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The Sixteenth Indian Scientific Expedition to Antarctica : An Introduction to the Expedition and Achievements

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The XVI Indian Scientific Expediton to Antarctica sailed off from Marmugao port on 12th Dec 1996 in a chartered Norwegian vessel-POLAR BIRD.

The expedition team comprised of 61 members. Out of these 26 were for winter and 35 were for summer period.

Twenty scientific organisations viz. IMD, IIG, NPL, IITM GSI, JU, SASE, SOI, ITTK, NGRI, BSI, WII, AIIMS, DIPAS, NAL, DIFR, NHO, DARL, DEAL, R & DE and the Indian Army and AFMS participated in the expedition.Five organisations viz. IITM, IITK, BSI, NAL and DIFR participated for the first time and SASE commenced their wintering programme.

After two and a half days halt at Mauritius, the expedition reached Antarctica (fast ice) on 4th Jan 1997. Berthing of ship at the shelf was belated. After remaining stuck at the fast ice for 28 days ship reached the shelf in India Bay on 31st January.

Discharging of cargo commenced on 5th February and most of it was completed by 20th.

Helicopter reece for assessing the freezing of water channels on shelf ice was done on 20th February. Next day the first convoy with two new PB 330s and one old PB 270 vehicles started for Maitri.

The first priority of the expedition on reaching Antarctica was to set up summer camp at Maitri and field camps in other places so that scientists were able to take fullest advantage of the limited number of good weather days. Maitri summer camp and J.U. field camp in Schirmacher oasis were established on 8th January. Combined GSI and IIG camp was established in Filchneifjella (orvin-IV) mountains on 9th and DG camp was started from the 12th. These camps were operated for 50, 35, 20 & 27 days respectively.

Republic day was celebrated on 26th January. The function was significant for two reasons. First, a bust statue of Mahatma Gandhi was installed in Maitri station to mark the golden jubilee year of country's independence. Second, the prestigious project of Digital Picture Transmission between India and Maitri conceived by DEAL, Dehradun was successfully achieved. In a specially arranged function in the prime minister's residence the then prime minister Mr. H.D. Devegowda, addressed the expedition members and on his signalling the

statue of Mahatma Gandhi was unveiled by the expedition leader. Video frames of this event were transmitted to New Delhi in real-time and were shown onTV.

The XIV winter over team (WOT) took over the charge of Maitri station on 1 1 th February.

Out of the 20 scientific organisations as many as 15 had their work in Maitri and its neighbourhood (JU BSI IITM NPL IMD IITK NGRI AIMS DIPAS DIFS SOI NAL DARL DEAL and R & DE (E). GSI work was in both orvin IV mountains and in DG while SASE's work was at shelf. Two organisations namely NHO and WII had their work along the coast line and in India Bay area. For the greater part of the summer expedition, 47 members were in Maitri, 5 in the mountain camp one at DG and 8 in the ship.

SCIENTIFIC AND LOGISTICS OBJECTIVES OF THE EXPEDITION

I SCIENTIFIC OBJECTIVES

A *ATMOSPHERIC SCIENCES*

1. Vertical Profile of ozone and dynamics of ozone hole :

This is a study by NPL

(a) to operationalise the Laser Heterodyne System (LHS) designed by them on a year round basis,

(b) to obtain the vertical profiles of ozone and other minor gases in the atmosphere upto a height of 60 km.

(c) to operationalise the liquid nitrogen plant.

(d) to generate the liquid nitrogen required for LHS experiment

2. Electrical Conductivity and Aerosol Particle Distribution Studies: This is a new experiment intiated by the IITM Pune. In the experiment it is proposeed to measure the atmopheric electric field alongwith size distribution of aerosol particles over Antarctica and during the sea voyage. The main objectives of these measurements are as follows :

(a) Study the diurnal variation of the electric field and air-earth current at Maitri vis-a-vas global electric circuit and solar terrestrial effects.

(b) Study the inverse relation between electrical conductivity and aerosol concentration with change in the size spectra of atmospheric aerosols.

(c) To study the change in electric conductivity with latitude and examine the validity of ion-aerosol balance equation.

3. Meteorological studies and study of ozone hole phenomenon:
This is the ongoing programme of IMD for generating ciimatological data base, and

(a) to take weekly/biweekly ozonesonde and radiometer sonde balloon ascents respectively, to study the ozone hole phenomenon and longwave radiation budget over Antarctica.

(b) to provide weather forecast/information to helicopter flying

4. Fluxgate Magnetometer Studies: This is the ongoing study by IIG to understand the dynamics of the mobile current systems in the Antarctic atmosphere. Three fluxgate magnetometers and riometers to be operated at the three vertices of a triangle with the objective to obtain velocity of mobile aerosol current systems that leave back geomagnetic pulsations. This study will give insights for the following near and deep space processes:

(a) Quiet time diurnal and seasonal changes in the geomagnetic field.

(b) Geomagnetic field variations in response to ionospheric and magnetospheric field aligned currents.

(c) HF radio communication in response to electromagnetic disturbances. (d) Harang discontinuity feature of the auroral oval at Maitri.

B. EARTH SCIENCES

1. *Geological Mapping and Glaciological Studies (GSI)*

(a) Geological mapping of an unmapped area of 1000 sq km in the Kurze and Holtedahl ranges of Orvin II mountains.

(b) To collect samples from Schirmacher hills for laboratory analysis in order to understand the petrochemical evolution.

2. Geological Evolution of Schirmacher Hills (JU)

The aim of this ongoing project is to understand the structural, petrological, geochemical and geochronological signatures in the rocks of the Schirmacher Oasis so as to elucidate the history of crustal evolution of the area.

(a) To study the pressure and temperature regime under which the litho units were generated by investigating the grades and stages of metamorphism.

(b) To study the micro structures of high temperature mynolites to decipher the deformation history of the area in order to co-relate with other shield areas of the Gondwanaland.

3. Snow Drift and Albedo Studies: This is an ongoing study to be continued by SASE

(a) to measure the albedo of snow and ice surfaces under different physical conditions such as type of snow, cloud cover, solar elevation etc for understanding

the net energy exchange budget between the atmosphere and the variety of terrains encountered in Antarctica.

(b) to study the transport of snow in the air in order to understand the drift density profile under various conditions like temperature, snow hardness, free water content and surface features.

4. Hydro-Geochemistry, Thermal structure and Sedimentology of Lakes: This is a new proposal to be undertaken by IIT, Kanpur. Studies on lake sediments representing annual depositional episodes can throw light on climatic fluctuations which are very well manifested in the mineralogical and chemical variations in the sediments. The specific objectives of the proposed studies on varve stratigraphy are as follows:

(a) Detailed geochemical analysis of lake water including isotopic composition. (b) Analyse the thermal structure of the lake in order to understand the heat budget.

(c) Sediment core analysis for mineralogical studies.

(d) to unravel the paleoclimatic fluctuations as recorded in the sediments from the above analysis.

5. Teleseismic Studies: Studies on seismic activities as recorded in Antarctica to be undertaken for the first time from the Indian station by the scientists from the NGRI, Hyderabad. This involves settung up a digital broad band seismograph as a part of the seismic observatory with the following objectives :

(a) to monitor and study the frequency and strength of seismic activity in Antarctica.

(b) to record the seismic shocks originating over the Indian Ocean.

(c) as a part of a world wide seismic network, it is envisged that this study will help to delineate the deep seismic structure not only in Antarctica but also of the earth as whole.

6. Topographic and Geodetic Survey: Survey of India to carry out a detailed topographical survey for preparing the following maps:

(a) The new site for an alternative summer camp set up in the vicinity of Maitri alongwith a close contour map indicating drainage and topography.

(b) Delineating and demarcating the convoy route from Shelf to Dozer Point near Maitri using GPS system.

