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TIPS ON ORGANIZING ARCTIC GEOLOGICAL FIELD WORK

J. Wm. KERR

1974

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TIPS ON ORGANIZING ARCTIC GEOLOGICAL FIELD WORK

ABSTRACT

The Geological Survey of Canada has developed efficient methods of conducting geological field work in the Canadian Arctic Islands, and this report summarizes those methods. It deals with important and potentially dangerous or costly problems, as well as the routine matters of camp life.

RÉSUMÉ

La Commission Géologique du Canada a mis au point des méthodes d'exploration efficaces dans les iles de l'Arctique Canadien. Ce rapport résume les méthodes mentionnees ci-dessus et aborde les points importants qui pourraient se révéler dangereux et coûteux, aussi bien que les problèmes courants tels que la vie dans les camps.

INTRODUCTION

In ten years of field work in the Arctic Islands, I have evolved a mode of operation that works very well for me. This summary of my system is made available in the hope that it might be of help to others. It does not include all aspects of an operation but only those that are potential problems. Since I may revise this, I would appreciate suggestions and criticism - please jot them down as they occur to you in the field.

The author is grateful to H. R. Balkwill and R. L. Christie for constructive criticism of the manuscript.

Conditions described in this report apply to those parts of the Canadian Arctic Islands lying north of about 70° N Latitude (Fig. 1). Resolute on Cornwallis Island is normally the main base of operations for geological work in this area, as that settlement is the only substantial supply and distribution centre in the region.

The work of my field party in the Arctic Islands usually consists of making a geological map and a stratigraphic study of a particular area, and spending the entire season within that area. The next season we may move to the adjacent area, or move to a new region. The optimum number of geological workers for such a study is five, which includes myself, two senior assistants, and two junior assistants. This provides two sub-parties, which mainly work from flycamps, remaining in them for about 6 days and then returning to base camp for one day. I fly out of base camp each day with the helicopter and usually visit or move the flycamps on alternate days. While they are being moved, I am left somewhere to traverse, and later carry on alone with the aircraft for the rest of the day. All told, my optimum-size permanent camp consists of nine people; in addition to the five geological personnel there are a helicopter pilot, a flight engineer, a cook, and a camp manager. I have found that a Bell 47 G4A helicopter on term charter is just adequate to support a group of this size on a mapping project.

The two and one-half month period from June 15 to September 1 is the maximum time for doing useful surface geology in the Arctic Islands. Winter usually comes quite suddenly in early September, and prolonging the season then is rather fruitless - snow obscures the geology; the days are short and many are unworkable; and morale deteriorates. If a season must be stretched beyond the two and one-half months, it is best to arrive earlier than June 15. At that time there may still be a substantial amount of snow, but valuable reconnaissance work can be done and checked later in mid-summer.

PLANNING

HELICOPTER

Good helicopter support is crucial to the safety and success of any operation. I find a Bell 47 G4A helicopter to be best for my medium-size party. Some of my reasons are as follows: (a) it has adequate power to carry 2 men and a light flycamp, yet is relatively inexpensive to charter; (b) it has a good safety record; (c) it has been around for years, and the bugs have pretty well all been taken out of it; (d) it will burn either 80/87 or 100/130 fuel; (e) in the case of an engine failure during flight, the controls continue to be power assisted and safe landing is easier; and (f) the passengers sit beside rather than behind the pilot, providing close communication and excellent visibility. The Bell 47G 3B1 is a similar aircraft that has the advantage of being able to operate at much higher elevations. This feature is quite unnecessary in the Arctic Islands. A drawback of the 3B1 is that it is more difficult to land safely in the event of an engine failure during flight, because the controls lose their power assistance. This is overcome if the 3B1 aircraft has been specially equipped with a 900 Series E transmission, but they are not so equipped unless specially modified. The 3B2 is similar to the 3B1, but has the advantage of having the new 900 Series E transmission.

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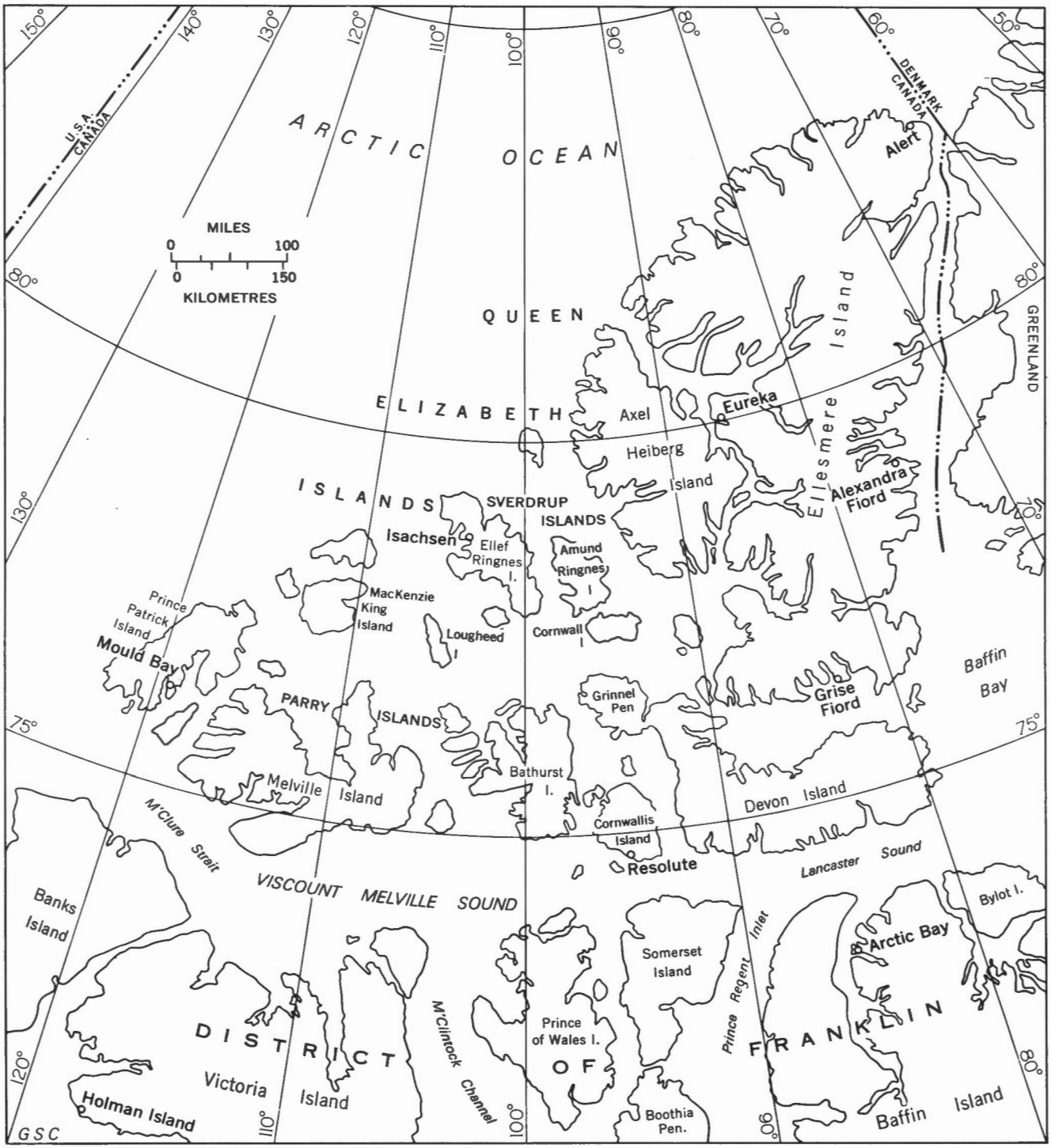

