THE INUIT TRAIL AND REMOTE CAMP RADIO PROJECT

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Introduction

This project was inspired by a visit made by representatives of the North Quebec Inuit Association (NQIA)* to Ottawa in November 1974. At that time the representatives met with the Secretary of State and the Ministers of Communications and Indian and Northern Affairs, as well as, separately with Maxwell Yalden, our Deputy Minister. Among the communication problems discussed at this meeting that of "trail and remote camp" communications was given priority, since this communications is perhaps the most difficult, and since the requirements for such communications is not very great in terms of numbers of radio sets required, Industry has not responded to the need adequately. The requirement here is for communications from the various Inuit settlements to hunting parties on the trail and in remote camps, 20-200 miles from the settlement. None of the trail radio systems that have so far been established effectively meets this need.

Accordingly the research sector undertook to develop and demonstrate a prototype experimental system, specifically tailored to meet this difficult communication problem. This temporary equipment will be installed in the early summer of 1976 in one of the Inuit communities in Northern Quebec (perhaps Koartac) for use by the native people, to ensure that it meets their needs and to obtain criticisms of the users, since operational use of the equipment is essential in order to optimize the system concept and design, and to determine which elements of the system need further development.

Briefly, the system involves a centrally-located automatic repeater, which is located preferrably on a high hill, a high tower, or both in or within the environs of the Inuit community. This automatic repeater operates simultaneously in both VHF-FM and HF-SSB modes. For distances up to a maximum of about 30-50 miles,

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*The Inuit of Northern Quebec have recently set up a separate organization from the NQIA, to handle communications only. The name of this organization Taqramiut Nipingat Inc. (TNI) means in English "the voice of the Northerners".

depending upon the topography of the land, the VHF trail radio is used for communications; beyond this the HF trail radio is used. The operation is described on Pages 4 and 5 of the attached progress report on this project: If an Inuit in the community or in the environs of the community wishes to speak with the hunting or fishing party he presses the microphone button of his VHF-FM transceiver ... which could be a hand-held unit or a unit more permanently installed about the community, such as the co-op store, the community hall or in the home of selected members of the community, much like we have public telephone boxes in the South. The signal from his VHF-FM transceiver is received by the VHF receiver at a centrally located base station (repeater) site. The received signal is automatically re-broadcast on another VHF frequency at higher power and higher antenna gain, and on an HF frequency suitably chosen to reach the more distant hunting and fishing party or remote camp. If the Inuit at the distant camp or on the trail is within the range of the VHF repeater, which could be distances up to 50 miles or more depending on the location of the repeater and the topography of the land, the area of coverage will be quickly learned by experience, he could reply using his VHF-FM trail radio as we illustrate in Figure 1. If he is at a distance beyond that which can be reached by VHF, he will use his HF trail radio.

The signal from his HF trail radio does not reach the HF receiver directly by line-of-site as is the case of the VHF signal, but it is reflected by the ionosphere, thus extending the useful communication range to scores of miles or hundreds of miles, depending on the HF frequency used, ionospheric propagation conditions, and powers employed. This is illustrated in Figure 2. The HF signal from the fishing or hunting party is received by the HF receiver at the base station, and this signal is rebroadcast by the VHF-FM repeater so that the Inuit within the community can hear the reply. Access to the base station repeater is obtained by the VHF carrier, or by tone signalling with the HF-SSB radio, the operator must first press his "call" button before he can "talk".

The system operates like a "party line", in that all users of the radio system throughout the community are potential (unpaid) operators, that is they will hear the call from the trail or remote camp. The system to be demonstrated will be as simple as possible, but obviously operational systems can be made as complex as one wishes. For example the remote radio sets could have an "emergency alert button" which when depressed would transmit a sequence of audio tone pairs. These tone pairs received by the base station radio and decoded, would ring an alarm, sound a siren or wailer, or what have you. The system could also be made pseudo-private in that all VHF-FM radios could be silent, except the one called. The party-line concept is thought best to meet the trail radio and remote camp radio requirement ... since the greater the number of listeners the better the chances are of hearing a weak emergency call from the trail.

The objectives of the project are to design and develop, together with participation by Industry, an automatic radio system like that described above, and to optimize it for use by the Inuit on the trail and in remote camps for communications back to their home communities. A prototype experimental system will be installed in a Northern Quebec community (perhaps Koartac) for use by the native people to ensure that it meets their needs and to obtain criticisms of the users, since operational use of the system is essential in order to optimize the system concept and design, and to determine which elements of the system need further development. For example it is already apparent that there is a need to develop in industry an HF radio transceiver optimized for trail and remote camp use, that is small, light, rugged, economical and simple and convenient to use. It is intended to develop such an HF trail radio. The development in industry of trail and remote camp HF radio sets is just one part of our strategy in improving communications in the North, but the existence of commercially available equipment of this type is essential to any adequate scenario for communications; for example portable power sources and antennas are also required.

The Experimental Prototype Base Station

The base station (Figure 3) comprises a VHF-FM repeater, which is a modified repeater by VHF Engineering, Binghampton, N.Y.; and a Drake Communications Station which includes a R-4B receiver and a T-4B transmitter (crystal controlled). The reasons for choosing these equipments is as follows: the Drake communication equipment has been used by CRC on many field trips, it is known to be reliable, and was on hand. We had no experience with VHF repeaters, and so the VHF Engineering repeater was purchased in kit form, and built in the Laboratory to obtain quickly experience with this type of equipment (besides the price was attractive $375 for a 15W repeater complete with CW identifier (programmable) and timer). The antennas to be used are a 6 dB gain* omnidirectional vertically polarized collinear by Sinclair Radio (Model 229B) (Figure 4) for the VHF frequency. The HF antenna will be an inverted V half wave dipole mounted on a 60 foot aluminum lattice mast. It is our opinion that a full wave delta loop apex down offers advantages over the inverted V, but this antenna requires two poles to support it. Operating frequencies are 3380.5 kHz

*This antenna is 22 feet long, and if it is too long to air transport a 3 dB gain collinear, Sinclair Radio Model SRL 233B will be used.

(suppressed carrier frequency) and 148.03 MHz repeater input, 148.60 MHz repeater output.

The four cavity duplexer by Sinclair Radio, Model F-150 is used, which provides 100 dB isolation between transmitter and receiver and, 1.6 dB insertion loss, for 600 kHz separation.

Trail Radio Equipment

Four types of trail radio equipments will be employed, but one of these will (probably) not be left with the Inuit. The Tempo CL-146A 10 watt VHF-FM transceiver (Figure 5) will be employed for use on the trail (four radios are available) and for use at various locations within the community (four radios are available). This radio requires 2 amperes at 12 volts on transmit and a 4AH battery provides 2-3 hours of continuous communications. Two 4AH Ni-cad battery packs will be provided with each radio. The fixed station radios are AC mains operated. Two hand-held radios, the Wilson 1402 SM 2.5 watt transceiver (Figure 6), are also available. These are not commercial radio equipments, they were chosen because their performance is excellent and their cost reasonable. The VHF transceivers will employ Laboratory built vertical "J" antennas, which are a half wave radiator matched by a quarter wave stub, which also decouples the antenna from the transmission line. Fixed Station (Figure 7) and portable versions of this antenna (Figures 8 and 9) have been built.

The availability of HF trail radios is not so satisfactory. Military man-pack radios, such as the Racal Syncal 30 (which is a completely synthesized radio covering the frequency range 1.6-30 MHz and the Comcal 30 (crystal controlled) are ideal. They are all solid state and provide 20W PEP, and although not channelized, are relatively easy to tune ... but they cost too much. The Racal Squadcal 5W PEP radio is more attractive, costing $1515 for a single channel radio. The Marconi CP34 is a similar kind of radio (10 or 20 watts PEP models are available), it is not as good as a radio as the Racal man-packs, in particular although the frequency range is said to be 2-18 MHz, the output power is already starting to drop off above about 5 MHz. The cost of this radio is more reasonable ($1700 for the 10 watt PEP radio). The radio is not channelized and may prove difficult for the Inuit to tune up ... too many knobs.

The Spilsbury and Tindall SBX-11 (Figure 10), 10 watts PEP is a channelized radio (cost about $1000), and we have some operational experience with this equipment. It was chosen for the present project (two radios are on hand). The receiver is quite sensitive, however the AGC pumps quite badly on strong signals. The transmitter power falls off quite significantly toward the high-frequency end of the band: the radio is supposed to operate in the range 1.6-8 MHz, however the output power decreases from about 12 watts near the low end of the band to 2.5 watts at 7.8 MHz. The clarifier on the radio is essentially useless, it only varies the receiver frequency by ±100 Hz or so.

