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# A Note on the Experimental HF Data Link Set Up Between India and Antarctica

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## Abstract

**An experimental HF data link between India and Antarctica was established during the eleventh Indian expedition. The system worked satisfactorily during the austral winter of 1992.**

## Introduction

**HF communication is that area of radio communication where the frequency falls between 3 and 30 MHz. These waves get reflected by ionosphere several times before reaching a distant destination like India from Antarctica. They are reflected from E and F regions of ionosphere and suffer very little attenuation in the process. HF communication from polar regions offers problems and challenges altogether different than those faced in India. HF data link means transfer of digital data between computers using HF as the medium.**

**An experimental HF data link was established between India and Antarctica during the austral summer of 1991-92. The work involved antenna erection, setting up of equipment, testing and initial trials. The programme during ninth wintering (1992) was regular communication on data and voice, observations on various parameters and carrying out experiments to find the circuit availability at different frequencies round the year.**

## Antennas :

**The main antenna which was used for this project was a Log Periodic Antenna (LPA) which has a bandwidth of 14 to 28 MHz. An improvised work was carried out on site to fabricate coupling for the antenna to the mast. The antenna was made rotatable by unbolting the antenna plate from the mast plate and devising a method to rotate it by either mechanical or electrical means. The**

firing end of the antenna faced N30°E which is approximately the direction towards India from Maitri.

Two other antennas were also fabricated and erected. These are two channel dipole and an inverted vee. The latter was erected on a 50 ft mast and the dipole was fixed between the LPA and Inv vee masts since the line between the two masts was perpendicular to N30°E.

### *Equipments :*

Besides antennas described above, other equipments used in this project are (i) 100 W pep Transreceiver, (ii) 1000 W pep Linear Amplifier, (iii) Radio Modem and (iv) PC AT.

### *Digital Transmission :*

Digital transmission refers to the transfer of computer data over HF using a radio modem. Three methods were used for data transmission viz., RTTY, AMTOR (Mode A - ARO, Mode B - FEC and Mode L - Lamtor) and Packet. The modulation was done by the modem using Audio Frequency Shift Keying i.e. shifting the frequency of the single side band transmitter depending upon whether a mark or a space is to be sent.

### RTTY:

RTTY transmission is by far. the simplest. The transmission rate was 50 bauds, but the method is highly prone to errors and grabbling. This is because conditions between India and Antarctica are not at their best most of the time. Further, there was the restriction in duration of transmission as it had to be kept short so that the set does not get overheated.

## AMTOR:

AMTOR requires that the Information Sending Station (ISS) synchronises with the Information Receiving Station (IRS). During disturbed conditions, the time taken to establish contact could be quite long (or not at all). There are three modes of AMTOR communication. Its baud rate is 100 baud though the actual throughput might be far less.

Mode A is called ARO and is used between two stations in two way communication. Messages are sent in blocks of three characters by the ISS. Error control is by means of control signals sent from the IRS to the ISS, signalling whether a repeat of a block of the signal is required. With this method the chances of overheating are less as transmission alternates with reception. Mode B is also known as FEC and is used when one station wishes to communicate with several others. Here the error correction is via the same text being sent twice by the ISS, five characters apart. Problem of transmitter Overheating like that in the case of RTTY is also faced in this mode. But this method is the best method to transmit when conditions are bad. Mode L is listening to AMTOR mode A traffic passively.

## Packet:

Communication was also tried out on Packet radio. The Packet radio follows the AX-25 standard which implements the physical, data link, network and a part of the transport layer of OSI model. There were only very few successful connections of Packet between India and Antarctica. However, once connected, Packet offers the best form of data communication. It is error free, not heavy on the transmitter cycles, offers virtually full duplexing and one can transmit both ASCII and Binary files.

## Communication from a polar region :

Communication from polar region offers some peculiarities as compared to communication from lower latitudes. Beacon transmission and listening watches were done during the year to find out the circuit availability. In Beacon transmission a fixed length of text on Packet is transmitted at regular intervals. It was observed that there is only a limited time slot available for communication every day. This was maximum during the austral summer wherein one could communicate for as long as six hours (approximately between 1200 and 1800 UTC) and gradually narrows down to as low as one hour during peak winter.

As this experiment was being tried out during the fringe time, there was virtually no communication for almost three months during peak winter. It was also seen that the time of best communication was not constant but kept changing during the year. It has been observed that frequencies around 17 MHz were better during the earlier part of the day and 14 MHz was better in the later half. One of the most significant aspects of communicating from Antarctica is the near absence of local noise. This helped in reading even the very weak signals from the mainland.

## Ionospheric abnormalities

### *(i) Sudden Ionospheric Disturbance (SID) :*

With the appearance of strong solar flares, there occurs an intense increase in the D-region ionisation. This causes increased absorption of short wave signals which in turn gives rise to higher reflection of atmospheric noise. In this way there is a continuous rise in the value of least usable frequency (LUF). Often the value of LUF increases beyond the value of maximum usable frequency (MUF) causing a complete blackout of all high frequency communication via the ionosphere. The SIDs are believed to be caused by the increased ultraviolet radiations coming from solar flares.

*(ii) Sudden enhancement of atmospherics (SEA) :*

SEA also affects communication from polar regions. In contrast to the effects of SID which occurs during day time, this can take place during night as well, as charged corpuscles emitted by Sun are guided to polar latitudes by the earth's magnetic field resulting in intensification of the absorbing D- region. When the enhancement of D-region ionisation is sufficient to prevent radio propagation, 'no-echo' condition or 'polar blackout' takes place.

*(iii) Ionospheric storms :*

Sometimes ionospheric disturbances in the form of increased absorption of sky waves and an abnormal change in the critical frequency of E and.F2 regions occur which persists for days together. Though these disturbances are worldwide, they are more severe in the regions of higher latitude. All ionospheric storms are associated with magnetic storms (severe disturbances in the earth's magnetic field).

Auroral activity which is manifestation of magnetic storm, also causes blackout of short wave communication.

## Polar endurance of antennas

Constant observation was made on the antennas and their associated structures. It was found that the LPA elements stood very well even in the face of winds gusting over 80 knots. However, due to winds being incident laterally on the LPA, there was a deviation in its firing direction. High winds and blizzards also loosened the connections and caused an increase in the SWR. Antennas like inverted vee and dipole which were fabricated locally could not withstand the winds and snapped. During blizzards, dry powder snow brushes against the antenna elements with great speed. Due to very low humidity heavy static electricity builds up. This is likely to spoil the equipment unless they are shorted. PVC cables become brittle in very low temperatures and break apart if disturbed. Teflon cables are recommended.

## Voice communication and phone patch

Voice communication was carried out whenever conditions were good.The system was patched on to an EPABX using phone patch and team members could talk to people in India who had an extension.

## Conclusion

The trials and experiments with HF communication from Antarctica including data communication, have been very satisfactory and encouraging. It is inexpensitve and can be used to keep track of the performance of life support systems, acquire and transmit experimental data and also for personal messages.

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