Figure 1. Index map of Canadian Arctic Islands.

The choice of helicopter type will depend on the project. Most projects cover larger areas than I do and need larger machines. The Helicopter Safety and Operations Manual prepared by the Alberta Society of Petroleum Geologists (1972) is most useful. A reference chart of operating specifications for helicopters that was published in that manual is reproduced herein, slightly enlarged (Appendix).

If helicopter flights are to be made over water, floats are essential for safety reasons. Skids are safer in forced landings because one can ski a little on them, whereas skiing even slightly on floats turns the helicopter over. Skids might be used in spring until the ice has broken up, and then a switch can be made to floats. For working in the area of lower Paleozoic rocks where prickly weathering surfaces commonly are developed, floats should be reinforced with an extra thickness of rubber on the base to resist punctures.

It is a very good idea to get to know both members of the air crew before going to the field so that they are completely familiar with the environment and method of operation. At best they may come without warm clothing; at worst they may fail to bring spare parts. I use a standard letter to invite bids on aircraft that specifies an experienced crew and a machine that has been overhauled recently. A sample aircraft contract is contained in the Helicopter Safety and Operations Manual (A.S.P.G., 1972).

It is my intention in future years to specify a list of spare parts that should accompany the aircraft. For a Bell 47 G4A the list is as follows:

Contract field spares for 47 G4A model helicopter

1. one starter, all models
2. one generator, all models
3. one turbo charger, B1 or B2 only
4. one auxiliary fuel pump, B1 or B2 only
5. one spare battery
6. one engine tachgenerator
7. one set of points & condensors
8. one set of Tail Rotor control cables
9. one set of elevator cables
10. one servo overhaul kit
11. six Rocker cover gaskets
12. six intake pipe gaskets
13. one carburator + U joints
14. one Rocker Box drain hose
15. 12 spark plugs
16. two 47-140-252-1 bearings
17. one damper, A13965
18. four 47-140-240-1 bearings
19. four KP4 bearings
20. two KP6A bearings
21. one 51 x 215 seal
22. one 51 x 233 seal
23. two AN5H-14A bolts
24. one set of belts (fan)
25. sprag & spares, bolts, etc.
26. two carb air filters
27. two 47-645-239-1 bearings
28. three 47-644-220-1 covers
29. four 47-140-252-3 bearings
30. one cargo net
31. one barrel sling
32. one Lanyard of 6 ft. nylon
33. one paddle
34. one set of O rings
35. reinforced heavy duty floats
36. interchangeable skids
37. 8 bungee cords with multiple strands

Many parties have been grounded for the want of a tiny $10.00 part that could have been sent along with the spares. If you go to the trouble of getting a machine in good condition and with adequate spare parts, the pilot and engineer will be most grateful, because their objectives are the same as yours - a trouble-free contract. They must fly in the machine themselves and receive very reduced pay while it is grounded. It is worth noting that the company usually loses nothing, or may even make a little extra if the machine is grounded during a contract.

RADIOS

There has been a remarkable improvement in field radios in the last few years, and this has improved greatly the efficiency and safety of Arctic field work. A CH25-SSB receiver-transmitter radio is good for base camp. It has six channels, operates on one 12 volt battery, and consistently reaches out 200 or 300 miles. The frequencies that are used in a GSC base camp are:

1. 4472.5 Dept. E.M.R.
2. 4982 Dept. E.M.R.
3. 5281.5 Oil Patch
4. 4520 Ministry of Transport
5. 5680 Ministry of Transport
6. other

The first two frequencies are for the exclusive use of the Department of Energy, Mines and Resources, but are used also by aircraft the department has on charter. The Oil Patch frequency has been assigned to the Canadian Petroleum Association and is used by aircraft either owned by or operating for oil exploration companies. It is wise to have extra frequencies for possible emergency use. The first MOT frequency is for ground-to-ground contact and is useful for sending telegrams to the south. The second MOT frequency is the air-to-ground frequency in the north, and should be used only in emergency. A sixth crystal could be installed for contact with one of the companies working in the region, and for this their approval should be obtained.

The SBX-11-SSB is a very small yet powerful radio that is ideal for flycamps. It has 4 channels that should include the base camp frequency, the MOT ground-to-ground frequency, the frequency of the aircraft company supplying the base camp, and perhaps one used by a neighboring field party.

Radios are important items and often are in short supply in the spring, so it is a good idea to request them very early. If one wishes to use a frequency that has been assigned to a private company, prior written approval must be obtained from that company before the crystals are installed.

Bright flagging should be tied to radio aerials in base camp and flycamps so that they are visible to pilots.

The radio equipment installed in smaller helicopters very commonly is useless, yet it weights 50 or 60 lbs., and decreases the payload accordingly. The ones I have had to work with could contact the base camp radio only when the helicopter was sitting on the ground in camp. My perfectly adequate though unorthodox solution has been to specify that the helicopter come without a radio and to carry instead an SBX-11-SSB portable which, complete with aerial, weighs only 8 lbs.

The reasoning in this matter is mainly as follows. The main argument for having a radio in a helicopter is for the purpose of contacting camp in case of trouble. If you are in trouble during flight, the pilot will be completely occupied with bringing the aircraft down safely, and is not about to use the radio at this time. If you are not in trouble during flight you don't really need the radio. If the helicopter should happen to be involved in a forced landing or crash, a portable radio that is being carried along is more likely to survive and remain operable than a radio that has been installed in the aircraft.

