarded as unclaimed. The Norwegians had an historic but undeveloped claim to the islands west of Ellesmere, thanks to the explorations and discoveries of Otto Sverdrup in 1903-1905. American sponsored explorations were apparently in the offing and it was reported that a recently published American atlas showed Ellesmere in the same colour as Alaska—an ominous sign to concerned Canadians.[3]

In response to these perceived threats, the Department of the Interior formed a small group of senior civil servants into the Advisory Technical Board in 1919. The Board's mandate was twofold: to determine whether the Canadian title to the Arctic islands was worth developing; and, if so, to recommend what steps should be taken to establish such a title. The focus of the study was on the islands of the Eastern Arctic, but in some respects it touched on factors affecting the entire archipelago. Although the federal government and Canadians more generally perceived neither the potential value nor the importance of the islands, the Board found many compelling reasons for Canada to perfect her claim to the region. "Ellesmere and the other northern islands, have always been regarded in Canada as Canadian," it noted, "and there doubtless would be strong sentiment against their being taken possession of by any other flag."[4]

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[3] On these developments, see Gordon W. Smith, A *Historical and Legal Study of Sovereignty in the Canadian North, 1870-1942*, ed. P. Whitney Lackenbauer (Calgary: University of Calgary Press, 2014); Janice Cavell and Jeff Noakes, *Acts of Occupation: Canada and Arctic Sovereignty, 1918-25* (Vancouver: UBC Press, 2010); and Janice Cavell, "Sector claims and counter-claims: Joseph Elzéar Bernier, the Canadian government, and Arctic sovereignty, 1898-1934," *Polar Record* 50/3 (July 2014): 293-310.

[4] Canada, Department of the Interior, *Report by the Sub-Committee of the Advisory Technical Board* (henceforth *ATB Report*), (n.d. 1919?). There are apparently several drafts of this report extending well into 1920. The one referred to here is probably the first draft. It was submitted to the Commissioner of the RCMP in January 1920. Eyre originally accessed the report in the RCMP Historical Section, file G-516-37, *Sovereignty over Islands Lying North of the Mainland of Canada* (henceforth *RCMP Northern Sovereignty*), vol. 2. It has since been transferred to the Library and Archives Canada (LAC), Record Group (RG) 18, accession 1984/-85/084, vol.33, file G-516-37. On the ATB, see Cavell and Noakes, *Acts of Occupation*, 57-62.

The emotional and nationalistic nature of the issue would probably, in itself, have been strong enough to cause the Board to recommend development of the Canadian claim. In any case, the Board produced several other perceptive and far-sighted reasons for action. For example, they noted the role the islands might play in civil and military aviation, broaching a subject that was to beguile and haunt defence planners in the late 1940s and early 1950s. As the Board saw it, "It would be undesirable and dangerous to allow another nation to get a foothold in the north now that aerial navigation has become so far advanced." Nor was the significance of the Alaska precedent lost on the Board members. They were well aware that the unknown land that had been dubbed "Seward's Folly" at the time of purchase not only turned out to be a literal gold mine but also eventually yielded substantial other resources. It was anticipated that the Arctic Archipelago might well contain vast reserves of mineral wealth. There was even at that early date the suspicion voiced that oil might be discovered in the more westerly islands. Clearly, for a wide variety of reasons, the Board thought that it was in Canada's immediate interest to develop her sovereign claim.

Interestingly, none of the major legal reports written in 1920 and 1921 suggested that the government utilize the sector principle to bolster Canada's sovereignty position in the Arctic. Instead, all called for further acts of occupation.[5] Of the various methods by which a state can acquire territory within the established conventions of international law, the Board saw occupation as most appropriate to the case of the islands of the Eastern Arctic. Occupation required more than just a symbolic act such as the hoisting of a flag. A real claim to sovereignty, through occupation, had to be based upon a physical presence and the establishment of government administration in the area.[6] Obviously, some agents of the Canadian government were going to have to go north.

The Board was quite definite as to who these agents ought to be: sovereignty in the Eastern Arctic was to be established by the Royal Canadian Mounted Police. The men of the Force had already established a presence in the Yukon, the Mackenzie, and along the fringes of Hudson Bay. It seemed natural that now they should be sent farther afield. The Board does not appear even to have considered such alternatives as a military garrison or a civil agency of the Department of the Interior.

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[5] See Peter Kikkert and P. Whitney Lackenbauer, *Legal Appraisals of Canada's Arctic Sovereignty: Key Documents, 1904-58*, Documents on Canadian Arctic Sovereignty and Security (DCASS) No. 2 (Calgary and Waterloo: Centre on Military and Strategic Studies/Centre on Foreign Policy and Federalism), 2014.

[6] ATB Report.

The *Report* produced by the Advisory Technical Board became the key planning document for subsequent Canadian occupation of the Eastern Arctic. Virtually all its recommended programs and approaches were eventually implemented. The one area where the opinion of the Board differed from that of the Cabinet was the need for haste. The bureaucrats thought that immediate action was imperative; the politicians perceived no such pressure.

The members of the Board were concerned with the need "to get there first," but by the time the *Report* had been fully considered in the Department and the Cabinet, it was mid-1920 and the summer shipping season was too far advanced for Canada to do anything concrete that year. It was the potential Danish "threat" to Ellesmere Island that most concerned the Department of the Interior. The Board went so far as to outline a tentative plan to be used if definite evidence became available that the Danish government was going to support an expedition in 1920. They recommended that Canada should attempt to borrow an airship from the imperial government, which could be loaded with a group of RCMP constables and a winter's worth of supplies, then launched from Scotland towards the Pole. Over Ellesmere Island, the police could parachute onto the island in time to greet the Danes.[7] Given the state of the art of arctic aerial navigation and parachuting technology, it is fortunate for the police that there never was a need to implement this hare-brained pre-emptive scheme.

At first glance, it would seem that it would have been reasonable to turn to the Department of Militia and Defence for the men for this contingency plan. "Airborne operations," as the mass parachuting of troops was to become known in the next war, were still a phenomenon of the future. Parachuting in the early 1920s was still very much a fairground display stunt or, increasingly, a lifesaving means for aviators. The link between parachuting and the military had yet to be formed.[8]

In another sense, this minor plan is illustrative of the manner in which the defence establishment was regarded in Canada. There is no evidence that the Department of the Interior ever even considered consultation with the Department of Militia and Defence on any aspect of the problem. On the other hand, it is unlikely that the military would have had the slightest interest in the project had they been

[7] In point of fact the Danish government was quite helpful to Canada when the expedition was actually launched, and continued to provide assistance during the period 1922-25. See Smith, *Historical and Legal Study*, and Cavell and Noakes, *Acts of Occupation*.

[8] Brigadier-General William Mitchell's plan to drop the 1st Division of the American Expeditionary Force behind German lines at Metz in support of the 1919 offensive had naturally not come to fruition, fortunately for the American troops as the concept was ahead of the technology required to support it.

approached. Canadian attitudes were very fixed. The business of the military establishment was the defence of the country and the support of the forces of law and order. The protection of sovereignty was the responsibility of the RCMP. There is no evidence whatsoever that anybody—politician, civil servant, professional soldier, or private citizen—at the time considered that the military had or could have a role to play in the establishment and protection of sovereignty.

The Danes did nothing in 1920, and Canada was able to proceed at a leisurely pace with the planning and the preparations for an expedition in 1921. A wooden hulled sailing ship, the *Arctic,* was procured for the expedition, and a massive refit initiated. Her former Master, Captain Joseph E. Bernier, Canada's most experienced Arctic mariner, was called out of retirement. J.D. Craig of the Department of the Interior was appointed commander of the expedition, and staff officers at RCMP headquarters began to examine the nominal roll of the Force in search of likely candidates for the northern deployment.

Then, all activity ceased and the expedition was cancelled. William Lyon Mackenzie King, the Leader of the Opposition, demanded to know why. Prime Minister Arthur Meighen claimed that the expedition had not actually been cancelled, but had merely been put off until the following year because of the high costs involved. The issue was pursued with the suggestion that Canada should accept the additional expense in view of the rumour that "another power just might be contemplating the same action." Meighen's disagreement with his civil servants' assessment was most apparent when he stated that there was really no pressing need for action and that Canada's claims would not be harmed by waiting a year. He did assure the House, however, that if any other power made a move in the Canadian Arctic, "the Government will not hesitate to take action to protect the interests of Canada."[9] The Prime Minister did not say what that action would be or how the government would take it.

The perceived Danish threat had all but blown over by the summer of 1921. Most Canadian officials accepted repeated Danish assurances that they had no interest in contesting Canada's sovereignty over the Arctic islands. Accordingly, the "fear about what Denmark might do in the archipelago was gradually replaced by concern over what Canada herself ought to do," historian Gordon W. Smith later observed.[10] The Danish 'threat' and the legal appraisals it spawned inspired the "transformation of Canada's earlier Arctic policy – in which proclamations and other purely 'formal acts of possession' were deemed sufficient – into a more active and sustained postwar

[9] House of Commons, *Debates*. 30 May 1921, 4106.
[10] Smith, *Historical and Legal Study*, 265.

program that emphasized the need for 'acts of occupation' even on remote and uninhabited northern islands like Ellesmere."[11]

Plans for the occupation of the Eastern Arctic continued to be developed and refined during the year-long lapse in activity. Government officials paid considerable attention to the notion that a claim to sovereignty based upon the fact of occupation required both physical presence and the provision of government administration. In the Canadian case, however, the occupiers and the administrators were to be one in the same: the RCMP. As Commissioner of the North West Territories W.W. Cory saw it, "in order to establish occupation it is necessary to perform certain administrative acts and that the Police Force should be empowered to act as Customs Officers, Immigration Officers, Postmasters, etc."[12]

International convention deemed symbolic acts such as the building of a cairn, the reading of a proclamation, or the hoisting of a flag to be inadequate to support a claim to sovereignty. Canada's response was to provide a symbolic presence and a symbolic administration. It mattered not that it was extremely unlikely that anybody would actually require the services provided by the police detachments. The presence of the police detachments in the North was seen from Ottawa to "close up what might be called the front door of the Arctic Archipelago."[13]

This context sets the stage for 1922, a year that marked a turning point in the history of the Canadian North. The Canadian Arctic Expedition finally departed from Quebec City on 18 July. Aboard *Arctic* was a force of nine members of the Royal Canadian Mounted Police, commanded by Inspector C.E. Wilcox. Cargo included a two year supply of food and fuel, along with the necessary materiel to build Quarters for the men who would occupy and administer the Eastern Arctic. By the end of the

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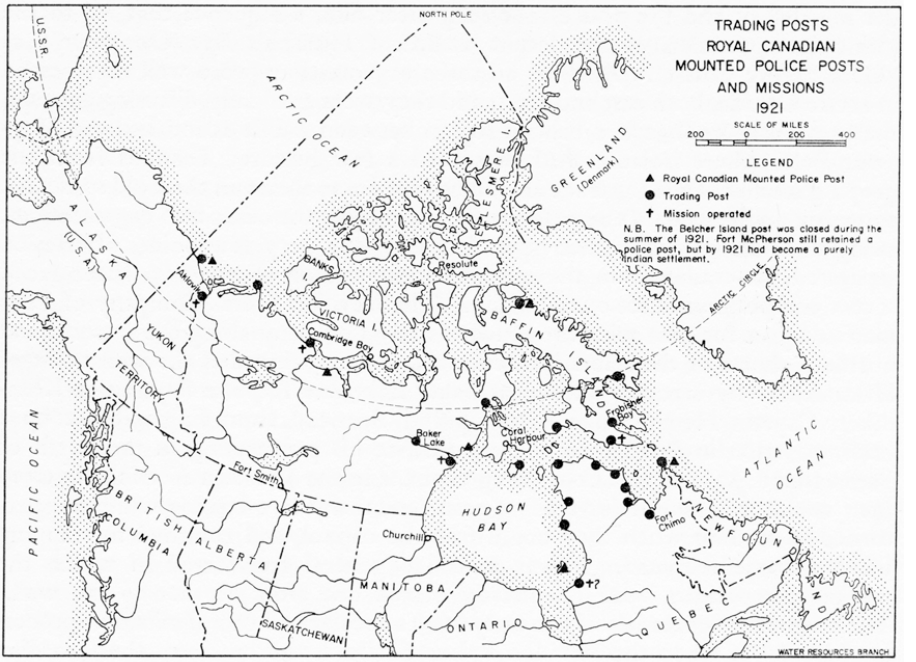
[11] Cavell and Noakes, *Acts of Occupation*, 6.

[12] Cory to Perry, 12 March 1921, *RCMP Northern Sovereignty*, vol. 1, quoted in K.C. Eyre, ""Custos Borealis: The Military in the Canadian North" (unpublished Ph.D. thesis, University of London - King's College, 1981). It is often popularly assumed that the men of the RCMP who performed basic tasks of government administration in the early years in the High Arctic acted on an unofficial basis, as and when the need arose in the areas they patrolled. In reality, the government always intended (because of the perceived legal needs of Canada's sovereignty claim) that such services should be provided on an official basis. The RCMP had approached all the departments concerned to have the Force's detachment commanders in the North formally appointed (without salary) to the posts of Immigration Officer, Customs-Excise Officer, Justice of the Peace, Coroner, and Postmaster. On this topic, see William R. Morrison, *Showing the Flag: The Mounted Police and Canadian Sovereignty in the North, 1894–1925* (Vancouver: UBC Press, 1985).

[13] ATB Report.

summer, Wilcox and his men were established in the forlorn camps that were to be their homes for the next two years. The RCMP posts established at Craig Harbour on Ellesmere Island, and Pond Inlet on Baffin were the beginnings of what was to become a far flung net of police posts. The subsequent story of the RCMP presence in the High Arctic has been woven into the basic fabric of the history of the area, and the summer cruise of the *Arctic* (and those of her successors) to re-supply the police posts and to provide an ever increasing range of government services became an annual feature in the North.[14]



Map: Diamond Jenness, *Eskimo Administration: II. Canada* (Montreal: Arctic Institute of North America Technical Paper No.14, 1964), 24.

[14] For more detailed studies and analyses of the sovereignty-establishing aspects of the 1922 Expedition, see K. C. Eyre, "Policemen and Post Offices: Canadian Sovereignty 1922 Style," *North/Nord* 23/3 (May/June 1976), 2-5; Janice Cavell and Jeff Noakes, "The origins of Canada's first Eastern Arctic Patrol, 1919–1922," *Polar Record* 45/2 (April 2009), 97-112; and Smith, *Historical and Legal Study*.

The Logan Report (1922)

Squadron Leader Robert Archibald Logan of the Canadian Air Force was ordered, at the last minute, to join the 1922 Eastern Arctic Expedition after the Department of the Interior approached the Air Board to supply an aviation expert. The Advisory Technical Board had sensed that the war-inspired technology of aviation, and the promise of extensive further development, would have an important significance to the Canadian North. In turn, the Air Board wisely decided to conduct a thorough investigation of the Arctic climate and topography before sending aircraft and equipment to the Arctic or attempting any actual flying.[15] By sailing with the expedition, Logan became the first member of the Canadian military establishment ever to serve in the Arctic – albeit as an aviator without an aircraft.

Given Logan's expertise as a surveyor and his robust knowledge of meteorology, aerial navigation, and wireless (radio), as well as his previous experience in northern Canada, the officer proved "splendidly qualified for the task."[16] Born to small land-owning farmers in Middle Musquodoboit, Halifax County, Nova Scotia, on 17 August 1892, Logan helped his mother on the farm while attending high school before continuing his education at the Nova Scotia Technical College and the University of Alberta. He began surveying in 1910 and received his Dominion Land surveyors certificate in 1914. He enlisted in the Canadian Expeditionary Force in Edmonton on 29 January 1915, studied flying at the Curtiss Aviation School in Toronto (at his own expense), received his Pilot Certificate, and went overseas to serve with the Royal Flying Corps as a Second Lieutenant. During the war he distinguished himself as a pilot and navigator and was involved in training other pilots. On 8 April 1917, he was shot down behind enemy lines in an aerial attack led by the famous German ace Baron Manfred von Richtofen ("the Red Baron"). He survived the crash and was captured by the Germany Army along with his observer Reginald Harry (the son of the mayor of Edmonton). They spent the remainder of the war (630 days) as Prisoners of War in six different German camps.[17]

After the war, Major Logan studied meteorology, aerial navigation, and wireless communications. In 1920 he took charge of the Ground Instruction School at Camp Borden, training airmen for the fledgling Canadian Air Force (formed in May 1920).

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[15] Ernest Cable, "Air Force: Leader in the Arctic," in *De-Icing Required: The Canadian Air Force's Experience in the Arctic*, ed. P. Whitney Lackenbauer and William March, (Trenton: Canadian Forces Air Warfare Centre, Canadian Aerospace Power Studies Series No.4, 2012), 1.

[16] J.R.K. Main, *Voyageurs of the Air* (Ottawa: Queen's Printer, 1967), 76.

[17] Based on biographical sketches in Provincial Archives of Alberta, Robert Logan Fonds, and Dalhousie University Archives MS-2-580 – Robert A. Logan Fonds, as well as his attestation paper in Library and Archives Canada (LAC), RG 150, accession 1992-93/166, box 5715-35.

In early 1922, he was attached to the North West Territories Branch for approximately five months to join the expedition led by J.D. Craig, another land surveyor by training.[18] Officials recognized that before air operations could be safely and effectively undertaken in the Arctic, they would need to amass precise information about the climate and working conditions that aircrews would face. Accordingly, Logan's task was:

> to endeavour to obtain as much information as possible regarding flying conditions (in the Arctic Archipelago), and from investigations made actually in the country concerned to submit suggestions which might be of assistance in determining the types of aircraft suitable for use and methods for their employment in various ways in the northern Archipelago.[19]

Departing from Quebec onboard the steamer *Arctic* on 18 July 1922, he spent the summer in the High Arctic at the northern end of Baffin Island, as well as Bylot, Devon, and Ellesmere Islands, reaching as far north as 76° 20′N – about 820 miles (1320 km) from the geographic North Pole.

Logan's comprehensive report on aviation in the Arctic naturally reflects his personal background and the organizational environment of which he was a part. As a member of the military establishment, he looked at the Arctic Archipelago from the point of view of a defence strategist. He also assumed that pioneering aviation enterprises in the North would, of necessity, be carried out under government sponsorship and that the Canadian Air Force would be the agency that carried out the actual work involved. In reality, this latter aspect does not mean, as it appears to, that Logan saw the Air Force specifically as having an important role to play in the opening up of the North. Rather it reflects the primitive state of the organization of aviation in Canada at the time. In 1922, the Mackenzie King administration was in the process of merging civil and military aviation under a single Director of the Canadian Air Force within the Department of National Defence. While it was possible to distinguish between flying done as purely military training and flying done "in support of other government departments," all the actual work was done by the same group of people using the same group of aircraft. Logan was selected by the Air Board in his capacity as an expert on aviation, not in his capacity as an officer of one of the three fighting services.

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[18] "Investigations of conditions affecting flying in the Arctic Archipelago," 1922, Department of National Defence, Directorate of History and Heritage (DHH) 74/414, file 16.

[19] R.A. Logan, *Report of Investigations on Aviation in the Arctic Archipelago carried out during the summer of 1922* (henceforth *Logan Report*), DHH 74/414.

The *Logan Report* is an important historic document containing the first suggestion that the Far North had astrategic role to play in the defence of Canada. In many respects, the officer's thoughts were a generation ahead of their time, correctly anticipating the development of aviation technology and even the potential enemy that Canada would face during the Cold War. Logan built an analytic model which depicted four classes of global aviation, explaining that the last two classes (which included sub-Arctic and Arctic flying) would require special equipment, skills, and support facilities. On the grounds of defence alone, he urged that Canada should take the necessary steps to master northern flying.

The opinion that it would be necessary to develop such an obviously costly capability reflected Logan's adherence to the then current western democracies' concern with international communism in general, and the success of the Bolsheviks in Russia in particular:

> Much has been said of the possibilities of future hordes of Slavs overrunning Europe. Aircraft operated from Arctic or sub-Arctic bases which would swoop down and leave trails of destruction through-out the rest of the world, but from the very nature of their bases of operation they would be almost inaccessible to aircraft of countries to which "cold weather" flying was unfamiliar.[20]

Logan clearly saw it as a Canadian responsibility to develop the capacity to deal with any northern threat. He wrote:

> Whether war with such a country as Russia would ever come or not, should not affect the determination to develop flying in the Canadian Arctic and sub-Arctic regions because Canada, if it considers itself worthy to be called a Nation, should have enough pride and spirit to take at least ordinary precautions and be prepared to defend itself in any emergency.
>
> …It now remains for (Canada) to show the rest of the world that she can defend herself, and the whole British Empire if necessary, from all comers from the old countries in the north of Asia—or Europe—by having men trained and proper materiel and information available through actual practice within her own boundaries.[21]

This particular notion was strikingly out of accord with the then-current Canadian political and public mood. Canadians as a whole were war-weary, anti-military, and certainly not about to spend a single cent for defence from some prospective enemy in the far distant future. Under Prime Minister Mackenzie King's leadership, the federal

[20] *Logan Report*, 2.
[21] *Logan Report*, 3.

government was disinclined to spend much money on defending Canada, let alone the entire British Empire. Logan was shrewd enough to realize this and he showed a fine grasp of Canadian political and economic reality when he wrote:

> Canada cannot afford at the present time to carry on expensive investigation and research work unless some immediate benefit is to be obtained, and it is probable that the best policy will be to encourage flying which will materially assist many civil operations, and at the same time a knowledge of aircraft operation in cold climates for defence purposes will automatically be gained.[22]

This passage expresses a philosophy essentially the same as that put forth by J. A. Wilson, the Naval Director of Stores, who in April 1919 proposed the establishment of a Canadian Air Board:

> The upkeep of large Air Force establishments for purely Naval and Military duties in time of Peace will be expensive and a constant object of criticism. It should therefore be advantageous to the country generally to encourage and assist the Civil development of aeronautics in every way, and to so guide and regulate its organization and any aircraft industry which may develop in Canada, so that it may form a reservoir on which to draw in any emergency.[23]

Unlike the other armed services, military aviation could be adapted to fulfill a wide range of civil support functions in peacetime. Accordingly, Logan had no difficulty in identifying useful tasks to which aircraft could be put in the developing North. He realized that airplanes were the ideal means for "the exploration and investigation of the extent of the natural resources of the territory." He noted that the work of the Royal Canadian Mounted Police, both in respect of their civil tasks in support of sovereignty and in the more fundamental task (for them) of the administration of law and order, would be greatly facilitated by the use of aircraft. In anticipation of the development of a major caribou and musk-ox herding industry, he pointed out that aircraft would be the ideal means to identify existing and potential breeding and feeding grounds. From the tenor of his writings, Logan clearly anticipated a tremendous boom of development and exploitation throughout the North. The domesticated caribou and musk-ox herds, as he saw it, would provide a ready and economical source of food for workers "if a mineral or oil strike were ever made in the Arctic Islands, or even in the sub-Arctic."[24]

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[22] *Logan Report*, 37.

[23] Cited in James Eayrs, *In Defence of Canada: From the Great War to the Great Depression vol.1* (Toronto: University of Toronto Press, 1965), 188.

[24] *Logan Report*, 15.

Logan was generally correct in his assessment of the direction of northern development, but he overestimated the tempo of that development. But who, in 1922, could have forecast the Great Depression and another world war? What is important about Logan's work is his realization that before development could take place, a considerable amount of experimentation and investigation had to be completed. He realized that modern communications and air transportation infrastructure would be prerequisites to economic development. He saw the Canadian Air Force as the primary agent in establishing Arctic air routes.

Canada on the whole, however, was not ready or willing to get into the business of Arctic flying. "So pleased were his immediate superiors with Logan's report that plans were made to send him back for further investigation during the following season," historian J.R.K. Main noted, "but a general lack of interest in the Arctic put a stop to any further scientific work along these lines for several decades."[25] For his part, Major Logan retired from the CAF and became an employee of the Fairchild Aerial Camera Corporation in New York City.

In the spring of 1925, however, word reached Ottawa of another potential threat to Canada's sovereignty over the High Arctic islands. American explorers Donald B. MacMillan and Lieutenant-Commander Richard Byrd, with U.S. government backing, hoped to aerially explore the area between Canada's northernmost islands and the North Pole that summer, using bases on Axel Heiberg and Ellesmere Island. The State Department had not consulted with Ottawa on this mission or applied for any permissions or permits. In response, Ottawa established the Northern Advisory Board to discuss the implications of the American expedition on Canada's sovereignty and lay out possible policy responses.[26] The Board tasked James White, an official from the Department of Justice, to prepare a report on the legal basis of Canada's sovereignty in the Arctic.

After careful deliberation, the Northern Advisory Board decided to continue relying on the internationally accepted method of effective occupation to strengthen Canada's claims, supported by a government announcement of a sector claim in the House of Commons.[27] On 1 June 1925, Minister of the Interior Charles Stewart stood in the

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[25] Main, *Voyageurs of the Air*, 77.

[26] For further information on the MacMillan Expedition and Canada's response, see D.H. Dinwoodie, "Arctic Controversy: The 1925 Byrd-MacMillan Expedition Example," *Canadian Historical Review* 53, no. 1 (March 1972): 51–65; Cavell and Noakes, *Acts of Occupation,* 217-41; and Smith, *Historical and Legal Study,* 321-40.

[27] For a further explanation of the important role that James White played in Canada's legal strategy, see Cavell and Noakes, *Acts of Occupation*, 75, 221, 227.

House of Commons and claimed all the land between Canada's coast "right up to the North Pole."[28] Ten days later, Stewart elaborated that "Canada claims the territory outlined between the degrees of longitude 60 and 141 but I have nothing to say regarding any claim the United States may make. They have Alaska and naturally they will lay claim to land north of their territory there, which would be adjacent to ours."[29] Stewart made it clear that any explorer or scientist who wished to travel in Canada's sector had to apply to Ottawa for a license.

After the surge of activity and appraisals in 1925, the Canadian government slowly continued its "peaceful penetration" into the Far North. The Eastern Arctic patrol continued, more RCMP posts were constructed (including one on the Bache Peninsula on Ellesmere Island), and police officers extended their patrols in the High Arctic islands. Ottawa also continued to utilize the sector principle in its broader sovereignty strategy. A 1926 Order-in-Council, for instance, established the Arctic Islands Game Preserve comprising all the land within the Canadian sector.[30]

The MacMillan – Byrd expedition of 1925 also provoked a Canadian reaction of a rather different kind. Although Logan had become an American citizen, his allegiance to Canada had not dissipated and he warned the Canadian Government that many Americans interested in the North, including MacMillan, did not take Canada's Arctic claims seriously. Accordingly, he remained very anxious to "help the Canadian cause along," and wrote a letter to the Prime Minister of Canada in June 1925 asking to lease four small tracts of land, of about 640 acres each, in the Far North, for the purpose of establishing and operating air bases. One of these tracts would be located near the northern extremity of Ellesmere Island, one near the northern extremity of Axel Heiberg, one at Craig Harbour on the south coast of Ellesmere Island, and the last on the "so far uncharted land" east of the 141st meridian and near the 83rd parallel (where no islands actually lay). In his letter, Logan explained his belief that " If the Canadian Government were to lease certain areas of land in the far north and to issue licenses for Air Harbours (or Air Stations) such action would materially strengthen the claims of Canada regarding that region between Greenland and the 141st Meridian." Logan's application was referred to the Departments of External Affairs, National Defence, and the Interior, and he eventually received "temporary permission ... to use all or any of the sites for the operation of aircraft." He did not enact his plan, however, and explained in correspondence that his idea was simply to invite government action that would "help in confirming Canada's intention of

[28] Canada, House of Commons *Debates*, 1 June 1925, 3773.
[29] Canada, House of Commons *Debates*, 10 June 1925, 4085.
[30] Referenced in Pharand, *Canada's Arctic Waters*, 51, and 1929 map on 52. See also LAC, RG 25, vol. 4252, file 9057-40 pts. 1-2.

holding and developing the Arctic Islands."[31] Indeed, the High Arctic air exploration role that Logan envisioned for the Canadian Air Force did not begin to develop seriously until after the end of the Second World War. In the meantime, it fell to American aviators – such as MacMillan, Byrd, Lincoln Ellsworth, Floyd Bennett, and Carl Ben Eielson – as well as Australian-born G.H. Wilkins to make air and exploration history with their polar flights in the North American Arctic.

[31] Based on Smith, *Legal and Historical Study*, 337-38; LAC, R5025-0-3-E, Robert Archibald Logan fonds, vol. 1, file "Licenses for Air Harbours in Arctic, 1925," 12 April 1925; and personal correspondence between Col. Logan and Gordon W. Smith. Smith noted that "this little project of Logan's was given a certain amount of publicity in the U.S., but, it would appear, not in Canada. This seems unfortunate, because it would have given the Canadian Government the sort of opportunity they were looking for to demonstrate that they were in full control of administration in the Far North." Logan went on to pioneer the field of aerial surveying, flying in south-central African and then for Pan American Airways, where he participated in the Jelling North Atlantic Expedition with the Lindberghs in 1933. He also managed a gold mining operation in Nova Scotia and worked for the Irish national airline . In January 1941, while serving as a U.S. citizen as a Navigation Staff Officer in the RCAF based in Halifax, he was called to staff headquarters in Ottawa to produce a report on aviation possibilities in Greenland based on his 1922 investigations and subsequent northern work. After his report attracted the personal attention of President Franklin Roosevelt, he was "given secret verbal orders" to don civilian clothes and was spirited away on a U.S. Coast Guard-Navy expedition to Greenland. The RCAF then detailed him to serve "as a special aide to a son of President Roosevelt, Captain Elliot Roosevelt," Logan recalled, "who had been flown to Ottawa in an Army B-24 to collect information on everything possible relative to Arctic Canada and Greenland." After supplying Roosevelt with his personal files, he assumed the duties of Director of Intelligence, RCAF Headquarters, and served as the chief liaison officer between the RCAF and the US Air Attachés at the US Embassy in Ottawa. In May 1942, he was transferred to the US Army at the rank of colonel and assumed responsibilities with the Assistant Chief of Staff, G-2, in Washington. Logan to Captain F. Kent Loomis, Assistant Director of Naval History, Washington, 25 July 1964, DHH 75/117, file 32. After his retirement from the military, Logan wrote on various topics including genealogy, history, and philosophy. He compiled and published a two-volume Cree-English dictionary, which he distributed to many libraries and archives across North America at his own expense. He died on 26 September 1995 in Duluth, Minnesota. See Saskatchewan Archives Board, Robert A. Logan fonds (SAFA 487).

1927-28 Hudson Strait Expedition

Although the Royal Canadian Air Force (with the royal prefix added in 1924) did not act on the main recommendations of Logan's study, concentrating instead on forestry and photo work in subarctic and southern regions of the country, it did undertake its first flights north of the mainland of Canada in 1927-28.

The main catalyst for the Hudson Strait Expedition was political. The government had started construction on the Hudson Bay Railway in 1913 and its lines reached The Pas, Manitoba, before the First World War. In the heady political atmosphere of the 1920s, Mackenzie King – in his efforts to woo Western Canadians and the "Liberals in a hurry" of the Progressive Party back to the Liberal fold – paid heed to Prairie voices arguing for an alternative outlet for grain exports. In this context, the RCAF's "bush pilots in uniform"[32] assisted the project of discerning the feasibility of the Hudson Bay-Strait route to carry the bounty of Western farmers to distant markets. In 1925, the RCAF completed the first flight to Hudson Bay in a float-equipped plane to survey the rail line to Port Nelson. Historian Margaret Carroll noted that "this pioneering flight, completed in nine days, encountered many of the well known difficulties in flying in this region, bad weather, problems of mooring a plane on a shallow beach subject to tides, and the necessity of refueling by primitive methods from gas caches on shore."[33] The next year air officials cast their sights further north, when work resumed on the rail system that would connect to Churchill, Manitoba and the vast, inland sea of Hudson Bay.

Captain N.B. McLean of the Department of Marine and Fisheries, who was in charge of the expedition, later noted that "for two hundred years the Hudson's Bay Company has transported its cargoes to and from Europe by the Hudson Bay route. For probably one hundred and fifty years of this period these cargoes were successfully carried in sailing vessels, consequently it does not seem unreasonable to suppose that modern ships, modern equipment and modern ideas should meet with a considerable degree of success…."[34] No one knew, however, exactly how long Hudson Strait remained navigable each season. To find the answer and build its business case for the

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[32] "Bush Pilots in Uniform" is the title of chapter 3 of W.A.B. Douglas, *The Creation of a National Air Force: The Official History of the Royal Canadian Air Force vol. II* (Ottawa: Supply and Services Canada, 1986).

[33] Margaret Carroll, "Defence Forces Operations in Hudson Bay," in *Science, History and Hudson Bay* vol. 2, ed. C.S. Beals (Ottawa: Department of Energy, Mines and Resources, 1968), 898.

[34] N.B. McLean, *Report of the Hudson Strait Expedition, 1927-28* (Ottawa: Department of Marine and Fisheries, 1929).