Amateur radio HF SSB equipment, although not in general suitable for use by non-technical persons, and the equipment often does not meet DOC specifications in terms of intermodulation distortion, spurious outputs and second harmonic output, does in my view indicate the coming trend. The Atlas Model 180 (presently superceded by the Atlas 215X) for example provides an output power of 100-150 watts PEP, in a radio of physical size that can be held in one hand (dimensions are 5½ inches wide, 5 5/8 inches high and 9½ inches deep). The advantages of this radio over all radios that I have experience with are:

1. Modular construction which includes plug-in circuit boards for ease of maintenance compare (Figures 11 and 12) this type of construction with the latest radio, built by Spilsbury and Tindall under PAIT funding, the SBX40;

2. The radio is broadbanded, each band being about 1.1-1.3 MHz wide, and needs no tuning. The Spilsbury and Tindall SBX-11 on the other hand is quite critical to tune up (although the radio is pre-tuned so this is of no concern to the user);

3. The sensitivity of the receiver is excellent, the audio clarity good, the AGC action smooth, and the adjacent channel selectivity is better than that for all radios considered.

The Atlas has higher power than is feasible on the trail, but not necessarily for remote camp use, but of course the output power can be reduced merely by adjustment of the mic-gain from essentially zero to full power. The radio will operate for 4-5 hours* at full power employing a 20AH gel-cell battery (a transportable lead-acid type of battery which unfortuantely is not very suitable for low temperature operation). A transportable carrying case has been designed at CRC (see Figure 13) for this radio.

An efficient HF antenna is not so easily transportable as at VHF. The radiation efficiencies of short centre-loaded whips is poor (radiation efficiencies of a few per cent), and a vertical antenna is not very suitable for short distance (beyond ground wave range) communications, because the antenna does not

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*Assuming that fifty per cent of this operational time is spent in listening.

radiate well at high elevation angles. The most probable antenna that should give the best results is the resonant half-wave dipole, which is a wire antenna about 140 feet long at 3.3 MHz. A transportable inverted V configuration is illustrated in Figures 14-22. A horizontal full wave loop, mounted on four 6-foot poles, has also been devised, but operationally the inverted "V" and the full-wave loop are yet to be compared.

Transportable Power Sources

Portable power sources have not been investigated to any great extent. The natural sources of power, to charge batteries or operate equipment are: solar cells, wind driven generators, and hand crank generators. The NRC are developing wind driven generators. We propose to investigate the possibility of developing a portable unit that will deliver 100 or 200 watts. Military man-pack radios are equiped with hand crank generators, but unfortunately like all MIL-SPEC equipment it costs too much (the Racal hand crank generator for charging Ni-cad batteries or for operating the man-pack radio in an emergency costs $1500).

A small 300 watt Honda generator provides a convenient reliable source of power, that is not too expensive to purchase, but providing that gasoline is available; or the battery and generator system on the ski-doo provides a convenient means of operating radio equipment on the trail.

Whatever the means of power generation batteries are the only means of storing this power so that it is available immediately under all circumstances (when there is no sun or wind) for emergency or routine operational use of the radio equipment. I don't profess to know very much about batteries, and the following comments more or less summarize all I know on the subject. The gel-cell lead acid type of battery is the most economical and compact high capacity transportable battery available. It is however more expensive than ordinary (so-called) spill-proof lead acid batteries. A point worth noting, the Fall-Winter 1975/76 issue of the Canadian Tire Corporation catalogue described a lead acid battery with the trade name Oasis. It is hermetically sealed, and (according to the advertisement) will keep for years. To activate this battery one breaks the seals and adds ordinary water, which reacts with the "dry" encapsulated acid and the resulting heat boosts the battery to working voltage. Lead acid batteries heat themselves when they are used, and for this reason they can be used in the north in spite of their relatively poor cold temperature performance. One must bury the battery in about two feet (or more) of snow to keep it warm.

The Ni-cad battery is the best type of rechargeable battery for use with transportable radio equipment. Its cold weather performance is excellent. The battery unfortunately has a few idiosyncrasies, all batteries do, that lead people into trouble. If the battery is discharged too much the terminal potential of some of the cells may reverse polarity, in which case it will not be possible to recharge the battery pack. The cure for this is to isolate the faulty cell(s), instantaneously put 12 volts across the 1.25 volt battery terminals for a split second (observing the right polarity), and recharge the battery in the normal manner. The batteries should be charged at a current rate equal to 1/10 of the AH rating of the battery: a 4AH battery should be charged at 400 milliamperes. The battery pack should be charged overnight (14-16 hours) when the terminal voltage of a 12 volt battery pack has dropped to about 10 volts. Some form of current regulation should be incorporated with the charger: a series lamp having the right current rating is the best and simplest method (the brightness of the lamp also indicates the state of charge). The Ni-cad battery provides a working voltage of about 1.25 volts/cell, that is ten batteries in series are needed to provide 12.5 volts ... whereas zinc carbon and alkaline cells provide 1.5 volts/cell and only nine batteries are required for a 12 volt battery pack. This creates problems for the manufacturer of radio equipment: for example the Spilsbury and Tindall SBX-11 transceiver has a battery compartment that holds nine size D batteries. We are using Ni-cad batteries and therefore we should be employing ten batteries. The size D Ni-cad battery has a capacity of 3.5-4AH; the size C cell has a capacity of 2AH; the size AA cell has a capacity of 0.5AH. Ni-cad batteries like to be worked: they do not provide relaible service as a stand-by battery trickle charged unless the batteries are periodically discharged and recharged.

We should, before concluding this brief discussion on batteries, consider the perhaps controversial alternative: rechargeable versus throw away batteries. Throw away batteries such as zinc carbon, alkaline, or lithium cells (listed in order of cost, and also in order of performance, particularly cold temperature performance) are certainly technically simpler to use ... one plugs them in, uses them and when the radio no longer works, one throws them away. I do not believe however that this is the right long term solution. Batteries in my view should be a means of storing power generated in some other way, be it a natural power source (sun, wind, water, muscle power) or gasoline.

There is certainly a need for continuing battery research and development, to devise a better cold temperature battery ... the salt water battery for example seems to have certain advantages. Only water needs to be added, which could be melted snow, sea water, or in an emergency situation the battery could be activated by urinating into it, which provides not only the electrolyte but the warming required for low temperature performance.

Concluding Remarks

Radio communications from the trail, or from remote camps to the community is difficult. Yet the methods of improving communications, which we have been discussing, seem fairly straight-forward ... one could almost say that the solutions discussed are no more difficult than could have been proposed by practical radio amateurs. Why then is there a problem? The problems are many:

1. an important consideration is that of economics. Commercial radio equipments for use by Northerners should not cost appreciably more than commercial equipments manufactured for radio amateur use;

2. commercial communication systems often seem to have lost sight of practicality, simple changes can sometimes result in marked improvements;

3. the question of complexity should be critically examined. There is certainly a needed compromise between radio equipments having essentially no knobs and no meters to judge performance, and amateur radio equipments with a front panel full of knobs and two or more meters;

4. the question of maintenance is not given the necessary due consideration by the manufacturer. No matter how well a communications equipment works initially it will not continue to operate satisfactorily without proper maintenance;

5. radio equipment for trail and remote camp use has to be rugged (few equipments are rugged enough); and last but not least,

6. our Department (you and I) needs to take a fresh and practical look at the requirement for trail and remote camp communications. For example let me site a for instance. Why should our Regularity Service insist that the manufacturer achieve a frequency stability of ±100 Hz (or ±20 Hz) for SSB suppressed carrier transmission when the spectrum bandwidth is about 3000 Hz. While it is necessary for the automatic base station kind of communication system described that the remote and the base station SSB radios be on the same frequency with ±50 Hz (or better) for optimum audio clarity, there is no way that the transportable radio will be able to achieve this (crystal ovens must be ruled out), even with the best of designed temperature compensated crystal oscillators. The only reasonable alternative, in my view, is that the "clarifier" control on the radio should also control as well the frequency of the transmitter, so that the remote station when tuning for best clarity, automatically puts himself on frequency (the frequency of the base station).

The radio spectrum is a natural resource that should be optimumly used to make it possible for Northerners to talk to each other ... and if to achieve this we have to change the radio regulations, or if we have to reconsider the Department's Policy which discourages private radio systems (is this really a policy?), we should be prepared to do this. People in the North are important, and people in the North talking to each other is our first priority. It is my intention that they should have suitable equipment and that they will have the opportunity to use it.