(c) To conduct a systematic survey of the ice Shelf, in association with SASE and Naval Hydrography, around the Indian Bay in order to identify a suitable berthing site for the expedition vessel.

7. Hydrographic Studies: (NHO)

(a) to carry out hydrographic survey in the areas falling within IHO chart Nos.9050 and 9051, forming the approach waters to the Indian Bay in Antarctica.

(b) to assist SOI and SASE for charting the Shelf margin in the Indian Bay region. This study will also help to build up a data set required for preparing Bathymetric and navigational charts alongwith the information on physical oceanography parameters and sea level.

C. MEDICAL SCIENCES

1. Studies on Human Physiology: The All India Institute of Medical Sciences will continue to co-relate Circadian Rhythimicity and metabolic status of personnel exposed to the severe Antarctic conditions in order to understand the adaptive processes. The study will include monitoring of heart (pulse) rate, body temperature, body composition, liver tests, food intake and related physioemotional studies. In addition, the following experiments will be undertaken

(a) Interaction of opiods and altered phtoperiod in immunomodulation during Antarctic winter.

(b) Geomagnetic effects on neuro-behavioural measures and reproductive system.

(c) Melatonin and body temperature coupling.

2. Biochemical Evaluation of Nutritional Requirements: Defence Institute of Physiology and Allied Sciences will mount a new initiative to study the nutritional aspects in order to evaluate the effects of physiological stress and resultant metabolic requirements to which a subject is exposed to in cold conditions. The primary objectives of this study are:

(a) To rationalise the nutritional requirement of the members of Antarctic Expedition (both summer and winter)

(b) To evaluate the effects of supplementation of specific antioxidants vitamins and minerals with regard to the physiological acclimatisation and performance of the expedition members.

D. BIOLOGICAL SCIENCES

1. Long Term Monitoring of Mammals and Birds: This is a continuing project being undertaken by the Wildlife Institute of India, Dehradun to devise a monitoring system for population dynamics for mammals(only seals) and avian taxa. This will be carried to define and evaluate the ecosystem health and interspecies relationship. Monitoring protocols will be developed that can be applied on a long term basis to understand the vital aspects of the fauna assemblage on a time series analysis. The data obtained can contribute to the International APIS project being undertaken under the aegis of SCAR.

2. Polar Horticulture: Defence Agricultural Research Laboratory to continue experiments on development of package of practices for protected polar vegetable production in Antarctica. Within the Greenhouse already present at Maitri the following experiments are proposed to be conducted:

(a) Perforxnance of vegetable crops in different kinds of media.

(b) Effect of natural radiation on vegetable seeds.

(c) Yeld performance of beans/peas influenced by legume.

(d) Effect of UV-B radiation and ozone depletion on plant photosynthesis

3. Studies on Bryo-vegetation: As a part of studies on bio-diversity of Antactica, Botanical Survey of India for the first time will carry out a taxonomical survey of bryophytes including both mosses and liverworts in the Schirmacher Oasis. These plants play an important role in the ecosystem such as the nutrient status and primary productivity. Hence, a detailed study of their distribution can be used as Biomonitors and Bioaccumulators in a particular ecosystem. This project is designed to address the following:

(a) Morpho-taxonomy and floristics of bryophytes.

(b) Phytogeographical affinities vis-a-vis Indian occurences.

(c) Development of an 'Environmental Specimen Bank' in the context of ecomonitoring

E. ENGINEERING & COMMUNICATION

1. Structural Engineeriug Studies: Research and Development Establishment, Pune will undertake a study on condition monitoring of the structural components of the station under low temperature conditions. A novel aspect of these studies include an online monitoring facility between Antarctica and R&DE Pune through INTERNET facilities. Experiments for the improvement and upgradation of infrastructural facilities like water supply, heating, electrical systems etc. will also be taken up.

2. Communication: The Defence Electronics and Application Laboratory of DRDO has been given the complete responsibility of maintainence and upgradation of the communication linkages from Maitri. This includes Maitri to India communication, Maitri to convoy communication and convoy to convoy communication using various modes. In addition, DEAL will carry out the following experiments:

(a) Upgradation of data and voice communication between Maitri and India using high speed modems and computer interfacing.

(b) HF propagation studies as a factor of ionospheric conditions and geomagnetic storms.

(c) VHF propagation vis-a-vis radiometeorological conditions.

(d) Packet Beacon experiments to specify ideal frequency and time schedule.

(e) Experiments on transmission techniques of still frames.

3. Wind Energy Utilisation in Antarctica: With the available data on energy needs of the station a simulation study as to the possible energy inputs through renewable energy devices, particularly wind would be undertaken for the system In this expedition, it is proposed to install continuous data logging systems designing purposes for the first time by National Aeronoutical Laboratories. Over a 28 meter mast to collect data on wind. In addition, a detailed study of energy demand of the station will be made. With the available data, NAL will design a suitable wind turbine generating system that can be operated in Antarctic conditions.

4. Fire Fighting Engineering: In addition to the routine upkeep of the fire iighting equipments in Maitri, a scientist from the Defence Institute of Fire Research will carry out testing and installation of Linear Thermal Fire Detecting System which is a modern equipment to guard and detect iire break-outs.

II LOGISTIC OBJECTIVES

a. De-induction of four gensets from the 'A' Block of Maitri and their relocation in containerised accomodation.

b. The space thus created, will be converted into a full-fledged MI room comprising of OT, examination room, X-ray and dark room, sterilisation room, linen and store room.

c. The replacement of MEG mixture as an antifreeze in the main water supply line with electrical trace coil heating system.

d. All disused items including the non-operational green-house, loose barrels, food dumps, unoperational vehicles etc. will be backloaded as a part of clenup operation. A special Environment Task Force under the overall coordination of the environment officer-cum-observer for this purpose will oversee the whole operation.

e. A modified door for the vehicle garage cum workshop and panels for the balloon launching hut will be provided to complete these structures.

f. Upkeep of station infra structure and all life support systems as a part of regular maintenance task.

g. Upgradation and regular maintenance of communication systems.

h. Upkeep of fire iighting equipments at Maitri and updating the servicibility of all fire fighting equipments. Both the exterior and interior of the station complex will be painted with fire retardent paints as a precautionary measure.

THE VOYAGE

The XVI Antarctic expedition sailed off from Mamugao port at 1500 hours IST on 12th Dec 1996 after a formal but impressive ceremony. The ship experienced the first spell of bad weather and rough sea rather early on the 14th itself and several members got the first kick of sea sickness. The situation improved on 16th. In the first few days of sailing, living on the ship was streamlined and all the members were given a good orientation to the ship by the ship's crew. Demonstrations were given to the members about the use of life jackets and the life boats in case of any emergency. Every day a meeting was held in the ship's lounge at 9 A.M. It served as a good interactive forum. Leader would brief members on various aspects of ship journey, expedition aspects etc. Common problems used to be discussed and sorted out.

The ship reached Port Louis at 0700 hours (local ship time) on 20th Dec. Some imported clothing and tent consignments which could not reach Goa in time, were sent to Mauritius and were taken aboard. Two Australian helicopters chartered for the expedition were taken onboard. A stock of fresh vegetables and fruits were bought. Sri Ravindra Environment Officer-cum-DoD observer gave a talk on "Indian Endeavour in Antarctica" to an invited audience. The talk was arranged by the Indian High Commission in Port Louis in the evening. On 21 st a Russian Doctor who was tojoin the Russian Wintering team at Novolazerevskya boarded the ship, as per the understanding reached between Indian and Russian governments. Three member helicopter crew embarked onboard on 22nd. While all these things happened, the expedition members enjoyed sightseeing and did shopping in this port city. The ship sailed off from Mauritius at 1500 hours on 22nd after 56 hours of berthing in Port Louis.