Hudson Bay Railway, Cabinet established an interdepartmental Hudson Strait Committee, with an advisory board advisory board representing the Departments of Marine and Fisheries, National Defence, and Railways and Canals. It began planning an aerial ice survey expedition in December 1926, with aviation aspects left to the Civil Government Air Operations Branch of National Defence. The expedition had three objectives:

a. to obtain accurate information about weather and ice conditions using aerial photography and visual reconnaissance so that the length of the season for safe marine navigation through the Strait could be determined;
b. to examine the feasibility of aircraft aiding marine navigation; and
c. to assess possible landing sites and the suitability of aircraft and equipment with the aim of establishing air bases in the Strait area.[35]

Flight Lieutenant T.A. Lawrence, a staff officer at RCAF Headquarters, was promoted temporary squadron leader and given command of the expedition's flying operations. First, he set about evaluating various British and American aircraft – a process that divided senior officers. The Department of Marine and Fisheries ultimately purchased six Fokker "Universals" for about $16,000 each and gave them civil registrations, but the RCAF provided the crews to fly them and mechanics to maintain them.[36] "The Universals were flight tested at Camp Borden, then packed into crates and shipped to Halifax by rail," historian Ernest Cable recounted. "Most of the aircraft spares, safety equipment, and other supplies were shipped directly from the factory to Halifax."[37] The Air Force also acquired a seventh aircraft for the expedition, a float-equipped, two-seater de Havilland 60 X Moth, to conduct preliminary reconnaissance flights when searching for potential bases.

In the end, seventeen of the forty-one people involved in the expedition were from the RCAF. Three RCMP constables and three members of the Royal Canadian Corps of Signals also were involved, with the Department of Marine providing the majority of civilians, including four wireless operator-engineers, three storekeepers, three

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[35] Main noted that, "Among other items, Logan recommended that, should it be decided to carry out further exploration, a party consisting of a pilot and two mechanics, with two special aircraft, spares and other necessities, should spend a whole year in the Arctic, making flights whenever possible, keeping weather records, taking photographs, looking for landing grounds and generally gathering a mass of information that would be useful in future flying exercises. The Hudson Strait Expedition of 1927-28, though with narrower terms of reference, promised to meet this recommendation, at least in part." *Voyageurs of the Air*, 77.

[36] On the deliberations over aircraft, see Douglas, *Creation of a National Air Force,* 106 and 112.

[37] Cable, "Air Force: Leader in the Arctic," 3.

doctors, and three cooks. The RCAF personnel received special air and ground refresher training at Camp Borden in early 1927, with the six aircraft riggers completing special training on the Universal at the Atlantic Aircraft Corporation factory in New Jersey. The intensive training for the participants was "not only in flying but also in meteorology, navigation, engines, first aid, seamanship, snowshoeing, skiing, shooting, dog-handling (this with RCMP instructors), welding, carpentry, rigging, photography and instrument servicing," historian Hugh Halliday notes. "Attention was paid to emergency supplies and even to the smoking and reading needs of the men who would be living in isolation for sixteen months."[38]

The Hudson Strait was a remote posting for southern Canadians. The Advisory Board's general plan was to establish an air base at each end of the Strait and one in the middle. Each base would be manned by two RCAF officers and four airmen, a medical officer, a radio engineer, a signaller from the Royal Canadian Corps of Signals, an RCMP constable, a storekeeper, and a cook, and equipped with two Fokker aeroplanes with wheels, skis and floats, spare engines, motor launch, tractor, a radio station with two 150-foot masts, aviation fuel, oil, coal, stoves, bedding, firearms, and food – "everything that a crew of eight or nine men might need to live in fair comfort for a period of 16 months was provided." Seven prefabricated buildings would be assembled at each site, including a blubber house for Inuit helpers.

Lawrence's report provides a detailed overview of the expedition, from the departure of the expedition's two ships (the CGS *Stanley* and the SS *Larch*) from Halifax on 17 July 1927, to the last flight on 18 August 1928. It documents how he chose base locations and built the necessary infrastructure to conduct operations, and describes the system of route and special patrols that the commander put in place, the constraints posed by weather and ice conditions, and the processes by which air crews conducted photography, and the radio communication systems (both air-to-ground and with Ottawa) that the Department of Marine and Fisheries and the Royal Canadian Corps of Signals established and maintained. It also reveals navigational techniques, innovative procedures for starting and maintaining airplanes in Arctic weather conditions (no scheduled patrols were cancelled owing to mechanical failure), and the more general challenges faced by air crews operating in an austere environment. As aviation history J.K.K. Main observed:

> A tougher flying assignment it would have been difficult to find anywhere in Canada. Indeed, few parts of the world have the high winds, intense cold and sporadic, unpredictable open water conditions that can

[38] Hugh A. Halliday, "Flying the Hudson Strait: Air Force, Part 10," *Legion Magazine* (1 July 2005), https://legionmagazine.com/en/2005/07/flying-the-hudson-strait/.

conjure up fog, ice in the air, and impenetrable snowstorms as a local phenomenon, in a matter of minutes.

The long open reaches of the Strait invite and intensify the sweep of Arctic gales along its length. The gales, in turn, tend to keep the ice moving and the water open. Open water in low temperatures induces a heavy, wet fog that clings and freezes to everything, shuts off visibility and eventually turns into a local snowstorm. High winds, fog and wing-icing are the bane of the aviator's life; and the Hudson Strait Expedition was camped on the rim of the cauldron that brewed them all.

This would not bother the high-flying aircraft of today, but the limited performance and open pilot cockpits of that period made the life of the pilot uncomfortable at best and hazardous at all times.[39]

Lawrence's narrative recounts four occasions when aircraft were lost or forced down, placing crews in danger. On 15 December 1927, Flight Lieutenant Leitch was returning from Erik Cove (Cape Wolstenholme or Anaulirvik, the extreme northernmost point of the province of Quebec) to Nottingham Island (Tujjaat) when he encountered a snowstorm and lost his way. With no sign of land, he set down his plane on an ice floe, drained the engine of oil, over-nighted with his crew (who suffered minor frostbite), and the next day corrected his navigational error, refilled the engine with oil, and returned to base with barely a quart of gasoline left in their tanks. On 8 January 1928, Squadron Leader Lawrence set out from Wakeham Bay (Kangiqsujuaq) for Nottingham Island when he ran into heavy snow, forcing him to land at "Suglet Inlet" and then, the next day, at Deception Bay (near the present-day community of Salluit). Facing heavy storms for the next nine days, he and his crew camped in their plane and lived off survival rations until they were located by a rescue crew and returned to Wakeham Bay on 17 January. The third and most serious incident was summarized by Main as follows:

Flying Officer A. Lewis, who was stationed at Port Burwell with the endless icy stretches of the North Atlantic to the east, Hudson Strait to the north, Ungava Bay to the westward and a narrow saw-toothed mountainous peninsula stretching southward. Flying in this area called for precise navigation: landmarks are far apart on two sides; non-existent on the third; and studded with 6,000-foot peaks rising out of the ocean, on the fourth.

While returning from a patrol by way of Resolution Island to the north on February 17, 1928, Lewis and his crew, Flight Sergeant Terry and an Eskimo, Bobby Anakatok, encountered snow and fog so thick that visibility was lost for long periods. The pilot set a compass course

[39] Main, *Voyageurs of the Air*, 81.

somewhat west of his base to avoid the danger of being blown out over the Atlantic. In due course he obtained a glimpse of land which he took to be Akpatok Island in Ungava Bay, and about 100 miles west of Port Burwell. Thereupon he set a course and flew, as he supposed, toward that point which never appeared. By the middle of the afternoon Lewis was compelled to land on the ice, lost and out of gas. Now the Eskimo, Bobby Anakatok, was in charge.

The trio spent the night with the aircraft which, though not severely damaged, was unserviceable, and struck out next morning dragging the life-raft, emergency kit, rations and the compass which they had taken from the aircraft. Heavy snow obscured their view but, supposing themselves to be in Ungava Bay, they set a course to eastward and struggled through ice-hummocks all day. The next morning was calm and clear and Anakatok's lore came to their aid; to the east were great banks of steamy fog, indicating open water; to the west, but far distant, the irregular skyline of the mountainous peninsula. They were, after all, on the Atlantic and had travelled one full day in the wrong direction.

Seven days later the party, having struggled over endless fields of ice-hummocks, ferried themselves across open leads and butted their heads into Arctic gales, reached land. The life-raft retarded rather than aided their progress and it, along with most of the rations they carried on it, had to be abandoned. Thereafter, Bobby ferried the party across open leads on ice pans that don't have to be lugged after one. The Eskimo shot a walrus the meat of which they ate raw though it made Lewis sick; and for a day they were out of food. They still had sufficient strength to continue northward up the coast for four days, at the end of which time they met an Eskimo and his wife. The Eskimos fed the starving men and took them to Port Burwell, which they reached after an absence of 13 days.[40]

All of the men on the expedition eventually returned home, succeeding (often through trial-and-error) in completing the RCAF's first Arctic flying experience. The expedition continued patrolling until ice observations ceased on 3 August 1928, when efforts turned to preparing for the return trip.[41] The initial plan was to fly the five remaining planes back to Ottawa, drawing upon fuel caches that had been laid along the eastern shore of Hudson Bay over the summer. Mechanical difficulties, coupled

[40] Main, *Voyageurs of the Air*, 79-80.

[41] On March 2 the Hudson Strait Committee recommended that the operation be extended for one or two years to obtain more detailed information, but the Department of Marine and Fisheries (satisfied with the results already obtained) informed the Department of National Defence on March 10 that it did not wish to prolong the expedition.

with salt water corrosion that had weakened the undercarriage mounts and float fittings on two of the planes, led Lawrence to dismantle the aircraft, load them onto ships, and evacuate the expedition by sea. The ships reached Quebec in November, thus ending the expedition.[42]

The aircraft from the three bases flew a total of 269 hours 44 minutes on 227 patrols, taking 2,285 photographs and amassing "valuable information on ice conditions, the potential length of a shipping season in Hudson Strait and ice-breaker requirements there." Lawrence's report also reveals how the expedition learned a lot about winter flying, Arctic clothing requirements, and the challenges of establishing semi-permanent bases in an austere Arctic environment. "Generally, the equipment and supplies issued had proved to be appropriate for the conditions met; Lewis's ordeal and Lawrence's nine days in isolation proved that," Halliday observed. "The final reports noted, however, that the messing had been deficient in fresh meat; one had to acquire a taste for seal, white whale and walrus. A 21-day expedition by Constable J. Murray from C Base in search of game had been a dismal failure; the policeman and his Inuit companion had travelled inland for 200 miles, yet never once fired their guns; they returned with only five fish."[43]

Historian Ernest Cable noted that "the RCAF officers were not entirely happy with the expedition as they had been told that regardless of the outcome of their dangerous task, the port at Churchill would be built to placate Western grain farmers."[44] Nonetheless, the Hudson Strait Expedition answered the three questions originally posed. As Main observed, it produced systematic, reliable data on when heavy ice appeared and disappeared in the strait, when skis and pontoons could be used, and on "non-flying" periods. Photographs documented ice conditions in different parts of the Strait throughout the year. More generally, "the experience gathered about flying conditions along the Strait gave an emphatic 'No' to the question relating to its suitability as a base or line of bases for air operations. No more was heard of the proposal to use aircraft to guide ships through the Strait."[45]

Lawrence's recommendations sought to chart a course for aviation to support safe and efficient Arctic navigation. First and foremost, he suggested that the government invest resources in preparing accurate maps and charts. He reported that existing charts were "so inaccurate ... as to present a large and dangerous factor in the development of the strait as a commercial water route." He also recommended a

[42] Douglas, *Creation of a National Air Force,* 111.
[43] Halliday, "Flying the Hudson Strait."
[44] Cable, "Air Force: Leader in the Arctic," 3.
[45] Main, *Voyageurs of the Air*,

detailed aerial survey followed by a hydrographic survey, as well as the permanent stationing of at least one aircraft in the region during the shipping season to inform vessels of ice conditions and to provide navigational advice. He also explained the importance of clear lines of authority and command when operating in a "whole of government" context. The official history of the RCAF concluded that:

> Lawrence's report was recognized as an important contribution to the development of the Hudson Bay transportation route. Radio stations were established as aids to navigation and in I930 a government icebreaker, *N.B. McLean,* began regular patrols. Nevertheless, the route's potential remained unrealized and it was not until after the Second World War that interest in the region was revived, and then for strategic rather than economic reasons. Nor did Lawrence and his men gain public acknowledgment until the 1970s, when the National Film Board production, *The Aviators of Hudson Strait,* featured an interview with Lawrence and made extensive use of original film footage taken by the expedition's cameramen. In 1980, belatedly, Lawrence was made a member of the Aviation Hall of Fame.

By the early 1930s, both military and civilian aircraft had become a fixture of transportation in the Canadian subarctic and Arctic regions. "Aircraft had emerged from the chrysalis stage and were becoming more generally accepted as a means of transportation," Moira Dunbar and Keith Greenaway observed. "The 'headline flights' were still very much in evidence, but the emphasis was now less on achieving 'firsts' and more on demonstrating the capabilities of the machine and pioneering possible commercial air routes."[46] The RCAF photographic and survey programme photographed nearly 1.4 million square kilometres within the northern provinces and covering large swaths of the Arctic mainland by 1939. RCAF aircraft ranged up to the Arctic coast in support of other government departments, particularly the RCMP and Indian Affairs; opened up new air and water routes in the Northwest Territories; inspected gasoline and supply caches; and conducted search and rescue operations for downed planes. They did not venture out over the Arctic Archipelago until after the Second World War, however, and the follow up to many of Lawrence's detailed observations about the unique challenges of operating in the Arctic were left to civilian operators until after the war, when RCAF navigators developed innovative navigation procedures for polar latitudes[47] – a subject beyond the scope of this volume.

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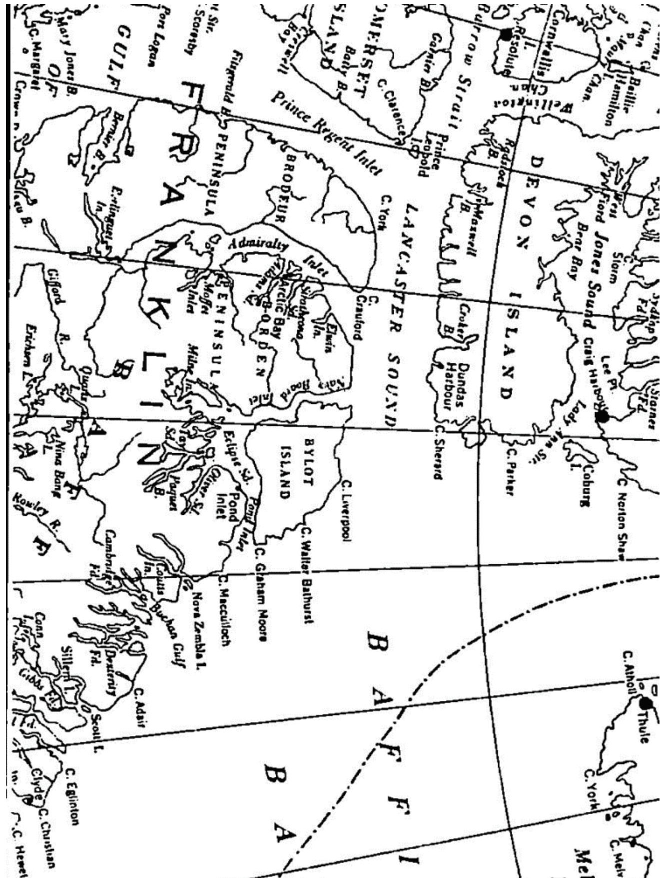
[46] Dunbar and Greenaway, *Arctic Canada from the Air*, 489-90.

[47] Cable, "Air Force: Leader in the Arctic," 3. On this topic, see Keith Greenaway and M.D. Gates, *Polar Air Navigation: A Record* (Ottawa: private printing, 2009).



Source: “Pin-Points in the Past,” *The Roundel* 7/7 (July-August 1955), 13.

1. R.A. Logan, Report of Investigations on Aviation in the Arctic Archipelago, 1922

DHH 74/414

Report of Investigations
on

AVIATION IN THE ARCTIC ARCHIPELAGO
carried out during the summer of
1922

by
R.A. Logan,
Squadron Leader,
Canadian Air Force

AVIATION AND NORTHERN CANADA

Canada, extending as it does from midway between the equator and the North Pole to the Pole itself, a distance of three thousand miles north and south, includes within its boundaries hundreds of thousands of square miles of land and water which have never been examined by civilized men. In such a wide spread territory it is possible that untold wealth may be lying dormant awaiting only discovery and development to make this one of the most prosperous countries in the world, but before we can have development we must first find out what we have to develop. Only the southern fringe of Canada has been even partly developed up to the present time, but each year finds the frontier carried a little farther north all along the line from the Atlantic to the Pacific.

Not only the development of the country increases, but the rate of increase keeps steadily expanding and it becomes necessary for the employment of new methods in various ways to increase our knowledge of the natural resources of the country to make that information available to those who desire it and to give assistance to the men who will attempt to carry out the important work of development and conservation of whatever resources are found in the country. One of the important of

these changes which have taken place within the past few years is the employment of aircraft and wireless, or perhaps these should be included under one head aviation — for these two sciences work hand in hand.

Just as the horse replaced the ox and the motorcar replaced the horse as the chief factor of transportation in towns and country, so in time will aircraft and wireless replace the canoe and dog- train as the chief means of travel and communication over large areas of Canada which today can only be reached with great difficulty with ordinary methods of travel.

But before the operation of aircraft can be utilized to greatest advantage a certain amount of research and experimental work must be done in investigating the conditions under which the air- craft will be required to operate, and in endeavouring to determine the best types of aircraft to use and the most efficient ways to apply their use to widen the scope of mankind in the hitherto practically untouched areas of Canada.

Practical flying in Canada is peculiar from nearly all other countries in the world, in that it may be divided into four distinct classes, each of which has many phases peculiar to itself.

The first division may be taken to include flying which can be carried on all the year round even if there are seasonal difficulties to contend with. This includes flying such as is carried out on the Pacific coast and Camp Borden, Ontario, and to a limited extent on the Atlantic coast. This class of flying is found in many countries of the world.

The second division is more peculiar to Canada, although it is probably applicable to flying in Eastern Europe. This includes flying operations which are possible during not more than half of the year but during the flying season meet with ordinary conditions similar to those to be found where flying is carried out during the whole year. At present flying operations of this class are being carried out during the summer season in Quebec, Ontario, Manitoba and Alberta, performing work for various Departments, but chiefly engaged in forest fire patrols and aerial photography.

The third class includes flying in what may be called the sub-Arctic zone. The sub-Arctic zone may be taken to include the greater part of the mainland of Canada which lies north of the 60th parallel of latitude on the west side of Hudson Bay, and north of the 55th parallel on the east of Hudson Bay, the chief characteristics of this zone being the cold weather to contend with, the very short season of open water on rivers and lakes (with corresponding long season of ice and snow), and the use of river routes for transportation into and through the territory. Flying would probably be

done by machines which would be equipped with skis or pontoons, according to the season. This class of flying has so far received very little attention anywhere in the world.

The fourth class may be termed Arctic flying, and the Canadian zone of this class includes all of the islands lying between the mainland of Canada and the Pole, together with the peninsulas of Melville and Boothia. This class of flying will be similar in many ways to that of the sub-Arctic zone, but there will be more ice and snow and very little, if any, use for seaplanes or flying boats, except those operated from ships. No flying of this class has been carried out up to the present time, but it is expected that a certain amount will be attempted by the Amundsen Arctic Expedition during the summer of 1923.

Canada is therefore one of the most important Dominions of the British Empire, in that such a variety of flying conditions are found within its boundaries, and the development of Arctic and sub- Arctic flying is of the greatest importance, not to Canada alone, but to the British Empire as a whole.

Much has been said of the possibilities of future hordes of Slays overrunning Europe and the great use of aircraft which would be certain in such an event. Aircraft operated from Arctic or sub-Arctic bases which would swoop down and leave trails of destruction throughout the rest of the world, but from the very nature of their bases of operation they would be almost inaccessible to aircraft of countries to which "cold weather" flying was un-familiar, and it is generally agreed that the best method of defence from aircraft is to destroy the enemy's aircraft before it leaves its own borders.

Whether war with such a country as Russia would ever come or not, should not affect the determination to develop flying in the Canadian Arctic and sub-Arctic regions because Canada, if it considers itself worthy to be called a Nation, should have enough pride and spirit to take at least ordinary precautions and be prepared to defend itself in any emergency.

Canada proved during the Great War that her men in the Royal Air Force were equal to any in the world, and it now remains for her to show the rest of the world that she can defend herself, and the whole British Empire if necessary, from all comers from the cold countries in the north of Asia – or Europe - by having men trained and proper material and information available through actual, practice within her own boundaries.

Important as this question is, Canada cannot afford at the present time to carry on expensive investigation and research work unless some immediate benefit is to be obtained, and it is probable that the best policy will be to encourage flying which will

materially assist many civil operations, and at the same time a knowledge of aircraft operation in cold climates for defence purposes will automatically be gained.

There are doubtless many useful ways in which aircraft can be employed in the Arctic and sub-Arctic regions, but when it is considered that so little information is available for anyone desiring to operate commercial flying in those districts, it is not to be expected that rapid development will take place through commercial firms. The majority of uses for aircraft at the present time would be in connection with the various Government Departments and Branches, and therefore it is only reasonable to expect that the first flying in the country should be done by the Government. As flying increases and becomes applicable to commercial work, then the Government will be in a position to offer advice and render assistance to commercial aviation firms, but the pioneer work must be done by the Government.

All of the Arctic and the greater part of the sub-Arctic flying zones of Canada are in the Northwest Territories, and in order for the Federal Government and the Government of the Northwest Territories to become acquainted with the conditions under which flying could be carried out and used to advantage, it was decided in 1922 to send a representative of the Canadian Air Board to the Arctic zone to endeavour to obtain as much information as possible regarding flying conditions there, and from investigations made actually in the country concerned to submit suggestions which might be of assistance in determining the types of aircraft suitable for use and methods for their employment in various ways in the Northern Archipelago.

THE NORTHERN ARCHIPELAGO

The Northern Archipelago comprises all of the Arctic Islands lying to the north of the main- land of the American continent, with one combined area of some six hundred thousand square miles, equal in area to one-fifth of the remainder of the Dominion of Canada, and form part of the British possessions in North America which were transferred to the Dominion by Order in Council of the Imperial Government on the 1st September 1880, and in 1903-4, 1906-7, 1908-9 and 1910-11 the Canadian Government despatched expeditions to winter in the northern waters of Hudson Bay and the Arctic Archipelago to take formal possession by raising the British and Canadian flags and by depositing copies of the proclamation in cairns erected at various points. During the summer of 1922 an expedition was sent North on the Canadian Government Steamer "*Arctic*" to establish Mounted Police Posts and thereby confirm possession by occupation of several of the islands in the eastern frontier of the Archipelago. This expedition, in addition to establishing the Mounted

Police Posts, carried a representative of the Canadian Air Board for the purpose of investigating the conditions affecting the operation of aircraft in the Arctic regions.

Owing to the limited time available, and the necessity of establishing the Mounted Police Posts according to previous arrangements, very little time was available for actual investigations of any particular place for any length of time over a few days.

Northern Archipelago consists of a large number of islands which have, for convenience, been divided into four natural groups as follows:—

> Group No. 1 - The islands situated in the northern parts of the Hudson Bay and Hudson Strait. The chief islands in this group are Southampton, Mansfield, Nottingham, Salisbury, Charles, Coats and Akpatok while many of the smaller islands are still unnamed on the charts.
>
> Group No 2 - includes the islands lying between Hudson Bay and Hudson Strait on the south and Lancaster Sound on the north, the western boundary of the group being Prince Regent Inlet and the Gulf of Boothia. There are two large islands in this group, Baffin and Bylot, while the remainder are generally small and are fairly close to these two large islands.
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> Group No. 3 - This group includes the islands lying west of Prince Regent Inlet and south of Lancaster Sound, Barrow Strait and Melville Sound. These islands are almost inaccessible by ship from the east as they lie to the west and south of the usually ice-covered waters of Lancaster Sound - the only channel by which they may be reached from the eastward. The western islands of the group can be reached by passing through the Arctic Ocean from Berring [*sic*] Strait along the east, or by descending the Mackenzie and Copper Mine Rivers. They comprise the islands of Banks, Victoria, Prince of Wales, North Somerset and King William.
>
> Group No. 4 - This group consists of the islands north of Lancaster Sound and Melville Sound. The chief islands are Ellesmere and North Devon, Cornwallis, Bathurst, Melville, Prince Patrick, Axel Heiberg, Ellef Ringnes, King Christian and North Cornwall. Of these, Ellesmere Island is by far the largest.

During the summer of 1922 parts of only two groups were visited, namely the north end of Baffin Land and Bylot Island in the second group, and Ellesmere Island and North Devon Island in the fourth group, and it is intended in this memorandum to deal only with the parts of the country actually observed, although it is probable that similar conditions will be found in at least a large number of the other islands of the Archipelago.

Baffin Land has generally been supposed to have an area of approximately 211,000 square miles, but according to the preliminary reports of the explorer, Mr. Donald MacMillan, who spent the winter of 1921-22 exploring the hitherto uncharted part of the central western boundary of Baffin Land, the area of the island is very much less than has been previously supposed. It is certain that it has a length of about one thousand English statute miles, with the greatest width being five hundred miles. It was until recently called Cockburn Land, although it had been named Baffins Island or Baffin Land by Admiral W.E. Parry in 1821, out of respect to the memory of that able and enterprising navigator.

The eastern coast of Baffin Island is generally high and rocky, and has never been accurately surveyed and charted. The land rises quickly from the sea, often in precipitous cliffs to an elevation of one thousand feet or more, after which, the upward slope is more gentle as the land rises towards the interior table-land. The general elevation of the table-land to the north of Cumberland Gulf ranges from fifteen hundred to five thousand feet, with occasional hills rising above that perhaps one or two thousand feet higher. Inland to the south of Pond's Inlet the general elevation of the mountainous part does not appear to exceed two thousand feet, and to the westward along Fox Channel it is considerably lower.

A large part of the coastline of Baffin Land has been surveyed only by an approximate location of the chief headlands. This may be said of practically all of the islands in the greater part of the Archipelago. The charts have been generally compiled from notes and records of explorers who were endeavouring to find a passage to Asia, and who had no interest whatever in the interior of the country, and long as they found that a bay was closed and not en opening which might lead to the "Northwest Passage," they took no further interest in it but kept onward toward the west looking for open water.

The other mariners who contributed to the charting of the coast were either whalers, who were also searching for open water, or explorers who were either endeavouring to reach the Pole or find some trace of it John Franklin's ill-fated expedition. Very little time could be spared at any one place owing to the short season of open water and the desire to cover as much distance as possible. In the winter when ships were "frozen in the harbours there was little chance for extensive explorations at any distances from the ships towards the interior of the country, because of the difficulty of travel over the snow and because of the darkness.

The chief reason for lack of exploration of the interior of the country is that the Eskimos have a great aversion to travelling anywhere excepting on the ice along the sea-coast. They may make short excursions across portages to fresh water lakes, or during the summer they may make trips thirty or forty miles inland in search of

caribou, but only in cases of necessity and they return to the coast as soon as possible. The Eskimo depends on the animal life of the sea for his food and fuel, and therefore, especially in the wintertime, will seldom travel far from this source of supply. Even when short journeys have been made into the interior of the country by white men, it has always been done in a season of the year when the ground was covered with snow in order that they could utilize dogs for transportation of their clothing and supplies. This does not, of course, include short distances such as five or ten miles inland on the small valleys near the coast.

On looking at a chart of any of the Arctic Islands, it will be noted that, while the headlands are shown definitely on the map, the bays and inlets are shown as being only approximately located. Even the headlands may be several miles in error in position by latitude and longitude. There are several reasons for this, one being that they were more or less sketched in by ships travelling along the coast, with points here and there established by astronomical observations, but even these latter points were often in error owing to the errors of the ships chromometers, as it was impossible to keep accurate time on voyages lasting several years, although this difficulty at the present time is overcome by using wireless time signals.

On the majority of expeditions to this region a certain route, or definite schedule of duties to be accomplished during the season, was laid down, and naturally the sailing master was always anxious to have as little delay as possible, and as he had the final word as to whether the ship could wait or proceed to the next port of call, he would very often consider the movement of the ship of more importance than the exploration of the coast or the interior; consequently during the season of the year best suited for interior exploration the explorers remained on board the ships travelling from place to place exploring the country from the deck by aid of field glasses, with an occasional visit ashore for a few hours, and comparatively little territory was covered other than the regular routes of the whalers or the routes possibly taken by parties searching for Sir John Franklin, where open water was all that was looked for. Very little investigation was made of the natural resources of the country.

It would appear that in the summertime practically all of the small bays and lowland near the coast have considerable areas of bare ground, at least partly covered with vegetation, but the extent of this ground free from snow can only be determined by photo- graphs from the air during the summer season of the year. The interior of the country in some places may consist of mountain ranges or high table-lands covered with snow, but there is no reason to believe that the whole of the interior is of this nature, in fact there are many indications that the interior of the country may be much more free of snow than is generally sup- posed. The western interior of the northern half of Baffin Island is described by the Eskimos as a rough plain, probably

less than one thousand feet in elevation, diversified by rolling hills with numerous lakes in the valleys between. This country is well covered with Arctic vegetation which provides food for large herds of barren ground caribou. There are two large lakes in the lower country of the southwestern part of the island, called Nettilling and Amadjuak; both are upwards of one hundred miles in length and the lowlands surrounding them are the favourite feeding grounds for large bands of barren ground caribou. Large numbers of natives from the various parts of the coast resort to the shores of these lakes annually to slaughter large numbers of these animals for food and for their skins, which are used for winter clothing and bedding. These lakes are reached by ascending rivers and making short portages.

Bylot Island lies to the northeast of Baffin, being separated from the latter by Ponds and Navy Board Inlets, and Eclipse Sound. It is roughly circular in outline, with a diameter of nearly ninety miles. In physical character it closely resembles the northeastern part of Baffin. The general elevation of the interior ranges from two thousand to three thousand feet, and the coastal highlands are covered with an ice-cap which extends ten or fifteen miles inland, although the interior, according to the Eskimos, is free of snow during the summer.

North Devon Island lies to the north of Baffin and Bylot Islands, being separated from them by Lancaster Sound, The Island is about two hundred and twenty miles long, east and west, and averages seventy-five miles across. The eastern third of the Island is composed of crystalline rocks and rises to an irregular ice-capped table-land some three thousand feet in altitude. The western part of the Island is formed of limestone and is a flat table-land cut by deep narrow fiords that extend inland may miles from the coast. The general elevation of the table-land in the eastern part is nearly two thousand feet, but this decreases in the west so that on the west side the cliffs are below one thousand land along the western side of the island where there is a good growth of Arctic plants on which large numbers of musk-oxen feed, together with some barren ground caribou and Arctic hares. Walrus and white bears are also plentiful among the ice of Wellington Channel, which separates North feet. There is lower Devon from the islands lying to the west. It is unpopulated, although indications have been found in several places of ancient Eskimo habitations. It is probable that Eskimos from Baffin Land cross Lancaster Sound to hunt on North Devon Island, but it is not believed to be regular practice for them to do. There are several extensive plains of land which are free of snow close to the sea-coast. This also may be said of several islands which are along the eastern coast.

A large area of the northeastern part of North Devon Island was observed from an altitude of about three thousand feet on the ice-cap of Ellesmere Island southeast of Fram Fiord, in the latter part of August 1922, and as far as could be seen to the south the interior consisted of slightly rolling table-land covered with perpetual snow,

broken by several gorges a mile or two wide, which ran southerly for probably ten or fifteen miles. Towards the west, however, the land appeared to become gradually lower and there appeared to be a large area free of snow. The distance from the point of observation was from thirty to sixty miles, but with exceptionally clear visibility.

Ellesmere Island is only second in size to Baffin Island and is remarkable for its north end extending to beyond the 83rd parallel of northern latitude, or to within five hundred miles of the North Pole. Its length from north to south covers nearly seven degrees of latitude, or approximately five hundred miles. Its greatest breadth across the northern part exceeds two hundred miles. Its outline on the west side is quite irregular, being indented by large bays. The island is separated from Northern Greenland by Smith Sound and Kennedy and Robeson Channels. The general elevation of the eastern half of the island is high, probably exceeds two thousand, five hundred feet. In the northern part the United States mountains are upwards of four thousand feet high, with isolated peaks probably reaching to five thousand feet. It has been remarked by several explorers that, contrary to their expectations, the northern part of Ellesmere Island is not covered with a continuous ice-cap but instead there are extensive plains or table-lands comparatively free of snow, especially in the summer. These plains, like the extensive plains on the western side of the island, are covered with Arctic vegetation, and muck-oxen, barren ground caribou, foxes and Arctic hares are found there in large numbers, along with geese, ducks and other aquatic birds. This island has been crossed from east to west about the central part, and has been explored on the west by the Norwegian explorer, Sverdrup.

Only the southeastern point of this island was observed this season, and as far as could be ascertained the southeastern quarter of the island is covered with perpetual snow excepting the more prominent headlands and the larger valleys, although many indications were found of ancient Eskimo habitations, and several horns of caribou were found, indicating that these small areas of bare ground are not absolutely isolated by the ice-cop from the feeding grounds of these animals, and that, though uninhabited now, were at one time quite thickly settled with Eskimos. It may be noted here that the best book of reference on the western part of Ellesmere Island is "*New Land*" by Captain Otto Sverdrup, 1904, being a narrative of his four years' work in that region.