It should be mandatory to mark on a map in camp a generalized route or an area of study for the day. If it is necessary to deviate from this route during the course of the day, the camp manager can be informed of this by landing and quickly setting up the portable radio in the field. If it is not possible to get the message through to camp, then one should stick to the original plan - otherwise, it would have been better to have left no route map at all.

FUEL

In former years it was necessary to send drummed fuel to Resolute from Montreal by sealift in the fall preceding a field season. This is no longer necessary, for bulk drummed fuel is available for purchase in Resolute, but it still is necessary to reserve fuel well ahead of time.

In 1972, the fuel purchased in Resolute had less dirt and water than the drummed fuel that had been shipped from Montreal. Propane is not available for purchase in Resolute, but heating oil, deisel fuel, and iosol (naphtha) can be obtained.

FOOD

If there is time, heavy, non-perishable staple foods can be sent north from Montreal by sealift the year before the field operation to save on airfreight costs. Then during the field season, the cook can order fresh and additional food to be shipped by air from a food store in Yellowknife as it is needed. Despite this attempt to strike a balance, the cook each year says that the meals suffer because the wrong things were sent on the sealift; however, this must be accepted as inevitable. The cook should be given the list of staples that are already in Resolute before he goes north, so he can arrange for pick up of the first supplementary grocery order in Yellowknife on the way through. Thereafter, he should have another order sent up every two weeks. A cook takes pride in his work and will do a much better job if he can do his own grocery ordering.

BASE CAMP

LOCATION

In the eastern and southern Queen Elizabeth Islands (Fig. 1), where Paleozoic carbonate rocks predominate, both consolidated rock and unconsolidated alluvium provide a good substrate for landing sites, and thus there is considerable choice possible in the location of a base camp. In these areas a good place for base camp is on a high gravel bar at the head of a long fiord or bay that extends into the middle of the study area. The advantages of this are: (a) at sea level it is not so likely to be fogged in, (b) one can find his way home in fog or snow by following the coast, (c) marine fog banks often do not roll in as far as the heads of the fiords, and (d) all parts of the area are equally accessible. A flat plain high in the interior of these islands might look good because the landing site is smooth. However, such a place will tend to be socked in by fog, water may not be available, and it will be hard to find the way home in marginal weather.

In the Sverdrup Islands, and other areas underlain by Mesozoic or Tertiary rocks, the ground is extremely soft in summer. The coastal areas are too wet for the landings of fixed-wing aircraft and base camp must be placed on a high plateau that is better drained and drier.

If a campsite is to be used in excess of 300 man-days, a permit must be obtained from the Regional Manager, Water, Forests and Land Division, Department of Indian Affairs and Northern Development, Yellowknife. When choosing a base camp it may be possible to find a good one that has been used before. Otherwise one should have an experienced Otter pilot help to pick out a new one. The pilots are conscious of wind, weather, landing, and other conditions. An excellent campsite (Fig. 1) at the head of Barrow Harbour on Grinnell Peninsula that my party occupied in 1972 was chosen with the help of John Cesnik. During the course of the summer the extra cost and effort in searching for this site paid off amply in economy, convenience, and safety. Various suggestions for building and maintaining a base camp are included in the job instructions of the camp manager.

Choosing and designing base camp is always pleasant and interesting. It is the opportunity that town planners always want and are never given - building a settlement from scratch in the middle of nowhere. Figure 2 is a base camp that was carefully planned, and some of its features should be pointed out. It is close to running water; equipment and fuel storage are right near the runway; the helicopter pad is well away from the other tents and upwind so that small items around camp will not be

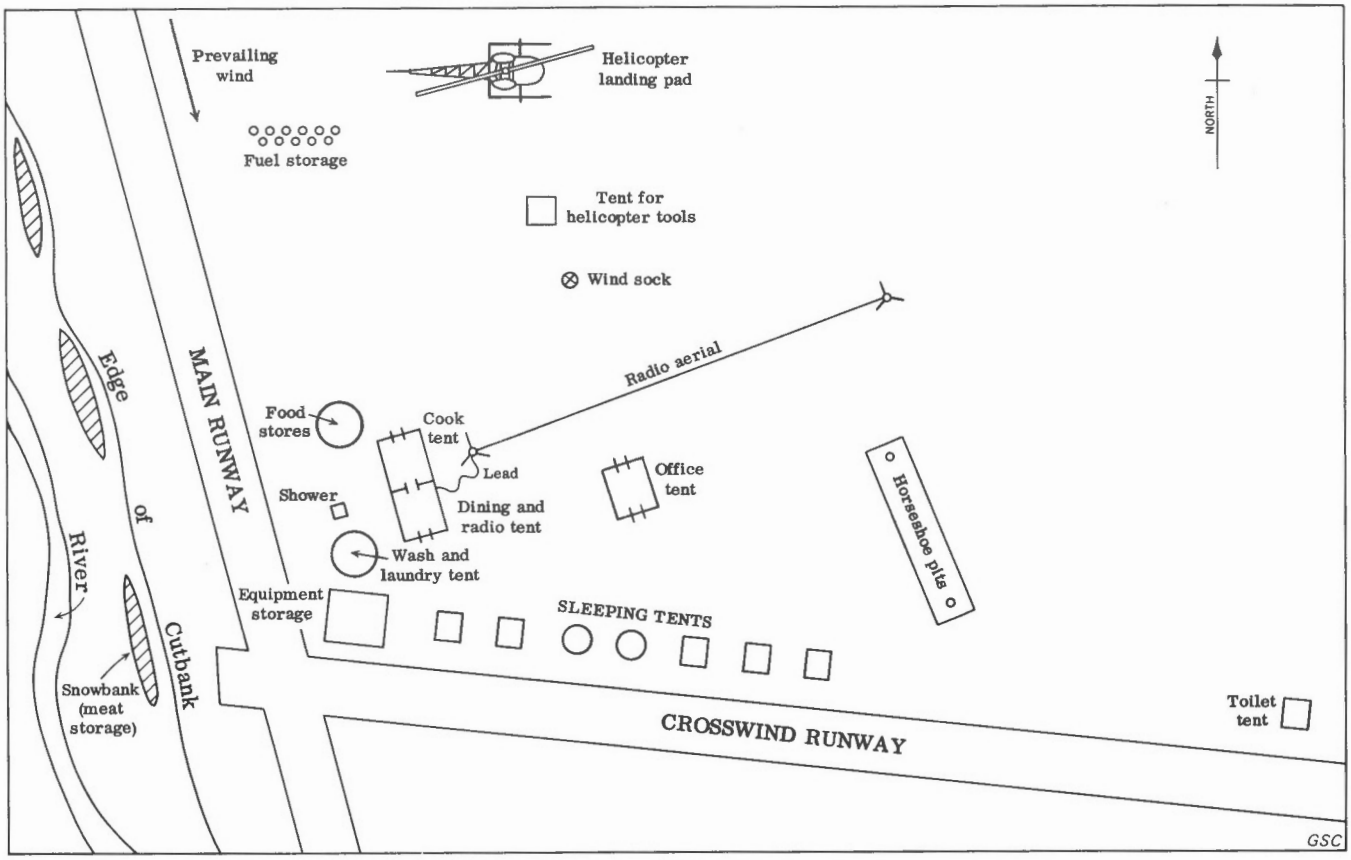

Figure 2. Plan of the Geological Survey base camp situated at the head of Barrow Harbour, Grinnell Peninsula during the summer of 1972.

blown toward the helicopter; and the cook tent and laundry tent which require water are as near to the stream as possible. Long lasting snowbanks in the cutbank near the creek are used for the storage of meat. The focal point of the camp is the cook tent area, and this is central.