The expedition members were given Antarctic clothing in the next few days after departure from Mauritius. Conventional lecture series was arranged in which senior member from each organisation presented their scientific programme in the expedition. This helped greatly to understand the overall mission of the XVI expedition by all members. A committee had been formed to discuss in detail the logistic requirement of each organisation and the priority of movement of men and material. Between 25th and 30th the committee completed its task and on the last day a blueprint of logistic planning including the helicopter sorties was ready.

SALIENT FEATURES OF ONWARD JOURNEY OF XVI I.A.E.

DATE	TIME	COORDINATES	EVENT	TIME RETARDATION
12.12.96	1455	15°24'1"N	SHIP SAILED 073 °43' 3"E	IST FROM GOA
14.12.96	2200			30'
15.12.96	2343	00°00'0" 066°25'3"E	CROSSED EQUATOR	
18.12.96	2200			60'
20.12.96	0700	20°OS'0 S 057°20'5"E	ARRIVAL PORTLOUIS	
22.12.96	1505		DEPARTURE PORT LOUIS	
24.12.96	2200			60'
26.12.96	2343		CROSSED 400S	
28.12.96	2000			60'
29.12.96	1 108		CROSSED 500S	
31.12.96	0700	56°57'0 S 028°00'0"E	SIGHTING OF FIRSTICEBERG	
31.12.96	2200		CROSSED 600S	
02.01.97	1000		CROSSED 66030 '0"S THE ANTARCTIC CIRCLE	
02.01.97	1655	67°44'7 S 015°01'7"E	ENCOUNTERED PACK ICE	
02.01.97	2200			60'
04.01.97	0435	69°48'0 S OII°55'0"E 3	AT FAST ICE	UTC
31.01.97	1800	69°56'5 S OII°55'2"E	SHIP REACHED SHELF	UTC UTC

The ship encountered second spell of bad weather and rough sea when she crossed 46 S latitude (on 28th). Members had a good experience of pitching of ship when they were tossed from one end to another in their cabins and the unsecured articles moved like balls on a billiard table. First ice berg was encountered on 30th at 0925 UTC when the ship crossed 53°28'S (31°53' E) and generated a great deal of excitement onboard. Pack ice was encountered at 67° *44'* S at 1555 hours UTC on 2nd Jan. The concentration of pack ice went on increasing until on 4th Jan (0435 hours UTC) when the ship unable to penetrate any further got stuck at the edge of fast ice at 69° 48'S. Seals were sighted occasionally on the pack ice. No night fall condition began since 3rd. Courtesy sortie to Maitri was made on the 4th Jan which brought a lot of cheer to the 13th WOT members.

At Antarctica

After the courtesy sortie on 4th, transport of personnel and material started in full swing on Sth Jan. Maitri summer camp and Jadhavpur University field camp in Schirmacher were established on 8th. GSI plus IIG camp was established in Filchner Fjella (Orvin IV) mountains on 9th and DG camp started functioning from 12th.

In order to give all out support for scientific research several actions were taken. Dr Mishra of SASE required a snow scooter for moving over Shelf area to collect radiation data. To provide the required mobility a snow scooter was taken from Maitri to DG underslung by the helicopter. To facilitate comparative studies on the lake water chemistry and sediments of lakes in Schirmacher oasis, boat and other accessories were air-lifted in the helicopter. And to give a good data set to IIG scientist, the Orvin IV Mt. camp was extended by one week after the GSI geologists had finished their work inspite of deteriorating weather conditions since some problem had come up with IIG instruments. Normally this camp is closed when GSI work is over. Buddy arrangement was done by roster.

Problems and accidents

It is naive not to expect any problems in an expedition. But problems cropping up due to improper planning could be avoided. One such problem was not getting access to some of the containers stacked up in the Hold. Food container and the container containing NPL equipment were to be accessed urgently; but could not be opened as they were kept facing the wall of the Hold. We realised how important it is to thought-fully load the container in the Holds at the starting port.

The next problem was non-availability of fuel for helicopters at Maitri. Although there was no dearth of filled up fuel barrels at Maitri, the entire lot was rejected by the helicopter crew since the fuel samples from many barrels contained moisture. These barrels were lying behind Aditya power unit in a pool of water. Snow accumulation on the barrels in the previous winter had

melted in summer and some moisture had soaked into the barrels. We therefore had to carry fresh fuel barrels from ship underslung to Maitri in batches of two. A fuel dump was made at Maitri and then at mountain camp. This exercise could have been avoided and several hours of flying time could have been saved if the fuel barrels in Maitri were stored properly. It was therefore resolved to store the fuel barrels in front of Maitri near the main helipad stacked in a horizontal honeycomb structure, as one of the first winter time tasks.

There was a problem of failure of helicopter underslung mechanism. In one of the helicopter sortie which was carrying a load of scientiiic equipment boxes of NPL and IMD underslung, the underslung mechanism failed and the whole load fell on fast ice shortly after take off. The scientific equipments were badly damaged and could not be used. In another sortie the two fuel barrels being carried underslung fell on fast ice from a height of 300m.

Naval Hydrography team faced several problems in operating the boat. It had problems like radiater overheating, water leakage into the boat etc. All their efforts to rectify the problems failed and they could not achieve the survey work.

As the date of closure of summer camp at Maitri approached I had to encounter a new kind of problem. Major (Dr) Balani of AFMS, winter team member, started telling he wants to return as he felt it is impossible for him to winter over in Antarctica for various reasons. Initially it was thought to be a response of an unsettled mind and he would make up his mind to stay for wintering soon. But as the date of ship's return journey neared, Dr Balani's resolve to return became stronger and eventually he had to be allowed to return to India and was accordingly air-lifted to ship on 8th March, just a day before departure of ship.

Mr Ramesh of NAL fell down twisting his body while carrying his own organisation's steel pipe lot at Maitri on 8th Jan. The impact of the fall was on left elbow. Swelling caused a lot of pain; his left arm was bandaged. Although there was no fracture, he could not use his left arm during the entire period of summer expedition.

One of the helicopter crew Mr Nigel Sander fell down from the main deck (heli deck) to the twin deck (Port deck) onboard the ship while signalling the landing helicopter on 11th Feb, resulting in bone fracture in the right wrist and right ankle. His right elbow was also injured. He was immediately flown to Maitri alongwith 13th winter team doctors. At Maitri Dr Balani, Dr Ramesh Lai and Dr Tripathi worked for several hours treating the patient.

On 16th Feb. Mr Faimuddin of NPL met with an accident while shifting an empty helium cylinder to the helipad using crane. He sustained crush injury in his left thumb resulting in severing of the distal phalanx. It happened when he was trying to hook up the nylon rope around the crane hook which came on his hand. The doctors attended the case immediately and treated the thumb.

The chief officer of the ship Mr Hareide Dag while working in the Hold for placement of containers using crane on 2nd March fell from the top of the container onto the Hold floor. His right foot was hurt severely and was fractured. He was rushed to Maitri and given treatment by doctors.