There are several islands to the west which have been very seldom visited, but which, from all reports, are much better suited for human habitation that same of the Canadian islands which are at the present time inhabited by Eskimos [Inuit]. The apparent reason, however, for these islands being uninhabited at the present time is that the Eskimos [Inuit] prefer to live within reach of the whalers or traders, but no doubt would live on these islands were regular trading posts established. The islands to the westward of North Devon, namely Bathurst and Melville Islands, are suitable

for the development of the reindeer and musk-ox industry owing to the large areas of Arctic vegetation and the comparatively favourable climate, and in addition have every indication of extensive mineral resources. These islands were not visited in 1922 but it is recommended that further investigations be carried out to include the natural resources of these islands, and the possibilities of aircraft being in the development.

There are wide-spread indications of coal in nearly all of the islands inside the Arctic Circle. Considerable coal has been mined for local use at Ponds Inlet. Coal was found by Commander Nares at Lady Franklin Bay on Ellesmere Island in a seam two hundred and fifty yards long and twenty-five feet thick. He reported the coal to appear to be an excellent fuel, containing lees than three per cent of water. No doubt coal can be found in many other places if searched for, and although the general impression seems to be that this is coal of very poor quality, the explorers in their reports do not seem to hear this out, but indicate rather that the coal is of sufficiently good quality in many places to be used for all ordinary purposes. Oil-shale has been noted at several places and analysis of specimens obtained by Captain Bernier in 1910 from Bathurst Island shows one hundred and forty gallons of oil per ton of shale. This might indicate the possibilities of obtaining oil in this country, or at least sufficient to be used locally for aircraft and motor transport purposes.

During this season a peculiar sand was found on the shore of Dundas Harbour, of which a sample was brought back, and this has been described as being very to the famous ruby sands of Nome, and is a probable indication of gold. This has not yet been analyzed. It is considered advisable that this district be investigated by properly trained men in the near future. There are indications of copper in several places, although not many were noted this season. A peculiar discoloration of a rocky hillside was noted near the southeasterly point of Ellesmere Island. This discolored rock was of a bright green color and appeared to be stained from water running out of a crevice in the hillside. This was noticeable for a mile from the hill and may or may not be an indication of copper. In such an unexplored country it is impossible to foretell what mineral resources may be found when properly searched for.

Only the high hills of the interior have been observed and the interior of the islands may be entirely different from the immediate vicinity of the seacoast. It is possible that, as in practically all other countries, the weather conditions, and consequently the general vegetation, and so forth, are different fifty miles inland from those existing near the seacoast. Several theories are put forth in favour of a more moderate climate in the interior during the season of sunshine, especially in the western part of the Northern Archipelago.

The eastern side of Baffin Land, North Devon and Ellesmere Islands consists of fairly high table-lands, in both cases covered with perpetual ice and snow. The prevailing

easterly winds blow over the open water in Davis Strait and become laden with moisture, which is condensed upon reaching the cold mountains and forms clouds and snow, so that by the time the air has reached fifty miles inland the most of the vapour has been condensed and consequently there is less snow and fewer clouds than would appear from a view of the first few miles from the shore.

In addition to there being a lighter snow- fall in the interior, the general appearance of the country is that the land is lower as one goes west, and includes many fairly low plains covered with vegetation supporting herds of musk-oxen and caribou.

Owing to the comparatively light snowfall, and the drifting caused by the winds, it is probable that many of these plains become clear of snow quite early in the spring, and it is also quite probable that the surface air, at least, becomes quite warm, if not hot, during the summer months when the sun is shining for twenty-four hours per day, for when there is no night to cool the ground the sunlight, even if it is not powerful, is continual, and radiation from the ground must warm the air to a great extent and produce much Arctic vegetation. One thing in favour of this theory is that herds of caribou or musk-ox appear to find plenty of food in the interior during the winter, while during the summer they very frequently feed over the smaller scattered plains or bare ground near the coast. By means of aerial photography the extent of the plains or ground free of snow could be ascertained, and by transporting geologists and prospectors, and persons interested in the musk-ox and caribou industry, much of the hitherto unknown natural resources of the islands would be discovered.

Coal seams and indications of cool have been found at many places, and it is likely that with proper investigation extensive fields of good quality coal will be found, which, even if it is not profitable to ship to the south, will be sufficient for fuel in developing the other minerals known to exist, many of which only indications have been seen.

It is possible that the fishing industry could be developed in many places, particularly the salmon in several of the rivers of Baffin Land. If Government Eskimo Agencies, similar to those operated by the Danish Government in Greenland, are ever established in the northern islands, it will be more satisfactory to use aeroplanes for inter- communication between these than to use any other existing means of travel.

There are several Hudson's Bay trading posts on the south and eastern coasts of Baffin Land, while several are being established each year. The most northerly one is at Salmon River, Pond's Inlet, about latitude 73°43′ north, and was established in1921. There are also several trading poets belonging to free traders. One of these trading posts is operated by the Arctic Gold Exploration company ten miles east of the Hudson's Bay Company's post at Salmon River.

Another Company operating several small trading posts on the east coast of Baffin Land is known as the Sabellum Trading Company, Limited, with headquarters [in London], England. This Company has been operating in Canadian territory since 1911. Its main station is at Kivito. This is approximately latitude 68° north, and longitude 65° west. Another station is located at Cyrus Field Bay, with a branch station at Frobisher Bay. Both the latter are managed by one man and the stations are located on the peninsula between Cumberland Gulf and Frobisher Bay. A small station is also located at the peninsula north of Cumberland Gulf and is known locally as Kanaker's Inlet. Another small station was opened in 1920 at Gape Hater and it was intended to open another station at Igloolik in 1921, but it is not known whether the station was established, or not. The vessel owned by the Company in 1921 was the "*Vera*," a sailing vessel with auxiliary power, commanded by Captain John Pearson. This ship generally left England in the latter part of June and returned in November, calling at the head stations, but the branch stations are supplied by sledge parties from the head stations. This Company claims to supply the wants of, and trade with, approximately one thousand Eskimos [Inuit], but it is probable that this number has been lessened since 1921 by the establishment of several Hudson's Bay Company's posts.

The following list shows various trading posts along the coast of Baffin Land;-

> Lake Harbour, midway along the north shore of Hudson Strait, is operated by the Hudson's Bay Company and maintains a staff of four or five man. West of this are the following stations:-
>
> Stiniak, near the entrance of Markham Bay, and Amadjuak, at the mouth of the outlet of Amadjuak Lake, both operated by the Hudson's Bay Company, with one man in charge of each.
>
> Cape Dorset is the most westerly Hudson's Bay Company's post on Baffin Land, and two men are attached to this post. There are several Hudson's Bay Company's posts on both the east and west shore of Hudson Bay, including one on Coats Island.

The following posts operated by the Hudson's Bay Company, are on the north shore of Ungava, this being the southern shore of Hudson Strait:—

> Cape Wolstenholme there are two white men at this post.
>
> Stupart Bay, almost due south of Stiniak also maintains two men.

Another post at Payne River is managed by one white man.

Stations with one man each are operated at Whale River and George River, while larger stations, with several men at each, are operated at Port Burwell and at Fort Chimo.

Proceeding easterly and northerly from Lake Harbour along the coast of Baffin Land, the following stations will be found: —

Waddell Bay, operated by the Hudson's Bay Company.

Forbisher, a branch station of the sabellum Trading Company.

Nugumiut Station, operated by the Sabellum Trading company

Netchilik in the Cumberland Guld, operated by the Hudson's Bay Company.

Kanaker's Inlet Sabekum Trading Company

Kivitoo, main station for the Sabellum Trading Company

Cape Kater, operated by Sabellum

Pond's Inlet station, two miles west of Albert Harbour, in the entrance of Eclipse Sound, is the main station for the Arctic Gold Exploration Company, and several branch stations in the vicinity are operated from this station. "Pond's Inlet," or more properly Salmon River, about eight miles west of the last described post, is operated by the Hudson's Bay Company.

The above information has been obtained as far as possible from information given by officials of the different Companies, but it is possibly not absolutely up-to-date, although it is the latest information which could be obtained.

Information was also obtained from the natives of Pond's Inlet that trading posts were operated during the past winter, at least, at Igloolik and Admiralty Inlet by the trader, [Knud] Rasmussen, who told the Eskimos [Inuit] that he also intended establishing a station at Pond's Inlet in the near future.

FROM	TO	DISTANCE
Dundas Harbour	Pond's Inlet	160 miles
	Craig Harbour	120 miles
	Smith Sound	325 miles
Craig Harbour	Smith Sound	200 miles
	Pond's Inlet	260 miles
Pond's Inlet	Smith Sound	430 miles
	Cape Kater	350 miles
	Kivitoo	450 miles
	Igloolik	230 miles
	Netchilik	530 miles
Kivitoo	Cape Kater	110 miles
	Netchilik	170 miles
Netchilik	Lake Harbour	225 miles
	Amadjauk	200 miles
Lake Harbour	Amadjauk	120 miles
Amadjauk	Cape Dorset	120 miles
Lake Harbour	Port Burwell	250 miles
	Fort Chimo	330 miles
	Stupart Bay	120 miles
	Wolstenholme	240 miles

AIRCRAFT USES

There are many uses for aircraft in the Arctic Archipelago in assisting the exploration and investigation of the extent of the natural resources of the territory. Topographical and Geological surveyors may be transported to otherwise inaccessible places, and to many other places where their season of operation may be greatly extended by the reduction of time required for travelling.

The extent of grazing grounds capable of supporting animal life, such as musk-oxen, caribou or reindeer, may be found, as well as the number and locations of existing herds and breeding grounds of these animals. The latter will become necessary before much headway can be made in the industry of raising musk-oxen or reindeer for commercial purposes. This industry will receive a great deal of attention in the near future, especially if a mineral or oil strike were ever made in the Arctic Islands, or even in the sub-Arctic, and the time to investigate this is immediately.

Now is the time to find out what the possibilities of the country are before the big demand arises. The more the country is examined the greater will appear the natural

resources and commercial possibilities, and automatically the methods of development will appear. When the reindeer or musk-ox industry is in operation it is probable that the greater part of the "herding" and range patrols will be done by aeroplanes, especially in keeping wild caribou herds away from the "tame" herds.

It is certain that aircraft can be of great assistance in connection with Mounted Police work, and as this will call for long cross-country flights it will be imperative to have a certain amount of preliminary experimental work done before machines are sent out hundreds of miles from their nearest bases.

As it is practically certain that the future headquarters of the Royal Canadian Mounted Police will require the services of aircraft, it will be necessary for the former to be near an aeroplane base, and, while there are several places known to be favourable for the location of a Mounted Police Headquarters, none of those so far investigated are very favourable for a permanent aeroplane base, and it would be advisable to make a reconnaissance to locate the best place possible for combined headquarters for Mounted Police and Air Force and base of operations for Topographical and Geological surveyors.

In many ways the Arctic is an ideal country for "lighter-than-air" craft — airships.

The sunlight is practically constant during a long season of the year, and this is one of the greatest factors in the operation of any type of airship owing to the effect of sunlight on the expansion and contraction of the gas in the balloons. It is also of great assistance in navigation.

One great advantage of airships over aeroplanes is that an airship is self-supporting independent of the engine, for as the aeroplane depends on the engine for support it is forced to come down as soon as the engine stops or loses its minimum speed. An airship can remain in the air for much longer periods than an aeroplane on the same power, and can carry a fairly heavy load, but some of the disadvantages of airships are the bulky buildings required to house them and the number of men required to handle them in making landings, unless mooring masts are used. Owing to its bulk an airship is greatly affected by high winds, especially when near the ground, but it is possible that in such northern latitudes the high winds may be only at comparatively low altitudes, and an airship might be able, by ascending a few thousand feet, to ride out what would be a fairly strong gale on the surface.

During the summer of 1922 several peculiar wind conditions were observed which would seem to indicate that the strong winds so often referred to by Arctic explorers are in many cases very local in character and do not reach very high altitudes. Winds thirty to forty miles per hour were experienced at the entrance of Pond's Inlet for

several days in succession, while during the same period fifteen miles inland the air was dead calm.

Although airships may not be used locally in this district for many years to come, it is practically certain that before many years long- distance airship routes from Western Europe to Japan will be located over the Arctic Archipelago, for the reason that it is much shorter by making great circle sailing between two countries so far apart. By travelling in a direct line between Paris and Japan the direct line would pass well within the Arctic Circle and the distance would be at least three thousand miles lees than by travelling on the present-day route.

Another inducement for airships to travel over this Polar territory is that by flying in the continuous daylight of the summer less trouble would be experienced with the expansion and contraction of the gas owing to the varying degrees of sunlight, as well as the general advantages to navigation obtained from travelling in continual daylight over a greater part of the journey.

If information is obtained by the Canadian Government it is possible that this will be of international value, and may, moreover, assist in having international air bases located on Canadian territory, which will aid in the general development of the country.

One of the first demands for the use of aeroplanes will be in connection with Mounted Police work, for patrols and all long cross-country journeys. If it is generally known that aeroplanes are in use by the Mounted Police the moral effect of this on law breakers, whether Eskimo [Inuit] or white, is such that it will be one of the greatest aids in the prevention of crime, and trespassing on the parts of ships of traders or foreign Governments. During the season of 1923 alone much time could be saved by the use of aircraft in connection with the murder trials at various points, by transporting legal and police authorities and wit- nesses.

Surveys parties will save much time in being transported from place to place by aeroplane, for by using large machines capable of carrying several passengers and their baggage, whole parties, with several weeks' supplies, could be moved three hundred miles in less than four hours, while travelling by dog-train at least two weeks hard work would be required to cover the same distance. Supplies could be cached, by air, at many places and the full summer season could be spent on interior surveys and explorations.

The surveys could be greatly helped by using aerial photography, especially along the coastline. Oblique photographs covering large tracts will give, not only the topography, but, if taken for a few weeks over the same areas, would show the changes

in general appearances due to the seasons, which would be of general scientific interest, and if taken over the water would aid in navigation and in obtaining a practical knowledge of the ice movements, upon which navigation depends so much.

When regular navigation is established through Hudson Strait it will be necessary to have one or more detachments of aircraft to watch the ice and report positions to the ships. This may be done by wireless and photography. Regular ice patrols will become necessary adjunct to navigation through this Strait. Photographs of the ice and open water for miles ahead of the ship may be taken, developed, printed and dropped on the ships in the vicinity every day.

Ships will not require to waste time trying to get into harbours which are riot clear of ice, and advantage will be taken to call at open ports first, while through traffic will be able to follow the open water, and once the relation between weather conditions, tide and general ice movements is determined, and forecasts compiled by utilizing aircraft and wireless, navigation through the Hudson Strait will lose much of its hardship and danger.

In connection with the ice patrols, wireless ice condition reports will be broadcasted, and for any extensive navigation they will soon be considered as necessary as the wireless weather reports are today in the more southern parts of the continent where they are sent out every few hours.

The only practical way of observing on the daily movements of ice over large areas is by the aid of aircraft and aerial photography.

Meteorological reports should be sent south by wireless every few hours to aid in weather forecasting in the more inhabited parts of the world, and while this may not require the actual use of aircraft, it will require the use of the wireless stations operated in conjunction with aircraft.

ICE CONDITIONS

As far as could be ascertained from observations during the short season spent on the expedition of 1922, and from verbal and written reports of men who have spent many years in the Northern Archipelago, there should be several months during the summer when it is certain that aeroplanes could be operated, and the indications are that it is probable that operations could be carried on successfully for several additional months.

All of the waters within a few miles of the shore on the east side, and practically all of the inland waters of the Archipelago, are frozen solid during at least seven months of the year, and in the bays and small inlets the ice forms about the end of September and remains until about the 1st August, as a rule, although some bays may be cleared by the action of wind and tide earlier than this, and some places may not clear at all if the weather during the summer is fairly calm.

The ice forms each winter to a depth of probably twenty feet in many places, and is rotted to a certain extent during the summer by the action of the sun and is finally broken by the action of tides and wind and washed out of the straits and channels by the currents which flow towards the south and east.

In a season when there is much wind and heavy seas from the east the ice is broken in the larger channels about the middle of June, or possibly earlier, and the smaller bays and straits clear about the end of July.

The end of the season for regular ice travel along the shore is about the middle of July, and ice travel commences again about the middle of October.

When the sea is fairly calm in the spring and summer the ice takes much longer to break up and drift clear, because the wind has a great effect on the drift of the ice, as well as has the tide and currents.

The tide at both Pond's Inlet and Craig Harbour is about nine feet between ordinary high and low water. Large pans of ice drift into shallow or rocky waters at high tide, and when-the tide goes out are left high on the rocks, and consequently are broken by their own weight into smaller pieces. This nearly always happens to the edge of the ice near to the shore.

When the ice first moves it is in large pieces, sometimes several miles in length or breadth, but it gradually breaks up into smaller pieces. The larger pieces in many cases would make excellent landing places for aeroplanes if it were desired to land upon them. As far as could be observed this year the ice was still strong and smooth enough for this up to the 8th September in several places, but especially at Salmon River. In the sheltered bays where the ice had not cleared by that date, the new ice would prevent any further weakening of the old ice, so it would appear that many places in ordinary years will be available for suitable landing places.

The snow on the ice-cap of North Devon and Ellesmere Islands would make excellent landing ground, at least in the summer. The condition of this snow was investigated on the Ellesmere ice-cap at an altitude of about three thousand feet above sea level. The surface was swept smooth by the wind and covered with a fairly heavy crust in

most places, but on some hillsides the snow would not support a person walking, but in no case did one sink below the ankles. This would be quite satisfactory for landing aeroplanes equipped with skis. The surface of this ice-cap is slightly rolling, with wide expanses of level or almost level areas.

The top surface of the larger glaciers in the valley, while being in general appearances fairly level in places, are actually of a much rougher surface than the snow fields of the table-land owing to the cracks and crevices caused by the seaward movement of the glaciers.

Several glaciers were observed which would serve as emergency landing grounds, and probably many more would be discovered, but in practically every case where the glacier does not reach to the water's edge there is a wide strip of level gravel beach between the foot of the glacier and the end of the bay. This gravel sometimes is covered with vegetation, but in many cases will probably be found to be bare. These beaches will serve as the best landing grounds for aircraft equipped with wheels.

By using aeroplanes equipped with inter- changeable skis and wheels, landings could be made practically anywhere in these islands excepting the most mountainous parts.

It was found that when several hundred feet above the surface of the glaciers in the valleys it was possible to detect any small ridge or elevation in the surface of the ice or snow, owing to the shadow cast by the sun, for in this latitude the sun's altitude is always so low that very long shadows are cast, even of very small objects, on otherwise comparatively smooth surfaces,

The surface of the sea ice will also be visible so long as the sunlight is strong enough to cast a shadow. There are many places where ridges of broken ice are formed by the winds and tide breaking up the edges of the ice on large areas of partly open water before the whole surface is frozen over. This sometimes results in ridges, several miles in length, of broken ice cakes piled many feet high, making landing of aircraft impossible. These ridges or rough areas can be avoided under ordinary circumstances, for, while it is necessary to have smooth ice to land on, the actual area required is not so very large, and when the sun is shining strong enough to cast a shadow it will be fairly easy to pick out the areas of smooth ice from the ridges or rough ice. One of the great difficulties in travelling by dog-train in this country is that when such ridges of rough ice are met they have to be crossed over, and sometimes it takes many hours to travel one mile. All this could be avoided in travelling by aircraft.

It was noticed that the surface of the ice late in the season consisted of long narrow pools of fresh water or slush, with ridges of dry, hard ice between them. The hard ice is white, while the soft slush or water is dark color. The hard -white strips are

generally several hundred yards in length and ten to fifty yards in width. These alternate strips of dry white ice lie parallel to the direction of the prevailing winds. Actual practice will soon give the necessary experience to enable the pilot to judge the exact surface conditions of the snow and ice underneath him, but as a general rule small pans or small areas should be avoided when there is a choice, for the larger the field the more likelihood of it being free of rough ice.

CLIMATIC CONDITIONS

The observations of weather conditions during the summer of 1922 were very limited owing to the fact that the ship was moving from place to place generally many miles out to sea, where the weather conditions were quite different from what would be found either by remaining at one place on the coast or be travelling inland.

Large areas of open water tend to keep a more constant temperature than would be found were there nothing but ground, snow or ice, as the water prevents extremes of temperature, and in the northern part of Baffin Land, at least, the temperature seldom goes as low as it does in some of the southern districts of Canada, such as Northern Ontario, Manitoba and Northern Alberta, where thousands of people are living and carrying out farming operations.

In the winter there are from all accounts many high winds which blow much of the snow from the level plains and when the sun begins shining in the spring the remainder of the snow soon melts and the bare ground acts as a reservoir of heat received from the sun.

The sun at Pond's Inlet is not visible from about the 9th November to the 3rd February. During this time the only light is from the stars or the moon, and travelling at any time when there is no moonlight is very difficult and dangerous owing to the darkness. For several weeks after the sun sets in November, and the same period before it rises, the sky is partly lightened at noon similar to the ordinary dawn, but the bright stars are visible throughout the whole twenty- four hours. The period of total darkness when there is practically no light whatever from the sun is approximately two months, and during this time it is like continual midnight in the more settled parts of Canada.

The moonlight is said to be much stronger than in southern latitudes, but this is partly due to the reflection from the ice and snow, and partly because the eyes are not accustomed to the bright rays from the sun

When the sun is first visible it is seen only for a few minutes at noon, but the length of this period increases steadily as the sun seems to get higher in the sky each day until it appears to travel around the whole horizon without setting. It does not get very high at noon, but the lowest it gets is at midnight. It continues to revolve in a spiral, gradually approaching the zenith and getting farther away from the horizon until about June 21st it begins to gradually spiral back to the horizon until it finally touches it at midnight, and then continuing in its southerly spiral the periods when it is visible become shorter each day until it is seen only a few minutes at noon for a few days and then sinks out of sight about the 9th November.

During the period of continuous day-light flying could be carried on for the full twenty-four hours as far as visibility would be concerned, and for a large part of the year the darkness is not sufficient to prevent flying, at least several hours per day, although it is probable that there may be several months when the temperature will be too low to permit flying, but whether flying can be carried on in temperatures much below zero on the ground remains to be determined only by actual experience.

Apparently the coldest season of the year is in February and March, especially after the sun has commenced to shine. The weather during the winter of 1921-22 and the following summer, according to the reports of the white men who were living at Salmon River and Pond's Inlet, was not very severe, and there were no gales or strong winds, and from May to the time the C.G.S. "*Arctic*" departed, September 8th there were practically no windy days and the sun was shining most of the time.

There was and always is wind close to the open sea, especially when the country near the sea is covered with ice or snow. This is caused by the difference in temperature between the air over the open water and that over the ice and snow.

Salmon River, being twenty miles or more inland from the open sea, although it is on the edge of a channel or sound, has an entirely different climate from that of the eastern coast of the island, even twenty miles away. The Sound remained frozen until September in 1922, and Salmon River was beyond the range of the local sea breezes and in addition had immediately to the south at least one hundred square miles of bare, rolling plains to radiate the heat received from the sun's rays, with the result that the sky in that vicinity was fairly clear of clouds all summer.

It would appear that flying would be possible from probably the let of May to the end of September, although this is perhaps a shorter season than may be found by actual experience. Until July 15th it will be possible to land almost anywhere on the ice if skis are used, and after that date there will be many places on the ice and also many places on the surface of the ground where an aeroplane could land.

In Baffin Land there are many lakes in the interior, the ice on which could serve as landing places, or later on in the season the surface of the water could be utilized for flying seaplanes, although this season would be very short.

The fogs noticed in the summer of 1922 were all very low and were very local. The prevailing type of cloud was cirrus, but very thin and forming very little obstruction to the rays of the sun. Layers of strato-nimbus clouds were observed a few times near the coast at an altitude of about two to three thousand feet, and were seldom over one thousand feet thick. The visibility at all times was good except for one very noticeable peculiarity — fog clouds formed by the air from the open sea striking the cold hills. Low fog is frequent at certain times of the year along the outer edge of the stationary ice.

When even a slight breeze was blowing off the water a fog cloud would be formed for perhaps one-half mile in breadth all along the seaward edge of the hills or table-lands at various heights, but generally about fifteen hundred to twenty-five hundred feet above the sea level. The density and extent of this fog bank depended on the temperature and strength of the wind. With certain condition the fog settled low, but seldom was very thick vertically. When the sun is shining in the valleys or farther inland, snow may be falling from the fog cloud along the high ground near the sea. This fog cloud is very local and the position of the clouds in relation to the open water would give a very good indication of the direction of the wind.

AIRCRAFT AND ACCESSORIES

The foregoing notes on weather conditions are some of the reasons why an aerodrome should be as far inland as possible from any large body of open water, on low bare ground where the air may receive as much heat from the sun as possible. It should be as much as possible sheltered from the north by high ground, but lower the ground towards the south, the better, as this will give longer periods of daylight.

Great care should be taken in the careful location of any aircraft base, and no location should be chosen within fifteen miles of the open sea, because if such a location is chosen it is certain that great difficulties will be experienced with fog and with winds. The more open or bare ground in the vicinity, the better, as this will tend to keep a clearer atmosphere and it will also offer more chances of game, which will be required for food. If motor transport could be utilized for transporting supplies over the ice it is probable that the best place for an air station would be at the head of some deep inlet with country free of high ground, and from what has been seen of the country it is believed that at the head of every inlet there is a certain area of law or fairly level ground.

The general type of aircraft recommended from the information gained in the short season of 1922 is an aeroplane equipped with skis, which may be changed for wheels when, or if desired. The ideal lending gear would be a combination which might be made somewhat similar to the landing gear of an "amphivian"[1] [*sic*] so that skis or wheels could be interchanged at will. The aero plane is desired in preference to the flying boat because the season of open water is very limited, and the open water is generally at some distance from the shore, separated from it by ice, and the numerous pieces of black or rotten ice would always be dangerous to the thin hull of a boat or pontoon. A seaplane convertible to a land machine might be of some advantage in flying over the fresh water lakes in the late summer, but an "amphivian" would not be an advantage as the greater part of the flying season would call for landing on skis.

There are several reasons why an "amphivian" type of aircraft should not be chosen for work inside the Arctic Circle, although there are times and places where either a flying boat or aeroplane could be used. The great danger in using a seaplane or flying boat is caused by large numbers of small pieces of ice which are practically invisible and would, if struck by the aircraft, very badly damage the hull or pontoon. Owing to the temperature of the water being so near the freezing point much ice would form at times on the hull or that part of the aircraft coming in contact with the water.

It would also be difficult for the aircraft to approach close to the shore in the majority of cases, as there is quite often a ridge of ice at the water's edge. Ice cakes drifted by the wind and tide would make it impossible to leave an aircraft moored in the open water for any length of time. In landing an "amphivian" on the ice there would always be danger of particles of ice puncturing the hull, and the weight and general shape of the hull would be against its use for landing on ice or gravel.

The only way a seaplane could be used to advantage would be a small type of seaplane kept on board a ship and lowered overboard as required, and flown from the surface of the water close to the ship and used for scouting purposes only. By its means a much greater knowledge of the ice conditions ahead of the ship could be ascertained, and very little difficulty would be experienced in connection with the formation of ice on the pontoons, because after each flight the ice could be removed by the application of steam or hot water. A seaplane might be used at times in the fresh water lakes in certain districts, because there it would be possible to pull the seaplane out of the water when not landing or taking off, as the majority of the fresh water lakes, although small, have very sloping shores. It would be useless to use seaplanes or flying boats for general work, using the surface of salt water.

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[1] *Editor's note:* The report consistently uses the term "amphivian," implying an amphibious aircraft that can take off and land on both land and water. I have left the word as it appears in the original.

Any patrols or flights more than twenty miles from the base should be carried out with two machines flying together. This is of the greatest importance in cross-country patrols in such a country, and no mistaken ideas of economy should be allowed to interfere with this most important principle. When it is considered that the means of travel on the ground are so limited and difficult, it may be understood how necessary it is to have two machines always within sight of each other, so that should one have trouble and be forced to descend, the other may either lend assistance or may return to the base for whatever is needed to make repairs. The cargo which is absolutely imperative to be carried on all cross-country flights includes light but sufficient sleeping robes for each member of the crew or passengers, one week's rations, a small silk tent, a small gasoline or kerosene stove for cooking and heating purposes, a rifle with three hundred rounds of ammunition, two snow-knives, an ice chisel, black snow goggles and four light ice anchors and ice mooring wire cables. These articles should be as much a part of the equipment as the revolution indicator or pressure gages on the pilot's dash-board.

One Eskimo [Inuk] should always be carried on one of the two machines, as an Eskimo [Inuk] can find food and direction where a white man would be lost, starved or frozen to death.

As one of the chief uses for aircraft will be transportation, the machines will have to be capable of carrying several passengers and their baggage, in addition to the crew and the standard cargo, which may be considered part of the dead weight of the machine itself.

Flights of at least three hundred miles will be required, but possibly double this distance will be more satisfactory. In all long distance flights at least a twenty percent margin of safety must be allowed in calculating the fuel consumption.

It is considered that the best general type of aircraft would be a tractor aeroplane, carrying at least one thousand pounds of passengers or freight and using an air-cooled radial engine. It would probably be an advantage in many ways to use a single engine, although if a double engine machine such as Vickers Vimy were used it might be possible to taxi many miles on the ice with one engine, using an out-rigger ice rudder should one engine fail. Another advantage in using a twin engine machine is that there is a much better opportunity for taking oblique photographs straight ahead, as in a flying boat. One of the greatest uses for aircraft will be aerial photography in surveying the coast and interior of the islands, and to do this successfully it will require a clear field of vision ahead.

This may be obtained in the single aero- plane only by using a pusher type, and at the present time not many of these are in use, although hundreds of a suitable type must be available in England, namely the F.E. 2D, or F.E. 2B.

It is believed that an F.E. 2D two-seater pusher would make an ideal machine for photographic work in the North if it were equipped with skis. If the type of engine used previously in that machine were unsatisfactory, a proper engine could probably be installed with a few alterations, but at any rate the general type of the F.E. is the most suitable single engine machine for photographic work with an oblique camera, and it is certain that a great amount of this work will be necessary.

If gasoline and oil were cached at various points along the coast by a larger type aeroplane, the pusher could operate for long distances from its base with a much smaller fuel consumption than a twin engine machine.

With the exception of the need of a clear field of vision straight ahead, it is probable that the best type of machine for the first work in the Arctic will be a large capacity single engine tractor, such as the Bristol ten-seater or the D.H.34, but if it were not for the increased trouble of using two engines in such a cold climate, where transportation of fuel is such a large item of consideration, it is probable that the best all-round machine would be a Vickers Vimy or some very similar machine.

The whole question of the success or failure of flying operations in the Arctic regions depends on two things — the proper choice of machine most suitable for the work and a careful choice of the right type of personnel. Either one alone will, if neglected, mean almost certain failure. In the case of aircraft it is not sufficient to assume that because one type of machine has proved satisfactory in some other part of the world it will be satisfactory in the North. Due consideration must be taken of the work which aircraft will be required to perform and the conditions under which this will be carried out, and the greatest care must be taken in deciding on the type which is most likely to be the most efficient for that peculiar class of work under those unusual conditions.

Aero Engines

It is believed that either water-cooled engines using an anti-freeze mixture in the radiator and properly installed in a closed compartment in such a manner that the amount of cooling air may be regulated, or an air-cooled engine, the cooling air of which is similarly controlled, could be used in the summer and possibly in part of the winter, but the best engine for winter use is probably a radial air-cooled engine with some means of controlling the temperature by regulating the amount of air striking

the outside of the cylinders by means of shutters and deflectors. This can only he found by actual experience in the air. The general type of engine required is one that may be powerful without excessive consumption of fuel, compact and easy to overhaul, and the fewer cylinders and small working parts, the better. Small pieces of metal are apt to be affected by the excessive cold air which is to be expected during the winter time. It must be possible to start at low temperatures and must be such that if a landing is made away from the base it will not be subject to freezing up solid immediately and becoming impossible to start, and, above all, it must be of proven reliability in the air under normal flying conditions.

If a water-cooled engine is used it should be of the simplest possible design, with as few cylinders and small parts as possible. It is not known what the effect of such a range of temperatures will have on the small metal parts of the engine, but it is positively known that the fewer parts the better. An engine such as the German Mercedes, or the engine used in the American built thinker, J.L. 6, is recommended for trial.

It would be advisable to take several types of aero engines and have them installed on starting benches at the base and carry out a series of experiments in starting them and running them for short periods throughout the different seasons of the year.

While at the bases aeroplanes must be stored under cover, but small hangars should be used and should be located in sheltered places to offer as little resistance to the high winds which are reported to blow in the winter.

Provision should be made for them to be heated by coal stoves and they should be kept free of cracks to prevent snow or cold winds drifting through. The site must be carefully chosen and they must be very carefully erected. Snow walls shaped with a slanting edge from a very wide base would act as a protection from the wind by deflecting the air upwards, if properly made.

If sufficient loose rocks are available a protecting wall several feet from the wall of the hangar should be built of rocks, and the space between the two walls, if filled with snow, will act as a protection from the force of the wind and from the cold. Any buildings should be surrounded in this manner by a wide dead air space. This space may be filled with loose snow or roofed over, for just the air alone will act as an insulation from the colder air outside.