INUIT TRAIL RADIO PROJECT

PROGRESS REPORT

1 April 1975 - 15 December 1975

Radio Communications Laboratory
Radio and Radar Research Directorate
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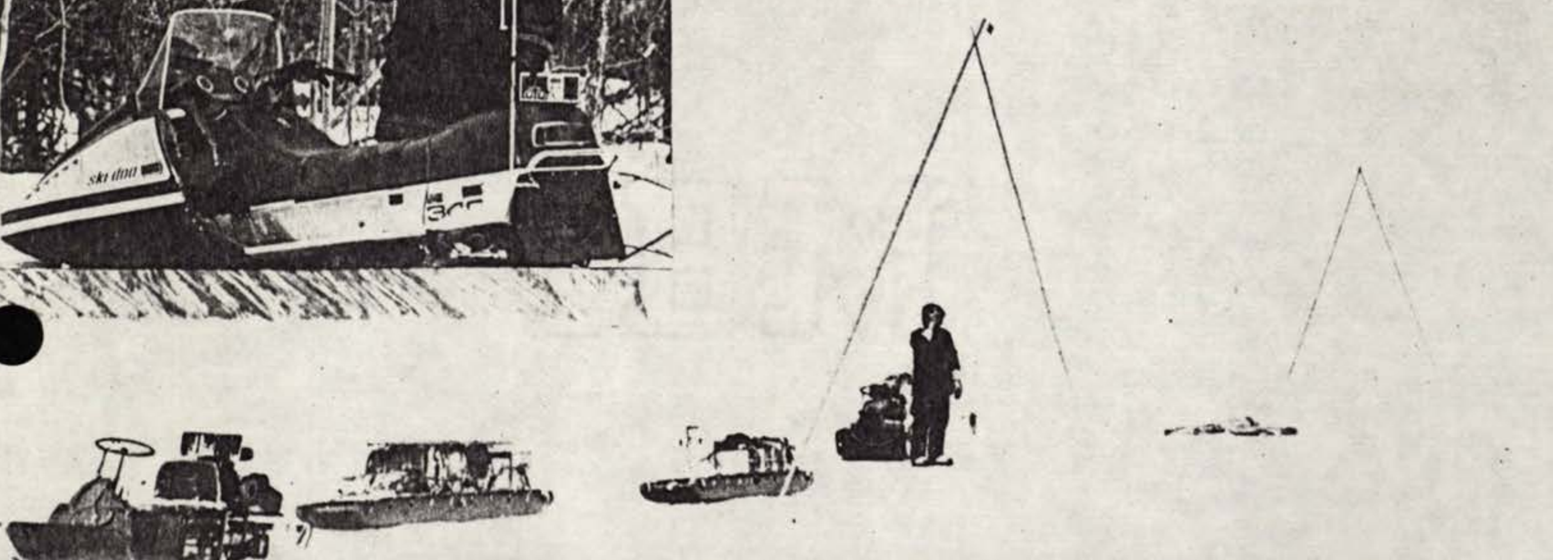

INUIT TRAIL RADIO PROJECT

PROGRESS REPORT

1 April 1975 - 15 December 1975

Introduction

On 31 October 1974, the Northern Quebec Inuit Association (NQIA) met with three Ministers, the Secretary of State, Communications and Indian and Northern Affairs, and presented their Brief entitled "The Northerners"[1]. They met separately with the Department of Communications on 1 November 1974. In the foreword to this brief it was made clear that when the Inuit think of communications, they mean four different kinds of communications links involving different groups of people talking to each other. These are:

1) communications between communities;

2) communications between the land and the communities (the trail radio and remote camp radio requirement);

3) communications within the community; and

4) communications from the South to the communities.

On 4 March 1975 a Regional Coordinating Committee was brought together, which included representatives from the regional offices of Secretary of State, who chaired the meeting,[2] the Department of Communications, the Department of Indian and Northern Affairs, the CBC, and the Quebec Government (Ministry of Communications and Municipal Affairs). The NQIA, represented by Mr. Josepi Padlayat, Communications Officer, NQIA, together with some members of his staff and consultants, Mr. Neil Greig, Mr. R. Ruston, M. Robert Pothier, Consultant, Prof. Anthropology, Laval University, and Mr. Len Petrie, Consultant, Petrie Telecommunications, briefed this Committee on their communications requirements.

After information had been exchanged on the nature of the communications requirements outlined in the Brief, and all participants of the Regional Coordinating Committee had expressed their viewpoints, it was agreed: 1) that the Inuit needs as outlined in the brief submitted cannot be questioned; and 2) that the most pressing priority was the establishment of a HF network and a trail radio system. The establishment of local radio stations and an Inuit-language periodical were also discussed. On the basis of these deliberations, the Regional Coordinating Committee recommended that the Secretary of State grant a $285,000 subsidy to the Native Communications Society of Northern Quebec, to cover the costs of installing and operating a HF network linking eleven Inuit communities in Northern Quebec. On 10 April 1975 (ref. Ottawa Citizen, 11 April 1975) Hon. Hugh Faulkner, Secretary of State, announced a $130,691 grant for a HF radio system to link the eleven communities, and provide as well HF trail radios.

At the time of writing this progress report (December 1975) HF communications equipments for inter-community communications have been installed in eight of the thirteen communities. Three new communities have joined the NQIA, these are Cape Smith, Aupaluk (near Hopes Advance Bay not be be confused with Cape Hopes Advance) and Deception Bay. Povungnituk (called for short Pov), for political reasons, have withdrawn their support from the NQIA. Six HF channels are available (in the frequency range 2600-6000 kHz), one of these (4508.5 kHz) is the calling frequency. Marconi CH25 100 watt transceivers, a rather outdated but reliable equipment, are employed. The antenna is a terminated folded dipole cut for the lowest frequency. The communications station is controlled by Inuit radio operators, who are hired to do the job. The radio is nominally available for use by the Inuit during three periods daily (in the morning, at midday and in the evening). One kilowatt amplifiers (manufactured by RF Communications) have been procured for some of the stations but have not been installed. Also a number of Marconi CP34 man pack radios are available for use on the trail and at remote camps, but these are not yet in service. These radios are more complicated to use than the Marconi CP25 base station (the channels are not pretuned), and of course they have to be "set up" by the user. A training program is planned but training has not been started.

The most difficult part of the communications requirement is that of communications from the trail and from remote camps to the community. While various commercial radio equipments are available, that could be used for this requirement, none are optimum in regards to portability, reliability, ruggedness, low power consumption, antenna configuration, operating temperatures, etc. The range of distances required (up to 200 miles), i.e. short range communication is to some extent more difficult than is communications to greater distances, for a number of reasons. For HF communications in this distance range, the lower frequencies in the band (2-4 MHz) must be used.

Antennas are long, and, in the case of transportable antennas efficiencies are low because practical heights of dipole antennas above the ground are small (small compared with the radio wavelength). Also, in this distance range propagation effects more dominantly control the communications link. The absorption or attenuation of the wave during daytime is higher at medium frequencies than at high frequencies; and "skip distance" effects can make communications employing a single frequency difficult at certain distances. This occurs in the distance range beyond which the ground wave becomes useable and the distance at which the skywave becomes sufficiently strong for reliable communications. In this distance range difficulties are encountered relating to the polarization of the wave: vertically polarized ground waves propagate better than horizontally polarized waves; and the polarization of the skywave is elliptical in the horizontal plane.

For these and other reasons CRC felt that there was a need for research in this area, to develop and demonstrate a system that would better meet the requirements than one employing HF alone, to define the elements of this system (a VHF/HF integrated system); and to develop in Industry the parts of the system that need further development. It was argued that by installing an experimental pilot system in a selected community in the North, by conducting communications and propagation experiments with this equipment, and by observing its operational use by the Inuit, we would learn at first hand and more quickly than by any other means about the communication problems that have to be solved. Learning by doing is a means that we believe should apply better to solve practical radio communications problems.

The Remote Camp Trail Radio Requirement

The economic base of the Inuit of Northern Quebec is dependent on the land resources so that, for a period of time, members of the community must leave the settlement to hunt "on the land". The community then becomes a large area containing both the settlement and the area frequented by hunting (or fishing) parties. There is a need for communications from the settlement to hunting parties on the trail and at remote camps (25-200 miles from the settlement). The system proposed by CRC, an automatic VHF repeater-HF communications system, envisages inexpensive VHF-FM transceivers located throughout the community as for example telephone call boxes are in southern cities (in the Co-Op store, in the school, in some of the homes), and portable VHF and HF equipments for use on the trail and at remote camps. The advantages of this system over previously used HF trail radios (which employ HF transceivers for communicating to the HF radio station located at one place in the community) are:

1) the VHF-FM repeater provides reliable communications employing small compact transceivers to distances of 25-75 miles depending on the topography of the land and the location of the repeater, which ideally should be on a high hill (see the illustration in Fig. 1);

2) the HF transportable radio provides for communications to distances beyond that which can be reached by VHF, to distances up to and greater than those to the adjacent community (see illustration in Fig. 2);

3) the system operates like a "party line", in that all users of the radio system throughout the community are potential (unpaid) operators, that is they will hear the call from the trail or the remote camp. Obviously the system can be made as complex as one wishes: for example the remote radio sets could have on them an "emergency alert button", which when depressed, would activate the transmitter and emit a sequence of audio tones. These tones received by the central (base) station radio, would ring an alarm, sound a siren or what have you. The system could also be made pseudo-private, in that all VHF-FM radios could be silent, except the one called, by employing touch-tone calling. The party-line concept is thought best to meet the trail radio, remote camp radio requirement.