EQUIPMENT

The cook tent area consists of two 12- x 14-foot tents on Jutland frames, placed end to end with a passageway between them. The tents should be ordered to take the convenient aluminum doors that are available for the outer ends. One is the cook tent and the other the combined dining tent and radio tent.

A four-burner propane range with oven is recommended for base camp. The cook tent should have a floor which can be built from 4- by 8-foot plywood sheets one-half inch thick, for without a floor that tent is impossible to keep clean. If the staple food was sent by sea, it should have been sent in sturdy wooden boxes, and the boxes can then be used to build shelves. Alternatively, this can be done with a bit of lumber. Stainless steel milk cans make good water storage containers. Serving cafeteria style with the men filing out to the stove to take their food and then back to the other tent to eat works very well.

A large square table can be erected in the dining tent from two folding aluminum tables; for stability the legs of the two tables should be wired together. This leaves plenty of room in one corner for the radio setup, and in another for a heater. If a space blanket is taped to the tent wall and roof behind it, the heater will throw a great deal more heat. A dirt floor is acceptable in the dining tent and probably preferable. Tent flys are a good idea to take along, but are not really necessary on good Jutland tents that have been waterproofed. Tents can be mended with a sailmakers needle and heavy linen thread, or patched with a glue called Easisew. A part-time door can be rigged up between the two tents with an old piece of canvas rolled onto a rod in the manner of a window blind. In the evenings when the crew is sitting around the dining table, the door can be lowered to seal off the cook tent and keep the dining tent warmer.

A metal-framed igloo tent, 11 feet in diameter, makes a handy wash-up and laundry tent. Laundry becomes an easier operation if a metal plunger is used along with the normal washtub and washboard. A simple shower can be constructed by building a frame of 2 by 4's and wrapping canvas around it for walls. A 10-gallon gasoline drum which has had the bottom removed and a shower head attached to

the top is inverted and placed atop the frame to hold the water. The shower head is made by having a regular shower head welded to a short length of pipe that can be screwed into the smaller bung hole of the drum. The small bung hole, incidentally, takes a 3/4-inch pipe with fourteen threads to the inch. The only special item that need be taken to the field for a shower is the modified shower head.

A convenient office tent can be set up in another 12- x 14-foot Jutland tent with 5-foot walls. Half-inch sheets of 4- by 8-foot plywood sawed down the middle lengthwise can be nailed to upended food boxes and make great desks. Two sheets are enough to make desks the full length of both long walls. Rocks piled in the bottoms of the opened food boxes make the whole thing stable. A canvas floor designed for the Jutland is recommended for this tent.

Pneumatic igloo tents are nice for sleeping tents because they are dark and keep out the midnight sun. They resist the weather very well if they are in good condition, but collapse in the wind if the pneumatic poles leak. The secret to keeping them really tight is to pump them up very hard and, in addition, use valve caps. One should never trust taking only an igloo tent to a flycamp; the Logan is best for that purpose because little can go wrong with it. For sleeping tents in base camp, an assortment of pneumatic igloo tents and Logans is best. Magnesium alloy tent pegs are adequate for Logan tents and pneumatic igloo tents. The larger Jutland tents should be anchored to either wooden food boxes or to strong potato sacks that have been filled with gravel. The scars that usually show up most prominently in an abandoned base camp are the small ridges of gravel that are used to hold down the tent skirts. A rake is handy for smoothing these out - one can be made easily with a tent pole as a handle, a wooden slab as a crossbar, and nails for tines.

PERSONAL EQUIPMENT

A list should be provided to all personnel prior to the field season to ensure that they are well equipped. Below is a list that I prepared for geological personnel and alter slightly for the cook and camp manager. It may serve as a guide to other party chiefs.

Geological personnel will be supplied with the following:

- Boots - one pair of insulated rubber boots. These are black rubber insulated boots designed for Arctic conditions. I swear by them and wear them every day. Some swear at them because they are heavy and clumsy. On nearly every traverse, you will have to walk through water and your feet will be soaked unless you wear boots that are totally waterproof.
- Parkas - one quilted parka for cold weather; one orange canvas pullover-type anorak for cool days; one waterproof lightweight yellow protective anorak.
- Mitts - one pair leather outer, one pair wool inners.
- Trousers - one pair of insulated trousers (made by Ambridge-Thompson).
- Sleeping bag - one Black's Icelandic outer, one Black's Icelandic inner.
- Camp cot and foam pad - one of each.
- Snow goggles - one pair.
- Downfilled vest - one.
- Hard hat - one supplied, we recommend using it.

Geological personnel should bring the following:

- Boots - one pair of 12-inch rubber insulated boots as a supplement. All leather boots and logans (rubber bottom, leather top) inevitably leak, and are useless except for lounging around camp. Boots are an important item insofar as both safety and comfort are concerned, and widely different practices are followed. Be sure you are set up well with footwear.
- Trousers - two or more pairs of heavy duck trousers; blue jeans are not usually very satisfactory because they get wet easily.
- Shirts - two or three work shirts; I find flannel the best.
- Underwear - two pairs of winter underwear. Thermal and thermopyle brands are very good. The two-piece style allows you to adapt best to various conditions. Buy this the previous winter, for in June it will not be available in the stores. Some wear longjohns all summer, others only shorts. Bring both.
- Sweaters - one heavy wool.
- Jacket - a quilted down ski jacket should be brought along for camp use and possibly traverse use. Very bright colours are advisable. The anoraks you are supplied with are pullovers and some dislike that feature.
- Socks - six or eight pairs of heavy wool socks. If you bring plenty you will need to do laundry less often.
- Gloves - two pairs of heavy work gloves. I find the type with leather front and canvas back to be very good.
- Towels - one or two, preferably heavy bath type.
- Headgear - bring something if you don't like a hard hat.
- Hunting knife or pocket knife - bring one.
- Extra boot laces
- Waterproof match box
- Toilet kit - tooth brush, razor, shaving cream, shampoo, etc. Bring a supply for the season (soap is supplied).
- Insoles - if desired - order them large and cut them down.
- Belt - an extra heavy belt is handy for attaching notebook, case and brunton.
- Sunglasses - one pair.