When it is necessary to leave an aero- plane in the open over night or for any period on the ice, it is necessary to anchor it in such a manner that the wind may not blow it over. Probably the best way to moor an aeroplane to the ice will be by cutting mooring rings in the ice and securing it to these rings by small strong cables. The

method to employ in cutting this ring in the ice is to use an ice chisel or knife and scoop out two parallel troughs in the ice about four inches apart and about six inches or more in depth. Then a small hole or tunnel is out from one trough to the other as deep down in the ice as possible. The mooring line is then passed through this hole and it is surprising the strain which may be put on it without it breaking away from the ice. Four such moorings would probably hold a machine in quite a gale of wind.

Stores

The stores should not all be placed in one building but should be divided into several different lots under separate roofs sufficiently far apart to pre- vent fire spreading from one to the other. The gasoline should be stored at a considerable distance from the other stores or buildings, in cylinders, and moved to the hangar in small quantities as required. The greatest care must be taken to prevent fire, especially in the food and clothing supplies, and every precaution must be taken to prevent destruction of aircraft or buildings by wind.

A large number of two-gallon petrol tins of the type used in England for transporting gasoline and oil should be included in the stores, as these will be necessary to use in carrying fuel in the air to be cached at various places.

Motor Transport

It is believed that motor transport of certain kinds could be used to great advantage, in certain seasons of the year at least.

The two types most suitable are Ford cars for ordinary light transport, and small caterpillar tractors for towing heavy freight on sleds over the ice. The light cars should be equipped with long skis under the body projecting six or eight feet fore and aft to prevent the car capsizing should one or two wheels sink into a crack. A Ford could be used on the ground as well as on the ice. These cars were successfully operated on the ice of Lesser Slave Lake before the War and it is certain that they could be used during several months of the year in place of dogs for the work required on an Air Force base. For moving heavy freight such as engines, gasoline, oil, spares, etc., and especially in hauling coal from the mines, small caterpillar or Ford tractors could be used, and in fact will be a necessity. By making runners for the cars and some method of grip for the rear wheels, it will probably be possible to travel over deep snow, as well as ice, provided it is not too loosely packed. Some type of portable bridge may be required to cross narrow cracks in the ice.

If motor transport can be operated it will be possible to save much time in the unloading of ships in places by allowing the ship to moor to the ice and unloading direct onto it instead of trying to unload at some particular point on the shore. The freight may then be moved after the ship has proceeded to its next port of call, or stores may be landed at a convenient point and transported farther inland when the solid ice has formed later in the season. In this connection it is highly recommended that immediate steps be taken to obtain all possible information regarding the operation of motor transport in the North Russian expedition during the War, and also information from the American Government regarding the operation of motor transport in Alaska at the present time.

Buildings

It will be necessary to take material from the south for all buildings because there is no wood in the Northern Archipelago. Buildings should be carefully designed and the timbers and lumber cut to proper sizes before being shipped from the south. They should be of simple design and if possible made up in sections so that they may be easily and quickly put together by men who are not necessarily expert carpenters. The greatest care must be taken in the proper inspection of all lumber or building material before it is placed on the ship, because poor material may mean life or death in the Arctic region.

Buildings should be low and must be built with double walls in order to provide a dead air space for insulation from the cold. Both inner and outer walls must be lined with some wind proof material, such as thick tar-paper or roofing material. It is important that this dead air space be built over the roof as well as the walls of the building. This does not apply to buildings used for store-rooms only, but for living quarters. Two walls may be sufficient, but if a third wall were built it would give a much greater insulation effect as there would then be two dead air spaces between the cold outer air and the inside of the building. These dead air spaces should be at least eight inches apart. When sufficient snow has fallen to form blocks, a snow wall should be built all around the buildings at a distance of about six or eight feet. This may or may not be filled in with loose snow. Snow should be piled over the roof because that is the part from which nest of the heat is disbursed into the outer air.

It is important that a small room be built outside the entrance to the living quarters to be used as a store-room for all outer garments, which should then be always removed and left there upon entering the building. This will prevent the snow from being melted by the warm air and then being frozen again and making the garments damp and stiff. This will also prevent much of the heat being lost every time the door is opened. There should be two stoves, one which may be used for cooking and the

other for heating alone. If it is possible to obtain coal, and it is believed that in many places coal will be available, cooking stoves designed for coal fuel should be used, but if coal has to be imported by ship the cooking should be done with kerosene oil stoves, and base burner type of coal stoves used for heating purposes.

The hangar for the aeroplane should be as small as possible, built in sheltered places and heated by coal stoves. In cases of excessive snowfall care will have to be taken that the weight of the snow does not break down the roof. Rock or snow walls should be built around the hangar and other buildings to prevent destruction from the winds. This will also tend to make life more comfortable in the buildings as it will be a protection from the cold winds. All buildings should be carefully designed, and for an ordinary base would have to include hangar, two store-rooms and living quarters for officers and men. The photographic workshop, navigation and meteorological offices and probably the wireless room could probably be under one roof, although if much wire- less work is to be carried out it would probably be advisable to have a separate building for wireless operating rooms and workshops, etc.

Much extra material of all descriptions should be included in the shipment in order that if any parts were lost or damaged, or used for any other purposes, there would still be a sufficient extra supply to draw on. All buildings will require artificial lighting in the winter, and this can best be done by using kerosene oil, although gasoline gives a better light, but gasoline is too dangerous to be used when it is considered that loss of living quarters by fire would mean almost certain death, or at least great hardships. Therefore, every pre- caution should be taken to prevent fires, and though kerosene may not give a very bright light it is fairly safe, and during about eight months of the year very little artificial light would be required. An electric lighting plant should be installed at any large base, using coal for fuel if more economical than gasoline. Provision should be made for plenty of paint for all the buildings as this will be a great protection to the material, as well as aiding in the appearance of the station. If only one or two machines are to be used it might be advisable for the first season or two to use tent hangars, one tent to each machine.

TRANSPORTATION

The present method of transportation to the islands of the Northern Archipelago, or that part north of Hudson Strait, is to travel by ship from Halifax or Quebec, generally the latter, starting out about the middle of July and proceeding through the Strait of Belle Isle to the southwest coast of Greenland. The coast of Greenland is then followed to approximately latitude 74° or the south end of Melville Bay, then the ship may either proceed northwesterly to Ellesmere Island, or southwesterly to Baffin Land or Lancaster Sound. The reason for travelling northerly along the western coast

of Greenland is that there is a northerly current flowing all along the west coast of Greenland, while along the east coast of Baffin Land and Labrador there is a southerly current which fills the waters there with thousands of icebergs and large areas of ice-flow, which make it in many places impossible for a ship to navigate for months at a time. There is also more fog along the eastern coast of the Canadian territory.

At the usual point of crossing Baffin say, roughly latitude 74°, there is generally open water between the drift ice, which is commonly known as the middle pack, and the more northerly ice which has not yet started to travel south with the current. In many places it is always necessary for a ship to work its way through fields of ice. These ice fields may extend for thirty or forty miles and may consist of large pans of ice sometimes several square miles in area, but more often a few hundred square yards, and anywhere from six to twenty feet thick. These pieces of ice are continually grinding together and separating by the force of the winds and waves, and a ship must be built to withstand heavy pressure on all sides if it is to be used in attempting to pass through narrow leads of open water to the ice-pack. Even from the tallest mast of a ship it is impossible to see more than a few miles ahead, and the only way of finding out whether open water extends in the proper direction is to keep on following the open water as far as possible, and much time is thus lost in following up false leads. A ship may travel for twenty or thirty miles in the right direction only to find solid ice ahead and then have to return and go through the same performance with possibly the same results time after time.

Were it possible to ascend several thousand feet it is probable that the proper leads of open water could be determined in a very few minutes and the course of the ship laid out accordingly, so that very little time would be lost. It has been noted that although very rough sea may be found in the open water, after entering the ice-pack for a few miles there is practically no noticeable wave movement, although the action of the sea tends to keep the cakes of ice moving in their relation to each other, and sometimes in a few hours cracks and leads of open water appear where previously it looked like solid ice. It is by taking advantage of these movements that ships at the present time work their way from point to point through the ice-pack, but it is believed with aerial observation there would be little necessity of actually entering the ice-pack, and that in this way even large ships of ordinary strength would be able to reach many of the harbours of North Baffin Land, North Devon and Ellesmere Islands. It is not likely that these ships would be able to dock close to the shore such as is the custom at the present time, but this is a mere detail considering the difficulty of getting cargoes into the region at all at the present time.

These waters have been navigated for many generations by whalers and Arctic explorers, first by heavily built sailing ships and later combined sail and steam, and it is only within the last two or three years that any ships have been used employing

steam only as their motive power. The whalers have practically ceased operations, partly because whales are becoming very scarce but chiefly because the price of whalebone and whale oil has decreased to such an extent that whaling operations can no longer be profitable carried out. The whaling ships were generally from Scotland and the New England States. The ships at the present time visiting the islands sail from Quebec or Halifax and make one trip per year, while the whalers and past exploring expeditions generally spent one or two winters frozen in in some harbour.

During the summer of 1922 three ships visited Pond's Inlet - the "*Arctic*," the ship of the Canadian Government expedition, the Hudson's Bay Company's Steamer "*Bayeskimo*" and a small ship belonging to the Arctic Gold Exploration Company, which outfitted at Halifax and after leaving Pond's Inlet sailed for Scotland. It was a small two-masted sloop with an auxiliary internal combustion engine. The largest and most modern ship was the Hudson's Bay Company's Steamer "*Bayeskimo*." This was an up-to-date steel ship with special reinforcements placed in certain places after the ship had been built as it was not originally designed for Arctic waters. It had no real difficulty in passing through the navigable ice fields and had a great advantage over the "*Arctic*" by having double the latter's speed. It is not probable that it will be possible to use the Hudson's Bay Company's boats for transportation of Government material to the North, so that for the present time the only boat that can be considered for transporting aircraft supplies will be the "*Arctic*," but it is certain that if any extensive aircraft operations are to be carried out in this country it will be important to have a proper ship, because the supplies for an air station alone, if of any size, would be all the "*Arctic*" could handle at the present time, and even at that she will require better engines. If a new ship is obtained by the Canadian Government it would be advisable to take into consideration the necessity of providing proper deck arrangements for a small seaplane to be carried and used for scouting purposes. It is also recommended that steam alone be used and that sails are not bothered with at all. If a ship is properly equipped with engines it is only a waste of time and energy bothering with sails. It is most important to have all supplies and all items of the cargo properly packed with as little bulk as possible.

It is certain that the methods of Arctic transportation will have to be completely revolutionized before any great headway can be made in Arctic navigation. Small slow ships will have to be discarded and speedy, large, up-to-date steel steamers will have to take their place in travelling from civilization to at least the central parts in the Arctic islands. It will probably be advisable to have one or two chief centres where these larger ships could discharge their cargo, and then these supplies could be distributed from place to place by a ship such as the "*Arctic*," which would remain in the North all the time. It might be possible in this way to make at least two trips per year, or by utilizing the harbour of Godhavn on Disko Island it might be possible to ship material there early in the spring and then move it from that point to the Canadian

territory during the open season, and in this way perhaps three or four shiploads could be landed in Canadian territory in one summer by one ship.

The "*Arctic*" is too small and too slow a ship to use between Quebec and Pond's Inlet if it is to supply air stations in addition to its regular work, but it would be a good type of ship to use in the various local waters of the Archipelago as it could be used as a supply ship for several months of the year, and especially if it can be found possible to transport supplies from the ship to the shore over the ice by motor transport, much time may be saved and many stations may be supplied each season.

It will probably be found necessary to either blast or saw a channel or dock in the edge of the solid ice in order that the ship may unload the supplies direct from the deck to where they may be loaded onto the motor transport.

It is possible that Dundas Harbour on North Devon Island would be a suitable harbour for a centre of distribution as it is on Lancaster Sound and is one of the first harbours in the North to become clear of ice, and although the harbour has not been fully charted, some soundings were taken in 1922 which would indicate that the harbour would be suitable for fairly large ships, and the inner basin is deep and well sheltered. If it were possible for the "*Arctic*" to winter here it would be possible to commence distributing supplies to the various posts possibly long before a ship could come in from the south. It is quite likely that coal could be mined locally on some of the islands during the winter and used on the ship during the summer, so that no fuel for the supply ship would have to be brought up from the south. The ship's crew could get out the coal during the winter. The "*Arctic*" is built for wintering in the northern regions and would make an ideal supply ship.

The ship necessary to fly between Quebec and the Archipelago should be much larger and must have more power and speed, but by using aircrafts for location of open water it should not have to be especially heavily reinforced. It might be possible to use a captive balloon for observation purposes, as a small balloon could be sent up to about two thousand feet and towed along by the ship, but it might be found more trouble than it was worth, although it would be far better than nothing at all. The small seaplane scout, it is believed, would give much better results and would give less trouble to operate.

It might be noted here that for Arctic navigation on the open sea or straits the ship should be supplied with a bubble-sextant to be used in times of low fog when the sun may be visible but the horizon too indistinct to be used. During the summer of 1922 there were many occasions when for several days at a time it was impossible to read altitudes of the sun with an ordinary sextant, although the sun itself was visible. Experiments were carried out with an ordinary hand level clinometer and very good

results were obtained in both latitude and longitude observations, but much more accurate work could be done with a proper bubble-sextant such as is used on airships.

Another thing which is imperative is that any up-do-date ship must carry is the gyroscope compass, which gives true bearings. The ordinary magnetic compass is very inaccurate because the needle not only acts very sluggishly owing to the proximity of the magnetic Pole, but the amount of magnetic variation changes every few miles and is continually changing year by year, so that no accurate charts are available showing the amount of variation to be used in the dead-reckoning calculations for the ship's position. The existing charts are very inaccurate and very incomplete, so that taking it all round navigation in the Arctic waters is very different from navigating in the open seas where most of the marine traffic is carried on at the present time. There are many places in the Arctic Archipelago where the compass needle points, not north, but west, and even southwest and south. This is because the North Magnetic Pole is not coincident with the North Geographical Pole. The former is approximately located about latitude 70° 20′ north, longitude 96° west.

It would be advisable at the present time to prepare plans of organization of Government ship transport to the Northern Archipelago in the event of the necessity of rapid development of the mineral resources of the country in the future, and some experiments with aircraft co-operation should be made as soon as possible.

PERSONNEL

If aircraft is operated in the North by the Government it is probable that all the personnel will be supplied by the Canadian Air Force, which will probably develop its own policy regarding the choosing of personnel and of regulations connected therewith, but there are several points which might probably be just as well considered in a general way. All men detailed for Arctic work should be healthy and strong, neither too young nor too old. They should be volunteers and men whose previous experience has fitted them in some manner for life under such conditions. No man should be sent North unless he has previously demonstrated to the satisfaction of the officer in charge of the expedition that he is qualified physically, mentally and temperamentally for the work he will be required to do. The success or failure depends on the type of individual, and the greatest care must be taken in choosing men of the proper character, as well as those having the proper technical qualifications.

The officer in charge must have had at least one year's previous experience in somewhat similar conditions before being placed in charge of a detachment. Pilots and mechanics should, in addition to their ordinary qualifications, have as many other

technical qualifications as possible in order that the number of persons actually required to carry out the various phases of the work will be as low as possible. Everyone will be called upon to do a certain amount of manual labour. This is an absolute necessity in order to keep physically fit.

There will be considerable coal mining to do in the wintertime as it is not likely that the Eskimos [Inuit] will be of very great assistance as workmen, although their services should be utilized as much as possible, but two good white men will do more in a week than half a dozen of the best Eskimos [Inuit]. It is recommended that the Air Force personnel be retained in the North for at least two years and that fifty per cent of new personnel be taken in each year. This is in order that a man may have one year's training with men who have had some experience in the North. It is also recommended that all mechanics be given double the ordinary rates for their rank, or it might be advisable to have no distinction in pay of the ranks but make it a flat rate of six dollars per day. The reason that these men should receive extra pay is that they will be called upon to perform, not only the duties in connection with their regular trade classification, but all technical and manual work which may be required around a station. It will be necessary for them to work at all hours of the day and night during certain seasons of the year. They will have to contend with living conditions and put up with far greater hardships than men at the ordinary stations farther south, as they will be isolated from their friends and relatives for two years and will have very little recreation or fellowship with other white men. In addition to this they will be out of touch with their trades in the Air Force for this length of time and consequently when they return they will be more or less out of date as far as their trades are concerned. All these points should be taken into consideration and should be pointed out to the men before they are asked to volunteer for this work.

It is believed that, provided there are proper inducements, the right type of men will volunteer, but it is certain that there will be many of the wrong type of men who will volunteer, but it would be worse than useless to send up unknown or untried men, as they cannot be replaced for at least another year and would do more harm than anything else could do. It would be better to have two real good men at six dollars a day than to have six average poor mechanics at two or three dollars per day. Each man of the detachment must be more or less a jack-of-all-trades but, above all, he must be a willing worker and take an interest in his work and in all the work of the detachment.

It is considered that there should be a definite number of machines at each base, for instance four machines should be an average establishment for an ordinary base. This would permit two machines being kept on active service all the time. It must be borne in mind that two machines must always fly together and two extra machines should always be on the base; thus there would be two machines on active service and two in

reserve. There should be two active pilots and one reserve pilot to each base of four machines, and it is imperative that there must be this reserve pilot. There should be two mechanics to each machine, but these men will also act in various capacities, as will the pilots. There must be at least two photographers and two wireless operators at each station. There should be a doctor. It is probable that the doctor could also carry out medical duties for the whole station, that is, supply medical treatment if required to the Eskimos [Inuit] in the neighbourhood and the trading or Mounted Police Posts.

It is imperative that all men take daily exercise to keep in good physical condition, and one of the inducements to take exercise in the open air is to permit a certain amount of trapping to be carried on during the winter and the men should be allowed to retain any furs which they may catch. This will not take up a great deal of time but will ensure them taking a certain amount of exercise in the open air every day, and give them something to be interested in, in addition to their work.

The pilots, in addition to being expert pilots, must have a thorough knowledge of Arctic navigation, because without a knowledge of navigation it is almost impossible to travel anywhere in this region unless guided by Eskimos [Inuit]. They must be thoroughly acquainted with their engine and with their machine, so that they may perform running repairs if required. They must be willing to perform any duties whatsoever which may become necessary. They should have a practical knowledge of photography and wireless and must be of the type of man who has a high sense of responsibility, and must take a great interest in the development of aviation inside the Arctic Circle.

The general qualifications of the other ranks have already been dealt with. Each member of a detachment must realize that he has the opportunity of materially assisting in the advancement of not only his own particular trade, but the whole of the science of aviation in practically a new part of the world.

NAVIGATION, WIRELESS AND PHOTOGRAPHY

It would be foolhardy to attempt to fly or travel in any manner for any great distance in this northern country without knowledge of navigation and the means of applying that knowledge. Each aero-plane should carry a sextant or a small transit, and an accurate watch, together with the necessary tables for working astronomical observations. In a land where there are no maps it is impossible to follow landmarks alone over great distances, and all travel has to be carried out just the same as is done on a ship at sea. An accurate record is kept of distances travelled and the directions, so

that it is possible to calculate points on the journey in their relation to the starting point.

Navigation in the Arctic Archipelago becomes more difficult and complicated in some ways owing to the peculiar geographical position in relation to the true North Pole and the North Magnetic Pole. Positions on the earth's surface are generally located by latitude and longitude. The latitude is the distance in angular measurement that the point is north or south of the Equator, the Equator being an imaginary line drawn round the earth's surface midway between the North and the South Pole, thus if a point is said to have latitude 80° north, only the distance from the Equator or Pole is known and the point may lie anywhere on the small circle of the earth 80° north of the Equator and parallel to it. It is therefore necessary to have another system of imaginary lines drawn at right angles to the Equator. These lines pass through the North and the South Pole, cutting the Equator at right angles, and are called meridians of longitude. If a point is said to be in longitude 75° west, it is meant that it lies anywhere in the meridian which is 75° west of the initial meridian, or the meridian which is taken as the starting point. This has been accepted internationally as the meridian passing through the Royal Observatory at Greenwich, England. A point 75° west longitude might be anywhere between the North and the South Pole on the 75th meridian, but if its latitude is also given there is only one point where the meridian and parallel of latitude bearing those numbers given would intersect, and the point is therefore accurately located. If two points are thus located, even if the intervening country is unknown, the distance and direction between them can be determined by calculation.

To determine the latitude and longitude of these points two methods are employed, one, celled the dead-reckoning method, is to determine the points by calculation of the courses and distances connecting them, but the more accurate method is by taking observations of celestial bodies in relation to their distance from the horizon or from each other. Latitude is found by measuring the greatest distance that a celestial object attains frost the horizon, and is generally found from the sun at noon, although it may be found equally well from the maximum altitude of a star.

Longitude is found by determining the local time from the sun or from a star by measuring the altitude of the celestial object chosen several hours before or after it is at its maximum altitude. The time thus obtained is compared with the accurate time of the meridian at Greenwich and the difference between the two gives the difference of longitude in time between the point of observation and Greenwich.

By using a sextant and taking readings on the altitude of the sun, positions on the earth's surface are located to within a mile of their absolute latitude and longitude independent of what the magnetic variation may be, or independent of any courses

connecting the points. The observation for longitude will also give, with a little extra calculation, the true geographical bearing of the celestial object, and if a magnetic bearing is taken at the same time with the magnetic compass, the difference between the true bearing and the magnetic bearing, which is commonly known as magnetic variation, may be found and may be applied to the correction of any courses travelled or required to be travelled.

On shops at sea the usual method employed in measuring altitudes of the sun is to measure the angle between it and the sea horizon, but when the horizon is obscured by ice or by land it becomes necessary to employ what is known as the artificial horizon. The artificial horizon is simply a mirror placed perfectly horizontally and the angle is measured between the true image and the inverted image shown on the horizontal mirror. In order to get a truly level surface it is found best to use a small trough of mercury, shielded from the wind by a specially designed glass cover, Several other reflecting surfaces are used besides mercury but generally this is most convenient and reliable. It will be necessary for aircraft to always carry an artificial horizon, as well as the other instruments already referred to.

It has already been stated that the compass is a very unreliable instrument in the Northern Archipelago because many of the islands lie to the north of the North Magnetic Pole, and it is probable that in many places the compass needle will point straight south. During the summer of 1922 the greatest variation noticed was about 110°, so that the compass there was pointing approximately southwest. By using a gyroscope compass much of the difficulty of direction finding will be overcome.

It will be very important for the navigator on the aeroplane to keep an accurate record of all courses and distances flown. It will also be necessary in connection with the surveys of the outlines of the islands and probably of the interior, to land fairly frequently and take astronomical observations for the accurate determination of positions of prominent objects on the earth's surface. Many observations will have to be taken to determine the magnetic variation throughout the whole territory in order that shops not equipped with gyroscope compasses can navigate with safety. All existing charts will have to be revised as far as magnetic variation is concerned.

It is recommended that one method which might be employed on the preliminary survey of sea-coast and bare ground in the interior would be to determine the geographical position of prominent objects twenty to thirty miles apart by astronomical observations, and have the intervening country located by aerial photographs, and if wide angle oblique aerial photographs are taken at right angles to the line of flight a great deal of territory could thus be explored.

In connection with air navigation it will be necessary to have a fairly complete meteorological station at each base. One of the most important things is a pilot balloon outfit. This consists in the instruments required to fill a small rubber balloon with hydrogen at a certain pressure, which is then set free in the air and ascends at a uniform rate of five hundred and twenty-five feet per minute, and is followed by a special type of transit theodolite and readings of altitude and direction are taken every sixty seconds, which would, when worked out on a special instrument, give the velocity and direction of the wind at various altitudes.

It may not be generally known that air currents at different altitudes have different velocities and direction, and while the wind on the surface may be south, the wind at an altitude of a mile may be due north and perhaps double the velocity, while at a height of two miles the wind may be blowing only one half the velocity and from the west. There is a great relation between the barometric pressure, the temperature and the air currents at various heights, and although the science of forecasting upper air currents is still in its infancy, sufficient is known to materially assist in air navigation.

It is often possible to gain much time by taking advantage of the knowledge of the winds at various heights, as a round trip journey between two points may sometimes be made with a favourable wind in both directions by flying at two different heights. Each base will require to be equipped with recording instruments such as [an] anemometer, which is an instrument for recording the velocity and direction of the surface wind, a barograph for automatically recording the height of the barometer, and a thermograph for recording the temperature. These instruments can be operated by the Air Force personnel without necessity of a meteorological officer being specially employed on the station. When a proper network of wireless stations is connected up with the outside world, regular weather reports and ice reports will be sent south or to the ships for purposes of aiding in the forecasting of weather conditions. On each aircraft base there should be a wireless station installed which would be able to keep up wireless telegraphic communication between other bases as well as with the aircraft. When the complete network of wireless stations is established it will be possible to relay messages from Ottawa through to the most outlying stations, but the most important use will probably be intercommunication between the various Government stations or the settlements throughout the Northern Archipelago. These wireless stations would be operated by the Royal Canadian Corps of Signals as this Corps handles all wireless communication in co-operation with the Canadian Air Force.

It is desirable that wireless telephone sets be installed on each aeroplane, which will permit intercommunication between planes while in the air, and will also permit communication with the bases up to certain limits.

The reception of wireless time signals is necessary for navigation and surveying, and small receiving sets suitable for this type of reception can be carried anywhere a person can travel. Even if standard wireless stations are not established in the North, it is highly recommended that all Government stations there be supplied immediately with small type wireless receiving sets suitable for the reception of time signals and daily news bulletins, and that some of the personnel of each such station be instructed in the Morse code as used by wireless stations. Such a receiving set could be made for less than fifty dollars and could be operated for one year for less than thirty dollars, as the only expense would be dry cells. The aerial for such a wireless set would give very little trouble to erect as it need not be very high.

A wireless receiving set was carried during the summer of 1922 and daily time signals and world news bulletins were received throughout all parts of the voyage. The receiving apparatus consisted of a simple tuning circuit using one vacuum tube detector with no additional amplification, and the aerial used was fan type and made of insulated bell wire, the span at the top being twenty-five feet and the height about twenty-five feet. With this, loud signals were received from stations in Europe and in the United States, and when the ship's aerial was used still louder signals were received. The climatic conditions appeared to be very favourable for the reception of wireless signals and the mountainous country seemed to have very little effect on these incoming signals. It is probably that during the wintertime the atmospheric conditions would be even better and it is believed that throughout this whole territory wireless telephony could be carried out over much greater ranges than farther south.

The chief press despatches which would be received in the Northern Archipelago each day would be as follows: From 6.30 to 7 a.m. and p.m. world's news in English from Berlin; three times daily for approximately one-half hour periods news in English from Leafield, England; and from 10 to 10.30 p.m. the American Navy press from the Naval Station at Annapolis, U.S.A. Time signals for scientific purposes may be received from the following places:-

FROM	AT
Berlin, Germany	7 a.m. and 7 p.m.
Honolulu	7 p.m.
Annapolis, U.S.A.	Noon and 10 p.m.
Balboa, Panama	1 p.m. and 5 a.m.
San Diego, Cal.	3 p.m.
Bordeaux, France	3 p.m.
Lyons, France	3 a.m.

These stations send time signals for five minutes previous to the hours designated, and with an accuracy of a few one hundredths of a second.

It is believed that it would be possible for arrangements to be made for any Government employees who are intended to be sent North to receive instruction in wireless reception from the Royal Canadian Corps of Signals. While there is practically no limit to the distance from which wireless signals can be received from high-powered stations, the transmitting sets which would likely be used for aircraft co-operation would probably not have a greater range than three or four hundred miles, although of course much greater distances can be covered by more extensive and larger transmitting stations.[2]

One of the chief uses for aircraft will be in connection with aerial photography, for by means of photography wide areas of the country can be explored at leisure and all the records are kept for future reference. When a country is explored without the aid of photography, ninety per cent of it is overlooked because the eye cannot permanently record what it sees, and especially in a cold country it is not convenient always for the explorer to write down everything that he sees, and other new views tend to obliterate much from his memory. But with a camera, once the photograph is taken it may be enlarged and the details searched out at leisure. Large areas will be covered and will be of the greatest importance in connection with the making of maps and charts, especially if used in conjunction with astronomical observations taken at prominent points along the surface of the island.

There are two kinds of photographs used in aircraft. One is known as the vertical photograph and the other as the oblique. The vertical photograph is taken by a camera which is hung in the machine so that the plate or film is horizontal or parallel to the plane of the horizon. These photographs are generally taken in such a manner that a series of the prints may be connected and form a continuous photograph of fairly long stripe of ground. This is theoretically a map of the country flown over, but owing to inaccuracies caused by the axis of the camera not being truly vertical and by the aircraft not always being at a constant height, certain corrections have to be made in order to reduce this to one uniform scale. Only a narrow strip of the territory immediately under the aircraft is photographed, although by using lenses with a wider field of vision this may be increased to a considerable extent, and of course the higher the machine is flown the greater will be the area photographed.

The other style of aerial photograph is known as the oblique. This is taken with a camera which is free to move in any direction and the photograph is taken with the axis of the camera pointing about 20° below the horizon. A large area is thus covered but it is not possible to reduce this to scale without considerable calculation, but it is invaluable for getting a general idea of the topography of the country at some distance

[2] Editor's note: The original report included a "map of a suggested network of wireless stations to connect up with Ottawa by relays."

from the line of flight of the aircraft. These photographs may be taken either with a camera fixed to the machine or with a camera free to move round and operated by some person on the aircraft.

By taking photographs of the same area with a few seconds interval it is possible to get a stereoscopic effect and when viewed through a stereoscope contours may easily be seen. Aerial photographs should be taken as frequently as possible over the same areas and every time a flight is made photographs should be taken to show the changes in the appearance of the surface flown over, especially to show the areas of bare ground and the ice movements. The development of many of these photographs should be done at the base, but large films which are intended to be used for surveying purposes should be sent to Ottawa for development. Each base will require a small photographic laboratory for local work. Experiments should also be carried out using a moving picture camera in the air for recording ice flows and open water.

During the summer of 1922 several dozen photographs were taken with a small aerial camera and the results obtained would indicate that the visibility is favourable for aerial photography but much more experimental work is advisable as it is believed that one difficulty to contend with will be the glare from the snowfields, or the ice, making it difficult to record smaller details of the white surfaces. This will probably be overcome by experimenting with various light filters or shades, but it will be necessary to use a filter which, while being strong enough to absorb the glare from the snow, will not be strong enough to obscure the details of the surface of the bare ground. It is important that all aerial cameras employed on this work be fitted with a diaphragm which will make it possible to obtain the exact focal centre of the photograph.

FUEL, FOOD AND CLOTHING

One of the most important questions in any station in the North will be the supply of fuel, but it is believed that by a proper choice of location and by a proper investigation of the fuel supplies of the country it will be possible to find plenty of local coal. It is well known that there is a large supply of coal available at Salmon River, Pond's Inlet, although it is believed that this coal area, or a certain part of it, has been leased or granted to the Arctic Gold Exploration Company. There are many other places where coal seams have been noted and it is probable that many more coal fields can be found, so that if a local coal supply can be found available one of the greatest difficulties of work in the North will be overcome. Coal could be mined during the winter and freighted out sometime during the year, probably by utilizing motor transport.

There is a type of heather or moss which grows wherever there is bare ground, and has very good burning qualities. This is used to a great extent by the Eskimos [Inuit] as they burn it by itself and also use it as a wick for their seal-oil lamps. It is believed that this can be pressed into bricks while damp and would make a very good hot fire when dried, although it would probably burn up very quickly. If coal is sent north from the south it should be carried in sacks, Gasoline and oil for aircraft should be transported north in casks or cylinders, but it should be transported in the air in two-gallon tins similar to the tins used for that purpose in England.

For any extensive aircraft operation a large amount of gasoline and lubrication oil will be required and it would be a great advantage to have some source of local supply.

Indications of such a supply have been found on Bathurst Island, where analysis shows oil shales yielding one hundred and forty gallons of oil to one ton of shale. This might sometime be developed and in time would supply ail the fuel required for aircraft and motor transport in the worth, even if no better oil producing areas were discovered. It is recommended that oil stoves be used for cooking purposes unless there is a plentiful local supply of coal. Gasoline lamps are not recommended owing to the danger of fire through careless handling, not so much of the lamp as of the gasoline. Where sufficient fuel is available it would be much more convenient in every way to have a local electric lighting plant installed, which would be suitable for the illumination of all of the buildings on the station, and by using a small steam plant and utilizing local coal it might be possible to keep this running all the time required, for, while it will be required almost twenty-four hours a day for perhaps four or five months of the year, the remainder of the year it will not be required at all.

The food supplies should include much vegetable matter and substances containing much fat and sugar. Very little salt pork or salt beef should be used. Concentrated foods will be required to be carried on all journeys in the machines. Throughout the greater part of the year it will be necessary to melt snow or ice for water, but during the summer season there are many streams of fresh water as well as many pools of fresh water on the surface of the ice.

It should be possible to obtain supplies of fresh meat of various kinds, such as caribou, bear and seal. It will also be possible to get large supplies of salmon if attention is paid to procure them during the proper season, and quantities of them could either be salted down, dried or frozen. Frozen fish could be stored in local icehouses or, if transported and stored near the perpetual ice, there would be no difficulty in keeping them in good condition indefinitely. It is probable that other kinds of fish could be obtained at various parts of the islands.

It will be found necessary to carry extra stores of food, clothing and various small articles, such as tools, ornaments, etc., for the purpose of trade with the Eskimos. Any purchases, or payment for any work performed by the Eskimos, would be paid with this material, as at the present time ordinary currency is of no value for trading purposes.