Principles of Operation of the Experimental Trail Remote Camp Radio Communications System

The operation of the experimental system envisaged is as follows. If an Inuit in the community or in the environs of the community wished to speak with the hunting or fishing party he presses the microphone button of his VHF-FM transceiver ... which could be a hand-held unit or a unit more permanently located somewhere in the community such as the co-op store, or the home of selected members of the community, much like we have public telephone boxes in the South. The signal from his VHF-FM transceiver is received by the VHF receiver at a centrally located repeater site, which should be on a high hill, a high tower, or both. The received signal is automatically re-broadcast on another adjacent VHF frequency at higher power and higher antenna gain and on an HF frequency suitably chosen to reach the more distant hunting or fishing camps. If the Inuit at the distant hunting or fishing camp is within range of the VHF repeater, which could be to distances up to 50 miles or more depending on the height of the VHF repeater antenna, and the topography of the land, the area of coverage will be quickly learned from experience, he could reply by using his VHF-FM trail radio as we illustrate in Fig. 1. If he is at a distance beyond that which can be reached by VHF, he will use his HF trail radio. The signal from his HF trail radio does not reach the HF receiver directly by line-of-sight as in the case of the VHF signal, but it is reflected by the ionosphere, thus extending the communication range to hundreds of miles, dependent on the frequency used, ionospheric propagation conditions, and powers employed. This is illustrated in Fig. 2. The HF signal from the fishing or hunting party is received by the HF receiver at the base station site, and this signal is rebroadcast by the VHF-FM repeater transmitter, so the Inuit within the community can hear the reply.

The circuit details of the repeater are illustrated in Fig. 3. Each time the Inuit within the community activates the repeater by pressing his microphone button and speaking, the carrier-operated-relay (COR) automatically turns on the VHF and HF transmitters, and <u>resets</u> the timer provided that it has been initially set. If the timer is set for ten minutes the total length of his conversation and the reply must not exceed ten minutes. The timer and the tone sequence to be employed with the HF trail radio is needed so that spurious signals which could be received by the HF receiver during quiet times will not turn on the VHF repeater.

To originate a call from the hunting or fishing camp employing the HF trail radio, the Inuit must first press a tone calling button. This initiates automatic transmission of a special tone sequence (which could in the simplest case be two tones). These tones are received by the HF receiver at the repeater site, decoded, the timer is automatically set, the relay providing audio from the HF receiver to the VHF repeater is closed, and the VHF repeater transmitter is turned on. The signal received by the HF receiver will therefore be rebroadcast and can be heard by everyone in the community that is monitoring the repeater. The Inuit at the remote hunting or fishing camp can therefore press the microphone button of his HF trail radio and initiate a call. The Inuit in the community will hear the call, and reply. His reply will automatically reset the timer and communications can proceed as above, the operation of the repeater is controlled by the strong local signal. If no reply is heard before ten minutes have elapsed, or if the timer should be "timed out" during use, the Inuit at the remote hunting or fishing camp will have to press his tone calling button once again, then press his mike button and speak. This procedure may seem to be complicated, but, it can be quickly learned, and this technique will avoid unwanted HF signals from turning on the VHF repeater transmitter and so rebroadcasting interference and noise which could be very annoying.

It is clear from the above that the communication system is entirely automatic, and therefore it can be operated during "silent hours". If there is an operator on duty, he could monitor the operations of the system, and he could interface the system with the HF intercommunity radio network if so desired. The VHF to VHF repeater operation provides within the community communications where the community encompasses not only the settlement but a part or the whole of the area frequented by hunting parties. More distant hunting parties would have to employ the less reliable HF trail radio. The trail system operates like a party line. In an emergency situation several parties could be called simultaneously, or "round table" discussions can take place. When an operator at a trail radio camp calls the settlement, his call could be heard by several members of the community in their homes, thus the chances of hearing the call are better than in the case of one operator at the radio shack who may be asleep or momentarily absent from communications station.

The VHF-FM repeater HF trail radio system is intended to facilitate communications between the land and the community. In the concept of the plan the community then becomes a large area containing both the settlement and the area frequented by the hunting parties - and the system provides communications between homes within the community and those out on the trail. The system proposed therefore can provide communications within this extended community, as well as communications between the fixed locations within the community. That is communication <u>between</u> the fixed stations. To avoid tying up the repeater to the extent where trail and remote camp calls cannot be heard because of intensive local use, and to avoid wastage of the HF spectrum, since every time the proposed system is acquisitioned the HF transmitter is turned on, local communication should be functionally separated from the trail radio system. Local communication could however be possible by employing the same VHF-FM radios as used for the trail radio communications by switching to a different direct or local repeater channel. If the fixed VHF station employed antennas mounted on 10-30 foot masts attached to the side of the house direct communications from one house to the next, to the co-op store, the school, or to wherever a fixed station were installed, to distances of 10-20 miles, dependent on terrain, would be possible. Such a local communications system would be of the "party-line" type, i.e., everyone on the party line (who has a radio) could switch to this channel and hear everyone else. While the main purpose of the experimental trail radio system to be demonstrated is for communications between the land and the community a direct channel will be provided in the VHF-FM radios to ascertain whether an additional channel would meet Inuit requirements for local communications. Such information will be of value to those concerned with more sophisticated "private line" systems.

It is assumed that families within the community, who have one or more members of the family out on the trail, would normally monitor (listen to) the trail remote camp radio channel, so that calls from the trail will not be missed. Users of the system will quickly learn how to operate the system to best meet their requirements, and the usage pattern will be a part of the experimental communication study.

An operational system could of course be made more complicated as dictated by the needs of the people. The VHF repeater could, for example, employ touch-tone calling so that only one receiver would be activated, that of the station called, or touch-tone calling could activate a loud haler or a siren under emergency situations.

The Equipment to be Used to Demonstrate the Trail Radio System

The VHF-FM repeater and integrated HF transmitter-receiver will be laboratory-built and assembled using a modified VHF repeater kit available from VHF Engineering, Division of Brownian Electronics Corporation, Binghamton, N.Y. The four cavity diplexer by Sinclair Radio, Maple, Ontario, Model F-150, will be used so that a single antenna for transmit and receive can be used. This diplexer provides 100 dB isolation between transmit and receive frequencies as little as 600 kHz frequency separation in the 148-174 MHz frequency range with 1.6 dB insertion loss. The HF radio will be a Drake Model R4B receiver, T4B transmitter which has been used by CRC as a portable HF communications station on many field trips during the past several years.

Four types of trail radios will be employed (two HF and two VHF). These are illustrated in Figs. 4-7. The HF trail radio by Spilsbury and Tindall Model SBX-11 is illustrated in Fig. 4. This 10 watt PEP (peak-emitted-power) unit comes complete with its own internal nickel cadmium batteries, and the equipment is well known to remote communicators. They have been used by the Polar Continental Shelf Group, by the Defence Research Establishment. Six of these little radios were bought by CRC, and the Central Region trained the operators and provided the sets to the Slavey people at Ft. Franklin. During the winter of 1973-74 the sets were used on the trail and a number of hunting camps within a 100-mile radius of the community.

Everyone had access to the sets, and the system was well used. The requirement exists for some type of charging device, such as windmills, hand-crank, or thermo-electric generators. In his evaluation of the project Robbins[3] of the Central Region states: "present indications are that this is indeed a viable method of meeting a northern communication problem expressed and experienced by Northern people".

Environmental constraints and differing communication patterns may modify Inuit use of such a radio, but trail communications is a definite requirement and so CRC has purchased one of these radios to be used with the present communication/propagation experiments with the NQI.

In Fig. 5 we show a state-of-the-art radio, the Atlas Model 180, designed for use by radio amateurs. While the unit shown is controlled by VFO (a variable frequency oscillator), the unit purchased by CRC will be operated under crystal control (fixed frequency channels like the HF radio sets presently used). The size of this little radio can be judged by comparison with the hands holding it, yet it will deliver more talk-power (up to 120 watts PEP than other radios very much larger). While the primary power required to operate such a radio is much greater than for the 10 watt PEP Spilsbury and Tindall SBX-11, the use of this radio is intended to illustrate the type of equipment which could be operated at a more permanent camp. We have estimated that the radio could be operated for up to 16 hours employing a standard 70 ampere-hour car battery (assuming that fifty percent of this operational time was spent in listening and that the transmitter was operated at full power).

VHF radios are shown in Figs. 6 and 7. The first is a hand held unit by Wilson Electronics Corporation, complete with built-in nickel cadmium batteries and "rubber flex" antenna. A more efficient CRC designed collapsable vertical "J" portable antenna will be used instead. The transmitter power is 2.5 watts. A much greater communication range will be achieved by employing the Tempo Model CL146 10 watt VHF transceiver, shown in Fig. 7, which is still rather small, as can be judged by comparison with the size of the microphone; but a larger more bulky and heavier nickel cadmium battery pack will be used with this radio. A mains operated version of this radio will be operated at one or more fixed locations in the community; perhaps at the home of an Inuit participating in the experiment and at a central location such as the Co-op Store. Eight Tempo VHF radios have been purchased, four mobile units and four units installed at fixed locations in the community will be employed.