Miscellaneous - optional:

- Reading material - nothing is available for purchase in Resolute; however, everyone in camp brings books and lending goes on. Don't bring your whole library.

Writing material - bring stationery, envelopes and stamps.
Smoking accessories
Playing cards, etc.
Fishing tackle - they go for spinners but the opportunities for fishing are rare.
Camera and film
Glasses - if you use them bring an extra pair.

All equipment used in camping, cooking, geological work or first aid is supplied.

You should have a dental checkup before coming and have any imminent work done. Resolute gets mail service twice a week. We get mail at irregular times, and it may be anywhere up to two weeks between our pickups. The address you should give for the summer is:

c/o Dr. J. W. Kerr
Geological Survey of Canada
Resolute, N.W.T.

JOB INSTRUCTIONS

The party chief could easily spend his whole time organizing, training, and shepherding the crew, or worse, doing many things himself because it is quicker than explaining the procedure. To reduce this problem, a list of job instructions should be given to the field crew and the party chief should insist that they read them. This saves an immense amount of work and trouble, and allows the party chief to concentrate more fully on the geology.

CAMP COOK

This is a most important position for maintaining camp morale. The whole camp is grateful when the cook uses imagination and care in his work. Food orders should be prepared by the cook and sent out by the camp manager once every two weeks, having been shown to the party chief before they are sent. Arrival of the order in Resolute should be scheduled so that it soon gets onto an Otter flight coming to camp. The cook should check that everything on the invoice has been received.

Meals should be prepared for those who are in base camp. The camp manager will know how many are expected for each meal. The cook will prepare food orders to be sent to flycamps. The camp manager will help in preparation, for he knows what the flycamps have ordered by radio or note. It is the responsibility of the camp manager to see that the orders go out to flycamps on the right flights.

The cook should wake the camp in the morning and turn the heat on under some washing water. After breakfast he should set out material for lunches; those going on traverses can put together their own lunches from this. Thermos bottles of tea or coffee should be made for those going on traverses.

Washing dishes is a duty of the cook. The camp manager or geological assistants who are in camp will help whenever possible. The cook should tell the camp manager when his propane bottles have run out and the camp manager will replace them.

CAMP MANAGER

This job includes many diverse duties that result in keeping the camp running efficiently, and the person holding it should have initiative.

1. Radio. Radio schedules should be set up and maintained with Resolute, with our flycamps, and with other camps that may be appropriate. When a fixed-wing aircraft is attached to our camp, the camp radio should be monitored at all times that the aircraft is away until the pilot's flight plan is closed. If it is necessary at these times to leave the radio tent, he should ensure that someone else, the engineer, the cook, or an assistant, is monitoring the radio. The 12-volt storage batteries for the base radio should be kept well charged and the generator maintained properly. In the event that the generator is not operational, it is possible to have the engineer charge the storage batteries from the helicopter when it is on a short flight or warming up. Two batteries must be charged at a time, for the helicopter has a 24-volt system and would blow out a single battery. For this operation 3 jumper cables are required. Proper radio procedure should be learned by studying the manual and by asking questions of experienced people around camp. Be brief but clear on the radio. It is very important that you take and send telegrams and radio messages accurately. There should be no superfluous traffic on the radio, and definitely no kidding, profanity, or joking. Learn weather estimating and reporting from pilots, and be prepared to give a weather report when one is requested.

2. Expediting. The camp manager should know the location of each flycamp and when it wants to be moved. He should learn where the geologists are going each day and discuss emergency procedures with them. A location map posted near the radio shows the positions of flycamps, rock caches, and fuel caches; it should be updated continually. The flycamps will request orders of food and equipment either by radio or by note. It is his responsibility to see that both food and equipment that have been ordered are on the aircraft the next time it visits a flycamp. The cook will prepare the food order and the camp manager will prepare the equipment. Be sure also that no flight goes to a flycamp without taking all the mail for that camp. If men are leaving base camp for a new flycamp, it is of course their own responsibility to see that they take along what they need, but he should help them find things. The camp manager should see that there is an adequate supply of iosol (naphtha), fuel oil, aviation gasoline, aviation oil, propane, sample bags, and wrapping paper in camp. Ten-gallon kegs of iosol (naphtha) and fuel oil should be kept full and convenient for use in camp. The cook should be kept posted on the number of people that can be expected at the next meal if it varies from the routine. The camp manager is the official mailman. He also should meet all aircraft that arrive or depart, and help to load or unload them.

3. Camp Maintenance. The camp manager should maintain the general order and tidiness of camp and have a routine inspection every day. This should include checking the condition of all tents in camp, repairing them, tightening ropes, and banking them when necessary. He will keep a supply of water hauled for the cook and set out hot wash water before meals. Before retiring each night the camp manager should leave some wash water on a stove in the wash tent, and have the stove filled up ready for the cook to simply light the next morning. He should maintain an adequate supply of water for showers and laundry. Each individual in camp should replace the amount of water he has used in showers and laundry. A most satisfactory yoke for hauling water can be constructed by tying a short piece of aluminum tent frame to a Trapper Nelson packboard (Fig. 3).

Figure 3. Carrying water with the aid of a yoke made from a Trapper Nelson packboard and the corner brace from a Jutland tent frame

The territorial Land Use Permit specifies certain operating conditions, including incineration of garbage, and the burial of sanitary wastes. The camp manager will erect and maintain a toilet tent, check it daily, and move it when necessary. The most effective toilet for Arctic summer base camps is a 10-gallon drum which has had both ends removed and been sunk in a hole. The drum keeps the sides of the hole from caving. By using the drum the number of pits required is reduced to about one-quarter of the number that would be required without one. A seat is built over the drum and a tent is pitched over the whole thing. When full the drum is simply covered with gravel. If the area is hollowed out slightly before placing the drum in the hole, the top of the drum will end up a few inches below ground surface and leave no signs on the landscape.