Clothing

The clothing worn by all aircraft personnel should be as much as possible similar in every way to that worn by the natives of the islands, with such improvements as may be found advisable. The best material for all clothing is either caribou skin or seal skin tanned with the fur on, and while woolen clothes are satisfactory to a certain extent, it is generally agreed that skin clothing, for at least the outer garments, is much to be preferred.

The usual clothing worn in the North, by the natives [Inuit] at least, consists of two suits of fur garments, the inner one worn with the fur inside and the outer one worn with the fur outside. The foot covering universally worn is made of seal skin sewn in such a manner that the boots, or kamiks as they are called, are absolutely water-proof. They reach almost to the knees and are made large enough to permit several pairs of socks being worn. These socks generally are made of seal skin with the fur inside. If woolen socks are worn care must be taken that the socks are not all the same size. The outer ones must be a larger size than the inner, otherwise there will be a tendency to cramp the foot and stop circulation, and cold feet will be the result. The seal-skin boots are absolutely necessary and are worn by all persons at all times. The sewing on them is very carefully done and all repairs to the boots are made by the Eskimo [Inuit] women. It will therefore be necessary to employ at least one Eskimo woman [Inuk] at each base for the purpose of looking after the repairs of boots and other skin garments. The soles of these kamiks are made from the large bearded seal locally known as the oogjook, and will stand a great deal of rough wear on the ice, but of course will not stand very much travelling over bare ground. Knee-length rubber boots should be supplied and it would be advisable to take a sufficient number of ordinary heavy boots for wear when travelling in the interior or working around the coal mines. They should be large enough to permit a sufficient number of heavy socks being worn. During the wintertime it will be necessary to wear kamiks all the time.

The outer jacket is generally made of caribou skin, although it is also made of seal skin. This is a large pullover coat with hood which may be pulled up over the head, the edges of which should protrude several inches in front of the face. This projecting part of the hood acts as a protection from the extreme cold air during the winter as it acts as a dead air space and the cold air directly in front is partly warmed by the

breath. The leather or skin garments have the valuable property of keeping the wind from penetrating and are therefore much warmer than any garments of wool. Garments worn in the open air during the wintertime should not be brought into a warm room but should be taken off outside and have the snow shaken off, and left in the cold air but away from the reach of the dogs. It will be found that when garments are brought into a warm room the fine particles of snow in the fur soon melt and make the garment damp and they are then frozen stiff when taken into the cold air again. The mitts worn should be roomy and of two pieces. The inner mitts should be of wool and separate from the outer covering of smoked, tanned leather. Each person should be supplied with at least two sets of all garments, especially mittens and socks, and care should be taken that garments worn during the day are taken off and dried in the evening. Clean dry garments are essential for warmth.

Recreation

All persons on an aircraft station in the Arctic would necessarily be away from all ordinary amusements or recreations and it would be very necessary to provide means whereby it would be possible for them to have various other interests besides their everyday work. This will be a great assistance in keeping up their spirits and they will give better service and take greater interest in their work if they have some other things to think about. Guns and ammunition should be provided. Books and games should be provided, as well as gramophones or other musical instruments. A small wireless receiving set to obtain news of the world would be of great interest if a regular wireless station were not included in the general equipment. It is recommended that each base be supplied with a complete library of books of former Arctic expeditions, as these are of the greatest help in showing how other people overcame difficulties such as they themselves will probably be meeting from time to time. This would also be of historical and geographical interest. It is also recommended that a complete *Encyclopedia Britannica* be included in the library of each base. Text books on various subjects connected with such a base should be included for reference purposes. Books on the Eskimo and dictionaries or grammar of the language, if available, should also be supplied.

ESKIMOS

It will be necessary for the personnel of an air station in the North to learn the language of the natives of the country - the Eskimos [Inuit]. The country is not very thickly inhabited but the various tribes of Eskimos [Inuit] scattered throughout the country speak practically the same language. It is true that there are various local dialects, but these are only slight changes made in the general language which is spoken from Greenland to Alaska. There are quite a few Eskimos [Inuit] who speak a

little English, but it is generally very poor English, just as the so-called "Eskimo" that a few white men speak is really very poor Eskimo [Inuktitut]. The Eskimo language [Inuktitut] itself is really a wonderful language, with innumerable forms and rules of grammar, etc., but it is not always used properly by many of the more ignorant natives.

The language has been standardized in Greenland and has been reduced to writing, using the ordinary Roman letters with two or three additional letters to designate the peculiar sounds not covered in the English alphabet. On the Canadian aide, however, the system of writing is known as the "syllabic," and this system, whereby syllables are designated by certain characters, with the vowel changes shown by the relative position of the character, was originally invented by the Rev. Mr. Evans, Missionary to the Cree Indians in Manitoba, and was later expanded and adapted to the Eskimo tongue by other Missionaries. Several religious books have been translated and written in this syllabic system and have been distributed throughout practically all of the tribes. This system of writing is very quickly learned as it is really very simple, and is understood by practically all of the Eskimos [Inuit], more especially the woman. Nearly all Eskimos [Inuit] are able to write in this manner. The greatest help in standardizing a language is by having it reduced to writing, and as the written language is then used throughout a large territory gradually the local dialects will change to conform with the general character of the written language. It would probably be a great advantage in many ways to make use of the books and literature printed in the various parts of Greenland. It may not be generally known that the natives of Greenland have at least two monthly newspapers printed in Greenland in the Eskimo language. If the Canadian Eskimos [Inuit] could be educated to make use of this literature it would be of great assistance in their general education.

It will be found advisable to employ Eskimos [Inuit] for work around the air station in various ways, but especially in connection with hunting for food and clothing. When employing an Eskimo [Inuk] it is always necessary to include his wife and family, because one Eskimo man [Inuk] alone is of very little use. An Eskimo [Inuk] and his wife always work together, and to engage an Eskimo [Inuk] without his wife would mean that he would have no one to look after his clothes, and consequently it would be impossible to get very much work out of him. The Eskimos [Inuit] do not require very much pay, but what they want most of all is a little food and clothing, but the greatest care must be taken for square dealing between Air Force personnel and all Eskimos [Inuit].

It will be found advisable to carry an Eskimo [Inuk] in at least one of the two aeroplanes on every long trip. This Eskimo [Inuk] will assist as a guide, but his chief duties will be to look after the welfare of the party when on the ground or ice, as an Eskimo [Inuk] will find game where a white man would starve to death, and he can

find his way over the country where a white man would probably be lost or would become frozen to death. If no Eskimos [Inuit] are living at the place where it is decided to make an aircraft base, it is highly recommended that several families be induced to settle there.

There are no Eskimo [Inuit] settlements or trading posts north of Baffin Land in Canadian territory, but it is believed that many other places could be profitably established if Eskimos [Inuit] were transported and colonies established where game is plentiful. Should this be done it is highly recommended that any new colonies of Eskimos [Inuit] be legally placed "out-of-bounds" to all persons excepting those having direct authority from the Canadian Government, and that trading posts (operated similar to dry canteens in the Army) and the education of the Eskimos [Inuit] be under the complete control and supervision of the Government, similar to the Danish colony of Greenland.

The greatest care would have to be taken in choosing the proper personnel to act as "practical life Missionaries" rather than religious Missionaries among these people, and it will be found that the Eskimos [Inuit] would in a few years, if free from the contaminating influences of the ordinary run of traders and sailors, become an asset and a source of revenue to Canada.

This has been amply demonstrated in Greenland where, while religious education has been by no means neglected, it has been realized that it is of greater importance to first of all apply common sense, matter-of-fact practical instructions on the main principles of ordinary everyday life and to teach the natives of the country by theory and practice how to be more healthy, comfortable and prosperous during their earthly life, and that the only way to do this is to permit only persons who have no self interest in the country to associate with the natives, and for these persons to live what they teach.

No matter how hard missionaries throughout the world — and especially Canada — have labored and tried to help the natives, their work has always been undermined and ninety per cent of the results strived for have been made impossible by the contamination and living example of the irreligious white men who followed the Missionaries - white men, who needed Missionaries far more than did the natives in the first place.

It would be a great benefit to all concerned if the whole of the Northern Archipelago were made a Government Reserve for the preservation and development of Eskimos [Inuit], reindeer and musk-ox, but especially for the Eskimos [Inuit]. No trading companies should be permitted to operate within the Reserve under any circumstances, and the sooner the traders are excluded the better, for it is believed that

the chief reason they are establishing many posts each year in these islands is in order that they can claim greater compensation when the Government eventually takes over their trading rights in the country.

If the Canadian Government established such a Reserve the organization should be such that the persons who act as instructors to the natives in their everyday life be qualified as scientists or practical men in various lines, in order that much of the work of exploration and development of the country could be done by them, aided by the Eskimos [Inuit]. In addition to the practical instruction to the Eskimos [Inuit], explorations, etc., could be done in the summer season, and the trading, teaching, etc., could be carried on by practically the same men during the winter months.

If Canadians could see the difference between the natives of the Canadian Islands and those of Greenland, where such a Government Reserve is in operation, there would be no hesitation in deciding what should be done.

If properly organized and managed, such a Reserve would in a few years not only become self- supporting, but would be a great financial asset to Canada, and one of the chief factors in the development of the Reserve would be the use of aircraft for communication between stations, aids to travel, navigation and exploration, and the many uses described elsewhere in this Report.

CRAIG HARBOUR

It was originally intended to establish a Mounted Police Post at Fram Fiord on the southeastern part of Ellesmere Island, but when the neighbourhood of the entrance of the Fiord was reached it was found that for several miles in all directions from the entrance there were extensive fields of unbroken ice, and after waiting several days in hopes that this ice would be broken up sufficient to permit the passage of the ship, it was decided to make no further delays in attempting to enter the Fiord, but to find some other place which would serve as a temporary location for the Police Post.

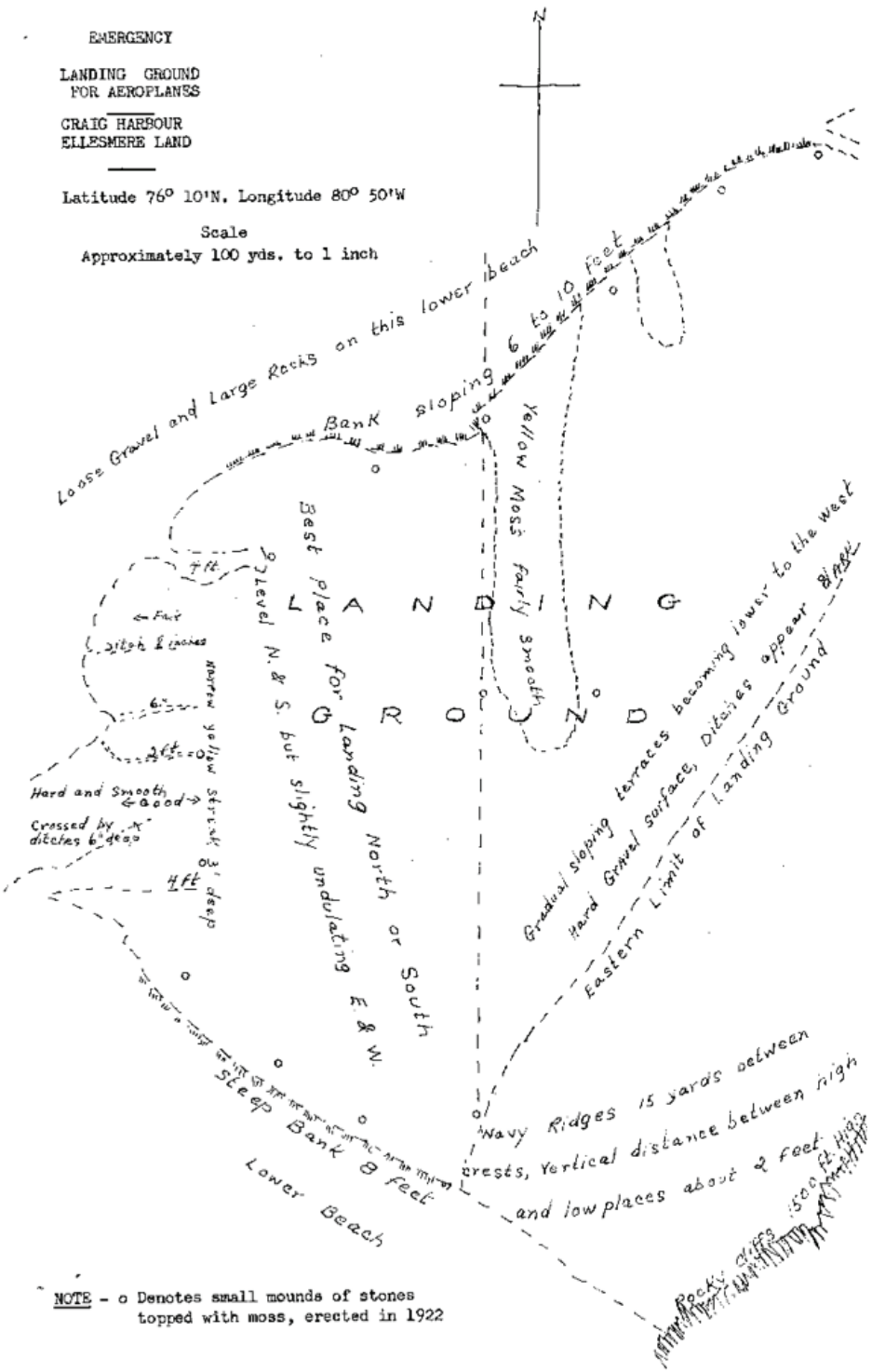
For various reasons the location chosen was a small shallow harbour northeast of Smith Island, and the supplies for the Mounted Police were landed and buildings erected at approximately latitude 76° 12′ north, and 81° west longitude. The harbour or bay ran about a mile and a half to two miles inland with an average width of about two miles. At the end of the bay there is a valley left, by retreating glaciers, composed of gravel and rocks with patches here and there of Arctic vegetation, such as moss, small shrubs and various kinds of small grass and flowers. There are fairly steep cliffs on both sides of the harbour and valley. The bay appears to be an inlet running into a table-land which has a fairly level top at an altitude of about two thousand feet. There

is perpetual snow on the top of this table- land, although it is not very deep in places and many rocks show up, especially near the top of the cliffs. The widest part is not over two miles wide. It gradually rises towards the north and runs back about a mile and a half from the water's edge, where it terminates in a glacier. This glacier does not appear to be moving either forward or backward, although it is probable that there is a gradual movement downward, but this is counter- balanced by the amount which it melts each year.

An ascent was made up the face of the glacier to the perpetual ice-cap about eight miles inland from the foot. The slope of the glacier is very gradual and if necessary it would be possible for light loads to be drawn up it on sleds. It is also possible to ascend the cliffs at several points. From the foot of the glacier several streams of water run down through the terraced gravel beaches to the bay. The general surface of the western half of the valley is fairly rocky and broken by channels which have been furrowed out in the gravel by the streams from the glacier in the spring. There is considerable vegetation here where the soil is fine enough to sustain it. The eastern half is more level, especially on the terraces running parallel to the water's edge. There is not so much vegetation on this side, although there is considerable close to the foot of the cliffs and near the edge of the bay. The finest gravel is nearer the water and the farther back from the water's edge the rougher the quality of the gravel and the larger the rocks. All of the valley was free of snow during the time "Arctic" the remained in that vicinity. This was during the last week in August.

Twenty rock rings of ancient Eskimo [Inuit] habitations were discovered on the western side of the valley and a considerable number, but not counted, were found on the eastern side on a small grassy bench fairly close to the shore. The Mounted Police buildings were erected close to the water's edge on the western side of the valley, but the best place for an emergency landing ground for an aeroplane would be on the eastern side, although it is probable that an aeroplane could be landed almost anywhere on the gravel beach along the front of the valley. A rough survey was made of the most favourable looking terrace and it was found to be roughly six hundred yards in length and about two hundred yards wide, with fairly smooth surface. It is not, however, recommended to be used as anything other than an emergency landing ground as all conditions there are unfavourable for the operation of aircraft.

The harbour is too shallow to permit ships to come nearer than one and a half or two miles from the valley, and all cargo would have to be transported in small launches, and even this is very difficult owing to the numerous boulders in the shallow waters of the bay, and owing to the drift of the tide and currents in that vicinity the bay is nearly always partly filled with floating cakes of ice, and with winds blowing the ice into the bay navigation becomes not only difficult but dangerous. The landing ground in this valley being so low beneath the surrounding walls of the valley, it

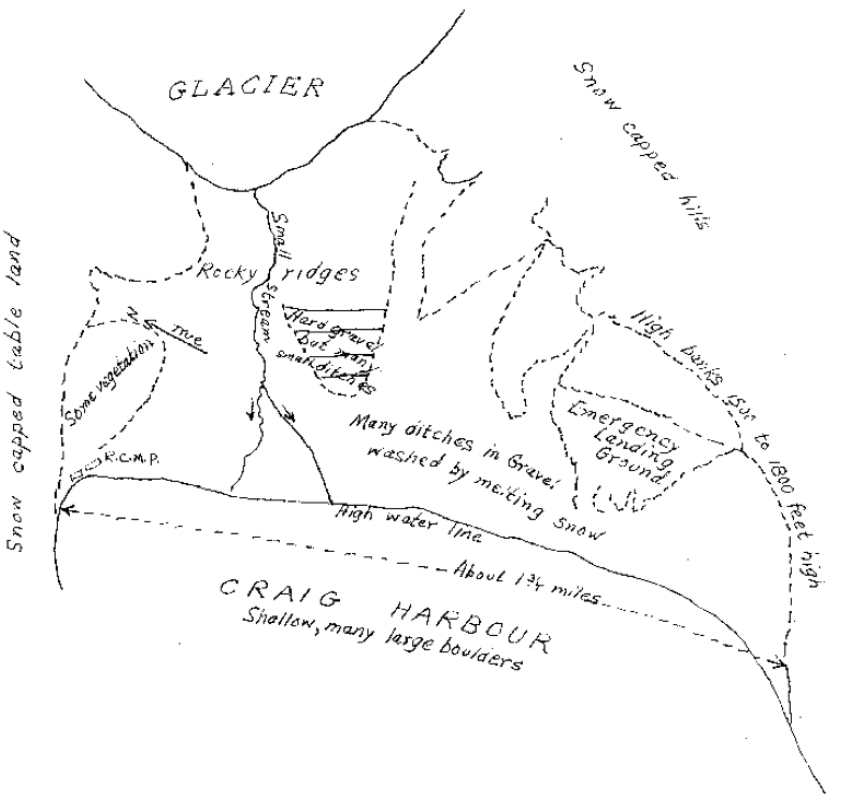

EMERGENCY
LANDING GROUND
FOR AEROPLANES
CRAIG HARBOUR
ELLESMERE LAND
Latitude 76° 10'N. Longitude 80° 50'W
Scale
Approximately 100 yds. to 1 inch
N
Loose Gravel and Large Rocks on this lower Beach
Bank sloping 6 to 10 feet
Yellow Moss, fairly smooth
Best place for Landing North or South
Level N. & S. but slightly undulating E & W.
L A N D I N G
G R O U N D
Gradual sloping terraces becoming lower to the west
Hard Gravel surface, Ditches appear slight
Eastern Limit of Landing Ground
Navy Ridges 15 yards between crests, Vertical distance between high and low places about 2 feet
Rocky cliffs 1500 ft. High
Steep Bank 8 feet
Lower Beach
7ft
Level
Fair
Hard and Smooth Good
Crossed by "A" ditches 6" deep
6"
2ft
Narrow yellow streak 3' deep
4ft
NOTE - o Denotes small mounds of stones topped with moss, erected in 1922

would probably be difficult for an aeroplane to get out owing to the probable downward currents of air in nearly all positions of the wind. The harbour apparently breaks up quite early and the ice would be rough because of the shallow water and the range of tides. The tide measured at this harbour showed a range of about nine and a half feet between high and low water, and at each low tide large cakes of ice were stranded high and dry on the rocks. This would be certain to create a very rough surface on the ice in the winter, and would therefore be almost impossible for use for landing aircraft. It would be possible to land almost anywhere on the snow-capped table-lands or on the top of the glaciers, but it would be rather difficult climbing up and down to the buildings in the valley.

It is recommended that no attempt be made to establish an aircraft station at Craig Harbour, but that investigations be carried on farther west as there is every reason to believe that the conditions in some of the Fram Fiords farther west would be very favourable for aircraft operation. It was noted during the season that there were extensive areas of open water far to the west of Fiord and valleys of bare ground were seen all along the coast as far as could be seen from an altitude of about three thousand feet slightly southeast of the entrance of Fram Fiord. One of the reasons for choosing Craig Harbour as a landing place for the ship this season was that as it is at the entrance of Jones sound it would be fairly accessible each season. Supplies could be landed there and later moved to points farther west if required. It is recommended, therefore, that if any aircraft work is to be carried on in the southern part of Ellesmere Island this harbour be disregarded entirely and that steps be taken to locate a more favourable base farther west, or at least find a place where supplies could be landed and taken in over the ice to some bay or inlet as far as possible from the open waters of the sound.

It is believed that the farther the air station is from the open water the better, and therefore it would be preferable to have it placed as far inland as possible in a fiord which may not necessarily be accessible by ships, for it would probably be found that a ship can unload a cargo onto the ice of the inlet or at some point from which the supplies may he reshipped by ice transport to the point where they are required. One of the reasons for choosing Fram Fiord is that the reports from Captain Sverdrup, who discovered it and explored it in 1899, indicate that there was a great deal of vegetation there and many indications of game, although he observed none during his short stay in that vicinity. According to his reports there was a large area of bare ground in the vicinity of the fiord, and this would probably indicate the possibility of suitable location for an aircraft base, although if it were possible to proceed regularly each year as far west as Musk-Ox Fiord on the southwestern part of Ellesmere Island, it is probable that a much more favourable location could be found where there would be more bare ground and more possibilities for game.

Rough Sketch of Topography
of Vicinity of
CRAIG HARBOUR, ELLESMERE LAND
Latitude 76° 10', Longtitude 81°W. appx.



All reports would indicate that there are many more winds and gales in Smith Sound than in any other part of the islands, and if an aircraft station were placed on Ellesmere Island somewhere in the vicinity of Cape Sabine, each greater difficulty would be found in connection with flying than at points farther south. It would appear that the valley or break between the mountainous country of Greenland and Ellesmere Island acts as a natural channel for winds blowing from the polar Sea towards Baffin Bay, or vice versa. The prevailing winds appear to blow down the channel from north to south. The natural route of aircraft from Cape Sabine to the other islands of the Archipelago would be to cross Ellesmere Island to the western coast and then proceed southerly along the low ground on the east side of Norwegian

Bay. It is probable that if a base for aircraft were required somewhere in the vicinity of Smith Sound this would have to be established well inland in one of the numerous fiords west of Buchanan Bay, and would probably not be accessible by ship.

DUNDAS HARBOUR

The second harbour visited was Dundas Harbour on North Devon Island, approximately north latitude 74° 32′, longitude 82° 32′ west. This appears to be a very good harbour, well sheltered from the open waters of Lancaster Sound and apparently one of the first harbours of the North to become clear of ice. There are several rocks near the entrance of the harbour, but once inside in the inner basin there is a well sheltered harbour large enough to accommodate many very large ships. The water appears to be fairly deep right up to the edge of the land on the eastern side and there are good facilities for erecting buildings and using this harbour as a distributing centre where large ships from the south could discharge their cargoes, which could later be reshipped by smaller ships to the various parts of the islands. The best place for landing supplies would be on the eastern side inside the harbor about one-half mile or a little more, but the area of level ground would probably not be suitable for an air-craft landing ground, although it is possible that an aeroplane might make a landing there if certain areas were cleared of loose boulders.

The most likely place for an aeroplane landing ground would be at the head of the inlet about two miles north from the entrance of the harbour. The ground here was not actually investigated at a closer range than a mile, but it appeared to consist of a valley about a mile wide and a mile or two deep, with a fairly level plain of gravel or soil free of snow, and there were many indications of vegetation and musk- ox and caribou. The sides of this inlet and valley were probably not over one thousand feet high and appeared to be of horizontal bands of alternately hard and soft rock much cut by the action of wind and water. There appeared to be much bare ground on the valley and hillsides towards the north and west, and the north- westerly end of the various branches of the valley could not be seen.

It is probable that this would make a fairly favourable base in many ways, but it remains to be seen whether a point so close to such a large body of water as Lancaster Sound would be sufficiently free of fog and winds to permit the extensive use of aircraft throughout all ordinary, seasons of the year.

A peculiar formation of rock was noted near the western entrance of this harbour, and a sand beach was noted near it which seemed to resemble the ruby sands from which gold is washed on the beach at Nome, Alaska. This sand is very heavy and appears to

contain myriads of small particles of either ruby or garnet, as well as some kind of iron particles, and it is possible that further investigation might be profitably carried out.

It is quite probable that the most favourable place as far as central location is concerned would be somewhere at the western end of Lancaster Sound, probably at Cornwallis Island, although the indications are that somewhere on Bathurst Island or Melville Island would be more favourable as far as climatic conditions are concerned. It is certain that if all conditions were favourable for an aircraft base to be established somewhere in the vicinity of Cornwallis Island, this would be very central for operations throughout the whole of the Northern Archipelago, and it is believed that a ship would have more chances of reaching a harbour or the western end of Lancaster Sound than it would have of reaching many of the harbours on other parts of the islands, as it is believed that Lancaster Sound is one of the first channels to become broken up in the spring.

It is probable that a fairly good location could be found in Admiralty Inlet in North Baffin Land, but the most suitable place which was investigated during this season was in the neighbourhood of Salmon River in Eclipse Sound, or more commonly known as Pond's Inlet, between Bylot Island and Baffin Land. At this point a Hudson's Bay Trading Post was established during the summer of 1921, and about ten miles farther east at Pond's Inlet settlement a Trading Post was established by Captain Bernier ten or twelve years ago and operated by him for several years, but it is now operated by the Arctic Gold Exploration Company.

POND'S INLET

The Hudson's Bay Company's most northerly Post was established in the summer of 1921 on a small point about one and a half miles east of the mouth of Salmon River on the south shore of Eclipse Sound. This point is about fifteen miles from the entrance of Pond's Inlet. Pond's Inlet is really the part of the channel which lies east of the narrowest point between Bylot Island and the north end of Baffin Land. This narrowest part of the channel is about three miles in width, and westerly from this point the channel widens out to an average width of about fifteen miles, but with many deep bays or inlets running southerly from it, very few of which have been accurately charted.

The settlement formerly known as Pond's Inlet is about ten miles east of the Hudson's Bay Company's Post and consists merely of a few Eskimo habitations and a few small houses and store-houses owned and occupied by the Arctic Gold Exploration Company. This settlement is at the extreme easterly edge of a large area of bare ground and lies at the westerly side of a high range of hills or mountains

covered with perpetual snow, which appear to run in a southerly direction far down the eastern side of the island. This area of bare ground appears to extend westerly for probably sixty miles or more and southerly for at least ten miles, where there are a certain number of hills, but it is possible that to the south of these hills there may be considerable more ground which is free from snow in the summertime. The bare ground consists of rolling plains varying in height from one hundred to one thousand feet, and is dotted with small ponds and lakes and cut by numerous ravines and many large streams of running water during the season when the snow is melting, the largest of these streams being Salmon River.

Salmon River is a small stream about fifty feet wide, flowing northerly and emptying into the south- eastern part of Eclipse Sound. The adjacent country consists of a series of hills and plateaus which rise from a few feet to one hundred feet along the coast and reach a height of five or six hundred feet, six or seven miles inland. These hills consist of yellow and red stone covered in many places with a whitish clay of a few feet thickness. Plains and hills dotted with numerous lakes and ponds, and cut by numerous ravines, gullies and small streams extend east and west along the coast from the mouth of the river and inland probably eight or ten miles. In the summer time the plains and low hills are covered with moss, turf, coarse grass, stunted herbage and heather. In the months of June, July and August innumerable bright colored flowers, green, white, red, yellow, purple and mauve, besprinkle and liven the landscape. The birds arrive in June and include many species.

The river has been traced inland for about twenty miles and is fed by numerous side streams, and has its origin near a large glacier almost due south of Pond's Inlet village. The bed of the river consists of a series of rapids and falls, filled with boulders and gravel banks. There are several lakes connected with this river and lying about eight or ten miles inland, although there are large numbers of small lakes at various points all over the plain, from which smaller streams run down to the river. To the south of this plain there are mountains but there appear to be several gaps in them and it is probable that the bare ground runs much farther inland than the presence of these mountains would indicate. There is much coal- float in the river and about four miles from the mouth coal is mined by the Arctic Gold Exploration Company for local use at the trading post. The spring salmon run from the lake to the sea from June 15th to July 5th. They apparently become very fat during the summer and during the month of August they ascend the river to spawn. The fish are reported to ascend and descend the river in greatest numbers when the moon is full. The salmon are reported to be very fat in the fall and nun from twenty to thirty inches in length and very in weight from three to twenty pounds.

There appears to be a fairly abundant vegetation of Arctic mosses, grasses and heather, etc., and apparently the plains to the south and west would support large numbers of

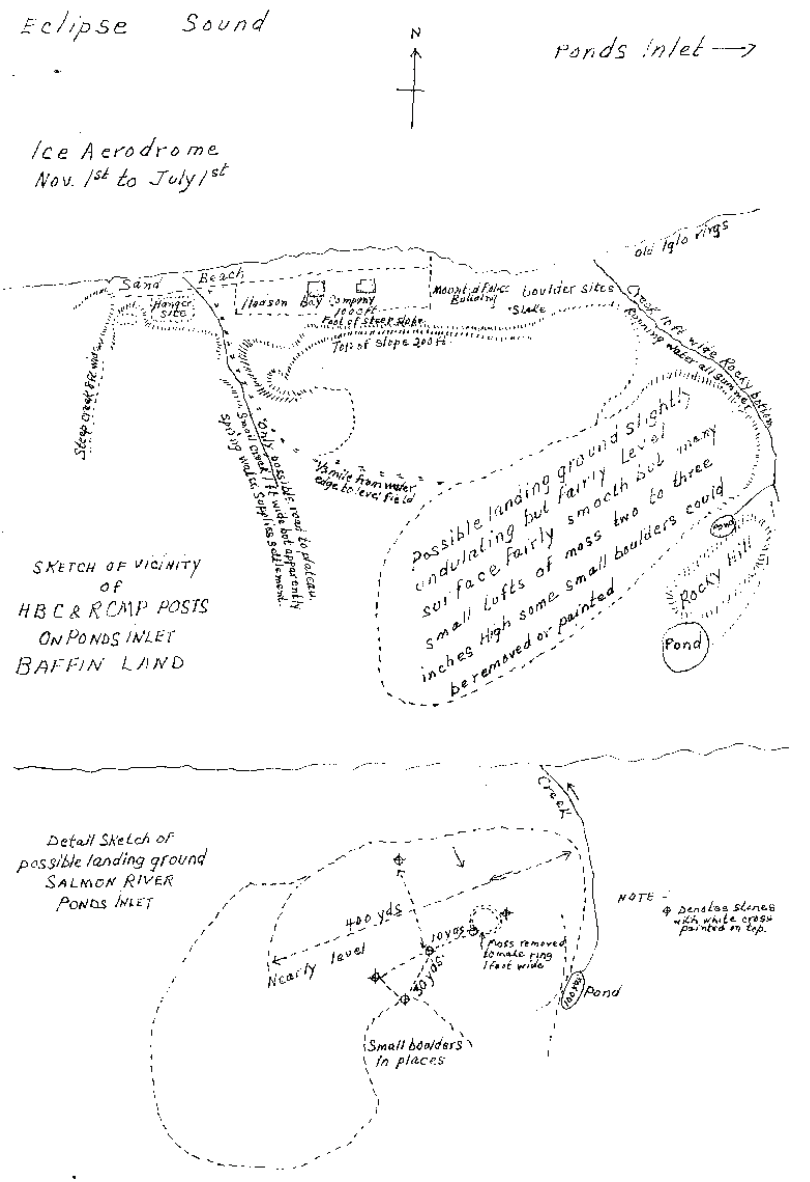
caribou or musk-ox, but no have musk-ox been killed here for many years and the caribou seem to have been killed off and are very seldom found not without proceeding twenty or thirty miles inland from the seacoast. This place has been inhabited by Eskimos [Inuit] for a great many years and it is probable that since the use of firearms, especially rifles, has become common with the Eskimos [Inuit] the local herds or caribou have been killed off or driven farther inland.

The bare ground, and the distance that this plain lies from the open waters of Baffin Bay apparently have a beneficial effect as far as the local weather is concerned, because it was observed, during the past year at least, that, even while fog banks could be noted at the Narrows and at Pond's Inlet settlement, it was very seldom that there was any stormy weather in the vicinity of the Hudson's Bay Trading Post at Salmon River. The Hudson's Bay Company's buildings were erected in the summer of 1921 and the Royal Canadian Mounted Police buildings were erected in 1922 only a few hundred yards east of the former. Apparently one reason that this location was chosen by the Hudson's Bay Company was that although there is lower ground near the mouth of the river, the best location was granted by the Government to Captain Bernier and transferred by him to the Arctic Gold Exploration Company, and any sites which might have been favourable for building purposes were bordered by such shallow water that it was impossible to get a ship nearer than half a mile from shore. As it is, the ships cannot get nearer than a quarter mile from the Hudson's Bay Company's buildings.