The Antennas

The VHF antenna is very portable; the vertical "J" is essentially a rod about 55 inches long. The photograph in Fig. 8 illustrates VHF communications from a ski-doo employing a vertical "J" antenna. A ski-doo battery is being used for power, which can just be seen on the ground near the rear of the vehicle (the radio could have been connected to the battery powering the machine). An efficient HF antenna for use with the HF trail radio is not so easily come by. The Spilsbury and Tindall Company provide a so-called "talking stick" antenna, which is a short (100-inch or so) centre-loaded vertical whip. The radiation efficiency of this type of of antenna is poor and it is not the best type of antenna for short distance communications (100 miles or less). The most probable antenna that should give the best results is most likely to be the resonant half-wave dipole, which is a wire antenna 140 feet long (at 3.3 MHz), longer or shorter depending on the frequency employed, suspended between two trees or between aluminum poles, as shown in Figs. 9 and 10 when no trees are available. Other antennas will be experimentally investigated, such as a full wave horizontal loop antenna, but the horizontal dipole, or inverted "V" configuration (where the centre of the dipole is higher than the ends of the antenna) is considered to be the best type of antenna for the HF trail radio.

The Plan

An outline of the project plan follows:

a) discussion at an early phase with the NQIA, to learn as much as possible about their trail communications requirement;

b) to select a community (or communities) for field trials to test and develop innovative use of technology that responds to their needs;

c) to develop and construct a VHF-HF automatic system base station, and together with suitable (for demonstration) trail radio equipments to demonstrate this system in the Ottawa area to all interested (NQIA, DOC, IAND, Secretary of State);

d) to visit a selected community or communities and discuss with leaders in the community about the proposed experimental/pilot communications and propagation experiments, and to decide on those Inuit who will participate in the communications experiments;

e) to install the trail and remote camp radio communications system in the selected community, and, during a 2-4 week period to conduct communication and propagation experiments with the Inuit;

f) to leave the communication system with the community for their use and evaluation of it for period of 4-6 months;

g) the end purpose of the research is to define an integrated communications system, together with industry, to guide development of suitable elements of the communications system (e.g. improved transportable antennas, development of a reliable, rugged, lightweight, low power consumption HF SSB transceiver for trail and remote camp use, etc.), that will lead to development and implementation of an operational system that will meet the requirements for trail and remote camp communications, that best meets the requirements and that is within the budget that seems reasonable at that time.

While the system concept provides for trail and remote camp communications, it can be used also for within the community communications. Obviously it could be interfaced if required either manually or automatically with the HF inter-community radio system presently being installed by Petrie Telecommunications, with monies provided by the Secretary of State; as well as with the communications systems provided by the common-carriers. The interface with the HF intercommunity communications system could be accomplished merely by installing one of the VHF-FM transceivers beside the radio operator controlling that system, and providing him with a hybrid-patch circuit for system interconnection.

Progress to Date

The VHF-HF communication system as described above is essentially identical to that suggested by the undersigned in a memorandum d. 12 November, 1974.[4] A copy of this memorandum was annexed (Annex 1) to the memorandum on Remote Communications by W.L. Hatton,[5] f. 6030-17, dated 3 January 1975. Monies and man-year resources have been allocated for this research ($55,000 and 2 MY), and a Project Approval Document was prepared. The project was described in more detail in a document (f. 6000-19) dated 1 April, 1975 (revised 21 April, 1975)[6].

The NQIA, represented by Mr. Josephi Padlayat, Communications Officer, and Paddy Gardiner were briefed on our proposed research project in the DOC Regional Offices, Montreal on 30 May, 1975[7]. The DOC Regional Office was represented at this meeting by M. Laurier Fortin, Regional Communications Advisor and M. Lawrence, Regional Social Advisor.

A number of discussions have been had with Mr. Len Petrie, of Petrie Telecommunications ... the particular ones worth noting were the one on 23 May, 1975[8] when he briefed us on his tour of the 14 Inuit Communities of Northern Quebec; and in November, 1975 when he briefed us concerning the progress made in installation of the HF communication stations for inter-community communications.

After much discussion, with Len Petrie, and also with Josephi Padlayat, we have tentatively chosen one of the fourteen communities for demonstrating and experimental operation of the communication system: this community is Koartac, but the community has not yet been approached. Since the Inuit fish on both sides of Cape Hopes Advance (see Fig. 11), and on both sides of Diana Bay (20-25 miles across) a VHF repeater could provide vital communications. The terrain is rugged and offers interesting topography, e.g. the utility of VHF diffraction which could make possible VHF communications to a mobile behind Diana Island in Diana Bay will be investigated.

Early in 1976 it is intended to write to Josephi Padlayat, telling him exactly what we intend to do, and asking that he concur, and that he accompany us in a recognition visit to Koartac, in March, 1976. Copies of this correspondence will be sent to the Quebec Regional Office, and to the Quebec Government (Communications and Municipal Affairs) so that they are informed. It is absolutely essential that the Inuit in the selected community receive us with enthusiasm, and co-operate with us in operationally using the system.

Inuit help would be sought in setting up the communication equipment, in conducting communication and propagation experiments while we were there, and of course an Inuit interpreter would have to accompany us. The Department would of course have to pay for assistance provided. The help of IAND to translate simple operational use instructions into the Inuit language will be sought.

Most of the equipments for the experimental/pilot communication system have been procured, but development and integration of the HF and VHF equipments is yet to be done. The VHF-FM repeater is provisionally in operation (as of 17 December, 1975). Tone calling has been incorporated into the two HF radios: the Atlas 180M and the Spilsbury and Tindall SBX 11. Simple two-tone decoders have been incorporated into the HF base station radio, but the ability of the system to reject false triggering by noise, interference and voice modulation is yet to be determined.

Considerable development work on antennas has been completed, but much remains to be done. Three transportable antennas are ready for evaluation, in communication trials: a vertical centre-loaded whip; an inverted "V" employing a collapsable eighteen foot centre support (see sequence of photographs in Fig. 9); and a full wave horizontal loop which is supported by four six foot poles. The base station HF radio will employ either a full wave delta loop or an inverted "V" antenna (perhaps two inverted "V's" at right angles to each other). Three 60-foot towers oriented such that their location is at the vertices of a right angle triangle are installed at CRC Field Site Area 2, and antenna tests are presently being made. It is likely that the inverted "V" will be used in the North, unless the delta loop is markedly better, because only one supporting tower is needed (an important point since transportation and installation costs are high in the North). Also the inverted "V" is likely to be more resistant to freezing rain, since the water has a tendency to flow toward the bottom of the V before freezing, whilst water freezes easily on the wires of a horizontal dipole. Maintenance is also easier and the antenna can easily be adjusted to work on two frequencies. Preliminary measurements indicate (rather surprisingly) that the antenna is almost omnidirectional for reception of sky-wave signals over distances of up to 200 miles.

The VHF antennas, for transportable and mobile use will be a vertical "J" (an end-fed half wave radiator that operates independent of a ground plane). This antenna is not new, but its application for VHF land mobile useage has not been developed. While the roof of an automobile (especially a station wagon) makes a very good ground plane, the frame of a ski-doo or arctic tundra is less than an ideal ground plane and so an antenna that is decoupled from the ground plane is a better proposition.

Portable power sources have not been investigated to any great extent. Lead acid batteries, of the ordinary automotive type and (sealed) gel cells have been purchased for use with the higher power HF radio (the Atlas 180M); Ni-cad batteries (size D cell 4AH) battery packs will be used for the VHF transceivers and for the lower power HF transceiver. A small 300 watt Honda generator has also been purchased. After much consideration it was decided that the VHF trail radios would be provided with two 4AH battery packs. This seemed to be a good compromise. Firstly 4AH batteries are relatively cheap and readily available compared with 8AH batteries. Secondly the Inuit should quickly learn that when one 4AH battery pack is exhausted, they will have already used up half of their communication time ... unless the discharged battery pack can be recharged (from the generator on the ski-doo, from a larger capacity lead acid battery, or from the Honda generator). Wind generators seem like an obvious answer to provide power for remote sites in the North. The NRC are developing wind driven electric generators at the same CRC site where the VHF-HF base station radio for experimentation and demonstration in the Ottawa area is being set up.

It is anticipated that the recognition trip into the North will be made in March, 1976 and the experimental/pilot communication system will be installed in the selected community in April, 1976. The system will be made available for use by the Inuit during the spring break-up and during the period of their hunting and fishing trips in the summer season. The system would be removed in the autumn, either just before or after freeze up.