Achievements of the summer expedition

A brief description of the scientific work done by various organisations institutions is given below:

I Atmospheric Sciences	1. National Physical Laboratory
	2. Indian Institute of Geomagnetism
	3. India Meteorological Department
	4. Indian Institute of Tropical Meteorolog
II Earth Sciences	1. Geological Survey of India
	2. Jadhavpur University
	3. Snow & Avalanche Study Establishment
	4. Indian Institute of Technology
	5. National Geophysical Research Institute
	6. Survey of India
	7. Naval Hydrographic Organisation
III Medical Sciences	1. All India Institute of Medical Sciences
	2. Defence Institute of Physiology and Allied Sciences
IV Biological Sciences	1. Wildlife Institute of India
	2. Defence Agricultural Research Institute
	3. Botanical Survey of India
V Engineering and Communication	
	1. Research and Development Establishment (Engineers)
	2. Defence Electronics Applications Laboratory
	3. National Aerospace Laboratories
	4. Defence Institute of Fire Research

National Physical Laboratory

The indigenously developed state-of-the art experiment by using a Laser Heterodyne System *(LHS)* designed to yield the vertical profiles of ozone and other minor but important constituents in the atmosphere was commissioned on 19th Jan 97. Ragular observations on ozone line profiles started on 25th Jan'97 and continued upto 26th Feb - the date when summer camp was closed. Observations were taken on 16 days. Some data on NOz were also taken. But water vapour could not be measured due to very weak COZ laser line.

For running the LHS, liquid nitrogen is essential to serve as coolant for the detector. Therefore, production of liquid nitrogen at the site is a pre-requisite for running the LHS on a continuous basis. The liquid nitrogen plant, which had been taken to Antarctica in the 13th IAE (1993-94) could not be made operational due to various logistics problems. Even in this expedition many snags had to be overcome. But happily the plant was made operational on Sth Feb 1997. The capacity of the plant is 1 litre of liquid nitrogen per hour. In ten runs of the plant nearly 75 litres of liquid nitrogen was produced.

Using a sophisticated (micro-processor based) hand held sun photometer, solar radiation intensity at 300, 305, 312, 940 and 1020 nm was measured, on a hourly basis during onward voyage and at Antarctica. The first three filter channels were used to derive atmospheric total ozone while the latter two channels were used for water vapour and aerosol op~ical depth.

Indian Institute of Geomagnetism

The on-going study of the Indian Institute of Geomagnetism to understand the dynamics of mobile current systems in the Antarctic atmosphere was continued by the IIG team. Fluxgate magnetometers were operated to record daily variations and micro pulsations in three components viz., X (along the magnetic N-S), Y (along the magnetic E-W) and Z (vertical). The locations were Maitri, Dakshin Gangotri and Filchnerfjella (Orvin-IV) mountain camps. The three stations could be operated simultaneously from 11th January to 28th January 97 (18 days).

Riometers were operated at Maitri and Orvin mountains to study the absorption of radio waves. The riometer at camp had to be stopped after three days due to saturation of signal.

India Meteorological Department

India Meteorological Department Team earned on the on-going programme of the department comprising of a) 3-hourly synoptic weather observations during onward cruise as well as at Maitri during summer time; main synoptic observations viz., 00, 06, 12 and 18 UTC were reported to IMD Headquarters at New Delhi on telex, b) Ozonesonde balloon ascents - four ascents were taken during Jan-Feb 97. c) Sun photometer observations. d) continuous recording of surface weather and radiation parameters by autographic instruments and

e) reception of satellite cloud imageries. Based on all the above inputs relevant to weather prediction, forecasts were issued as and when required for logistics operations. Analysis of ozonesonde data showed that maximum ozone concentration of about 105 nanobar partial pressure occurred between 80 and 20 hPa in the vertical; Stratospheric temperature varied in the range of -30°C to -45°C.

Indian Institute of Tropical Meteorology

Indian Institute of Tropical Meteorology, Pune has initiated a new experiment to measure Electrical Conductivity and Aerosol Particle Distribution in the atmosphere over the sea passage and over Antarctica. Accordingly, measurements of electrical conductivity of both polarities and aerosol concentration were conducted during onward voyage and from 15th Dec 96 to 6th Jan 97. At Maitri (Antarctica) measurement of vertical electrical field, electrical conductivity of air were earned out continuously from 1 1th Jan 97 to 24th Feb 97. During the same period measurement of aerosol concentrations were done every three hours, The instrumental set-up was computer based and data acquisition was conrinuous.

Geological Survey of India

Geologists of Geological Survey of India carried out survey work in Filchne-ella (71°52' - 72°07'S and 7°E-8°E) in Central Dronning Maud Land, East Antarctica. An area of around 1000 sq km (including rock and ice areas) was mapped by establishment of an advanced mountain camp at 71°56'57" S and 7°41'E. The area was mapped by combined foot traverses and helicopter supported field work. In all, 45 locations were covered with collection of structural, petrological and geochemical/geochronological samples for further laboratory work. The duration of the geological work at the camp was from 9th to 21st Jan 97 (13 days).

In the Schirmacher Oasis and adjoining nunataks (Veteheia and vetan) 20 field traverses were undertaken and geochemical and geochronological samples were collected.

As part of the glaciological studies, monitoring of the Dakshin Gangothri and glacier snout from G and H points and from 15 spaced points was carried out in Jan and Feb 97. The location of 15 spaced points was also marked on the map with the help of Survey of India mapping party. Monitoring of Glaciological stakes on the Shelf ice for snow accumulation and ablation studies was also done.

Mr Ravindra, DOD Observer-cum-Environmental officer from GSI earned out detailed geomorphological mapping of area around Maitri on 1:5,000 scale, observed incidences for three main phases of glacial retreat, collected data on genetic classification of lakes in Schirmacher range and clay-samples from different lake environs for clay minerological studies in addition to completing his assigned tasks of Eco Task Force.

Jadhavpur University

Extensive geological survey was conducted in the Schirmacher range. Portions of this range were mapped in 1:10,000 scale. More than 200 loactions were identified and structural data were collected. Large number of rock samples of specific locations were collected for petrological and other studies. Several major deformational events were identified, classified and mapped. The two geologists of Jadhavpur University stayed in the field camp in Western Schirmacher for 35 days from 8th Jan to 1 1th Feb, probably the longest field camp in Indian expeditions.

Snow & Avalanche Study Establishment

As part of the detailed study for understanding the net energy exchange budget between the atmosphere and the variety of terrain encountered in Antarctica, albedo measurements were carried out on snow surface.

Sixty Reflectance data (incident and reflected solar radiation) were collected on the Shelf ice at DG on different snow surfaces in the wave length range 300A to 2500A. The area of about 4km x 4km was surveyed with the help of a spectro-radiometer. Reflectance data was collected after comparing reference with the target surface. Signature software was used for data monitoring and following snow parameters were also measured.

1) Water equivalent 2) Snow surface density 3) Grain type

4) Grian size 5) Snow surface hardness

Indian Institute of Technology

With the objective of studying Hydro-geochemistry, thermal structure and sedimentology of lakes in the Schirmacher Oasis, IIT Kanpur participated in the Antarctic expedition for the first time. In order to study the water balance of the Priyadarshini Lake, the life-line of the Indian Expedition, water intake data was collected; lake water level was monitored on a daily basis from 10th Jan to middle of Feb. An attempt was made to obtain evaporation data, by setting up a small-scale evaporation experiment in the vicinity of the lake, since no such data is available at present. Preliminary investigation has given crude estimates of evaporation rate as 4.22mm/day during January. For studying the thermal structure of the lake, daily observations of vertical profile of lake temperature were recorded for about a month. To study the lake water chemistry, water smaples were collected from three points and at three depths on two dates seperated by about a month. pH, temperature, TDS, salinity and conductivity measurements on these water samples have been done in-situ. Surface water samples from feeder lakes and receiver lakes of Priyadarshini Lake have also been collected for chemical and isotopic analysis for a comprehensive understanding of the surrounding terrestrial environment.

Sediment cores were collected from all three sites of Priyadarshini Lake for studying the annual depostional episodes which can throw light on climate fluctuations which are very well manifested in the minerological and chemical variations in the sediments.

Water and sediment samples have also been collected from a lake of different origin as compared to Priyadarshini Lake in the western Schirmacher for comparative studies.