The buildings have been placed on a strip of land about half a mile long and about one hundred yards wide, and averaging about ten feet above sea level along the front, gradually sloping back to the foot of a steep hill or rather sloping moss-covered bank which rises abruptly about two hundred feet to the edge of the slightly rolling table-land. At each end of this strip of fairly level ground there is a creek bed about ten feet wide, down which streams of fresh water rush during the summer season, but which of course are frozen very early in the autumn, but from which a plentiful supply of water or fresh water ice could be obtained throughout the year.

There is room for probably two or three more buildings only on this strip of ground, without encroaching on the lots staked out by the Hudson's Bay Company and the Mounted Police for their own use. There is also only one gulch or pass up the steep hillside which has a sufficient gradual slope to permit supplies to be freighted up to the more level plains of the table-land south of the settlement. It was decided that in the event of the Government desiring to use this gulch for a route it might save a lot of trouble by having it reserved before the land claimed by the Hudson's Bay Company is surveyed. It was thought advisable to stick up two stakes bearing the notice that this gulch, with certain other approaches from the water's edge, would be liable to reservation by the Government for military or aviation purposes, and small

wooden poets bearing the following notices were placed at points which are shown on the accompanying sketch.



One port was placed beside the boulder marked and used by Mr. L. O. Brown, D.L.S. as the eastern end of his base line in the survey of the settlement. This stake bore the following inscription written with a lead pencil: -

> "From the line bearing 340°true from this point to the intersection of the shore, thence easterly along the shore thirty chains, or 1980 feet, the land inland to a depth of one mile is liable to reservation for military and aviation purposes."
>
> September 6, 1922
> (SGD.) R.A. Logan
> S/Ldr. C.A.F., &
> Dominion Land Surveyor

The letters "M.R." were cut into the wood with a knife.

Another stake was placed one thousand feet distant from the first stake on the base line as laid out by Mr. Brown, D.L.S., the bearing of this base line being approximately 315° true and should be considered as the back line of the lots of the Hudson's Bay Company and the Mounted Police. The stake was placed in the centre of a pile of stones and had the letters "M.R." carved on one side, and the following inscription written with a lead pencil on the other side:-

> "All land for distance of 1320 feet westerly along the shore from the line with a true bearing of 105°, from and passing through this point, and inland to a distance of one-half mile, is liable to reservation for military and aviation purposes."
>
> (S.D.G.) R. A. Logan,
> Squadron Leader, Canadian Air Force,
> and Dominion Land Surveyor.

Since these stakes were planted it has been decided that it would be more advisable to simply reserve all the land within half a mile radius of the Hudson's Bay Company's Post, with the exception of the ground contained in the area bounded by the straight line joining these two stakes and the lines joining each stake with the nearest point of the shore. It is practically certain that a better location can be found a few miles farther west, but it will be just as well to reserve this area until such time as a better location has been found,

While no instructions from Ottawa had been given for any such monuments to be placed here, they were placed by a duly qualified Dominion Land Surveyor, and if it is

desired to use them to designate the boundaries of a Government Reserve, such can be done without irregularity.

There is a small area of comparatively level ground about one-quarter mile back of the Hudson's Bay Company's buildings, which could be used as a landing ground for aeroplanes during the season of the year when it would be free from snow, but it would require a little work done to it in removing loose boulders before it could be used for landing in all directions. Time was not available for this to be accurately surveyed, but a rough topographical survey was made of it, shown on the accompanying sketch, and a number of rocks were painted white in such a manner that they would appear to be parts of an equilateral triangle, with the sides about thirty yards in length. The length of runway on this level area would be probably three hundred yards in most directions, with very good approaches.

While the best location for an air station observed during the season of 1922 was at Salmon River, it is almost certain that better locations in the vicinity of Eclipse Sound can be found with more investigation. Some of the disadvantages of the Salmon River locality would be the melting of the ice in the summer, caused by the warmer fresh water from the river, and because the station would be located on the side of the Sound where there is a strong current caused by the tides. If the station were located on a sheltered by or inlet in deep water, it is probable that the ice would remain much longer in the summer than it would on the open edge of the Sound where there are tidal currents. It is probable that suitable locations could be found either in Oliver or Arctic Sounds or Milne Inlet, or farther west in Admiralty Sound.

SUGGESTIONS

One of the first questions to arise is "What is all this going to cost?" That cannot be definitely answered until it is known what types and numbers of machines are required. The chief items will be the initial cost of aeroplanes and aero engines, motor transport, hangars and other buildings, fuel and oil, spare parts, scientific equipment for wireless, meteorology, photography and navigation, salaries, clothing and food supplies and transportation, and of these the chief items will be the initial cost of aero- planes and engines and transportation, but it is impossible at this date to give estimates of what any of them may be a few years hence. Aeroplane prices vary greatly according to the type and numbers ordered, and the cost of transportation will depend a lot upon the Government owned ships which may be used.

If estimates were submitted based on prevailing prices at the present time, it is probable that they would be greatly different from what would be required in two years or even one year from now, but it is considered advisable to suggest that the cost

Department of the Air Board be asked to supply information regarding the initial coast of equipment at prevailing rates for one air station, to include the following: -

Four aeroplanes, single engine, four to ten-seaters, various types.

Four aeroplanes, double engine, four to ten-seaters various types.

(Four machines only required, of whatever type chosen). Two small scout machines, single or double seaters.

One small caterpillar traction engine.

Two Fordson tractors. One Ford one-ton truck.

Gasoline and oil required for one year

Scientific equipment; buildings for living quarters and hangars to house four aeroplanes.

Food, fuel and clothing supplies for ten men for one year.

Estimates should include not only cost, but also bulk and weight for transportation purposes. The salaries of officers will in all probability be determined by the Department of National Defence, but it is recommended that officers be paid their regular Air Force pay and allowances according to rank, plus an additional sum of $100 per month for work in the Arctic Archipelago. Salaries of mechanics should be $6 per day or $2190 per year, with all expenses paid.

It is probable that the minimum cost of each station for the first year will be about $200,000, although that can only be a rough estimate of what the actual cost will be. As this will be Air Force material the expenses will in all probability be borne by the [Canadian] Air Force, or if it is deemed advisable an arrangement may be made whereby the Department of the Interior would share a part of the expenses in return for service rendered.

But before any bases for aircraft operation are established, at least one season should be spent in investigating different places in order to find the most suitable location, because much of the success of any operation will depend on the local conditions of the place where the station is established. Such a place cannot be chosen in a day.

The territory in the vicinity of the proposed location must be examined for miles around, especially during the summer season, and for this reason it is strongly

recommended that immediate steps be taken to send properly trained Air Force officers to investigate possible locations whenever there is an opportunity to do so. It would be necessary for them to remain at the Posts during the winter and to explore the country and investigate local conditions in their relation to aircraft operations.

One officer should be sent to each locality where there may be a possible desire to establish aircraft stations in the future. He could live with the Mounted Police and accompany them on many patrols, or he could live at the Trading Posts and use this as his base of operations.

If there were time it might be advisable to have each man investigate more than one locality, this is to say, he would spend one season in one vicinity, then be moved by the supply ship to another point where he would spend another year carrying on further investigations. In this way possibly better comparisons of localities could be made where the investigations were carried out by the same man.

The men chosen for this work need not be supplied with aeroplanes, (unless very small ones can be supplied) but they should be picked men who could be placed in charge of stations when these were established, and their one or two years' experience in living in the country would be of great value to them when they have to take charge of men who have not had that experience.

There are at least three places at present to which such investigating officers should be sent: Pond's Inlet, South Ellesmere Island, and Lake Harbour on the south coast of Baffin Land. The officer detailed for duty at the latter Post should investigate the neighbourhood of other Trading Posts along the south coast of Baffin Land as far as possible. The examination of this district is important in connection with the air stations required in connection with the co-operation of aircraft with marine navigation through the Hudson Strait, which may perhaps not be required for a few years but which is certain to be developed in the near future.

As soon as a Police Post is established anywhere in the islands west of Lancaster Sound an experienced Air Force officer should be detailed there to investigate flying and relative conditions in that neighbourhood.

Although more territory could be covered in one year by several Air Force officers being sent to various places without being equipped with aeroplanes, it would be much better if they were able to carry on investigations by utilising aircraft in many ways, for there are many investigations which would be greatly aided or extended by the use of aircraft, although much information of scientific interest would be gained without their use.

When it is considered that this region is so little known, the actual flying conditions so little investigated and the whole country apparently so inaccessible at the present time, it would not appear advisable to attempt to send a detachment of aircraft there and expect to have regular extensive flights undertaken without previous preliminary investigations being carried out, and as much information as possible being obtained on the actual conditions as they exist, not only on the ground, but in the air.

A few thousand dollars spent in preliminary work might result in the saving of many thousands of dollars when regular air operations are inaugurated, for instance, if machines or engines were sent North and then found unserviceable owing to the peculiar conditions existing there, much time and money would be wasted, whereas if the peculiar conditions and their actual effects on aircraft material were properly investigated first, only the material most likely to be serviceable would be taken.

In addition to the experimental and research work carried on, investigation should also be made regarding the best place or places to make the more permanent air bases.

If a small detachment of the Air Force were sent to the north end of Baffin Land in the summer of 1923, to remain through the following year, much information could be gained regarding the many subjects connected with the operation of aircraft in the Arctic regions. Not only could local investigations be carried out regarding surface conditions of air, ice and ground, but by flying every possible day throughout the year, carrying recording instruments on the aeroplane, a fair idea could be obtained of the probable number of days on which flying might be carried out, and the knowledge gained regarding the temperature of the upper air, as well as the direction and velocity of the upper air currents, would be of great assistance in determining the best methods to be employed in more extensive operations when long cross-country flights are required.

A meteorological station would be operated and special attention would be paid to the investigation of the air currents and temperatures at various altitudes.

Experiments could be carried out in connection with various heating arrangements for containers of recording instruments which are run by clock-work, as there is always a great deal of difficulty experienced in getting these instruments to work reliably at low temperatures. This applies specially to tide gages which have to be left out in the open air. It is believed that some very valuable information could be obtained by carrying out experiments with double snow huts heated by oil lamps or small gas lamps such as are used on light buoys.

It might be noted in this connection that the best system for placing tide gages would be to have small snow huts or igloos built on the ice in some inlet where it is

reasonably certain that there will be no sideways movement of the ice during the winter season. A hole would be drilled through the ice in the centre of the igloo and a tube or pipe filled with coal oil would be left in this hole, and the tide gage would be installed in such a manner that a line running down through the pipe to a small anchor on the bed of the sea would record the rise and fall of the ice as it is moved up or down by the tide. It is probable that favourable locations could be found for this in a great many places where the ice would remain firm from the middle of October to the middle of June, or possibly even later in the summer season.

It also might be noted that the most favourable locality for tide readings would be in some inlet where there is as little tidal current as possible and where the ice might remain throughout the greater part of the year. This also is the most favourable locality for the location of an ice aerodrome, and in this respect a locality suitable for and ice aerodrome would also be very suitable for taking tide readings, and on an experimental station it would at least be possible to determine one or two favourable localities for the readings, and also the best methods to employ In keeping the instruments at a temperature sufficiently warm to ensure their steady operation.

Experiments would be carried out with both air-cooled and water-cooled engines, and with various devices of landing gear and landing places, and experiments could also be carried out regarding the use of motor transport.

It is considered that owing to the limited space available on the Steamer "*Arctic*" it would not be possible to carry more than two very small type aeroplanes next season, but if two machines of a type similar to the "Baby Avro " were taken a start could be made, and if a larger detachment were required the first year's work with the smaller machines would be sufficient to decide on the type of the larger machines, and especially the proper general type of aero engines to be used.

It is not considered that very much work, other than experimental or research work, would be possible for the first season, but it is probable that the vicinity of the experimental station would be photographed from the air, and probably short cross-country flights would be undertaken sufficient to obtain a little idea of the interior of the islands, of which nothing beyond the shorelines is known at the present time.

By carrying out daily pilot balloon observations of the upper air currents throughout at least one year, a fair idea could be obtained of the relative conditions of the air currents at different latitudes, and by making daily ascents with an aeroplane carrying a recording thermometer the temperature of the air at various altitudes would be obtained, and would form, in conjunction with barometer readings, local radiation, ice location and other conditions, a ground-work for calculation of general weather

conditions and weather forecasting, not only for aircraft navigation, but for marine navigation and for general information.

Owing to the great relation between the meteorological conditions in the Arctic and the ensuing weather in the United States and Canada, it will be a matter of only a few years before both countries will demand daily information by wireless of what the meteorological conditions are, and once a start is made in this direction for such a proposed experimental station, other Departments will demand an extension of this service in supplying information

Much experimental work would also be carried out in aerial photography if photographs were taken every day upon which a machine was flown, as it is considered that owing to the peculiar light conditions and glare of ice and snow it may be found necessary to make some slight changes in methods or materials, in order to obtain the best results. There is a greater contrast between ice and land than is usually found in aerial photographs taken in southern latitudes, and owing to the sameness of the surface of the ground and the absence of trees it will require a clear-cut negative to show the type of surface - whether grass, moss or barren.

A small wireless receiving set would be taken, and by this means an idea of the atmospherical [*sic*] conditions affecting wireless reception would be obtained throughout the whole year.

It will be imperative for the air operations personnel to be able to communicate with the natives of the country in which they may be working, and during one year's sojourn amongst the Eskimos [Inuit] a sufficient knowledge should be gained to be of great assistance to those members of the Air Force or other Government Departments who come after.

On scientific expeditions of the past it has apparently been usual to send a so-called specialist in each subject to be investigated, so that to obtain the information covering the subjects referred to above it would perhaps be thought necessary to send one each of the following:- Aeroplane Pilot, Aero Engine Engineer, Meteorologist, Photographer, Wireless Operator and Navigator, but it is considered inadvisable to send two men where one man will serve, because the smaller the party the better.

There are several Air Force officers available, each of whom, with a little intensive training during the coming winter, could carry out all the duties necessary in the different subjects.

Two officers working together would be sufficient, but to give them more time to carry on these different occupations it would be advisable to have two aeroplane

mechanics to look after the care and maintenance of the aircraft, and the ordinary work to be done around such a station; thus the total personnel of the station would be four.

It is believed that the initial cost and maintenance for one year of such an experimental station as suggested would be in the neighbourhood of $60, 000, but it is believed that if the Department of the Interior were to ask the Department of National Defence to establish such an experimental station in the near future, the total expenses of the operation would be carried by the latter Department because the work to be done would be of value not only to the Department of the Interior, but of the greatest value to the Canadian Air Force and to the general development of aircraft in Northern Canada.

It is important, however, to take into consideration the necessity of an early commencement of preparations should it be desired to have the station established during the summer of 1923, because in order to obtain the material required from various sources it will be necessary for these orders to be placed by the Equipment Branch of the Air Force not later than January 1, 1923.

It would also be necessary for all ranks who were being sent to the North to be given special courses in all subjects connected with the work which they may be called to do, and in order to give the Air Force the opportunity to make the proper preparations for the coming season no time should be lost in deciding whether or not aircraft is desired to be taken North next summer.

Should it be found impossible to send aircraft to the Northern Archipelago during the season of 1923, it is strongly recommended that two or more officers be sent to different points to remain during the following winter and to carry out investigations of flying conditions. They should be equipped with meteorological and other scientific instruments, and could be sent either on the Government ships or on the Hudson's Bay Company's supply ships. Two points especially should be investigated, Pond's Inlet and Lake Harbour, both on Baffin Land.

It is hoped that it may be seen fit to establish an experimental station at Pond's Inlet during the season of 1923, for even if it were twenty years before an urgent demand arose for extensive operations in the Arctic Archipelago, the information gained on such an experimental station as suggested would be of the highest value in determining the proper organization and equipment to be used, and in acquainting a certain number of officers and men with the conditions to be expected and some of the difficulties to be overcome on a smaller scale, whereas if there were a sudden emergency requiring aircraft to be operated on a fairly large scale, such as certainly would arise in the event of a big mineral or oil strike, and there had been no such

preliminary investigation of actual flying conditions, much time and money would in all probability be lost in trying to carry on service operations under practically unknown conditions, but the value of this information is not confined merely with the operation of aircraft, but will be of great value to everyone connected with the future exploration, survey or development of the Northern or Arctic regions of Canada.

2. Flight Lieutenant T.A. Lawrence, Report on the Hudson Strait Expedition 1927-28.

DHH 73-1018

Report
to
The Director Civil Government Air Operations
Department of National Defence
on the
Hudson Strait Expedition 1927 – 28

Prepared and submitted by Flight Lieutenant T.A. Lawrence, R.C.A.F., Officer in charge of air operations on the Expedition[3]

Part 1 Intention

Insofar as the Department of National Defence is concerned the Hudson Strait Expedition was organized and sent into the field to:

(a) Procure by means of Aerial Photography and reconnaissance, definite information for the establishment of an absolute time limit for Marine Navigation through the Hudson Strait.

(b) Test the feasibility of use of aircraft as an aid to navigation through the Hudson Strait.

(c) Test the suitability of Air Bases, aeronautical equipment and other equipment necessary to air operations with a view to establishing air operational bases in the Hudson Strait

[3] Note on original: "This report deals for the most part with those phases of the Expedition, in which personnel of the Department of National Defence were actively engaged and certain other items which may be of interest and information. (sgd) T.A. Lawrence, Flight Lieutenant, R.C.A.F."

Part II – Methods of Execution

The method used in procuring the foregoing information necessitated the establishment of three air operational bases, located as follows:- Base "A" at Port Burwell. Base "B" at Nottingham Island, and Base "C," Headquarters Base, at Wakeham Bay.

It was originally intended to have established Base "C" at Lake Harbour on the Northern side of the Strait, but due to the topographical features of the coastline in the vicinity of Lake Harbour, no suitable site could be located and the bases was established at Wakeham Bay, directly south across the Strait.

Part III – Organization

Two Federal Government Departments were detailed to an active part in the execution of the Expedition, i.e., the Department of Marine and the Department of National Defence. Prom the latter department personnel of two branches of the permanent service were engaged, the Royal Canadian Air Force and the Royal Canadian Corps of Signals.

The major portion of the responsibilities in the organization of the expedition fell to the Royal Canadian Air Force and were among many other details as follows:-

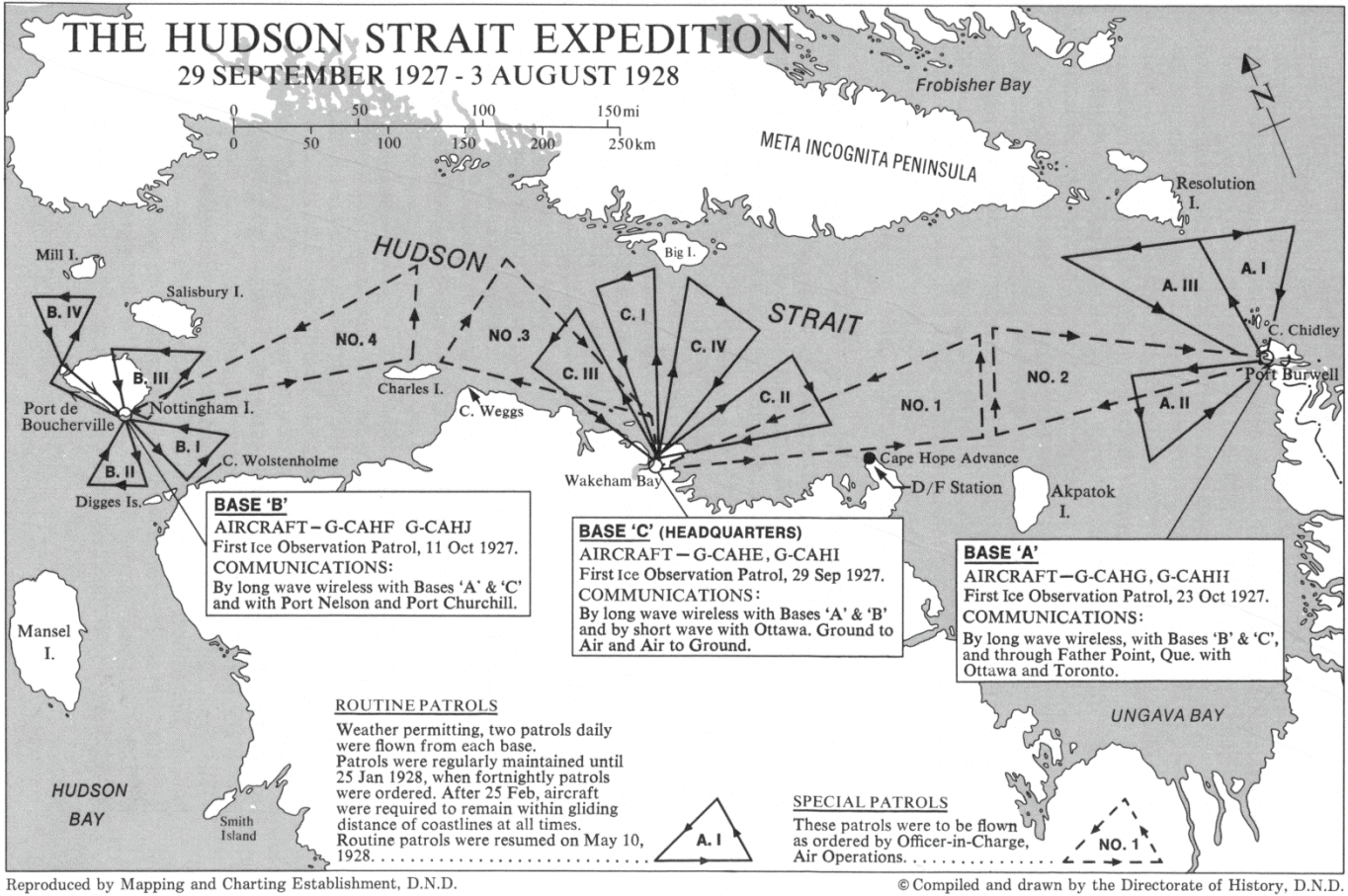
(a) The Selection of the type of aircraft to be used and their requisition together with aircraft spares, aero engines and aero spares.

(b) Requisition of band tools, general hardware, potable machinery shop equipment, aerodrome equipment, genera electrical equipment, rifles, ammunition, photographic supplies, aircraft emergency equipment, sleds, skis, tractors, barrack, and fire-fighting equipment, clothing (both personal and flying), petrols and oils, instruments fuel, medical, equipment, rations, trade goods, libraries and sporting equipment, tentage and meteorological equipment.

The Royal Canadian Corps of Signals became responsible for the requisition of parts and making up of wireless transmitting equipment for installation in aircraft and ground apparatus for reception of air to ground signals.

The following National Defence personnel were allocated to the expedition for duty:-

R.C.A.F. – Six Officers
Twelve Airmen.
R.C.C.S. – One officer
Three other ranks.



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The greater portion of all aeronautical equipment was concentrated at the Royal Canadian Air Force Training Depot, Camp Borden, where all stores were checked in, allocated in equal proportion to the three bases, packed and labelled to respective destinations. The remaining material for which the Department of National Defence was responsible and not concentrated at Camp Borden was delivered direct to the point of embarkation, Halifax, Nova Scotia, where it was similarly dealt with.

During the period of organization, the Air Force personnel of the expedition were mostly concentrated at Camp Borden, whore they received refresher courses in flying, air navigation, aerial cameras and photography, aero engines and first-aid. In addition the six air riggers detailed were given a three weeks course at the Atlantic Aircraft Corporation Factory in New York, for the purpose of familiarizing themselves with the aircraft and its construction and also in the maintenance and repair of metal fuselages.

Civil personnel such as doctors, wireless engineers and operators (for ground communication only) storekeepers and cooks were provided by the Department of Marine. One member of the Royal Canadian Mounted Police was detailed for duty at each base and one civil photographer to Base "C."

Part IV - Locating and Establishment of Bases

Final concentration of all personnel and equipment being complete at Halifax on July 16th, 1927 the expedition sailed from that pert on the following day, July 17th. Transportation to the scene of operation was effected by the Canadian Government Ice-Breaker "*Stanley*" and the S.S. "*Larch*." Permanent personnel of the expedition, forty-four all told, service and civil, were transported on the "*Stanley*." Non-Permanent personnel, carpenters and riggers, taken along for constructional duties in the erection of buildings and wireless masts, together with all supplies and equipment were carried on board the S.S. "*Larch*."

Port Burwell [Killiniq], the tentative location for Base "A," was reached on July 27, 1927, and the "Moth" seaplane, carried in assembled condition on the aft deck of the "*Stanley*," was launched and a flight carried out for purposes of locating a base location. In a short time two or three locations worthy of closer inspection from the ground were pin-pointed. With the knowledge of the fact, however, that the early Fall ice makes its first appearance at the west entrance to the straits, it was desirable to establish bases in sequence from west to east rather than east to west.

Accordingly it was decided to leave an investigation party at Burwell to thoroughly explore Port Burwell and vicinity for the most suitable base location. The officer in

charge of this Base, his medical officer and two airmen, together with a motor boat, supplies and equipment for two months, were left here to carry out the investigation and the remainder of the expeditions proceeded west towards Nottingham Island.

On August 1st, 1927, both ships put into Erik Cove to replenish their supply of fresh water. While this work was in progress the "Moth" was launched and an observation patrol carried out, but no suitable base locations other than at the head of Erik Cove were sighted. This site, however, had its drawbacks due to being located in a narrow cove between two very high ranges of mountains, being open to heavy seas and subject to a large percentage of continuous high winds.

The following evening anchor was dropped off Port de Boucherville, at the East end of Nottingham Island, and on the early morning of August 3rd a flight making the complete circuit of the island was carried out. A very close survey of the shoreline was made and one suitable site only was selected for further observation from the sea and land. Here it is worthy of noting the value of having taken along a light seaplane ready for use to carry out base location observations. It would have taken the ship months of hazardous work to have made a survey of the shore line of this island (coastline being very badly charted and soundings poor), and even then it is quite possible that the only suitable cove would have been missed. As it was it took several hours to find and approach the selected cove when moving the ships from their first anchorage. In fact, it was impossible to observe the entrance from the ships themselves, it eventually becoming necessary to cruise along the coast in a small motor boat to locate the proper entrance.

Careful inspection of the cove and its vicinity indicated this to be a suitable site for operating from, by no means perfect, yet the best available in such a rugged country.

After cleaning up a large section of the beach, unloading operations commenced at once and two weeks later all equipment and supplies were ashore and sufficient temporary accommodation erected for the use of personnel. Seven hundred tons is a close estimate of the amount of supplies and equipment unloaded during these two weeks, all of this material being towed from the ships, about one mile off shore, to the beach by use of surf boats and a scow. Full crawler tractors were used to great advantage in keeping the beach clear of equipment as unloaded. Tide and fog proved to be the greatest impediment to unloading activities, it becoming necessary to work the tides in order to approach the beach. At times such dense fog was encountered as to cause considerable lost time, tow boats and their tows actually becoming temporarily lost between the ships and the entrance to the base cove and vice versa.

On August 18th, after leaving ashore the permanent personnel of this base together with their constructional staff, both ships proceeded on their way to Lake Harbour to

carry on with the establishment of Base "C," the C.G.S. "*Stanley*" to return later in the year to collect the construction crew for passage South.

Extensive air patrols and ground reconnaissance expeditions were made during four days stay at Lake Harbour, Baffin Land, to no avail in the location of a suitable air base. The topography of the coast line for miles on either side of Lake Harbour and in the Harbour itself made the unloading of such a large amount of equipment and the establishment of a base impracticable in the short season at our disposal. Big Island was also visited and while a very fine land locked harbour was found to exist on the South side of the island, there was hardly a semblance of a flat beach or any possible terrain for the erection of buildings.

Whilst at Lake Harbour, the manager of the Hudson's Bay Company Trading Post had produced some small snaps of Wakeham Bay and vicinity. The country there appeared to be more desirable. This appeared to be the only solution for the establishment of this base at some point about halfway up the strait. Both ships then proceeded to Wakeham Bay, where anchors were dropped on August 24th, 1927.

A short flight in the "Moth and a ground survey of the best location sighted from the air very soon decided the site for Base "C."

Approximately the same tonnage and items of supplies and equipment were unloaded at Wakeham Bay as at Base "B." Unloading proceeded in much the same manner as at Nottingham Island, but benefiting by experience, a better sentience of bringing ashore supplies as required was followed and the work proceeded more smoothly and rapid. To offset this, however, the unloading crew was diminished by about 13 men, personnel who remained at Nottingham. A longer haul of supplies was required due to a very long beach at low tides. It was not necessary, however, to work the tides, which was a helpful factor, but due to the beach being open to prevailing winds, South-west, West, and North-west, unloading operations were hampered to a certain extent by heavy seas.

Unloading operations at Wakeham Bay were completed by September 11th, 1927, and after leaving ashore the permanent personnel and construction crew for this base, eighteen and twelve in number respectively, both ships proceeded to Port Burwell to establish the third and last base.

The decision in respect to a site for the location of Base "A" at Port Burwell was left for mutual arrangement between the leader of the expedition and the R.C.A.F. officer to take charge at that particular base. As the latter officer had had the previous two months investigating the vicinity of Burwell, their decision was soon reached and unloading and constructional operations commenced on September 12th, 1927.

There being a suitable building available, one-time Moravian Mission and now owned by the Hudson Bay Company, arrangements were undertaken and completed for the rental of same and the necessity of erecting two dwellings and a store-house eliminated. The construction material for these buildings was put ashore, however, so that there was no cut down in the comparative amount of freight and supplies as unloaded at other bases. Unloading conditions were somewhat similar to those experienced at other bases, possibly somewhat harder due to a more rugged beach, higher tides to contend with and a depleted unloading crew. Being the last base to be established though and the programme of establishment now being so well advanced, the same rush as necessitated at the other bases was not essential.

Later in the Fall the C.G.S. "*Stanley*" re- turned to Nottingham and Wakeham Bay, from where the construction crews were picked up, and in the second week of November we were left to our own resources, when the ships proceeded South.

At every base there was considerable constructional work loft undone, which had to be undertaken at once by the permanent staff so as to find it completed before severe weather conditions wore far advanced. Already conditions were becoming severe and cold, but by the end of November all personnel, equipment and supplies were comfortably and safely housed. The extra work in consequence of construction carried out by permanent personnel did to a certain degree hamper regular air operations.

Part V – Operations

(a) General

A system of routine and special patrols for all three bases was drawn up and approved in before flying actively started. Routine patrols were to be carried out daily from each base, weather permitting, and special patrols, on which aircraft from Bases "C" and "B" and Bases "C" and "A" were to rendezvous in certain areas between their respective bases on the same day. This latter system was adopted to provide for the collection of information throughout the length of the strait as closely as possible within the same period of elapsed time. Special patrols were only called for when considered essential.

The original scheme of patrols was not strictly adhered to in consequence of instructions received from Headquarters in Ottawa from time to time, and other unforeseen difficulties such as a combination of very bad weather and erratic air navigational conditions. The latter items are dealt with more fully later in this report.

Photographic operations were to be carried out using oblique hand-held cameras (see part VIII), and exposures made while flying on a direct course at constant altitudes, using the same angle of deflection and allowing for a sixty percent overlap. This method was adopted to permit of the interpretation of the nature of the ice by use of the stereoscope. Hydrographic survey charts on which a grid was superimposed were to be used and exposures pinpointed as closely as possible.

On the completion of each patrol, pilots were required to complete a concise detailed report of the ice conditions as seen in the area covered by their patrol.

Wireless communication from air to ground was maintained by the use of the C.T. 21A transmitting set with trailing antennae. Both voice and key were available with remote control installed for the use of the pilot. Whilst on patrol, aircraft were required to communicate with their base every five minutes.

(b) Summer and Fall 1927 - On Pontoons

Initial operations of the expedition were those observation patrols carried out for the locating of suitable base sites, using the "Moth" seaplane. The satisfaction of having had this aircraft for such work cannot be too highly stressed for two main reasons, first the time saving factor and second that of knowing that the bases were actually located in the best sites available near the tentative location, to which instructions stated they were to be established.

Unfortunately the "Moth" was completely wrecked a few days after arriving at Wakeham Bay. Incidentally the work for which it had been supplied was completed, but its loss was none the less keenly felt. This aircraft had been taken off the "*Stanley*" and was at a mooring awaiting an opportunity to bring it ashore pending the beach being clear of other equipment being unloaded, when a heavy South-west gale suddenly sprang up and in a few minutes it became impossible to even approach the machine at its mooring. After riding very heavy seas for slightly over twelve hours, the machine eventually turned turtle at the mooring. Some idea of the prevailing conditions may be indicated by the fact that both ships, the "*Stanley*" and the "*Larch*," each had two anchors out and as well were keeping their propellers turning over to keep from dragging anchor. For the "Moth" to successfully ride such a storm for as long as it did was an extremely good proof of the seaworthiness of this light plane.

Operations using the Fokker seaplanes in the Summer and Fall of 1927 were not very extensive for two main reasons (bad weather and lack of time), the permanent personnel having too many duties other than flying to take care of, duties too important in the establishment of the bases before winter set in to be put aside. Patrols were carried out, however, wherever possible. As the ice did not make its first

appearance until November 16th, and that in the vicinity of Nottingham Island, there was no loss of information suffered through a limited amount of flying this fall.

First patrols using Fokkers commenced at respective bases as follows:-

Base "A" – October 23rd, 1927
Base "B" – October 11th, 1927
Base "C" – September 29th, 1927

From the time ice (other than shore ice) first appeared in the straits, until the freeze up, conditions became unfit for further flying on pontoons with very poor flying weather existing due to rain, snow and fog.