An incinerator should be constructed by taking the top off a 45-gallon drum and punching plenty of holes in the sides. Garbage will be burned in it daily and subsequently buried. Save used engine oil and the leavings in gas barrels to incinerate the garbage thoroughly, and keep a supply of this waste on hand. Nothing should be put into the garbage pit for burial unless it has gone through several burnings in the incinerator, for it will not yet be completely burned. Unless it is completely burned it almost certainly will be dug up and scattered by animals the next year. If the procedure is done properly and thoroughly, a very small pit will last the entire summer. Moreover, the bears and foxes will have little interest in bothering the camp and no interest in digging up and scattering the garbage after the camp has been moved. I suggest that garbage be burned once a day only, and that first thing in the morning when the previous fire is certain to be extinguished. Someone who is too ambitious and burns several times a day might find himself pouring gasoline onto a live fire. Empty the garbage cans in the office and cook tents daily, or more often if necessary.

If there is time after his other duties, the camp manager could help the cook to wash and dry dishes. The cook will wake camp initially, but it is the manager's job to bug the pilot and engineer to get up for breakfast if they are late sleepers. They usually are. Keep equipment in orderly piles and covered by tarps. Keep camp clean of litter, and pick up tools and return them to where they belong. Clean the dining table for the cook before lunch and dinner. The assistants are expected to volunteer to help both the cook and camp manager with chores when they are in camp.

A deep freeze facility for meat should be built and maintained. If there is a nearby snowdrift that will last through the summer, the matter is simple. Aluminum food storage boxes containing meat are placed in a pit in the snowdrift; sheets of insulating material are draped over the boxes and the whole thing is covered with snow. If the snowdrifts all disappear, the same idea can be done in a frost crack, a cutbank, or a simple hole in the ground, trying in any case to get the boxes as close to permafrost as possible.

GEOLOGICAL ASSISTANTS

1. Flycamps. Most of the time geological assistants will be in flycamps. Whenever possible the flycamps will be established or visited in the morning so that the helicopter can set you out for a one-way traverse back to your camp. When a new flycamp is established it is important to locate it precisely on the aerial photograph, and mark it so that you can find the way home to it in bad weather. Try to choose your camp near a prominent feature such as a stream junction or a big rock so that it is easy for you to find it when walking home in fog. Be sure that you and your pilot agree on your camp location and that he has it marked precisely on his map when he leaves. He will transfer this to the camp manager's location map in base camp. This is important, for it may be some other pilot who picks you up. Remember that helicopter pilots rarely use maps in flight and, as a result, they often cannot mark their location on a topographic map when they

have landed, despite the fact that they are far from lost. Most pilots navigate superbly by memory, using the landscape as their map, and after a short while in an area are completely familiar with it. A geologist nevertheless should not count on this and should know his whereabouts at all times.

Your flycamp should be placed on high ground, far enough from a stream so that it will not be washed out in a flood. Furthermore, it should not be built in a slight hollow where a puddle can accumulate in a rainstorm. Be fastidious with garbage! Edibles should be dumped on the ground and soon will be cleaned up by foxes and gulls. Boxes and paper that have no food attached should be burned and buried. Cans and such things that will not decompose should be returned to base camp in a plastic garbage bag for proper incineration. Take both bottoms and tops out of the cans and squash them to reduce volume.

It is a mistake to dig a pit, throw garbage in it, burn it with gasoline, and cover it up. This may look fine when you leave, but it is a wasted effort, for soon the garbage will be dug up and scattered by the foxes. Edible things and bits of food attached to cans usually are too wet to burn completely, and just cook a little. The foxes then smell it out and dig the whole thing up, cans and all. Clean up your campsite when you depart and scatter the rocks from the tent ring so that the location looks natural once again.

Learn to estimate wind speeds and ceiling for sending weather reports to base camp. When an aircraft is landing, give the pilot the wind direction by standing back to the wind with arms forward, and he will land toward you. Learn to use your flycamp radio, but do not use it for superfluous traffic, and no practical jokes, profanity, or kidding on the radio. Hang some bright cloth on the radio aerial so an aircraft will not run into it. When back in base camp for short spells, geological assistants should take the initiative to help the cook and camp manager with chores.

A .357 Magnum revolver will be provided for protection against bears. Bears will probably avoid you on traverses, but are attracted to your camp where there are food smells. Keep the revolver in your tent at night. Arctic bear stories are legion and opinions varied. One thing that all agree upon is that if you ignore them they almost invariably wander off.

Treat firearms with the respect they deserve. An instruction session on them will be held in the spring. If you are not completely familiar with firearms, do not hesitate to ask for advice.

On traverses one should wear bright clothing to be seen better. An aircraft sees a man more readily when he is on the move, and best of all if against a snow background. An orange smoke generator, a signal mirror, and a bright fluorescent signal cloth should be carried on traverses for signalling aircraft. Never signal an aircraft unless (a) you are in distress, (b) you have a rendezvous with him, or (c) he clearly is looking for you. A mirror gives the best signal, but works only when the sun is not obscured, and is behind the plane. A proper signal mirror gives the best signal, but a Brunton compass will work, although it is tricky because the hole in the Brunton mirror is not centred. One holds the Brunton in the right hand close to your face, and looks through the hole in the mirror. The left hand is outstretched with the thumb tip raised as a foresight. The shadow which the hole in the mirror makes in the reflection is centred on the thumb tip. When the arms are swung until the shadow lines up with the aircraft, the signal will be hitting him.

An orange smoke generator gives a great cloud of smoke that can be seen for miles and is the best signal on cloudy days. These are manufactured by Hand Chemical Industries Ltd., of 221 Nipissing Road, Milton, Ontario. When they are set upright, which is the way they are designed to sit, the smoke generators often give only a small invisible flame and no smoke. To get a good cloud of smoke it is best to kick them over on their sides. For some reason this last tidbit is not in the instructions printed on the side, but I am suggesting it to the manufacturer. Railway flares are useless for signalling in the Arctic summer - they give a bright flame and are designed for night use.

One must always be careful with the fog, which can close in very quickly. If you do happen to be caught in fog, do not proceed unless you are absolutely certain of where you are going. I once walked into a fog intending to go in a straight line. A few hours later I walked back out of it again, and learned to my surprise that I had turned 180°. Ask me sometime to tell you the rest of that story.

If caught in a fog and in doubt about the route, sit down and wait there until the fog lifts. It is better to spend a night out and be uncomfortable, than to be both lost and uncomfortable. Because of the proximity of the magnetic north pole, a magnetic compass is not reliable for directions. If one needs to go only a short distance in the fog he can maintain a straight line by building and following a row of cairns. In this case each new cairn is lined up with the last two behind. Go back later on a nice day and knock them over.