National Geophysical research Institute

With the objective of establishing a seismic observatory in the XVII expedition preliminary studies were conducted during this expedition and a suitable site has been selected for a permanent observatory. Seismic and GPS systems were installed at Maitri on 9.1.97 and data was collected continuously upto 25th Feb. Seismic system was operated for recording seismic activity while GPS system was operated for the purpose of Geodetic studies.

Survey of India

Detailed topographical survey for preparing a contour map of the new site for an alternative summer camp in the vicinity of Maitri, on 1:1,000 scale with one metre contour interval was carried out.

Survey of India was assigned two other tasks viz., 1) to delineate and demarcate the convoy route from Shelf to dozer point near Maitri using GPS system and 2) in assocation with SASE and NHO, to conduct a systematic survey of the ice Shelf around the Indian Bay in order to identify a suitable berthing place for expedition vessel.

After completion of the first priority task of survey for the second station, it was found that the deliniation of convoy route was already done by the army engineers of the 15th IAE. So there was no need to take up this work again. By the time SOI team could go to ship, NHO team had already done the survey of ice Shelf at Indian Discharge Point.

National Hydrographic Organisation

The National Hydrographic Survey Team has accomplished the following tasks assigned to it:

(a) Established a geodetic ground control network on the ice Shelf using the GPS and cross checked the accuracy of the established positions by carrying out Check Baseline Measurements using Telurometer MRA-7.

(b) The entire Shelf Ice Coastline falling within the limits 09°59' E to 14°01' E longitude which would cover the entire Navigational Chart 9051 has been mapped using the helicopter with differntial GPS.

(c) The bathymetric survey of India Bay aspect of this mission was replete with major setbacks primarily due to inadequacies of the Fibre Glass Reinforced Plastic Hull of Survey Motor Boat.

(d) Views have been photographed, videographed and sketched from the bridge of the ship with the Positional and Azimuth details. First hand information of the stations- Dakshin Gangothri and Maitri has been collected for inclusion in the Antarctic Pilot. Requisite ariel views were also photographed and videographed during the coastline sortie by helicopter,

All India Institute of Medical Sciences

AIIMS could not undertake any studies as planned for the summer expedition due to non-availability of volunteers inspite of best efforts by the Leader.

Defence Institute of **Physiology and Allied Sciences**

The scientific study was started on the way to Antarctica on 30 members of the summer team, who volunteered to be subjects. The body composition, hatnelology and platelet aggregation were studied. They were later divided into four groups- control, vitamin-C supplemented, vitamin-F supplemented and vitamin-C plus vitamin-F supplemented. Again the above mentioned parameters were studied in the Lab. set-up in the ship after collecting the samples in January 1997 from the members stationed in Maitri. The second series of samples were collected from members in the month of February 1997 and were again analysed in the ship.

In addition to the above, blood and urine samples of the members of the summer team were preserved for further analysif at Delhi.

Wildlife Institute of India

The enroule monitoring of birds and acquatic mammals was earned out from the day of departure from (ioa on 12th Dec 96 till the ship reached the coast of Antarctica on 4th Jan97. livery day six hours of monitoring was carried out. During this period 42 species of birds were identified and their abundance was recorded. Ten species of mammals were recorded, notable amongst them were sightings of hump-back whale, Ross seals.

At Antarctica, to census the wildlife along the eastern and western Shelf, 25 hours of flying lime was used to develop a wildlife map of the coast. Census was done from the discharge point i.e., 69°56' 88" South and 11°54' 87"East, upto 10° East on the western part of the Shelf and upto 13° East on the eastern part of the Shelf. During the census, data on the distribution, habitat use and abundance of ime species of birds, namely emperor and adelie penquins, skuas, snow and Antarctic petrals: two species of seals, weddel and crab-cater seals were collected. During the stay at Indian Bay and during the arial census, im, sei and killer whales were also sighted. Larger number of wildlife was recorded along the western Shelf than the eastern Shelf. In all, approximately 450-500 seals, 500-600 emperors and 200-250 adelie penquins were recorded.

Defence Agricultural Research Institute

Vegetable, cereal, ornamental, medicinal and flowering plants and grasses were sown in three different media viz., peat moss (Indian), Antarctic moss and Antarctic soil to assess the comparative performance of these media and also to study the growth and development of different types of crops. Temperature and humidity were maintained at optimum level throughout the period of plant life cycle. Data on germination percentage, date of flowering and friuting and biomass weight have been recorded.

Vegetable seeds were exposed to natural radiation for subsequent studies on germination and crop growth.

Botanical Survey of India

Survey work was done on Schirmacher oasis in one of the nunataks-veteheia southwest of Schirmacher and in parts of Orvin IV mountains (Filchnerfjella). In all 29 traverses have been undertaken between 6th January and 21st February 1997. Of these, 23 are in Schirmacher Oasis, 1 in Veteheia and 5 in Filchnerfjella. A total of 345 plant specimen have been collected. These specimens include mosses, bryophytes, lichens and algae. The collected specimens have been processed in herbarium packets with complete field data. Phenological observations on the bryophytes growing locally around the Priyadarshini lake (Lake Zub) and its environs have been recorded from time to time. Interestingly, three populations of mosses bearing sporophyte, a condition quite rare for Antarctica have been observed in the western Schirmacher.

Research and Development Establishment

Research and Development Establishment and the Indian Army together completed the following tasks:

1. Trace heating of the water supply line: The main water supply line alongwith auxiliary pipe line hitherto used for MEG circulation have been installed with trace heating tape alongwith proper insulation. The main pipeline with trace heating system has been tested and is able to raise the temperature above 5°C of normal water. The trace heating system is put on around one hour in advance and the temperature is allowed to rise to 40°C and the pumping of water is started. As the cold water surges through, the drop in temperature is enormous. By the time the water tank gets filled up the temperature drops to around 10°C. Control panel board was also installed in Boiler room alongwith a stand.

2. Safety Harnessing System

After examining thoroughly the problems at site, the safety harnessing system has been installed with a few modifications as follows:

(a) The corner plate of the middle platform was cut to align the climbing rope to the top and pulley.

(b) The 'L' bracket was not used for top and pulley, instead the existing location (i.e for carrying the load to the top) was used.

(c) The GI SWR tension rope 1 1.7 mm dia X 40 m was not used as the other climbing rope of SWR 9mm dia X 120m long was adequate.

Rest of the assembly was installed without any change. Further an 80 kg rock was pulled up and down for testing the climbing arrangement and the arrangement was kept in "hung" position for two days for testing the safety harnessing system.

3. Balloon Launching Shelter

The balloon launching shelter had been erected by the XV IAE team except for instalation of roof panels. Due to damaged roof trusses considerable difficulties were experienced while fitting the panels. However the work has been completed satisfactorily.

4. Workshop Shelter Door

The earlier door was replaced with the new one brought by the team. However, the new door also had to be modified. The bottom channel on which the door frame stood was not completely straight. So an additional channel of adequate size was used to ~ atch the b~ttom channel.

Defence Electronic Application Laboratory

For the first time, the experiment with digital picture transmission between Maitri and India was successfully carried out. Live data connections were established with the remote computer in India using a telephone modem and both picture frames as well as slow scan pictures could be transmitted. On 26th Jan 97, a live data connection was established with the computer installed at the Prime Minister's residence via an INMERSAT circuit. Simultaneously, a voice connection was also extended and the Prime Minister addressed the expedition members from New Delhi. With the Prime Minister's signal the bust of Mahatma Gandhi was unveiled by the expedition leader and picture of the unveiling was instantly sent to the Prime Minister in India.

Another important achievement is that VHF communication was maintained between Maitri and Mobile convoy throughout the journey upto shelf. For this purpose a repeater was installed at nunatak (Veteheia).