Funds for development of certain elements of an operational system are anticipated for 1976/77. Preliminary discussions have already begun with Industry on the possible development of a HF SSB transceiver. Development of a compact, portable wind generator is a likely project for next year. The proposed HF SSB transceiver will require a change in the Radio Regulations. Discussions with the Telecommunications Regulations Branch have not yet been initiated.

John S. Belrose
December 1975

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2. The Northern Pilot Projects: An Evaluation, by Heather Hudson, Department of Communications Report, July 1974.

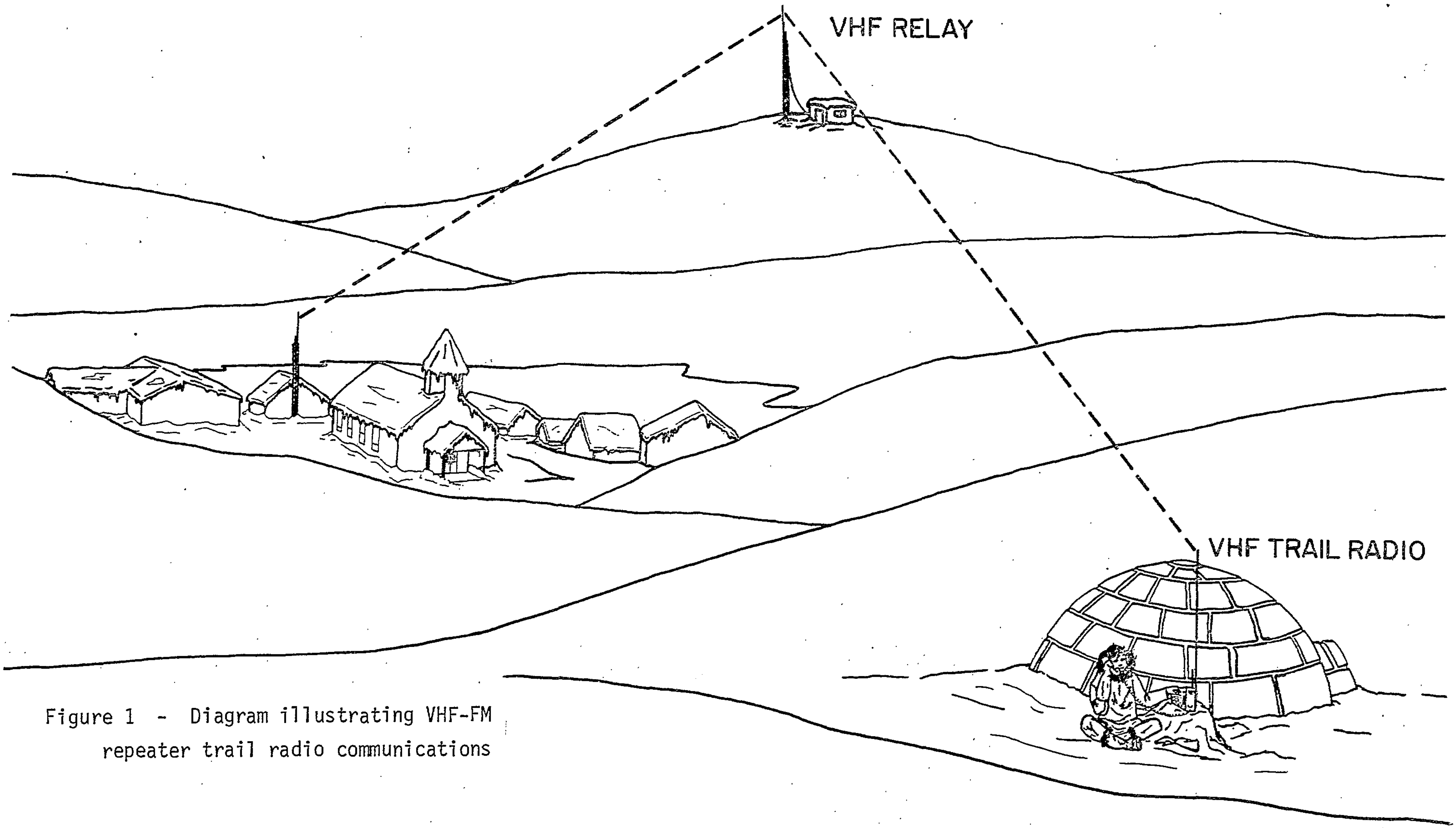

Figure 1 - Diagram illustrating VHF-FM repeater trail radio communications

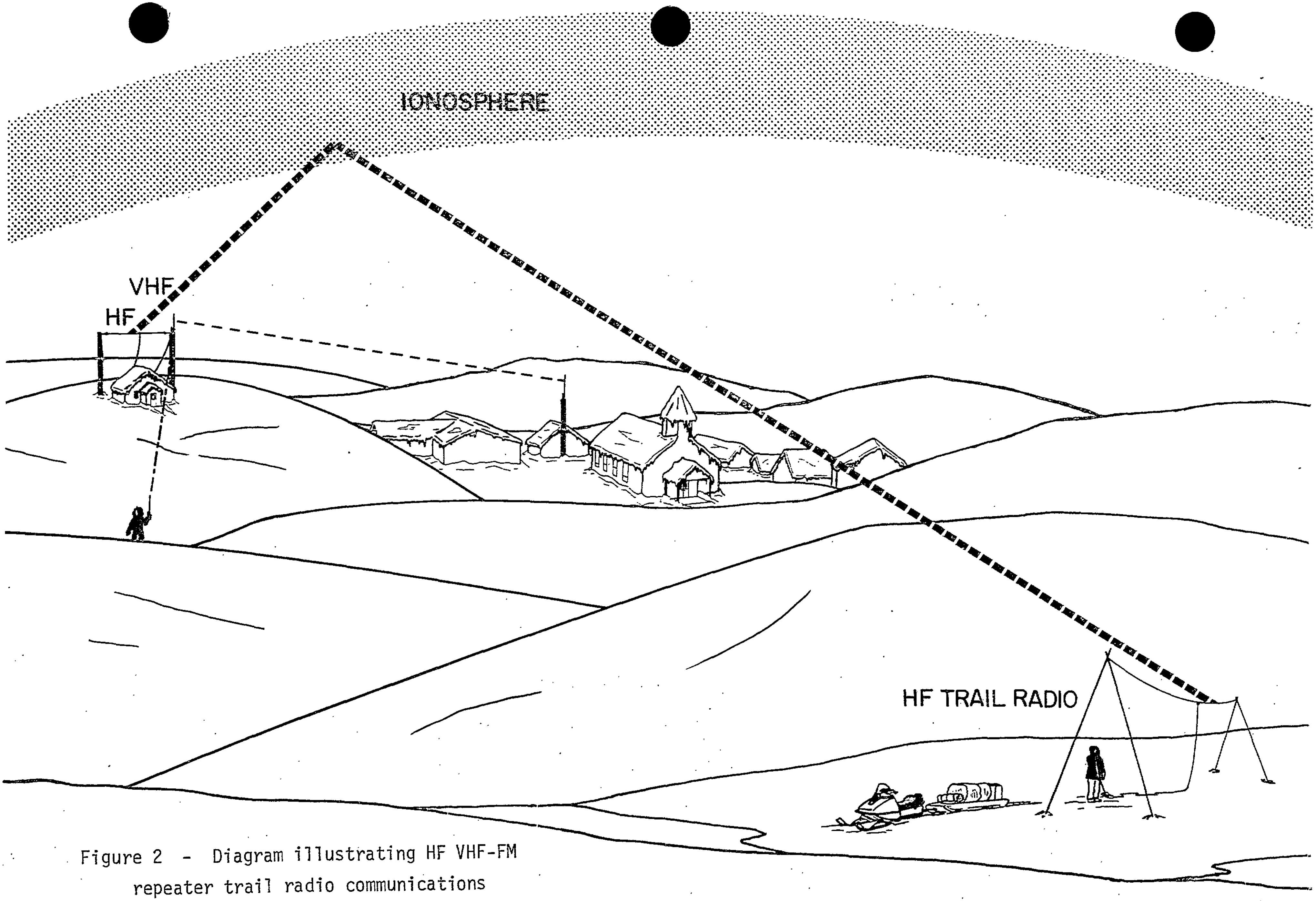