When the spring thaw begins, many snow-filled valleys have unseen creeks or ponds beneath, and there is a danger of collapsing into them. One should avoid crossing such valleys just above a lip, for this is a likely place for water to be ponded beneath the snow. The safest place to cross is where the slope of the snowdrift in the valley is steepest. Here the undersnow stream is running very quickly, is shallow, and is not creating either a pond or a cavern. Between about June 20 and July 15 when this problem exists, each traversing team should carry a rope, and the two should cross these valleys separately so that one can help the other if necessary. My trick is to carry a nylon rope that has a 2 lb. plastic bag of raisins inside a sample bag wired to one end. This weight makes it possible to throw the rope - and of course you can always eat the raisins.

2. Helicopter Safety. Learn helicopter safety from the ASPG helicopter manual that is available in camp, from brochures issued by the Workmen's Compensation Board, and by asking questions. At the beginning of the field season make a special point of discussing safety with the helicopter pilot and also with the flight engineer. It is most important to develop good helicopter habits that become automatic. There are only a few basic rules, and all are common sense.

a. Watch your head! Approach and leave the machine only from the front (Fig. 4a). This is to avoid the tail rotor, but also so that the pilot can see you. Always leave the machine going downhill and approach it going uphill (Fig. 4b). This is to avoid the main rotor. Because of these two restrictions there is for any position of the helicopter only one quadrant that is the correct one to walk through (Fig. 4c). A good habit is to hold your knees when approaching or leaving the helicopter, for this automatically makes you crouch and keeps your head low.

b. Sit still. Sit still while in the helicopter, particularly during takeoff and landing. If you are on the ground and the helicopter is landing or taking off nearby, once again give the pilot the courtesy of remaining still, either standing or squatting. If he is landing for a pickup, stop when he approaches and stay there, so as not to distract him until he has brought the machine completely to rest. He will then look up, thereby signalling that it is clear to approach the machine. If he is taking off, get well away from the machine, and sit down where you see each other until he is gone.

c. Loose equipment. Be sure that no equipment can get in the way of a moving rotor blade or tail rotor. The stories of ways helicopter accidents have been caused by loose equipment are legion. Equipment for loading should be carried close to the ground. A surveying rod that was being carried vertically was hit by the blade, mutilating the man who carried it and wrecking the helicopter. If anything is to be carried on the rack it should be tied down properly. A good habit is - never set anything on the rack unless you proceed to tie it down immediately; never untie anything on the rack unless you proceed to take it off immediately. This way nothing will ever by forgotten there. A lunch box was once set on the rack "just for a moment". When the helicopter took off, the box hit the main rotor, which then threw it into the tail rotor. The result was two fatalities. Don't litter - a shipping tag once got in a helicopter tail rotor and wrecked the machine. Don't hurry around helicopters. A small sleeping bag was once thrown from the passenger's side to save time in unloading; it went too high and hit the main rotor.

In the unlikely event that you are in a forced landing with a helicopter, put your head between your knees, largely to avoid back injury. Then do not get out until there is no more motion, for you could be hit by a flailing rotor blade as you walk away.

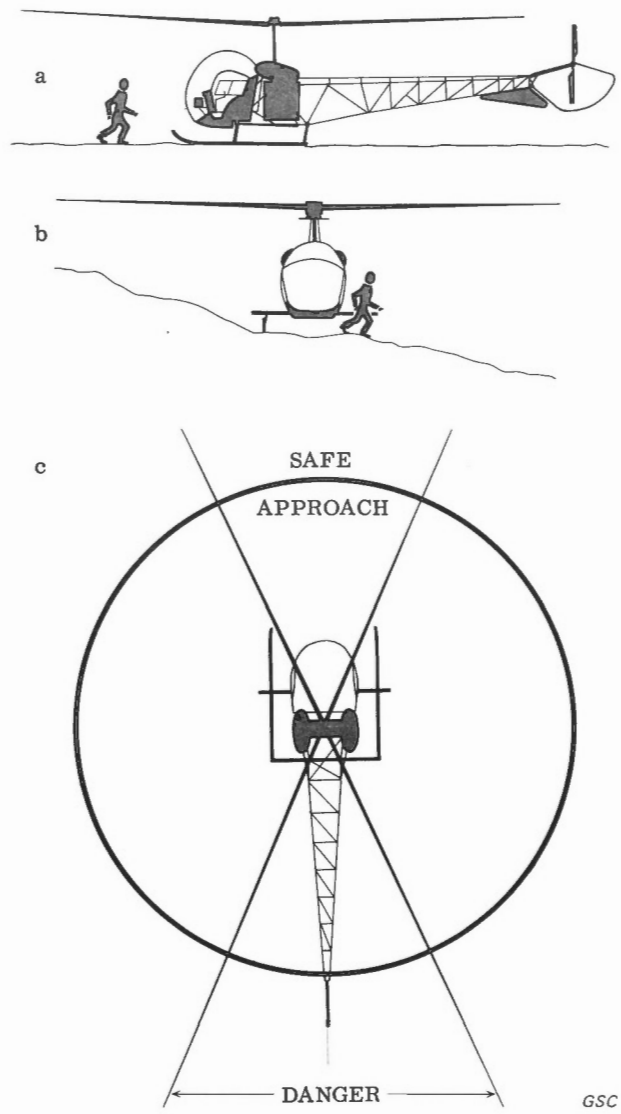

Figure 4. A safe helicopter approach. (a) Approach and leave in front only. (b) Leave downhill and approach going uphill. (c) For any position of the machine there is one safe quadrant.

3. Geology. The party has two complete sets of airphotos of the study area, a red series and a blue series. The party chief works on the red and assistants on the blue series, though there will be occasional trading. Assistants should keep no photographs from the red series with them in a flycamp unless by prearrangement, except for the ones they are camped upon and working upon. When assistants

are moved to a new flycamp, they should send back to base camp the photographs used in their previous camp.

Plot plenty of points on the aerial photographs and take plenty of notes, as someone else will later use your material. Moreover, someone else may want to visit the precise locality where you have made a collection or an observation, and they do not have your memory of locations, so put numerous points on the photographs and put them on accurately with a pin prick through the paper. A good punch can be made for this purpose with a needle imbedded in a piece of wood. Be sure that you do not also punch the photo beneath the one you are working on or there will be problems when working on the next one. Mark your initials, traverse numbers, and station numbers on the back of a photo, but before writing there, erase the clean back with an ink eraser to remove the emulsion so that the pencil will take better and not wear off. Numbering on the back should be small, done with a lead pencil, and lined up neatly so as not to take excess space, for someone else may later use the same photo in the field. India ink does not work well on the backs of photos for it tends to flake off. At the end of the field season when no more information will be added to the back of a photo, Scotch magic tape can be put over the numbers and they are permanently protected.