E-mail operation was upgraded by making it possible to operate the terminal remotely from the main station using a computer while keeping the terminal physically in the existing hut. The terminal can be operated from the hut also. This would facilitate operation of E-mail during blizzards and bad weather days, and in peak winter.

The existing second log periodic Array (LPA) antenna for HF communication, which got damaged during the previous winter was repaired and relocated

closer to the main station to minimise transmission feeder cable loss and to avoid damage to cable by the movement of crane/vehicle whose path crossed the cable route.

A new computer based HF weather fax reception system has been installed to receive weather charts for the use of meteorologists.

During the entire period of expedition HF and VHF communication was maintained between ship and Maitri, between Maitri and field camps, between Maitri and helicopters. The team also handled regular communication traffic of telephone, telex, fax facilities connected to the Inmersat Terminal.

National Aerospace Laboratories

'Ice-free" wind measurement system for continuous data logging of wind direction and speed was installed on the existing 28m mast. Wiring of sensor cables and heating circuit was carned out on the tower and from the tower to Nandadevi Hut. At Nandadevi Hut two solid state data loggers were installed and commissioned. The data logger samples data every two seconds and is set to determine the hourly and daily maximums, mean values for the wind speed, hourly averages, direction and other wind energy related parameters. Data loggers and system performance was checked from 15.1.97 to 16.1.97. On 17.1.97 the data loggers were initiated for data collection.

Data on energy consump6on pattern has been collected for study and analysis. A survey of sites for future installation of wind machines has been carried out, and infrastructure availabil~ity for propFsedRnstallation was assessed.

Defence Institute of Fire Research

The following fire safety related tasks were accomplished during the summer expedition.

1. Installation of Linear Thermal Detection Cable (LTDC) system

This latest technology in the field of fire detection comprising fire sense cable, fire control panel, interface module and termination box were installed in the boiler room covering all the four fuel feeding lines to the boilers, daily fuel storage tank (92500 litres). Fire sensing wire, interface module and termination box were installed in the boiler room while the fire control panel and hooter in the lounge/dining hall keeping in view the presence of members round the clock in this area.

2. Fire RiskAnalysis of Maitri Station and Summer Huts

A detailed fire safety survey was conducted covering main block (both ground floor and loft area), boiler room, kitchen, lounge/dining, Genset accomodations (Aditya, Bhaskar and Jan Gan Man), Nitrogen plant, Jwala Garbage incinerator and workshop area. This survey was extended to summer huts also.

3. Monitoring of Gases

The presence of toxic/flammable gases were measured in genset accomodations, garbage incinerators and vehicle exhaust. On observation it was seen that toxic gases like CO, HzS were present to the level as high as 800 ppm and 20 ppm respectively in the exhaust from these places. Also, the concentration of oxygen was seen as low as 16.4% in the garbage incinerator accomoadation, thus signifying the threat to presence of human beings in this area.

4. Maintainence of Fire Fighting Equipments

All the extinguishers lying in and around Maitri station hut areas were inspected for their operational readiness.

5. $C0_2$ Conductivity Test Apparatus

This apparatus/experiment was installed in Aravali Hut to evaluate the conductivity level of COz gas when used on an electriaclly charged target/switch gear etc. The various parameters measured included humidity, distance between target and COz cylinders, COz gas discharge time, voltage supply to the target and the current values for COZ cylinder etc. This experiment has been conceived with a view to measure the intensity of electrical shock received by the operator using COz extinguisher when fighting a fire in an electrically charged target.

6. Fire Retardent Paint

This experiment was set-up in Shivalik hut to measure the various fire spreadability related parameters in exterior Antarctic conditions. Four test samples were coated with FR paint and subjected to LPG stove flame to observe the various parameters which included the intensity of the flame, the exterior wind speed, the ambient temperature and the time of flame exposure to the test samples, and finally the char length of the samples after subjecting them to the flame for a period of 45 minutes to 60 minutes.

7. Fire Drill

Two fire drills were conducted during the period from 8th January to 25th February 1997 to observe the fire fighting preparedness of the members. After each drill the debriefing of the important points was given.

8. Visit to Russian Station (Novolazarevskya)

A visit ot the Russian station was made to study the type of fire safety arrangements existing there.

9. Retrieval of Halon Type Fire Extinguishers

About 130 iire extinguishers were retrieved from the places in and around Maitri station and summer huts.

Environmental Task Force

The environmental task force was assigned the following jobs to be accomplished in the XVI Indian Antarctic Expedition.

(a) Identification of an alternate site for summer camp in the vicinity of Maitri.

(b) Identiiication and backloading of disused equipment, machinery, vehicles and other structures etc.

(c) Environmental clean-up of Maitri and its environs, and backloading of the waste.

(d) Study of sewerage pit, incinerators and bio-degradation plants.

Selection of Alternate Site for Summer Camp

Extensive traverses were taken by Mr Ravindra, Environment ofiicer-cum DOD observer in different parts of Schirmacher Oasis. Out of the six different sites surveyed three probable locations were short listed

(a) Area around erstwhile German hut in the western Schirmacher

(b) Area north of Priyadarshini Lake

(c) Area east of Maitri station on Maitri-Novolazeraveskya road

The site, mentioned at (c) was found to be most suitable, satisfying most of the important criteria. This site is located between 500 and 700m east of Maitri station. While the drinking water would continue to be supplied by the Priyadarshini Lake, the treated grey liquid can be discharged in a naturally occuring depression, further east, that does not fall in the catchment area.

Environmental Clean-Up Operation

ETF took up a massive environmental clean-up operation and the quantum of the task can be judged by the following satistics:

1. ETF had to work for 2520 man hours from 9th January to 3rd March 1997, continuously without a break.
2. A total of 220 barrels were filled with various type of garbage.
3. Eleven standard ISO containers and 7 open bins were filled with waste and unserviceable stores (apart from two containers filled by XIII WOT) weighing about 250 tonnes, for backloading.

SEARCH FOR NEW DISCHARGE POINT

In the light of deepening and widening of cracks in the Shelf at the present Discharge Point (place of berthing of ship along the coast). DoD has been contemplating to search a suitable new Discharge Point in the same area. This was an important task assigned to the XVI expedition.

During the course of the summer expedition in 1997 and 1998, this matter was discussed among the expedition leader, DOD observer and the captain of the ship. They made ariel inspection of the nearby coast and also closely surveyed the area by sailing in ship. Alternate landing sites as selected by this group are shown in a figure 1. The order of the number indicates the preference. The captain of the ship Mr Soernes is of the opinion that inspite of the threat of deepening cracks, the present discharge point could be used safely for a few years more.

WINTERING EXPEDITION

The departure of the ship on 9th March 1997 marked the beginning of winter expedition.