Figure 2 - Diagram illustrating HF VHF-FM repeater trail radio communications

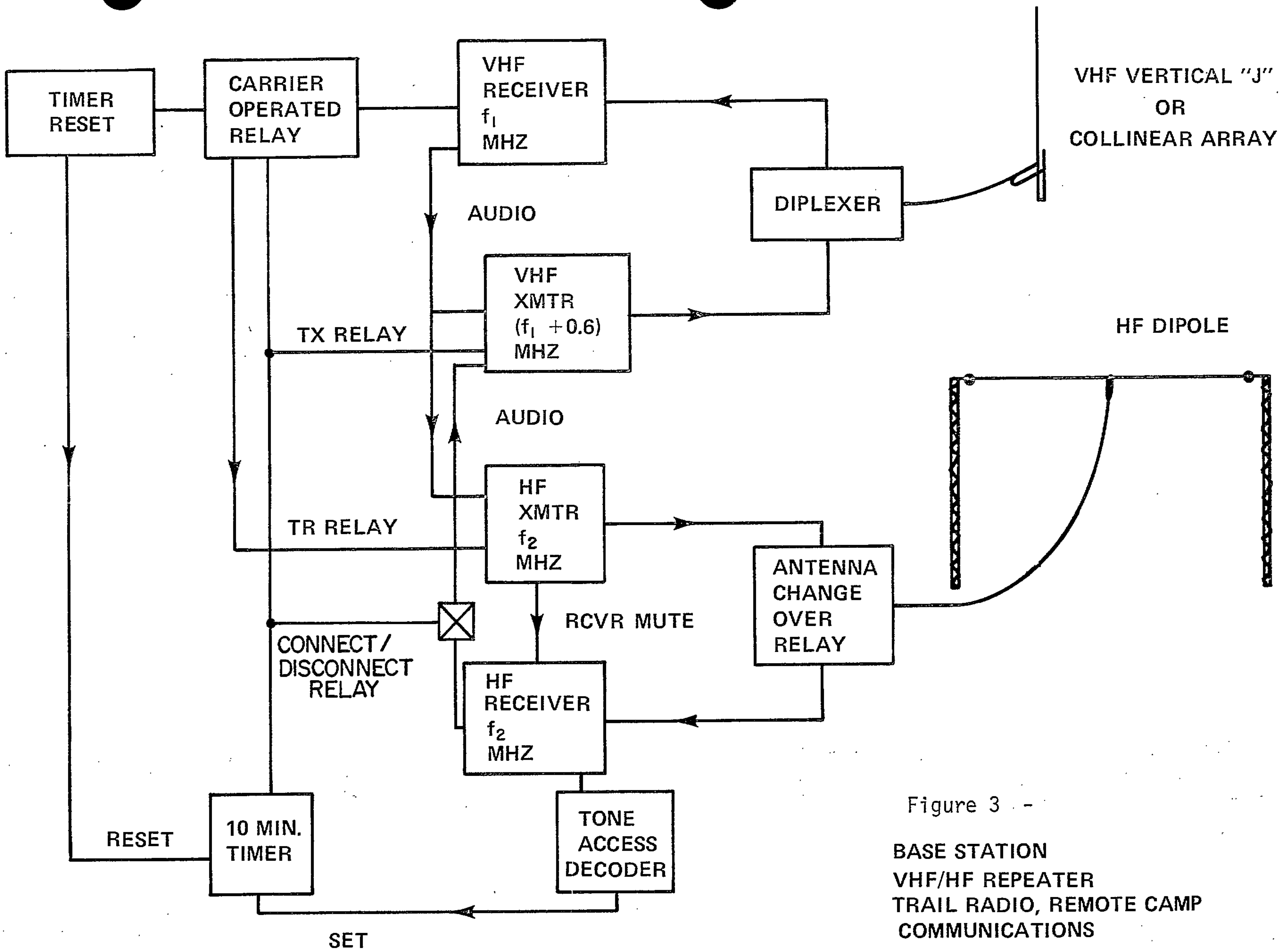

Figure 3 -

BASE STATION
VHF/HF REPEATER
TRAIL RADIO, REMOTE CAMP
COMMUNICATIONS

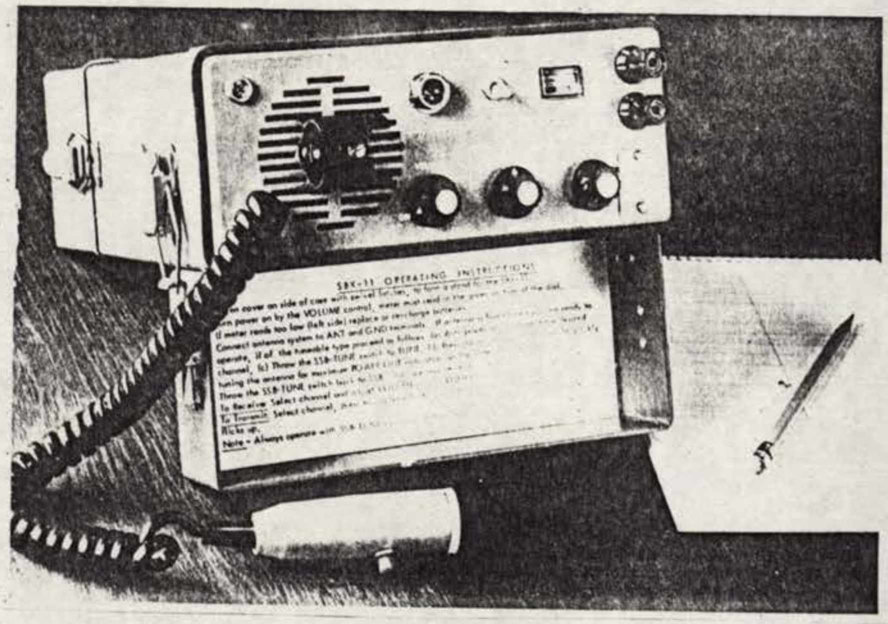

Figure 4 - Low power (10 watts PEP) solid state HF SSB trail radio (Spilsbury and Tindall Model SBX 11)

Figure 5 - High power (120 watts PEP) solid state HF SSB trail radio (Atlas 180)

Figure 6 - Hand held 2.5 watt VHF-FM transceiver
(Wilson Model 1402SM)

Figure 7 - VHF-FM 10 watt base station or
trail radio (Tempo Model CL-146)

Figure 8: Ski-doo operator in communication with base camp via VHF radio, employing a vertical "J" antenna. The antenna is sectionalized so that it breaks-down into a 19-inch length.

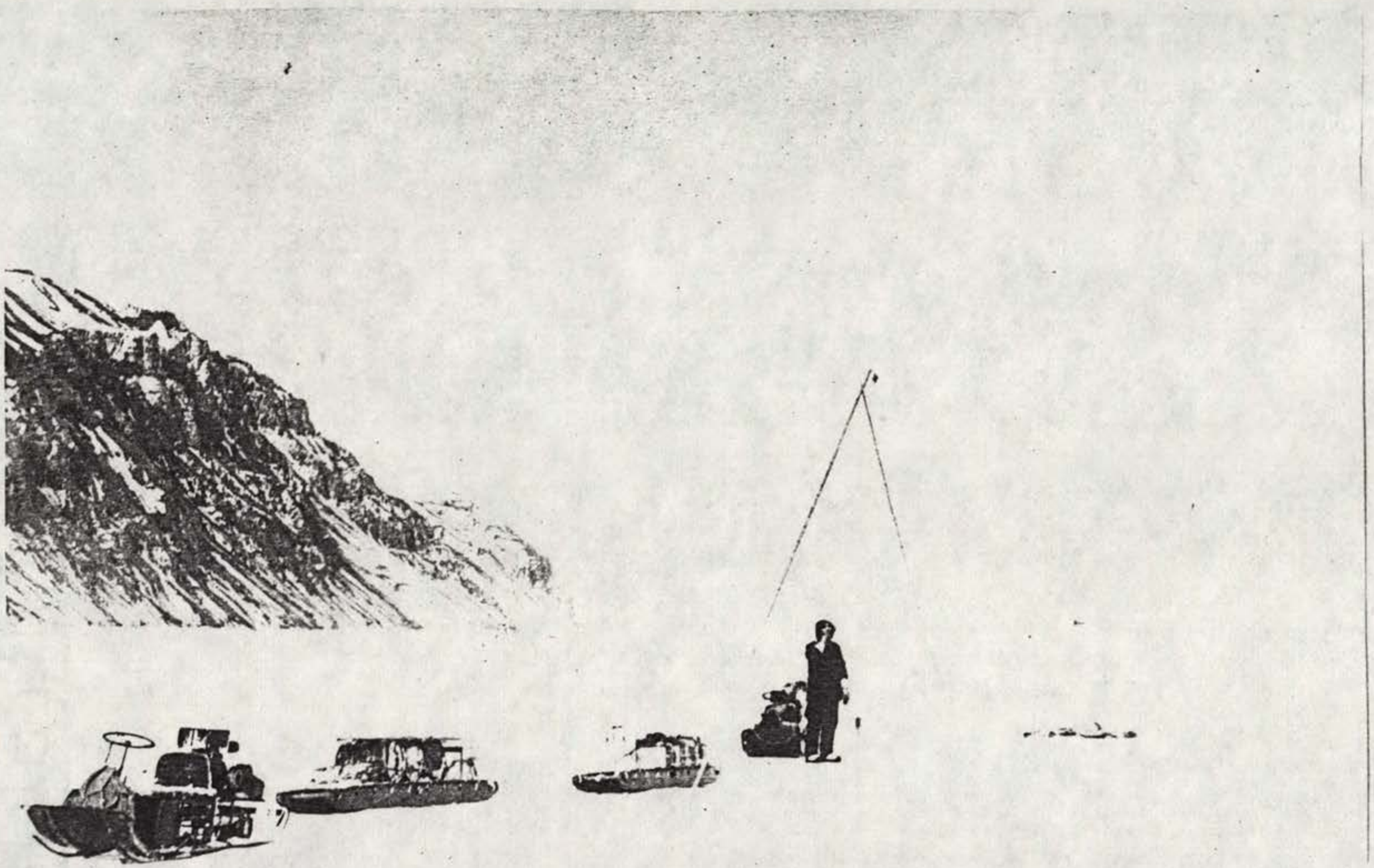

Figure 9 - HF trail radio antenna installation
(photograph courtesy H. Serson)