When measuring sections, mark on the airphoto the beginning, end, and important intermediate points such as contacts or fossil localities, and refer to them in the notebook. The formations, their names, and their boundaries will change, but the facts, observations, and collections from each point will not. Plot on the photographs all dips, contacts, faults and other features. Work out and plot on the photo your best interpretation of the structure. Don't leave it all for the party chief to tie together. If it ever is necessary to leave heavy bags of fossils to be picked up later, place them with the numbers down so they will not fade from the sun and rain.

When mapping, get problem-oriented above all. Sit down, study the photos, and then walk to the outcrop or place that will contribute most to solving the immediate problem. Do not sit on the rocks for long, or you may join the long list of field geologists who have piles. My trick is to sit on one or both ankles, Indian style. When the ankles begin to hurt, you have probably sat there long enough and will learn more by walking to another outcrop.

USEFUL BOOKS

DOWN BUT NOT OUT: Available from Information Canada, Ottawa. This is a handbook to assist downed aircrew, prepared for the Royal Canadian Air Force.

NORTHERN SURVIVAL: Available from Information Canada, Ottawa. This is a practical guide to northern survival prepared for the Department of Indian Affairs and Northern Development.

HELICOPTER SAFETY AND OPERATIONS MANUAL: Available from Alberta Society of Petroleum Geologists, 612 Lougheed Building, Calgary, Alberta.

CLIMATE OF THE CANADIAN ARCTIC: Available from Information Canada, Ottawa. Published by the Canadian Hydrographic Service, Marine Sciences Branch, Department of Energy, Mines and Resources, from material prepared by the Meteorological Branch, Department of Transport, Canada. This shows by table, climatic conditions for Canadian stations north of 60° N Latitude.

GEOGRAPHICAL DISCOVERY AND EXPLORATION IN THE QUEEN ELIZABETH ISLANDS: by Andrew Taylor, 1964; Memoir 3, Geographical Branch, Department of Mines and Technical Surveys, Ottawa. Available from Information Canada, Ottawa.

ILLUSTRATED FLORA OF THE CANADIAN ARCTIC ARCHIPELAGO: by A. E. Porsild, 1956; National Museum of Canada, Bulletin No. 146, Department of Northern Affairs and National Resources, Canada. Available from Information Canada, Ottawa.

RADIOTELEPHONE (LAND SERVICES) HANDBOOK: Available from Information Canada, Ottawa. Prepared by the Department of Transport, Telecommunications and Electronics Branch. This is a useful guide to those who operate field radios.

TERRITORIAL LANDS ACT: *in* The Canada Gazette, no. 22, v. 105; available from Information Canada, Ottawa. This lists the Territorial Land Use Regulations.

WORKMEN AND HELICOPTERS: The Workmen's Compensation Board of Alberta, Pamphlet NL-12.

HELICOPTER		SEATING CAPACITY	LOAD CAPACITY (lbs.) PLUS PILOT*		FLIGHT TIME (hrs.)	AIR SPEED MPH	FUEL CONSUMPTION 1 hr.	FUEL TYPE	RECOMMENDED CEILING W/FUEL LOAD	FEATURES
TYPE	MODEL	PLUS PILOT	BODY LOAD 2 hr. FUEL	SLING LOAD 1 hr. FUEL						
ALOUETTE II	TURBINES 318 C Astazou engine	4	960	1200	4/5	100	30 gal.	JP 4	12,000	Very reliable turbine and airframe. Ruggedly constructed. Excellent cabin & cargo rack for freighting.
	Artouste engine	4	520	930	3	90	45 gal.	JP 4	6,000	Same as Astazou engine.
BELL SERIES	47G-2	2	360	450	2-1/4	65	14 gal.	80/87 octane	4,000	Reliability, simplicity.
	47 Super G-2	2	360	450	2-1/4	65	12 gal.	100/130 octane	10,000	Supercharged increased performance over G-2 and a good machine with light sling loads.
	47G4A	2	600	600	2-3/4	65	15 gal.	80/87 100/130	6,000	Stability, wide cabin; more power than G2 models; passengers beside pilot have good visibility.
	47 G3	2	660	770	2	70	13 gal.	100/130	10,000	Same as 47G4A
	47 G3B	2	600	720	2	70	15 gal.	100/130	10,000	Good visibility, stability and greater speed than G-2 models, good altitude.
	47 G3B-1	2	450	600	2-3/4	65	15 gal.	100/130	10,000	As G3B with wider cabin seating.
	47 G3B-2	2	450	600	2-3/4	65	15 gal.	100/130	10,000	Wide cabin; low consol gives improved visibility; better TRANSMISSION & HYDRAULICS.
	47 AJ-2	3	500	600	2	85	15 gal.	100/130	10,000	Large cabin space. Improved air speed over G-2 and G-3 types.
	47-J	3	500	600	2	85	15 gal.	80/87	6,000	
	TURBINES 206 A	4	850	1050	2-1/2	125	22 gal.	JP 4	8,000	Good cruising speed, increased range and comfort for year round operation. Passengers behind pilot have reduced visibility.
	204B	10	2150	3700	2-3/4	110/115	65 gal.	JP 4	6,000	Good speed with inside loads, very reliable.
	205A	14	2550	4150	2-1/2	120	80 gal.	JP 4	8,000	
HILLER SERIES	SL-4	3	450	950	2	70	18 gal.	100/130	12,000	Good performance with load at high altitude. Passengers behind pilot.
	HU-12E	2	825	950	2	80	16 gal.	100/130	6,000	Excellent capacity at low altitude.
	TURBINE FH-1100	4	850	1050	2-1/2	125	22 gal.	JP 4	8,000	Excellent sling loads due to good pilot visibility. Passengers behind pilot.
HUGHES	500	4 (occasional 6)	920	1150	2-1/2	150	19 gal.	JP 4	8,000	High speed, seat and cabin construction advertised as giving better protection in hard landings. Licensed to carry 6 passengers by removing aft seats.
SIKORSKY	S55B	8/10	1500	1700	4	90	25/30 gal.	100/130	6,000/8,000	Large cabin for freight and passengers. Tail and main rotors high for brushy clearings. Can stop rotors and have engine running. Strong construction.

* For float equipped aircraft, deduct approximately 50 lbs. from load capacity shown.

Note - The above statistics are not guaranteed as to accuracy but are intended as a comparative guide.

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Appendix: Reference chart of operating specifications for helicopters commonly used in western and arctic Canada. Modified from a chart prepared by R. D. Ferguson and published in the "Helicopter Safety and Operations Manual" (A.S.P.G., 1972).