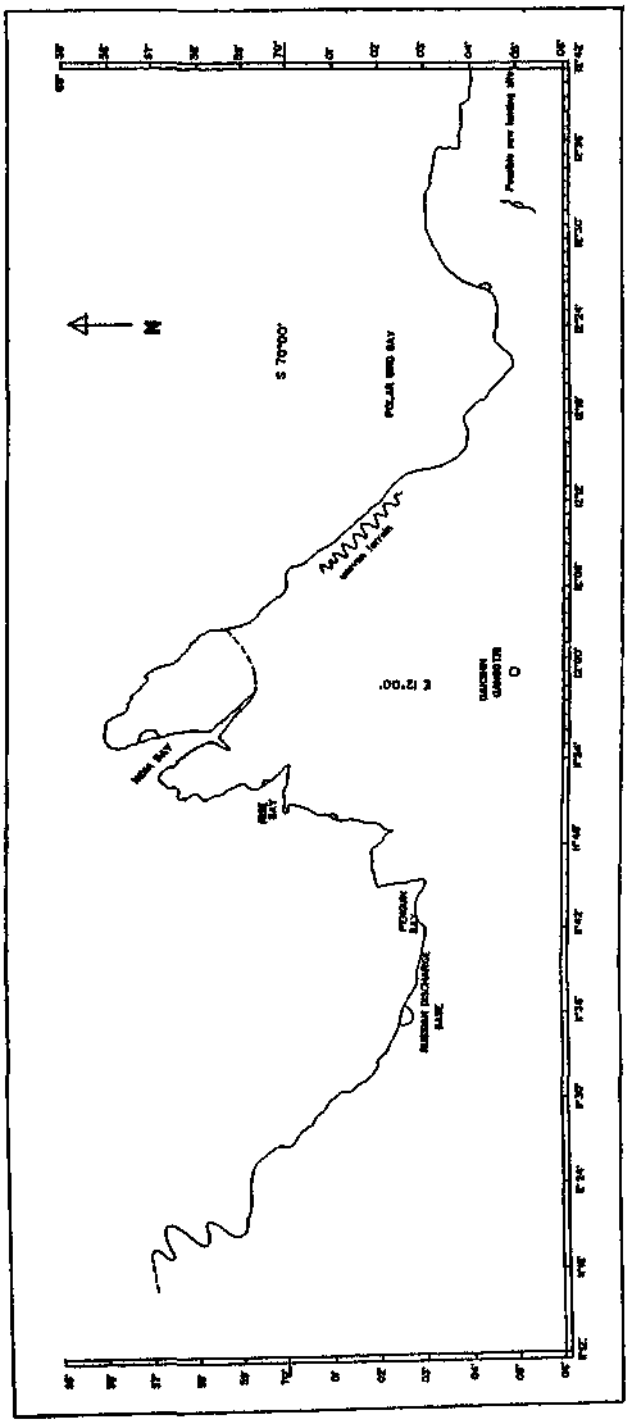
In the following few weeks the leader made efforts to streamline the wintering living of the team. For greater part of the winter period daily meetings were held at 0900 hours in the lounge for collective interaction. Members who were given different portfolios of station charge swung into action to manage their respective sub-charges. Scientific and logistic members settled down to carry on their organisational work programme. A detailed work plan which included apart from the assigned tasks many developmental and perhaps major maintainence works was drawn out.

Birthdays of members and Raising Days of organisations were appropriately celebrated. Saturdays used to have diversion from routine life since all members used to spend first half of the day sometimes the whole day in doing the shramdan -an exercise of the entire team in station maintenance works. Later opening of the station bar in the evening would give the much needed relaxation.

Station Galley duties and kitchen duties of members went on and on in cyclical rythum, in parallel with change of seasons. Occassional visits to Russian station by groups of members and reciprocal visits by the Russian team members were occassions of enjoyable get-togetherness.

Mid-winter day was celeberated with traditional gaiety on 21 st June. Indoor games tournament was held to mark the occasion. Polar night lecture series was conducted wherein a member of each organisation gave a lecture on the professional subject and also their wintering scientific programme. This was quite educative to all.

Sightings of aurorae in peak winter, the experience of blizzards and the widely varying day-night cycle were unforgettable experience to all members. The annual sunrise on 19th July and the beginning of no sunset period (22nd Nov) were all exciting and thrilling memories and left deep imprints on the minds.



f ig.I : *Antarctica coastline in India Bay region - probable new landing sites*

Convoys

During the XVI expedition nine convoys were made by the army contingent; three in the summer period and six in the wintering period. In the course of a few convoys, the convoy party was caught up in blizzard for several days and had to face extreme hardships. Besides breakdown of one or the other vehicle, breakdown of communication between convoy and Maitri offentimes and sometimes between vehicles in the convoy caused great hardship to them.

Medical cover

Medical cover in terms of availability of facilities and medicine was satisfactory throughout the expedition. Availability of doctor (4 in number) during the summer expedition was very good. However during the winter expedition there was only one doctor since the doctor from AFMS whose assigned responsibiJity was health care of members decided to return to India with the returning summer expedition. The doctor from AIIMS was in the winter team primarily as a research scientist. But he managed well with the additional responsibility of health care of winter team. Fortunately there was no serious medical problem except a case of concussion injury to head of one member in June. The patient was unconcious for a brief period and had to be put on oxygen. He suffered loss of speech for half a day. But became normal the next day. There was a case of hypothermia in early September due to long exposure to cold. After treatment the patient returned to normalcy within a couple of hours.

Problems and difticulties

Shelving of construction of Medical Inspection room

After the de-induction of four gensets from the A Block of Maitri, the space thus created was supposed to be converted into a full-fledged MI room. To achieve this objective construction of an extension shelter over A-block was required, in order to make proper passage (link) between main block and A-block. The construction of the Extension shelter over A-block was commenced on 24th March 97. However after an inspection of the pre-fabricated members supplied for the purpose the station engineer decided to suspend the work in view of the technical problems he encountered. Inspite of some clarifications from R&DE, Pune and their team members at Maitri the issue could not be resolved and the construction of extension shelter was shelved. Since this work was a pre-requisite to erection of MI room the latterjob was also left out unaccomplished.

Water line Problem

The main water pipeline from the pumphouse to the boiler room had developed a major leak on 4th July and the complete duct along the pipeline had frozen. The complete duct was cleaned thoroughly and the main pipeline relaid. Water supply was resorted to normalcy on 8th July after four days of continuous operation by the entire army team and some other members. Due to formation of ice inside, a number of copper pipe lengths had cracked and ruptured. Some

could be reused by welding. However some lengths were badly damaged and could not be reused. Some 70 metres in the water pipeline on the pumphouse end was replaced by rubber pipe. However the rubber pipe was once again replaced by copper pipes on 6th Aug. On 9th Aug there was problem in pumping the water again. On verification it was found that the pipeline was frozen upto a length of 250m. The duct was once again opened completely and the entire pipeline (comprising several seperate lengths) was immediately shifted to inside the station to avoid further damage to pipes due to expansion of ice. All the damaged pipes were welded and the line was relaid yet again, from 10th to 13th Aug. The repeated problem in water supply during July-August (peak winter) and poor light condition tested the endurance of team members.

Failure of E-Mail Facility

The e-mail at Maitri became unserviceable on 9th Aug 1997. Inspite of the best efforts of DEAL team to repair the E-mail terminal the facility could not be restored, due to non-availability of certain spares. This was a matter of great disappointment to most members and a few members were very much agitated. This facility became available in January 1998 when the XVII IAE DEAL team installed the newly brought terminal.

Blowing away of Balloon Launching Shelter

The Balloon launching shelter which was not fully constructed was severely damaged during an intense blizzard in June. The side facing the wind direction (SE) received the full impact of strong winds and collapsed. Several roof panels were blown off far away. As per IMD's recordings the maximum wind speed during the blizzard waVs 87 knots (160 Kmph) at surface.

The Veteheiah rescue episode

In the first week of September, the Sth convoy had gone to D.G. At Maitri a three member team went to Veteheia Point, a hill about 10 km away from Maitri on its west, to make radio contact with the convoy party. After making successful contact they were returning to Maitri when their vehicle broke down. There was no serviceable vehicle at Maitri to bring them back. Radio contact between the team and maitri also failed and the fate of the communication team could not be known for several hours. Presuming that they might have as well started walking the distance, I went to meet them half way to cheer them. But not finding them, even when I reached the base of Veteheia, I panicked and I returned (wisely of course). It was 1800 hours and darkness was setting; weather had started deteriorating since afternoon. There was despair and uneasiness in the station. It was decided to take Russian help and we tried to contact them on radio. There was no response. Not to lose time, two members from 14th WOT were sent to their station on foot. Russians readily agreed to help and set out to prepare their vehicles. It needed 45 minutes to prepare the vehicle, in the peak of winter. Finally the rescue team left the Russian station at 1930 hours. They went straight to Veteheia area. But since the Russian team had newly come in

June and Maitri members had not gone to Veteheia before the search mission failed and they returned to Maitri at about 9 PM. By now the stranded team was out in the cold for several hours. Realising the potential danger, I immediately took the rescue team to Veteheia again.