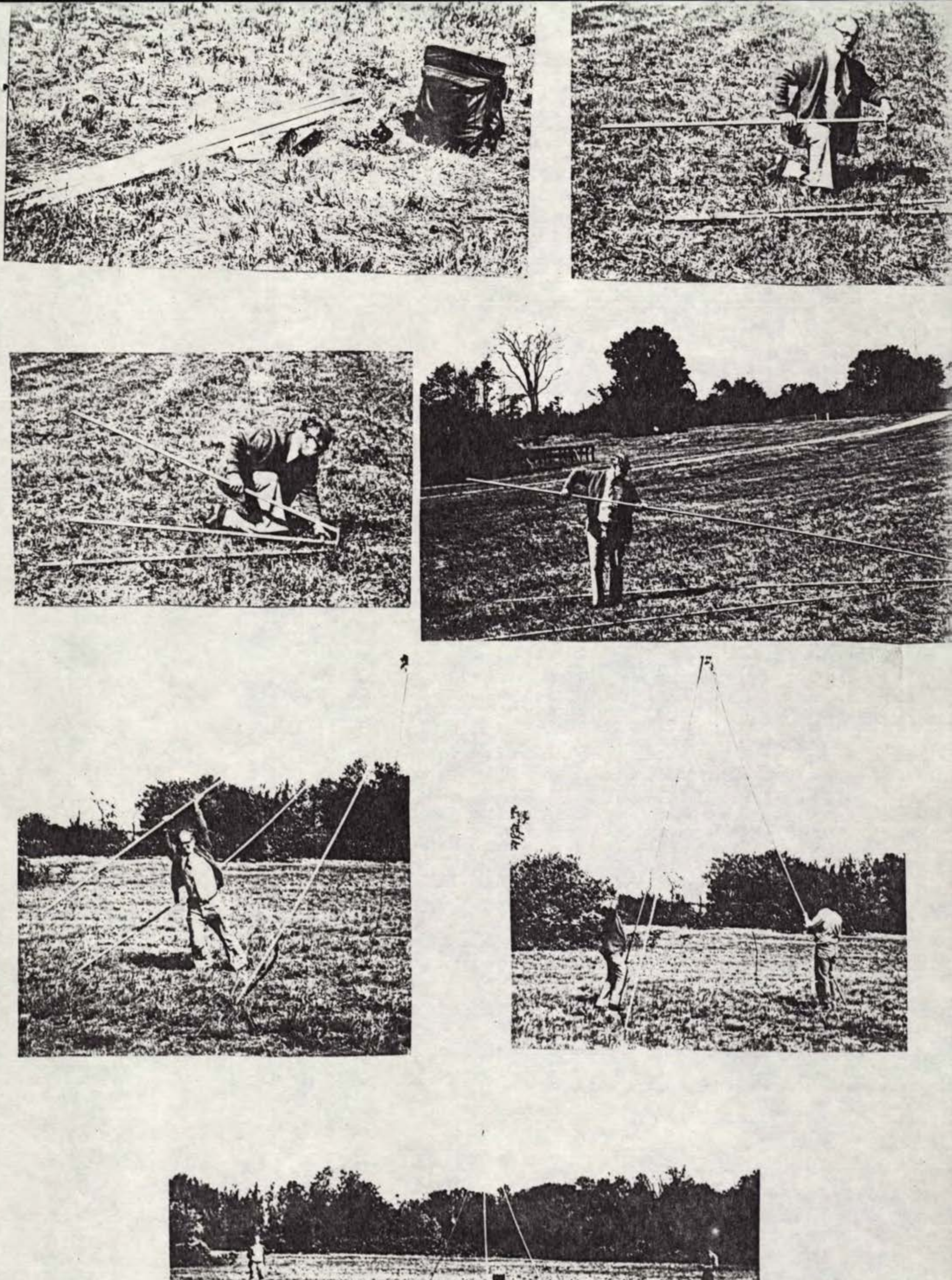

Figure 10: Sequence of photographs showing erection of an inverted "V" antenna for use on the trail and in remote camps.

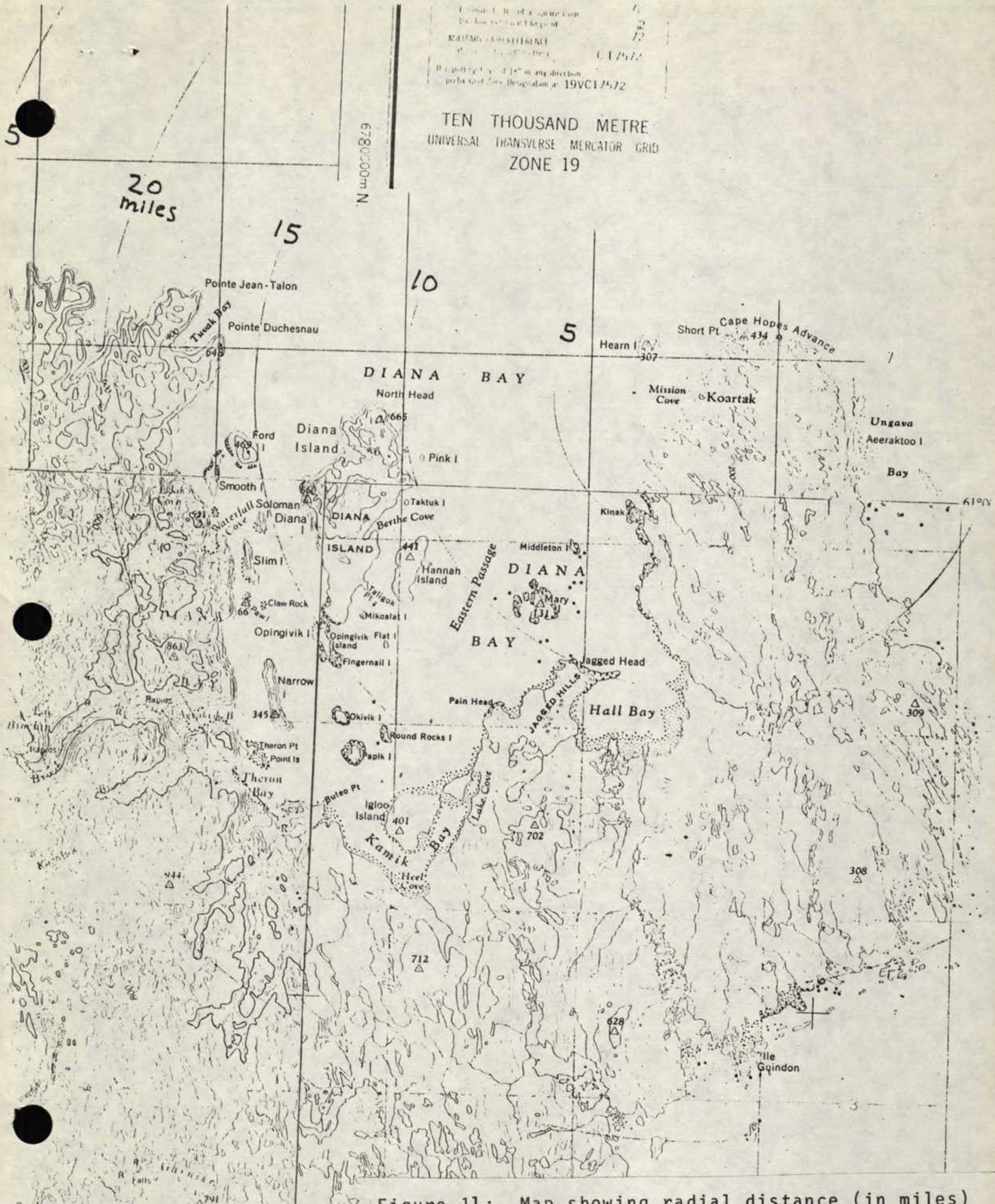

Figure 11: Map showing radial distance (in miles) measured from Kaortak, Quebec.