At Base "A," Port Burwell, from the date of the first patrol until local ice commenced to form (a period of thirty one days), the weather was very bad and accompanied almost continuously with high winds, snow, and poor visibility. The between season, from pontoons to skis, lasted for nineteen days during which time ice conditions, both along the shores and on the coves were unfit and unsafe for use. Every tide undid the efforts of all personnel in the construction of a runway aver the rough shore ice to the level ice from the hangars and entailed endless labour.

At Base "B," Nottingham, from the date of the first patrol until local ice commenced to form, a period of thirty-three days, generally bad weather existed. Flying was carried on whenever possible however, and the sighting and movements of the first ice in the strait on November 16th, was not missed. On the same day the cove froze over and further flying on pontoons became impossible. The inter-season period from pontoons to skis, at Nottingham, only lasted for seven days. This was account- able to much colder weather being experienced at Nottingham than at other bases, the ice becoming safe for operating from in a shorter time and also to the fact that the action of the tide on the shore ice was not nearly as noticeable. Access from the hangars to the ice was, in consequence, greatly facilitated.

Operations at Wakeham Bay during this period were carried on as consistently as possible up to the period of freeze up in 1927. There was an interval of fifty-three days from the date of the first flight on pontoons until the freeze up. Patrols were made on ten of these days. Weather conditions such as snow and fog hindered flying on twenty-four. The other nineteen days, nearly all in November, could not be made use of, due to high winds and heavy formations of shore ice long before the general freeze-up took place. These latter conditions made the launching and removal of aircraft to and from the water impossible, and previous experience had taught us to never leave machines at their moorings for never more than a few hours and then only in cases of necessity and under continuous watch.

Eighteen days passed from the time of Wakeham Bay freezing over until it was possible to get a machine on to the bay ice and commence flying, using skis. A combination of weather and ice conditions hampered flying during this period. Some idea of the conditions to be contended with in eventually getting a runway over the rough shore ice to the bay ice can be visualized by reference to plate 23.[4] Tons of ice and snow were chopped down, filled in, levelled off and packed into a runway, using the tractor as a roller. At each change of tide, this runway, which extended across a beach about 200 yards long, would have up and crack until eventually after much labour it became a solid bridge of ice, rising and falling with the tide, but immune to serious damage.

(c) Winter and Spring 1927-28 - On Skis

Conditions became such that flying could he consistently carried on with using skis, at respective bases starting from and continuing to, as follows:-

Base "A" - December 13, 1927, to May 22, 1928.
Base "3" - November 23, 1927, to May 30, 1928.
Base "C" - December 12, 1927, to June 18, 1928.

From the time flying using skis became possible, every effort to carry out routine patrols was made up to January 25th, 1928. On that date instructions were received from Headquarters in Ottawa to discontinue routine patrols and carry out fortnightly patrols only until it was considered more regular patrols were essential on the commencement of ice breakup in the strait.

At all three bases regular routine patrols up to January 25th, 1928, suffered from the very bad weather conditions, especially Base "A." Snow and fog were the worst conditions met with and for the greater part of the time very low and limited visibility existed with the hills and mountains in the vicinity of the bases being totally obscured for days on end. Over the strait almost continuous fogs and vapours prevailed, no doubt rising from the areas and leads of open water.

From January 25th, 1928, to May 12th, 1928, fortnightly patrols using the best available weather were adhered to as closely as possible, but after February 21st areas patrolled over were limited following instructions received from Headquarters, Ottawa, that aircraft on patrol were to follow routes, leaving them always within gliding distance of the coastline.

On May 10th, 1928, recommendations were made to Ottawa that routine patrols should be again started and patrols carried out as often as possible, weather

[4] Original plates can be viewed in the original document held in DHH file 73-1018.

permitting. These recommendations were concurred in, and from then up to the break-up, flying was carried on with on every possible day. During this period, considerably better weather conditions were experienced and a higher percentage of flying made possible than at any other period of the operation.

During the winter and spring flying on skis, there were three occasions on which some concern was had for personnel and aircraft being away from their bases, lost or forced down by bad weather.

The first of these incidents happened when Flight Lieutenant A.A. Leitch, M.C., D.F.C., was returning from Erik Cove at Cape Wolstenholme to Nottingham Island. When about halfway across to the island snow storms were encountered and Flight Lieutenant Leitch, having flown on for a sufficient length of time to have brought him to his base, and still not sighting land, decided it better policy to land on the floe ice and await clearer weather, rather than remain in the air and consume his supply of petrol. A landing was safely effected on the floe ice, which was not very heavy (about six inches thick), oil drained from the engine and the crew made them- selves as comfortable as possible under the conditions. Clearer weather prevailed the following day and although land was not in sight, Flight Lieutenant Leitch made a calculation of his error and decided to take-off. Using the available engine heating unit carried in the emergency kit of the plane, the oil heated and the engine started without trouble. Flying as per his calculations, Leitch followed a course North-east from his forced landing point and was successful in picking up land, which proved to be the extreme North-west end of Nottingham Island. The aircraft arrived back at its base with about one quart of petrol in the tanks. The temperature at this time was approximately 16 degrees below, but only a few minor frost-bites were experienced by the personnel.

The second incident occurred when Squadron Leader T.A. Lawrence was proceeding from Wakeham Bay to Nottingham Island in early January 1928. Heavy snowstorms were encountered about 20 miles East of Cape Digges, and the pilot proceeded to return and land at Sugluk Inlet to await “letter conditions. The following day another attempt to get through to Nottingham was made and equally bad weather encountered. Decision was then made to return to Wakeham Bay, but again, snowstorms encountered near Cape Wegges forced a landing to be made in Deception Bay. Here the aircraft and crew were forced to remain for nine days during which time typical Arctic weather and storms prevailed. On the eighth day, while making ready to take-off, a search machine arrived from Wakeham Bay. By the time the machine, which had been exposed to the weather for eight days, was dug out and made ready for flight, the short day was almost over. Both machines, therefore, stayed over-night at Deception Bay, returning to their base at Wakeham the following day.

The third and last incident came very closely to a disastrous ending when Flying Officer A. Lewis, with a mechanic and native on patrol from Port Burwell became lost in heavy snowstorms on their return from Resolution Island. After picking up a point of land, which he felt certain he recognized, Lewis took up a course to bring him out at Port Burwell. After following this course until the petrol supply was exhausted, a forced landing was made on rough hummocky floe ice. The crew fortunately were unhurt and while the machine had only minor damages, it became necessary to abandon it. Lewis and his party, carrying their emergency kits, started East across the ice and only after one full day's travel in that direction did they realize they were actually on floe ice in the Atlantic Ocean off the Labrador Coast and not in Ungava Bay, as they had at first estimated. They then travelled westward for seven days, reaching the Labrador Coast after much privation and hard travelling. During this time their food supply became exhausted and they were forced to live on raw walrus meat, walrus shot by their native companion. The ice over which the party was forced to travel was very rough and highly rafted. Endless lanes of open water had to be crossed, these crossings being affected by the use of the inflatable rubber air craft carried as part of the emergency kit.

After reaching the land, Flying Officer Lewis and his party travelled north along the Labrador Coast for four days. During this time they saw no signs of life of any description, human, animal or bird, and having no fuel for their primus stove, suffered greatly from cold, hunger and exposure. On the fifth day they were favoured by fortune and came in contact with an Eskimo hunter and his wife. Through their native companion they were able to make known their requirements and arrange for food (of a kind) and transportation by dog-team back to Burwell, at which point they arrived at mid- night on the thirteenth day of absence from their base.

During the absence of Flying Officer Lewis and his party, three machines, one from each base were engaged in search by air, for their whereabouts. The period of their being lost, however, was the coldest and stormiest part of the winter and out of the thirteen days elapsed, flying was utterly impossible on all but three. Out of necessity the three aircraft were kept outside at this time and despite all efforts towards their protection filled up with fine driven snow every night, which entailed endless work cleaning them out every lay as well as warming up engines and keeping a take-off and landing runway fit.

(d) Summer 1928 - On Pontoons

The interval between flying using skis and the time of using pontoons in the Spring and Summer of 1428, varied at respective bases due to local conditions encountered. The period during which flying was impossible was as follows:-

"Base "A" - May 23 - July 1, 1928 (Inc.)
"Base "B" - May 31 - July 1, 1928 (Inc.)
"Base "C" - June 12 - June 22, 1928 (Inc.)

At Bases "A" and "B," the harbours used for flying from were in close proximity to the strait, and in consequence the ice broke up early. After breaking up, these harbours failed to clear of drifting ice which was constantly going and coming with the tides.

At Base "C" Wakeham Bay, the harbour was some eight miles from the strait and the ice actually melted away and once weak enough to be broken up by the action of the tides, soon disappeared and did not return. Only eleven days were lost at Wakeham Bay from this condition, as compared with thirty-eight and thirty at Bases "A" and "B" respectively.

From the time of commencing flying using pontoons, in 1928 until August 3rd, operations were carried out in accordance with previous original orders. On August 3rd, navigation conditions were such that further aerial observations were unnecessary, there being no ice in the strait. Recommendations were then made to the leader of the Expedition to have flying operations cancelled and to commence at once the conditioning of aircraft for the flight south to Ottawa, it then being the intention to fly all serviceable machines out from the area of operations.

(e) Closing of Operations

Although actual operations on ice observations ceased as from August 3rd, 1928, there still remained the preparation for, and execution of the return flight to the south from the scene of operations.

Instructions for the removal of all aircraft from service, for their conditioning and for report as to their serviceability before commencing this flight, were issued and the work at once proceeded with.

Through the assistance of the Hudson's Bay Company and the Northern Aerial Minerals Exploration, Limited, fuel caches were laid down at such locations as instructed from Air Headquarters, along the east side of Hudson Bay. As well as fuel, temporary moorings and emergency rations were sent to certain of these caches for placing out and storage. One officer was sent from Base "A" with the Hudson's Bay ship "*Ungava*" to supervise the establishment of caches farther south along the Hudson Bay.

On August 12th, 1928, the one aircraft remaining at Port Burwell was flown to Wakeham Bay by Flight Lieutenant F.S. Coghill.

By August 17th, 1928, all aircraft were reported as in serviceable condition to commence the flight out and a local operation order covering the flight issued, with the commencement date as August 24th, 1928, giving one more week in which to unsure that fuel caches were completed.

On the 24th and in accordance with instructions, the five aircraft, three from Wakeham Bay and two from Nottingham Island, successfully made rendezvous at Erik Cove, Carpe Wolstenholme. Here they were moored for the night, delay having been occasioned by weather conditions turning bad about noon, and engine trouble with one machine from Nottingham.

This point, Erik Cove, had been selected for rendezvous due to the fact that it was considered too hazardous to moor out and attempt to take-off five aircraft at one time from the cove at Nottingham. Also too great a delay would have been occasioned, due to existing facilities in having the aircraft take-off individually and await others being launched, taken off, and formation made in the air.

On the morning of August 25th, heavy seas were running into Erik Cove from the north-east, and made the manoeuvring of the aircraft on the water somewhat difficult. Formation on the water was affected in spite of this and take-off started. Three of the five aircraft took-off successfully, one crashed with a pontoon broken off and the other failed to got off, having engine trouble.

The three occupants of the crashed machine were taken off their now sinking aircraft by Flying Officer B.G. Carr-Harris, who landed beside them immediately on seeing their plight. Radio calls for assistance were sent out from aircraft HI, flown by Squadron Leader T.A. Lawrence, to the ships of the expedition, now located about 85 miles to the east in the strait. Signals were also given to Flight Lieutenant A.A. Leitch to return to his base, to verify the S.O.S. calls to the ships, through the ground radio station. The wrecked aircraft was salvaged and eventually loaded with others on board ship.

Examination of the remaining aircraft, four in number, found that two of them were unfit to undertake the flight south. Those machines were affected by the same trouble as the one which had crashed, that of weakened undercarriage gear and pontoon fittings.

Taking into consideration the present condition of the remaining aircraft, the large portion of the flight yet to be made, the unknown sea conditions which had to be encountered, and the known weak points of the pontoons and undercarriage gear, it was then deemed best to cancel the flight and ship the remaining aircraft out by boat.

Rather this than encounter almost certain similar troubles, in more isolated areas yet to be covered, and the loss of more aircraft and equipment.

Three of the aircraft now unfit for flight (HI, HF and HH) were partially dismantled and loaded between decks on the S.S. "*Larch*" at Erik Cove. The other two, HJ and HE, with lightened loads, were flown back to Base "C" for dismantling and shipping out on the C.N.S. "*Canadian Voyageur*." Incidentally in ensuing take-offs and landings at Nottingham and Wakeham Bay, the undercarriage gear and pontoon fittings of these two aircraft indicated signs of weakening. With the return of aircraft HW and HE to Wakeham Bay, air operations in connection with the expedition came to a termination.

Part VI – Statistics

(a) Flying time

Base "A"	83 Hrs. 46 Mins.
Base "B"	134 Hrs. 10 Mins.
Base "C"	151 Hrs. 48 Mins.
Total	269 Hrs. 44 Mins

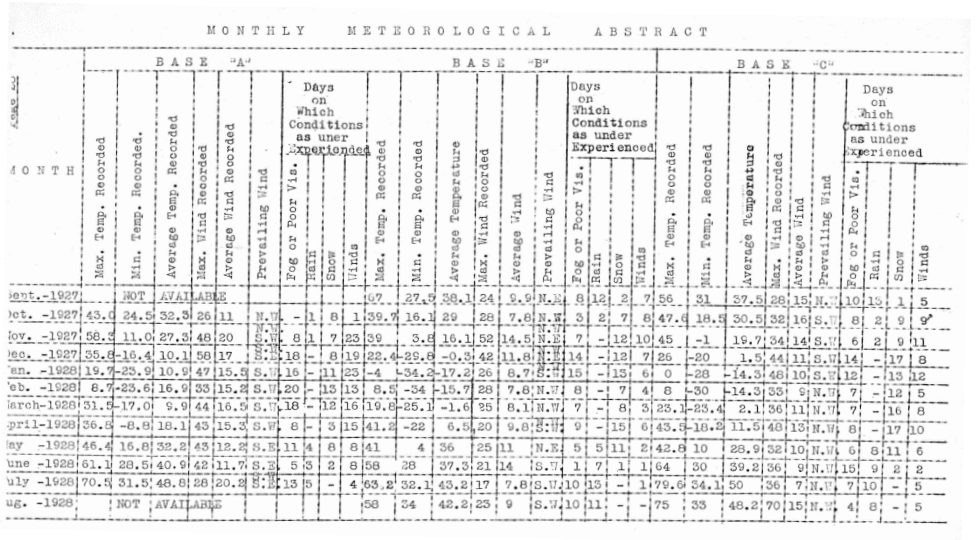
(b) Patrols

Base "A" 47
Base "B" 82
Base "C" 98

(c)Photographs – Aerial [5]

1. Base "A" – Using Fairchild Camera – 225 Exp
   Base "B" – Using Fairchild Camera – 307 Exp
   Base "C" – Using Fairchild Camera – 1024 Exp
2. Base "A" – Using A.1 Camera – 2 Exp
   Base "B" – Using A. 1 Camera – 449 Exp
   Base "C" – Using A.1 Camera – 278 Exp

[5] Note in original: "Only successful exposures recorded here. Many other exposures were made and lost due to light conditions, etc. (See part VII) At Base "A," only one A.1 camera was available and this was lost with aircraft HG, when abandoned on the ice in the Atlantic Ocean in February, 1928."



MONTHLY METEOROLOGICAL ABSTRACT

MONTH	BASE "A"										BASE "B"										BASE "C"									
	Max. Temp. Recorded	Min. Temp. Recorded.	Average Temp. Recorded	Max. Wind Recorded	Average Wind Recorded	Prevailing Wind	Days on Which Conditions as uner Experienced				Max. Temp. Recorded	Min. Temp. Recorded	Average Temperature	Max. Wind Recorded	Average Wind	Prevailing Wind	Days on Which Conditions as under Experienced				Max. Temp. Recorded	Min. Temp. Recorded	Average Temperature	Max. Wind Recorded	Average Wind	Prevailing Wind	Days on Which Conditions as under Experienced			
							Fog or Poor Vis.	Rain	Snow	Winds							Fog or Poor Vis.	Rain	Snow	Winds							Fog or Poor Vis.	Rain	Snow	Winds
Sept.-1927		NOT	AVAILABLE								67	27.5	38.1	24	9.9	N.W.	8	12	2	7	56	31	37.5	28	15	N.W.	10	13	1	5
Oct. -1927	43.0	24.5	32.3	26	11	N.W.	-	1	8	1	39.7	16.1	29	28	7.8	N.W.	3	2	7	8	47.6	18.5	30.5	32	16	S.W.	8	2	9	9
Nov. -1927	58.3	11.0	27.3	48	20	S.W.	8	1	7	23	39	3.8	16.1	52	14.5	N.E.	7	-	12	10	45	-1	19.7	34	14	S.W.	6	2	9	11
Dec. -1927	35.8	-16.4	10.1	58	17	S.W.	18	-	8	19	22.4	-29.8	-0.3	42	11.8	N.E.	14	-	12	7	26	-20	1.5	44	11	S.W.	14	-	17	8
Jan. -1928	19.7	-23.9	10.9	47	15.5	S.W.	16	-	11	25	-4	-34.2	-17.2	26	8.7	S.W.	15	-	13	6	0	-28	-14.3	48	10	S.W.	12	-	13	12
Feb. -1928	8.7	-23.6	16.9	33	15.2	S.W.	20	-	13	13	8.5	-34	-15.7	28	7.8	N.W.	8	-	7	4	8	-30	-14.3	33	9	N.W.	7	-	12	5
March-1928	31.5	-17.0	9.9	44	16.5	S.W.	18	-	12	16	19.8	-25.1	-1.6	25	8.1	N.W.	7	-	8	3	23.1	-23.4	2.1	36	11	N.W.	7	-	16	6
April-1928	36.5	-8.8	18.1	43	15.3	S.W.	8	-	3	15	41.2	-22	6.5	20	9.8	S.W.	9	-	15	6	43.5	-16.2	11.5	48	13	N.W.	8	-	17	10
May -1928	46.4	16.8	32.2	43	12.2	S.E.	11	4	8	8	41	4	36	25	11	N.E.	5	5	11	2	42.8	10	28.9	32	10	N.W.	6	8	11	6
June -1928	61.1	28.5	40.9	42	11.7	S.E.	5	3	2	8	58	28	37.3	21	14	S.W.	1	7	1	1	64	30	39.2	36	9	N.W.	15	9	2	2
July -1928	70.8	31.5	48.8	28	20.2	S.W.	13	5	-	4	63.2	32.1	43.2	17	7.8	S.W.	10	13	-	1	79.6	34.1	50	36	7	N.W.	7	10	-	5
Aug. -1928		NOT	AVAILABLE								58	34	42.2	23	9	S.W.	10	11	-	-	75	33	48.2	70	15	N.W.	4	8	-	5

Part VII – Operational and General Flying Conditions

The general flying conditions met with in the area covered by patrols of the expedition, were very erratic. Some of the conditions encountered have already been dealt with, in part, under the sub-headings of Part V, such as inter-season conditions at the freeze-up and the ice break-up. The early formation of shore ice before the harbours froze over, and the rough rafted conditions of this ice even after harbours did freeze, was a serious drawback in the fall of 1927, in that it prevented getting aircraft into the water and on to the ice for flying at the particular time when serial observations were most essential at the close of marine navigation.

Formations of shore ice and drifting ice in the harbours presented their difficulties in the spring of 1928, and caused a long break between regular patrols, particularly at Bases “A” and “B.” The spring interval during which no flying could be carried on with, did not cause any loses in the collection of in- formation as to marine navigation however, as navigation for shipping did not become fit for some few weeks after flying on pontoons started in 1928.

At no time during the flying season when ski were in use did the conditions of the ice, or snow on the ice, seriously hinder flying, and that for never more than one day at any one time, when the levelling down of a few hummocks of ice or snowdrifts soon

righted this condition. In fact, the ski flying was for the most part ideal, insofar as aerodrome conditions were concerned.

Apart from the adherent trouble experienced with weak pontoon fittings, flying using pontoons did not present any particular difficulties, other than the launching and removal of aircraft froth the water. Marine railways with trolleys were supplied and used at Bases "A" and "B." At Base "A" the use of marine railway was only possible between half and full tide. The beach formation and contour, limited the length of railway used and in consequence this condition did occasionally prevent the launching of aircraft when other conditions were suitable for flying. At Base "B" the marine railway was used with success. Here conditions were such that sufficient railway could be laid to be used at all tides. From low to high water mark at Base "C," the beach extended about two hundred yards and was covered by tons of stones and boulders from the smallest up to those weighing several hundred pounds. Insufficient railway was available to span this beach, and rather than have two modes of launching aircraft and so as to be able to make use of all tide levels, a runway about thirty feet wide was cleared free of stones, a comparatively level gravel bottom reached and the marine railway discarded. The aircraft were towed to the waters edge on the beach dolleys by the use of the tractor, and taxied into the water under their own power. Due to the exposed nature of this beach, the prevalence of on-shore winds, and the narrowness of the clearway, an extreme hazard in removing aircraft from the water was introduced. By good seamanship on the part of the pilots, combined with good handling by those in waders (and very often without) in the water, very seldom more than a few degrees above freezing point, no damage was ever occasioned to aircraft in their launching or removal from the water, although the task was hazardous and most uncomfortable.

With exception of a few weeks in the spring, mostly in May and early June, the weather was never very good for any appreciable length of time. Fog and vapour over the strait was more the rule than the exception. There were periods when the visibility was very good, but a very limited ceiling existed with the coastline almost completely obscured under banks of low lying clouds and fog.

In addition to the weather conditions encountered, actual flying was not assisted in any way by the proximity of operations to the North Magnetic Pole or by the inaccurate charts and maps. The approximate magnetic variation throughout the straits in given as 45 to 50 degrees. Four types of compasses were available for use: the Pioneer Magnetic, the Earth Inductor, the P.4 Aperiodic and the Bumstead Sun Compass (refer part XIV). The magnetic compasses were all very erratic at any time, but there were several localities where it was utterly impossible and unsafe to attempt to navigate by using them. A particularly noticeable action took place in the compasses in the vicinity of any Capes, such as Cape Hopes Advance, Cape Digges and Cape Wegges.

The maps and charts, those the only ones available, were very inaccurate. Some parts of the coastline were not recognizable when compared as actually seen and as charted. Countless islands existed which are not charted and others already charted are incorrectly located. As well, the contour of the land is not very well depicted and all of these features made aerial navigation somewhat difficult, and especially in the winter when on occasions it was almost impossible to recognize landmarks or tell land from ice when covered with snow. The only way in which one actually was able to arrive at the proper compass courses to be followed on patrols, was by making careful check and observations while flying over the patrol route on days when visibility was very good and flying from point to point within sight of each other, and noting the compass readings.

Part VIII – Photographic Conditions and Photographic Equipment

The general weather conditions which existed, as already dealt with in part VII, did not prove very fit for successful aerial photography over a very extended part of the year. On many days when patrols were made, there existed a layer of low haze over the ice and water which hindered the photographic work. This condition was very prevalent in the fall and early winter of 1927, and up to the early part of the 1928 aerial photography was practically a wash out. At that time the days were very short, and the sun, even when not obscured, was not very bright and was low in the sky. From January to August the conditions however were much better, while in May and June they were almost as perfect as could be desired for a fairly large percentage of the days.

Two types of aero cameras were used: the Fairchild Hand-Held oblique camera, Navy type, 5 x 7; and Eastman A.1 Oblique, 4 x 5. The Fairchild cameras gave endless trouble, due to mechanical failures and their susceptibility to the cold, jamming and failing to function in even moderately cold temperatures. Many opportunities of procuring useful photos were lost on this account, and this type of camera is certainly no recommended for use, at least not where liable to have to contend with strenuous conditions.

The A.1. Camera was used considerably more than was anticipated, due to the failure of the Fairchild, and never gave any trouble. The great majority of the exposures made with A.1 proved successful, although when functioning the Fairchild camera did give much superior results.

Apparatus and supplies for the developing and printing of the aerial photos in the field were available, but it was found inadvisable to do this work under existing

conditions. Climatic conditions together with the temporary nature of the buildings subjected rapid changes of temperature in the dark room and jeopardized the exposed film. As well the water supply for washing film was limited and none too clean, being surface water. Rather than risk the loss of exposed film, endeavoring to develop it in the field, the greater part of it was carefully packed and set aside for finishing where proper facilities existed. A few of the Fairchild rolls developed and printed at the bases did, however, turn out very good and served to give us some idea of the results being obtained.

Part IX – Aircraft and Aircraft Engines

The Fokker Universal type aircraft proved to be a very satisfactory type of machine. They had two faults worth recording: the first, their unsuitability as a photographic job, and the second, structural weakness of pontoons and pontoon fittings when used as a seaplane. One is of the opinion though that the most suitable type of aircraft for use in this area would be an amphibian flying boat fitted with skis in place of wheels.
All photography was carried out with the camera projecting through the window in the door. Exposures could not be made looking direct at right-angle to the machine, without bringing the rear wing strut into the photo. To avoid this, the camera had to be pointed slightly to the rear and it became hard for the photographer to always get his camera into the same position, where tilt, etc., were required to identical. The isolation of the pilot from the operator of the camera is not to be desired, as it leaves too much to guess work as to what is going on and what progress is being made.

On two occasions the undercarriage gear fittings broke away from the skin of the pontoon. On the first occasion it was-possible-to beach the machine under its own power and save it from being submerged. On the second, the machine was considerably damaged. This trouble was noticeable on every pontoon used, an occurred at the rear fittings. The pontoons themselves were by no means strong enough, and the workmanship where the joints were rivetted was rather questionable. Before being used, all pontoons were given a thorough coat of white lead and linseed oil applied to the joints and rivets. All the pontoons leaked slightly, some of them excessively.

The wood veneer wings stood up to the rigors of the climate very well, and all were in good condition at the completion of operations. Regular applications of varnish ensured better and longer life for this type of wing. The open pilots cock-pit was not uncomfortable even in the coldest weather, and it did have one distinct advantage in that the pilot's view was unrestricted and facilitated flying in thick weather. The performance of the aircraft was very good, particularly on skis. It was always possible for the machines to take care of the loads required to be carried.

Flat bottomed skis only were used and they were found to be very successful. They did have their weak points, such as insufficient overlap of the dural bottom over the wood filler, cone bolts too light and insufficient rivets on the top of the cone. These weak points developed when the skis were under extra strain due to no allowance having been made for the dish-in of the undercarriage of the Fokker, and consequently the skis always riding up on the inside edge instead of sitting flat on the snow.

One is of the opinion that for flying using skis, where hard surfaces of snow or ice conditions prevail, the flat bottom ski is preferable over the corrugated, and maybe oven in deep or soft snow. Comparative tests should be interesting and instructive providing carried out under identical conditions. The use of cable and shock-absorber as ski bracings is also recommended rather than the metal stiff leg with the double spring. The latter introduces the use of cancelled units subject to breakage while the former is equally effective, and is always in open view for any defect which may develop.

The Wright Whirlwind engines used, both of the J 4 3 and J 5 C types, gave every satisfaction and were extremely easy to maintain. Other than keeping careful check on valve clearances, the oiling system and the regular cleaning of petrol and oil filters, very little maintenance was necessary. On only one occasion did a forced landing occur due to engine trouble, and on this occasion the engine did not suffer complete failure. One distributing nozzle in the carburetor on a J 4 3 vibrated loose and dropped into the bowl of the carburetor. The pilot managed to keep in the air for about 15 minutes after first developing trouble and succeeded in getting back to within a mile of his base.

The only discrepancy worthy of note in respect to engines was the winter cowlings supplied. These were insufficient, in that too much of the cylinders and cylinder head were left, exposed, and the engines did run rough in cold weather due to insufficient protection from the cold. Engine starting in cold weather never presented any difficulties worth mentioning, after a few early experiments. At no time were the machines in a heated storage and the engines were always subject to the existing outside atmospheric temperatures. In temperatures above freezing and sometimes even with 5 to 10 degrees of frost, the engines were not artificially heated. Oil tanks were filled with heated oil, engines primed and started from the cold condition. While the oil was being put in the tanks and the engine primed, two men were detailed to keep turning the air-screws over by hand to supple up the engine and thus throw less strain on the inertia starter, A good plan when starting the engine in a cold condition is to place a piece of rag over the carburetor air intake removing it immediately the engine starts. The proper amount of priming required will vary with every engine and

type, and some time mu be taken for personnel to familiarize themselves as to how much is required. For this reason it was found most satisfactory to have the same personnel start the one engine each time. Originally the J 4 B engine could be primed to three cylinders only. With the coming of the cold weather three additional cylinders were modified for priming, making six in all.

As a rule in temperatures below freezing an always when more than 10 degrees below, artificial of engines was resorted to before attempting to start them. Heat was induced to the engine by means of an asbestos engine cover or bag and blow torches. The asbestos bag used fitted snugly around the engine especially in front and was laced on in a method which could lend itself to rapid removal, this for two reasons, in case of fire and also for speed in getting the engine started once heated. The bag should not fit too snugly at the rear, so that a draft may be created and condensation within the heating bag allowed to pass out. The asbestos bag used, was of double thickness with an interlining of fire-proof wool. Actually the type used was too heavy. Single thickness of absence would suffice as there is no necessity to use it as a thermos unit, and when always required as part of the emergency kit carried, should be as light as possible. At the bottom of the bag was left a hole large enough to permit the insertion of a seven inch stove pipe, through which the heat was carried to the engine from two half-gallon blow torches. The torches were not permitted to blow directly up the pipe but around an elbow, and a piece of wire gauge was placed in the pipe as a prevention against sparks penetrating into the bag. During the heating process, which lasted for approximately 30 to 40 minutes, the airscrew was intermittently turned over by hand, and when sufficiently supple indicated the engine was ready for starting. For a-time the practise of removing one bank of plugs while the engine was being heated, was followed, but this was found to be an entirely unnecessary, and in very low temperatures, uncomfortable procedure. When the engine was warm and supple, warm oil was put in the tanks, the bag removed, engine primed and started with little effort. On only one occasion did an engine fail to start after being heated in this manner, and that after one machine had been exposed to the weather for nine days during a forced landing, on account of bad weather. This failure was not due to the system being bad, but rather that at the time of applying it a 20 m.p.h. wind was blowing with the temperature 25 degrees below zero, and the blow torches were so badly affected by the wind that their proper heating capacity was handicapped.

In zero temperatures and down to about 10 degrees below, a mixture of oil about one part medium to two parts Arctic was used. Under 10 degrees below, a mixture of about one part medium to five parts Arctic was used. These mixtures were found to be better than pure Arctic and gave a smoother running engine with a more normal oil temperature and pressure. It is not considered the Arctic oil by itself has sufficient body.

Carburetor air intake heaters were supplied and used on some engines. Both J 4 B and J 5 C engines were used throughout the winter season with and without these heaters, and in every case functioned well, giving no carburetion troubles on this account. Ground temperatures as low as 36 degrees below zero were encountered, and in this weather altitudes of 8,000 to 10,000 feet were sometimes attained. At these altitudes where temperatures would range around 56 degrees below, the engines functioned perfectly either with or without the intake heaters. When heaters were not applied, the carburetors were reversed so as to leave the air scoop pointing to the rear.

The proportion of aircraft spares and engine spares carried, about 20 percent, preyed ample and at no time during the expedition were operations held up or even endangered through the shortage or possible shortage of spare parts.

The flexible metal exhaust and cabin heating lines as supplied with the Fokker Universal are very poor. These lines are very hard to keep secure and are subject to very rapid deterioration, both from the heat of exhaust gases and from exposure to salt water and salt water atmospheres.

Thomas Lawrence in front of a Fokker Universal on skis near Base "C," Wakeham Bay (Kangiqsujuaq). *Canadian Aviation Museum HSE-A11-P94.*

Part X – Aircraft Emergency Equipment

The following is a list of emergency kit carried in each aircraft on operations: -

Items	No. of	Weight	Remarks
Engine heating bag	1	22 lbs.	Winter months
Engine cover	1	4 lbs.	Summer months
Blow lamps, ½ gal.	2	21 lbs.	Winter months
Stove pipe, lengths, and one elbow	2	3 lbs.	Winter months
Primus stove, in metal case	1	6 lbs.	Year round
Coal oil, in container, gals.	1	8 lbs.	Year round
Lubricating oil, in container, gals.	2	23 lbs.	Year round
Engine tool kit in canvas roll	1	35 lbs.	Year round
Rubber aircraft with accessories	1	14 lbs.	Year round
Distress signals	4	12 lbs.	Year round
Rifle, .303 with 50 rounds ammunition	1	15 lbs.	Year round
Picks, ice	2	2 lbs.	Winter months
Hunter's axe	1	2 lbs.	Year round
Sheath knife	1	½ lb.	Year round
Sleeping bags (Arctic)	2	16 lbs.	Year round
Ropes, lengths of 30 feet	2	10 lbs.	Year round
Anchor and 10 fathom rope	1	65 lbs.	Summer months
Bilge pump and 6 foot hose	1	6 lbs.	Summer months
Water bottles, filled	3	12 lbs.	Summer months
Lucas signalling lamp	1	6 lbs.	Year round
Packsacks	2	4 lbs.	Year round
Native snow knife	1	1 lb.	Winter months
Sponges	3		Summer months
Minor engine spares, tape, etc.		4 lbs.	Year round
Snowshoes, pairs	3	12 lbs.	Winter months
Silk tent with one collapsible pole	1	12 lbs.	Summer months

In addition to the above listed, the following items weighing about 12 lbs. were carried at all times:-

> One pocket compass, six candles, one small medical kit, one box matches, three individual mess kits, three message bags, two loather chamois, one funnel, one flashlight with batteries, and one empty 4 gallon oil container.

The items of rations carried were of sufficient quantities to provide for three men for at least ten days, and were as follows: -

Bull beef in 1 1b. tins	12 lbs.
Hard tack biscuits	12 lbs.
Tea	1 lb.
Chocolate	3 lbs.
Bacon, sealtite	8 lbs.
Pork and Beans, medium size tins, 3	6 lbs.

In addition to all the above items under this part heading, pilots were advised to carry some items of clothing, such as sealskin boots, sealskin mitts, one pair of canvas pull-ever pants, a few pair of duffle mitts and socks, and a parka of native design. In event of a forced landing this clothing would have been much superior for hiking in, than flying clothing. Personnel flying in the unclosed cabin could always dress in clothing suitable for hiking in here it might be mentioned that the regular plane crews consisted of the pilot, a fitter, and an Eskimo [Inuk]. The latter was taken along as a helper and for his knowledge of conditions, hunting, etc., peculiar to the country. The benefit of this policy was vividly justified in the case of the experience of Flying Officer Lewis in February, 1928.

The remaining equipment carried in the air- craft was the radio set and accessories. The CT21A set, available for use by either key or voice, was used, and wireless communications from air to ground were successfully maintained on 98 percent of the patrols. Signals by key were possible and reliable up to 500 miles; by voice, up to 150 miles, but the latter was net as reliable and its use except on occasions for test was avoided. The trailing antennae was used.

During the operation the R.C.C.S. Officer of the expedition developed and tested a modification for transmitting signals from aircraft at rest on the ice or snow. By using a Ford spark coil attached to the C.T.21A set, successful signals were transmitted up to 45 miles. The regular trailing antennae as installed in the machine, strung from the machine to a pole the polo from the tent carried in the emergency kit) was used for these tests.

The items of emergency equipment used were all very satisfactory and one cannot at the present time really offer any recommendations as to improvements which might be incorporated in future kits of such a nature, but for one item, that of modifications to the sleeping robes to have an oiled water-proof covering, and instead of using "lift-the-dot" fasteners, substitute by small snaps and hooks. The robes should also be so made as to be adaptable for opening out and fastened together. This makes for a very comfortable bed for three people by using two robes.

Two main items for the pilot of a machine to ensure, besides a regular check to see that his emergency kit is complete, are: (a) to regularly open up and inspect his

aircraft, and (b) in event of a forced landing, to immediately commence personal supervision of the consumption of fuel and rations. The aircraft should really be left unfolded when not required in the machine, and unless personal supervision of fuel and rations is maintained, these items may be wasted or improperly rationed out, especially when there is an Eskimo [Inuk] in the party.

While a jack was not always carried in the machines yet, it is recommended for the following reasons. If necessary to abandon an aircraft during the winter months, one ski could be detached and used as a sled. For this reason the ski should be so constructed that the cone and axle fitting can be easily removed and a few small fittings installed on the flat portion of the ski for the attachment of a drag rope and fox lashing the load (emergency kit) to the so provided impromptu sled.

Part XI –Flying Clothing

Some items of clothing for cold weather flying were made up to special requirements and others of regular issue wore used. The clothing is dealt with by item.

Underwear

Three kinds of underwear, silk, medium weight wool, and chamois, were used and all found very suitable for use in various combinations according to degrees of cold weather experienced. In extreme cold all three were used and were not too bulky. The silk and wool suits were provided in combination pattern, the chamois in two pieces, shirt and drawers. The first two types are easy to wash; the third, chamois, soils very easily and is hard to wash. The most effective way to wash it is in only luke-warm water using plenty of lux. It should not be wrung dry, rather squeezed and while still damp stretched before hanging to dry.

Socks

No special socks were provided, but after becoming acquainted with the Eskimo [Inuit] duffle socks, these were worn and found so suitable as to be highly recommended for use. These socks are made of white wool similar to that used in the Hudson's Bay Company's 3-½ point blanket. The natives made them in three patterns: short or ankle length, half-leg length, and knee length. Two pair, one of the half-leg and one of knee length, were usually worn, and were always found comfortable when under proper outside footwear.

Outer Footwear

The boots recommended for cold weather flying are moosehide or deerskin moccasins under the present type of sheepskin lined leather outer boot. This combination, the

duffle socks, moccasins, and sheepskin lined outers, will suffice in the coldest weather on which flying can or will be carried out. Care must be taken though that the footwear does not fit tightly.

Shirt

No special shirt as an item of flying clothing was supplied, but a grey flannel pattern, which was issued as an item of regular clothing, was always warn summer and winter and proved very comfortable. This is not considered to be a necessary item of flying clothing, but when dressing personnel for special flying in cold weather, it certainly should be considered.

Breeches.

A special type of breeches made of suede leather ware supplied to the flying personnel of the expedition. These breeches were of a loose fitting out with a high waist similar to jockey's breeches. They were found to be Gory comfortable, warm, light, and wore extremely well. I personally lined mine with a pair of chamois drawers and found the effect very good in that it combined the two pieces and facilitated getting them on and off.

Sweater.

The regular pattern, dark blue sweater with deep collar, was already approved for issue as part of flying clothing kit in the R.C.A.F., is very efficient and one can see no room for improvement in this respect.

Sidcot Suit.

A special sidcot ["Sidney Cotton" flying] suit with whipcord legs and lower body and leather upper body was used. Slashed legs and sleeves and one opening up the front from the crotch to the left shoulder were incorporated, and zip-fasteners used on the openings. The whole inside of this outer suit was lined with suede leather. The outer suit was also fitted with a turn-up beaver lined collar, which was so out as to button well back on the neck and leave no front opening.

An inner detachable combination suit made of eiderdown was supplied for wear under the above outer suit. The legs and sleeves of this inner suit were also slashed and had zip-fastener attachments as well as the frontal opening from crotch to neck. No collar was attached to the inner suit.

These sidcot suits were undeniably warm but much too bulky, uncomfortable in fit, and too intricate in design for ready donning and removal.

Handwear

A special type of one finger and thumb leather gauntlet with a suede lining, beaver fur on the bank of the hand and having a long cuff fitted with zip-fasteners, were

provided for cold weather flying. The intention was to use an inner one-finger and thumb Jaeger glove, but this combination proved entirely unsuitable and was discarded; they were cold and very awkward to get on. A dog-skin gauntlet used with a Jaeger inner mutt was also found unsuitable being very cumbersome.

One procured a pair of Eskimo [Inuit] duffle mitts, made of the same material as the socks, with an outer pair of mitts made of dressed deerskin, and found these to be comfortable and pliable. There were no separate fingers in these mitts and no cuff attached. Around the wrist was a fringe of dog-fur, which gave ample protection against drafts up the sleeves.

Headwear

A special leather helmet with lambskin lining was used and, but for weight, found suitable. For extreme cold weather this helmet should have been made of heavier leather. The lambskin lining is exceptionally comfortable. The main features to be considered in the flying helmet are for a low and snug fit across the forehead and also around the nape of the neck, and a well lined chin strap. A badly fitted and unlined chin strap will cause great discomfort.

A chamois face mask of the old issue type with nose and chin covering, was originally supplied. These were a very poor fit and the nose piece tended to collect the breath, which penetrated up under the goggles, causing the latter to fog. One of these masks was modified, taking off the nose piece and cutting the remainder of the mask to a snug fit down the cheeks and around the chin. By using the fur-Lined mask type goggle and this modified face mask, the nose was sufficiently protected and only the mouth left exposed. A good application of mentholatum afforded the lips protection from the cold and prevented them drying and cracking.

As mentioned [later], the fur-lined mask-type triplex goggles [were] used and found suitable. They did tend to fog up but with care this tendency could be eliminated. It was found that by carefully drying the goggles off with a clean dry, piece of silk, and then leaving them outside in the cold where they would not come in contact with anything until pulled on over the eyes immediately prior to taking off, that they did not fog up. At least not to any appreciable extent and then immediately on pulling on, and even then they cleared almost immediately. Certainly the goggles should not be worn pushed back on the head and expected not to fog up. In very bright weather, when the snow and ice prevailed, tinted goggles proved the best. At all other times the plain triplex was most suitable.

General Remarks on Flying Clothing

On February 19th, 1928, with a ground temperature of 30 degrees below existing, there was occasion for a flight of three hours and forty minutes duration. During the greater part of this flight an altitude of 8,000 feet was maintained, when the temperature was approximately 56 below zero, and on landing the pilot was very comfortable. The following clothing was worn by the pilot, silk underwear under medium weight wool under chamois, leather breeches, flannel shirt, wool sweater, duffle socks, moccasins and sheepskin lined flying boots, deerskin mitts with duffle inter-lining, leather lambskin lined helmet, face mask as modified to fit, fur lined mask goggles and outer sidcot suit. The inner eider-down suit was not worn. This combination of clothing supplied ample warmth and allowed free movement of the body. It is considered that the trend to heavy outer sidcot suits is not desirable, but that for every exigency in cold weather flying, more under-clothing of a light, warm, and pliable nature and an outer-suit for a windbreaker only, is more desirable and efficient. One is also of the opinion that experiments should be carried out with items of flying clothing as described [below].

A light windproof, two-piece, outer flying suit, worn in pajama style with the upper portion designed after the Eskimo [Inuit] parka without the hood, but rather with a deep collar adjustable by means of a draw-string, is recommended. The pant portion should be made free and fasten around the waist with a drawstring, the top portion long enough to tack under the pants. The shirt cuff and the pant legs should be made to fit snug, adjustable by either elastic or short zip-fasteners, and the shorter the fasteners the better. This type of suit should be sufficient with proper underclothing of the foregoing types and should be very easy to put on and take off.

Deerskin mitts with long cuff and chamois lining should prove suitable. Summer deerskin only should be used as the hair comes out of the winter deerskin.

Suede face masks made to individual fits piece with no nose and a fringe of clipped wolverine fur around the sheets and chin are considered worthy of trial. This far does not frost up from the breath.

Part XII- General Equipment and Supplies

Aerodrome, Barrack and Rations

One Fordson full-crawler tractor was used at each base and their utility cannot be too highly stressed. Without them the unloading and establishment of three bases could not have been accomplished in the one season, so great was their value in speeding up work and in carrying out heavy towing. During the cold weather they were very hard to start if not left in a heated place. At Base “C” provision was made to allow storage

for the tractor in the heated engine workshop, and no trouble experienced when it was required. Very little mechanical trouble was experienced with them and a very limited supply of spares with exception of one item, brake lining, proved sufficient.

A motor boat of a cabin cruiser type powered with a 40 h.p. Thornycraft heavy duty engine was provided each base. While very manoeuvrable, the boat was too heavy and unless where good facilities were available for their removal from the water, this task became heavy and hazardous. The motor was very hard to start in cold weather and badly installed. There were two cases of broken wrists from back-fires when starting the engine in cold weather. It was almost impossible for the person starting the motor to clear himself from the flywheel in event of such back-fires. The whole difficulty could have been remedied by the provision of self-starters. For use around a seaplane base, a smaller power boat is recommended. One weighing no more than two tones and powered with a lighter and more accessible motor, equipped with a make and break ignition system is more preferable. One has had several experiences of encountering difficulties with magneto and battery ignition systems, from spray in rough seas and at the same time seen others using the make and break systems in less protected boats running along without any troubles at all, and appear to be able to start them at will under adverse conditions. The motor boat spares carried proved ample. Two motor boats were driven on the beach and badly wrecked at Base "C," one in 1927 and one in 1928, through breakages of mooring chains. In both cases a lighter type of motor boat would have been saved.

Gasoline and oils used were very good. Ethyl aviation gasoline, fighting grade to specification P.1E and Mobiloil B, BB and A grades of oil were used in aero anginas. All oil was supplied in four gallon tin containers packed two containers in one wood case. These oil containers and cases were sufficiently heavy and strong to withstand the handling and weather. A percentage of acre gasoline was supplied packed in like manner, but neither the tin containers nor wood oases were of as heavy a quality and there was a large loss of gasoline from broken cases, cracked and punctured tins. Had the gasoline been put up and packed in containers and cases even as heavy as those containers and cases as the oil, this loss would not have occurred.

Marine railway for use instead of slipways was supplied in units. Ten foot lengths of timber (10″ x 10″), with the rails already bolted to them, were shipped in. Where it was possible to use this railway it was easily placed, the lengths of timber and rails being standard and readily bolted together and cross braced by means of spreader rods. A four wheel trolley capable of accommodating the motor boat and equipped with extensions to which pontoon cradles were bolted for handling of aircraft, was available. This trolley was extremely heavy and cumbersome and might have been quite useful and yet built lighter. When it was not possible to use the marine railway, short two-wheel individual pontoon dolleys were used with success. These dolleys had

one fault, that of being improperly designed to permit even balance of the aircraft, which was always nose heavy on the dolleys, necessitating very careful handling.

Two four-ton hand wench derricks were supplied to each base. One of these derricks was erected as closely as possible to the high water mark, the other placed in such a position as to be available for hoisting of aircraft or engines, immediately between the two hangars, which faced each other. The derricks were of a useful type.

Shop equipment, tools (both carpenter riggers and fitters), rotary gasoline pumps and other minor aerodrome equipment was supplied in quality and quantity similar to those types and scales prevailing throughout the R.C.A.F. and in every case proved adequate for every purpose.

In addition to a supply of pyrennes and large chemical fire extinguishers, one small Evinrude pump engine with one thousand feet of hose was available as fire fighting apparatus. Occasion never occurred when the fire fighting apparatus was required, but it is not considered that the quality and quantity could have been improved on.

Barrack equipment on a scale of Army Issue was provided to each station, which was augmented by a few items as camp chairs, Hudson Bay woolen blankets and other supplies tending to make living conditions more comfortable in such an isolated area. In any event the supply proved adequate and no undue discomforts were suffered by personnel.

For recreation and amusement, boxing gloves, indoor baseball and bats, footballs, medicine balls, punching bags, cards and radio broadcast reception sets were supplied. With one exception all these items served a good purpose. The exception was the type of radio set (a Marconi 8 tube super-hetrodyne) and it proved to be a most undesirable type for suitable reception.

Among the requisitions for equipment was one asking for the supply of a small library to each base. Those responsible for the ultimate approval of requisitions were not in agreement with this particular one and in the end the libraries were supplied by the Department of National Defence. One can assure those responsible for its supply that such a library was highly appreciated. It is hard to surmise how man, hours spent by personnel in reading and study would have been passed without the necessary material, an even what might have been the result of so many vacant hours to be whiled away. Very few personnel supplied themselves with reading material of any extent, and many were not in a position to do so. No expedition should be sent to locate in isolated areas without a library, which may be small but should be comprehensive.

The scale and supply of rations proved ample in quantity and left a large surplus. The surplus, however, consisted of the more staple items of food, such as flour, sugar, bully beef, biscuits, and a few items of tinned goods, and actually represented an emergency supply, which was essential. There was a. lack of variety among the rations. This should be stressed in supplying future expeditions. The noticeable lacking item was fresh meat. This supply could be arranged for by taking along beef, sheep, and hogs on the hoof, with a supply of stock food. These animals could lee killed immediately the cold weather set in and the meat kept indefinitely. The cost so entailed would not be as great as an excessive supply of canned meats, stock on the hoof being comparatively cheap.

Part XIII – Buildings

The following buildings of which blue prints, plans, specifications, etc., are held by the Chief Engineer's Branch, Department of Marine, were provided for and erected at Bases "B" and "C." Only those marked X were erected at Base "A," another large building being available for living quarters suitable for all personnel, and the blubber house not being required:-

Officer's Dwelling.
Men's Dwelling.
X Two Hangars.
X Stores Building
X Power and Radio House.
Blubber House

With the exception of finishing material, sheeting, flooring, etc., the majority of construction materials for these buildings was cut to size, bundled, and marked for respective buildings and bases before leaving Halifax. Considerable handling and time was thereby saved when the scene of operations was reached.

The two dwellings were of similar exterior dimensions, but differed slightly in interior layout. Airmen, storekeepers, other ranks of the R.C.C.S. and cooks were quartered in the men's swelling. As well, the mess room, kitchen, and pantry, were in the same building. Service officers, doctors, and civil wireless personnel (latter classed as officers) were accommodated in the officer's dwelling and in the same building was located a common living room, an operating room and medical stores. Each living building had a section reserved for storage of food supplies of such a nature as to require protection from frost.

The dwellings were fairly comfortable, but during periods of cold weather, when high winds prevailed, it was found difficult to keep them at a suitable temperature. This

could have been remedied by the use of felt or rubber weather stripping on windows and doors, had such stripping been available. These buildings would undoubtedly have been more comfortable if the outside walls had been lined with beaver board instead of tongue and groove sheeting. As well, the beaver board would have been cheaper and made the construction more fireproof. The sheeting opened up badly when dried out, leaving large cracks in the walls. During the wet season, the roofs leaked considerably. This latter discrepancy was due to poor workmanship in the laying of the roofing paper rather than to poor material.

Where it is necessary to accommodate so many personnel under isolated conditions for such an extended period of time, it is considered that smaller buildings of a standard size in larger numbers would be more desirable for the following reasons:-

(a) Permits of more rapid construction.
(b) An easier and more even distribution of heating can be obtained.
(c) Elimination of an enforced degree of fraternization among officers and men and permits of more privacy, a desirable factor from the view point of all ranks.
(d) Affording a higher degree of safety in event of fire, in that an opportunity of confining the fire to one smaller portion of the camp is possible.

The hangars provided were very adequate for the housing of aircraft. They were of wood construction with steel girder bracing over the doorway. This steel girder construction came in four sections, which were fitted together on the ground and raised into place as one unit, by use of a derrick. The type of aircraft, being monoplane, permitted of a "T" shaped entrance. The entrance was closed in by means of curtains, which were operated by means of several ropes running through overhead pulleys. The curtains were originally supplied in three sections, two side and one centre, with gas piping sewn into each section to give rigidness and strength. It was afterwards found more satisfactory to stitch the curtains together and operate them as one. When left separate the wind penetrated the openings, causing excessive flapping and a greater tendency to rip. Pieces of canvas were permanently fastened to the front upper corners of the hangars and were left as flaps to prevent the wind getting behind the ends of the curtain. The two rear corners in each hangar were available for work shops and were partitioned off, floored, ceilings put in, and made suitable for heating. Carpenter shops, engine shop, aircraft spares, store room, photographic room, and, as well, a general room for a wash-house, were thus made available. The main part of the hangars was not heated.

The one stores building proved adequate, although as a precaution in case of fire and for the protection of perishable goods, two smaller buildings would have been much better. One of these could have been provided with heat for storage of perishable goods and eliminated using part of the dwelling for such use. The other could have

been left unheated and used for storage of such supplies not damageable by frost. The storage of supplies in living buildings is not desirable as it originates an atmosphere of an unpleasant nature (as from potatoes for example) which is unpleasant and cannot be overcome. At Base "C" the potatoes were stored in the end of one dwelling and, in the late winter and early spring, hundreds of small flies were prevalent, coming from the potato barrels.

The power house at each base housed all the radio transmitting and reception apparatus together with the power units. Electricity was available for lighting purposes, being generated by the same motors as used for radio power. This building was quite adequate in size but like the dwellings the inside walls opened up badly making them cold and the roofs were also leaky.

The blubber houses as supplied were un-required buildings insofar as their use for storage of blubber was concerned. Three tanks were sent in for erection in each blubber house. At Base "C" these tanks were erected and left outside, well away from the buildings and suitable covers or lids made for them. This method proved adequate for storage of dog food without placing the tanks inside a building. The building was then papered and lined inside, extra flooring put down, and used as a living quarter. It was easily the warmest and most comfortable building on the station and large enough to house four man without cramping. It was easily heated by a small-sized Quebec heater.

Part XIV – Aircraft Instruments

The supply of aircraft instruments was inadequate in some cases, due to the extreme cold, vibration and mechanical breakages, making inroads on the original supply. This did not cause much inconvenience, however, as tachometers and watches were the instruments with which trouble was experienced, and the lack of these particular instruments was not so keenly felt.

Oil temperature and pressure gauges, air speed indicators, and bank and turn indicators functioned perfectly at all times. This latter instrument is a very valuable one indeed. It provided an excellent check when flying in weather when no horizon was visible, a condition often encountered, and also gave an excellent indication when local magnetic attractions were affecting the magnetic compasses.

At no time did the Earth Inductor Compass function properly and it could never be relied on. One of this type of compass was used at each base with no satisfactory results. Personal experience with this compass in aircraft HI always proved unsuccessful and if the compass had been followed as a guide, one would have flown

in a continuous long left hand circuit. Frequently flights were made from point to point and a magnetic reading taken. This was checked against a dead reckoning of the same course, and found almost identical. The Earth Inductor Compass was then set for flying the same course and would still indicate one to be veering several degrees to starboard of the proper course. The Earth Inductor Compasses were eventually removed from aircraft to reduce weight.

The Pioneer Magnetic Compass was found to be too readily affected by local conditions and not very trustworthy where magnetic variations were so great.

The P.4. Aperiodic compass gave entire satisfaction and when used in conjunction with the Bank and Turn Indicator, could be relied on with safety.

One Bumstead Sun compass was supplied to each Base, but only used at Base "B." It was not used at other bases sue to lack of a suitable position to mount it with effect and yet be within the pilot's range of view. In any event when conditions were such that the sun compass could have been used it was not required. On clear days suitable for using the compass, some landmarks were always within view to navigate by. There is no doubt, however, that with a navigator and when flying for extensive periods of time out of sight of land or landmarks and with the sun shining, that the Bumstead Compass is a very fine navigational instrument.

Part XV – Medical Equipment

The medical and surgical equipment supplied was found to be most adequate for the needs of personnel at all Bases. An emergency operation could have been carried out or any fracture treated favourably with the supplied surgical equipment, the drugs were comprehensive and the quantities sufficient. There was a large surplus of certain items in both surgical and medical equipment. This was due to the fact that there were practically no accidents, only one major operation, and very little sickness among the personnel, rather than to an over-estimate of the quantities required.

Situated as some of the bases were, in a moderately-sized native Eskimo [Inuit] community, larger quantities of certain drugs would have proved an asset in the treatment of diseases peculiar to the natives. The amounts of atropine, castor oil, and cod liver oil supplied were inadequate for the treatment of the eye disease, intestinal disturbances, and deficiency disorders so prevalent among the natives. The younger native children were found to be in sad need of surgical attention to their adenoids, as chronic nasal discharge and Ottis Media were very common.

There was found to be considerable tubercular, pulmonary joint and glandular diseases among the natives, but for suitable treatment of these conditions a small hospital would be necessary.

These native problems are entirely apart from this expedition but are mentioned here for the guidance of any future medically equipped operations where Eskimos [Inuit] may be met with and lived among.

Part XVI – General Living Conditions

The general living conditions at all three bases were very much on a par. No direct sense of isolation was actually felt as there were sufficient personnel to eliminate, to a large extent, that feeling of monotony which would culminate from a very few people living together under similar conditions. There did exist a feeling of resentment held by certain of the civil personnel towards the service officers in charge at respective bases. This was not of necessity a result of the nature of the living conditions nor locality, and would have taken place even in civilization as it arose from the matter of command. Further reference is made to this item in paragraphs 168 and 169 of this report. There existed a hearty co- operation between the officers and men of the service units engaged on the expedition. The discipline and esprit-de-corps was very good, there being only one instance where a charge sheet was required and that within a few days of the completion of the expedition. One has no hesitation in commenting that, but for the initiative, work and example set by the service personnel (all ranks) of the expedition, the three bases would not have been established in 1927.

As has already been recorded, the quarters were such that no great discomforts were bad. Messing did lack in variety and fresh meat. Aquatic game existed in quantities, such as seal, white whale, walrus and occasional fish, the latter being more plentiful at Nottingham Island than the other bases. One has to acquire a taste for any these foods, other than fish, and the acquirement might be made easier were no other food available, even canned sausage. Seal liver does make a very palatable dish and the seal flesh quite passable when properly prepared. Its preparation seems to be an art. In the vicinity of Bases “A” and “B” there existed, in season, sufficient amounts of land game such as white bear, ducks, and ptarmigan, with an odd caribou at Nottingham, to provide a reasonable quantity of fresh meats. At Wakehan Bay land game was very scare and the lack of fresh food much more keenly felt. An instance of conditions occurred in December 1927. The R.C.M.P member of Base “C” made a 21 day hunting trip to the south of Wakeham Bay. This trip was made by the constable with one native and dog-team, with sufficient rations for about one month. They returned to the base after their 21 day absence and reported never having their rifles out of

their cases. During their trip they had been inland for about 200 miles. They did manage to catch five fish.

For pastime the personnel had their sporting equipment, ... libraries, radio, and certain personnel had skies and snowshoes. Some had even taken along a few golf clubs, and strange as it may seem this game could be indulged in for considerable periods of time during the winter months. The snow on the bay ice at Wakeham for the greater part of the winter presented a hard wind-packed surface, and with the balls painted a dark colour, golfing was not at all impossible. All personnel had keenly looked forward to the coming of the trapping season, and on its commencement the setting and visiting of traps originated one more source of sport and exercise. Unfortunately the season proved to be a very poor one and continuous hikes to find empty traps, more often lost ones, brought this pastime to a somewhat early close.

There was one fatal casualty on the expedition, that when an oiler of the Icebreaker "Stanley" fell into the crank-pit during the first night out from Halifax, from which port the expedition sailed on July 17, 1927. There were no injuries from flying accidents and only two minor injuries among permanent personnel of the expedition. These were two broken wrists, both occasioned by back-fires of motor boat engines. The health of the personnel was extremely good, noticeably free of even colds. There was one case of scarlet fever at Base "C," but this was confined to the one isolated case.

At none of the bases was any great inconvenience or trouble experienced by personnel coming into close contact with the natives. Occasions did arise but the presence and assistance of the R.C.M.P. constables helped to hold these to a minimum. Native families were employed at each base, the men assisting in general work around the bases and driving dog-teams when required. The women made and repaired items of clothing, such as boots, mitts, socks, and [parkas], and in some cases were capable of washing clothing. The head of each native family received a credit of forty dollars per month, plus an issue of rations for himself and family, plus a bonus for work carried out by the women.

The respective doctors (civil) carried out, in addition to their medical and surgical duties, the recording of all meteorological observations. The greater part of their time was spent in their professional duties among the natives, and all three of the doctors deserve considerable credit for their unstinted efforts for the benefit of the Eskimo [Inuit]. Dr. W.G.K. Clothier and Dr. J.C. Wickware deserve special mention. The former performed marvelous work during two flu epidemics among the natives at Wakeham Bay. One of these epidemics occurred in the fall of 1927 and the other in early summer of 1928. Seven deaths from flu occurred during 1927 and sixteen in 1928, this among a native population of about 175. Without a supply of medical

supplies available and a doctor extremely conscientious in his professional duties, there is no doubt the death rate would have been much greater. In the Spring of 1928 a small-pox epidemic, which might have had disastrous results, broke out at Erik Cove. This situation was handled in a most commendable manner by Dr. Wickware from Nottingham Island, who was flown to and fro between the scene of the epidemic and the base.

Part XVII – Recommendations.

(a) Use of Aircraft on Future Photographic Operations in Vicinity of the Hudson Strait

When one has had the opportunity of making personal aerial observations of existing charts of the Hudson Strait and vicinity as compared with the actual panorama of coastline, bays, inlets, capes, islands, and other formations as they really are, they are then in a position to comment on how inaccurate such charts are, so inaccurate as it happens as to present a large and dangerous factor in the development of the strait as a commercial water route. Beyond a doubt the most rapid and accurate method of procuring new charts for use in the navigation of the strait is by aerial vertical photography. The hydrographic survey for the making of soundings, etc., could follow and be facilitated by the procured aerial survey of the coastlines.

The most suitable time for aerial photography in the Hudson Strait is from the latter part of April up to the end of August, the months of May and July being particularly good. At this time operating conditions for flying using skis in May and June, and pontoons in July and August, are the best of the year. It is considered that machines with a small crew could carry out a survey of both the north and south coastlines of the strait in one photographic season, with bases at Wakeham Bay and Lake Harbour. While the latter place was not suitable for locating a base of the size as established for this past expedition, … it is sufficient for a one machine photographic base.

The aircraft for this operation could be flown to the scene of operations, leaving civilization about the middle of April. Such equipment as could not be flown in would constitute only a small cargo, and could be transported in by some ship passing through the strait the summer previous to the operations being carried out. Emergency caches along either coastline could be laid in by the aircraft after their arrival. This operation should not be a costly one and the results invaluable in the development of the strait as a marine route.

(b) Use of Aircraft as an Aid to Marine Navigation in the Hudson Strait

The information gained through the medium of this expedition, the locating of two Directional Finding Wireless Stations along with the intention of locating more such stations in the strait, will undoubtedly be of great assistance to marine navigators. There may, and no doubt will be, times when shipping may be beset by late or early ice movements through the strait, and yet certain courses of open water ne left where navigation is feasible. The presence of at least on aircraft somewhere in the strait at all times would be very useful, either to give information to shipping caught in the ice, us to their best course to get out, or to keep them informed of any ice movements which may occur.

An incident occurred during the past expedition which will illustrate the feasibility of using aircraft as an aid to navigation, providing marine navigators accept the information given them by aerial observation. On July 4, the C.G.S. "*Montcalm*" left Port Burwell for Wakeham Bay, and on the 5th was reported navigating through heavy ice abeam of Akaptok Island. Also on the 5th, an aircraft from Wakeham was on a photographic patrol at Cape Hopes Advance, and was thoroughly conversant with ice conditions then existing in the strait. Advice of such conditions was transmitted to the "*Montcalm*." On the 6th an aircraft proceeded to the approximate position of the "*Montcalm*," then slightly north of Akapatok Island. The ship was sighted and advised of the most direct and feasible course to take in order to reach a navigable area, which as it happened lay within about six miles, and from whence into Wakeham Bay there existed clear sailing. The "*Montcalm*" was also informed of ice conditions to the west and north. The observations given from the aircraft by radio were received on the ship and confirmed after the completion of aerial patrol. For some unknown reason the course of the "*Montcalm*" was not laid to follow that given from the aircraft, but rather to the north where heavy ice conditions were encountered, of which they were already advised, and did not arrive at Wakeham Bay until 48 hours afterwards. Had the course given from the air been followed, they should have arrived in Wakeham Bay in about one quarter of the elapsed time.

(c) Type of Aircraft Recommended for Use.

For future operations such as have been referred to in the few preceding paragraphs, it is recommended that a twin-engined amphibious flying boat with ski attachments should be used.

It should be capable of at least seven to nine hours cruising range at 90 to 100 m.p.h., and as well to carry a crew of three or four with full emergency kit, rations for about 16 days and photographic equipment. Wireless transmitting sets should be carried

and if possible D.F. radio apparatus. The ground D.F. Stations already exist in the vicinity of the strait for working with.

A flying boat type of aircraft with a hull constructed of a non-corrosive metal is desirable rather than a seaplane. The rough water conditions encountered make the latter too unseaworthy and are not nearly as maneuverable as the boat type. Preference should be given to a positively rigged monoplane, or failing that, a biplane with the bottom planes well clear of the water. Such an aircraft would be powered with air-cooled engines.

(d) Command on Future Expeditions of Such a Nature.

Should it ever again occur where commissioned officers of the Department of National Defence (any branch) are preparing to proceed on an expedition to an isolated section of the country, where they are to have command of a mixed nature, i.e., service and civil personnel, they should be provided with a commission authorized by an order in council giving them absolute powers of command. This should apply to officers who may find themselves in charge of sub-bases, as well as the senior officer in charge.

When, on account of ill health, the civil officer in charge of this expedition in consideration came out of the Hudson Strait with the returning ships in the late fall 1927, no clear cut delegation of authority was made available to the officer taking over. In consequence there was always a tendency on the part of certain civil personnel to question the Senior Air Force Officer's authority, as well as that of the officers in charge at Bases "A" and "B." To these civilians the application "Officer-in-charge," and his responsibilities, represented only an individual delegated to ensure of their being properly fed, clothed, comfortably and well quartered. Here it was apparently assumed their responsibilities ceased. Co-operation was almost entirely lacking and while the work of the Expedition did not suffer on this account, it certainly did not benefit nor did the prestige of the service officers concerned.

Not Reproduced

Appendix -1 Chart of Routine Patrols, Base "B"
Appendix -2 Chart of Routine Patrols, Base "C"
Appendix -3 Chart of Routine Patrols, Base "A"
Appendix -4 Chart of Special Patrols, All Bases
Appendix -5 Plates 1 to 80 Inclusive.
Appendix -6 Miscellaneous Illustrations.

Further Reading

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For photographs and a short overview, see also Canadian Aviation Museum, "The Hudson Strait Expedition (1927-1928)," http://casmuseum.techno-science.ca/microsites/en/timeline/index.php?file=exhiblet_7&Lang=e

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P. Whitney Lackenbauer and K.C. Eyre
DCASS Number 3, 2015

Squadron Leader Robert Logan displaying the Royal Air Force ensign at Craig Harbour, Ellesmere Island, 1922. DND photo 13080.

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