As we drove on the glacier ice, the two vehicles were sliding; at times the vehicles stopped for some engine problem. Later, on the slopes of Veteheia the thick snow posed problems. In the meantime we kept on firing the lights in the air to indicate the stranded team that the rescue team is on the way. Eventually as we were desperately moving towards the possible area of the stranded team we saw the headlights of the broken down snow-cat. I left a sigh of relief but the anxiety was still mounting as to the condition of the members since there was no response to my shouting of their names. I reached the vehicle in the next few minutes and opened the door. The three members had couched themselves on the back seat. Two of them could speak and came down on their own. But one was in bad state having suffered the cold severely, he was speechless and had to be lifted and brought down. Later all of them were brought to Maitri and given treatment. It was midnight by then. Thus ended a day of encounter with Antarctic uncertainty.

Achievements of I4th WOT

1. To study the planetary boundary layer, low-level, slow rising radiosonde balloon ascents were taken - one in each month by Dr. Koppar and IMD team members. The results are inconclusive. Perhaps more frequent ascents are needed.
2. Liquid nitrogen plant of NPL was maintained in working condition and operated for the second time in peak winter which enabled taking of laser heterodyne observations throughout the winter period.
3. Study on the influence of magnetic disturbances over HF communication was undertaken.
4. The observational work of SASE was streamlined and drift and albedo observatories were established enroute to Shivling. SASE member wintering for the first time, this work was fundamental.
5. Correlation of exercise with endocrine and immunological functions and post magnetic storm ECG studies were conducted.
6. A cabinet alongwith electrical connection and auto temperature regulation was made for preserving the heat for efficient functioning of the vegetables walk-in deep freezer.
7. Successful experimentation of the use of Repeater to provide VHF communication for the convoy during winter.

8. Testing the possibility of VHF communication from hill top in the rear of Maitri to DG to avoid going to distant Veteheia Mount for installation and servicing of Repeater during winter time. But the result was negative.

9. Reception of weather charts from Pretoria on fax for the use of Meterologists. This was successfully tried in summer time (Jan-Feb) and continued throughout the year, A seperate log-preiodic antenna has been erected for this purpose.

10. Internet access trials were conducted successfully.

11. De-induction of four generator sets from A-Block and making of SURYA power unit. The generator sets shifted from the A-block into containers have been named 'Surya-1' and 'Surya-2'. They have been incorporated into the power grid on 11 th Oct 1997.

12. Shifting of electrical control panels from A-block to SURYA power unit. This involved re-laying of powerlines and making of new control panels. The new power circuit change over system at Maitri station is shown in Figure 2.

13. Direct fuel supply to generators in SURYA, BHASKARA power units and boiler room from a 10 KL tank positioned on top of SURYA containers. This arrangement is a significant improvement on two counts:

(i) it simplified the fuel supply to generators and boiler room once in a week (ii) the fuel tank in the boiler room which was a definite fire hazard, was abandoned.

14. Shifting of German generator sets. The two German generator sets (mounted in containers) positioned behind the main station have been shifted to the workshop complex. They have been serviced and tested. But only one could be commissioned for catering to the needs of the workshop complex. The radiators of the generator has been shifted into the workshop shelter. Under full load conditions the estimated heat extracted out of the radiator is equivalent to approximately 30 kilowatts of electrical heating. As a result the temperature inside the workshop shelter rises significantly and working inside even on cold days is comfortable than it used to be before.

15. Making of a container complex. A container complex for 20 containers (2 rows of 10 containers) has been made near workshop and 17 containers have been positioned on concrete slab plat forms. A large stretch of rocky land was levelled by extnsive bull dozer operation after use of explosives to blast the rock and boulders when this container complex is fully developed, entire range of material tock of maitri station can be stored in systematic environ- ment-friendly manner. Viewed from this angle, this work by 14th WOT is commendable.

16. Segregation and rearrangement of food material into 6 containers in a classified manner.

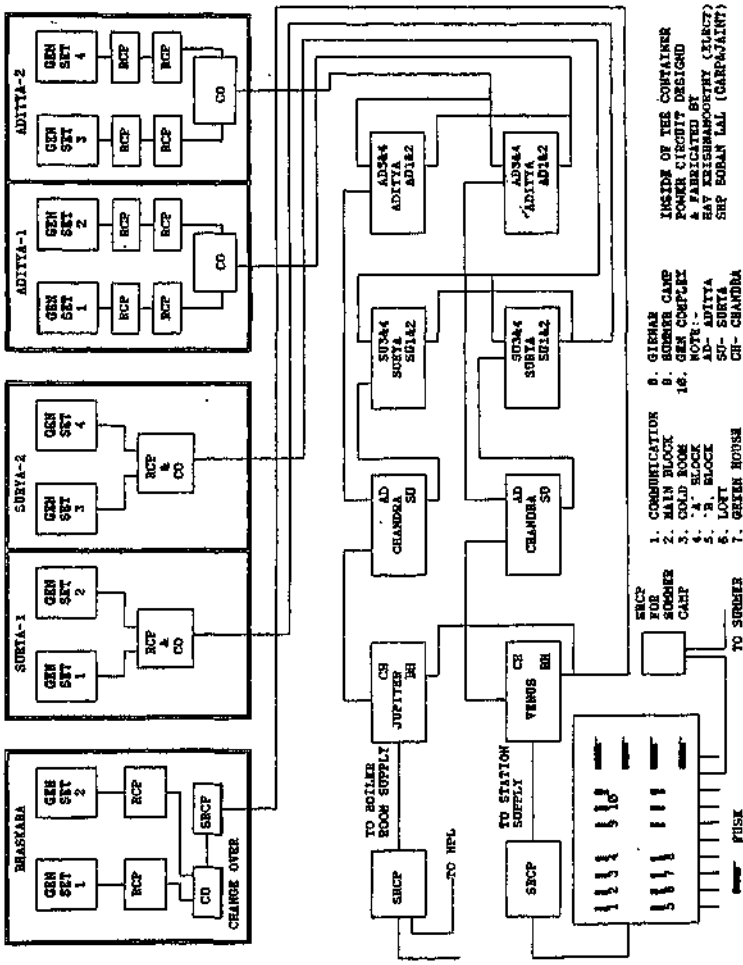


Fig.2 :The new power ciruist change over system at Matri station

17. Creation of proper vehicle and trailer parking area adjoining the workshop. 18. Spray painting of both exterior and interior of main building (except rooms) and B-block with fire retardent paint.

19. Painting of stilts of main building with red oxide. 20. Painting of interior of green house with white paint.

21. Extricating about 350 fuel barrels buried in snow and ice at Shelf.

    Fuel barrels of the previous expeditions left on the Shelf were buried under snow and ice. These have been painstakingly extricated and brought to Maitri and decanted into storage tanks. Due to this, fuel demand for the XVII expedition was reduced significantly.

22. Decanting of fuel from about 450 barrels extricate from Duzer point into storage tanks.

23. Stacking of fuel barrels in a professional manner for helicopter use near main helipad.

    Forty newly brought ATF barrels were stacked in the form of a honeycomb at the main helipad to avoid moisture contamination. One 20 KL tank filled with ATF was also kept in reserve for helicopter use in Jan-Feb 1998. This has saved helicopter sorties to carry fuel from ship to Maitri, for refuelling of helicopters.

24. Location of Hatch of D.G.Hanger

    The hatch of D.G.Hanger was buried under thick layers of snow leaving no trace of it for identification. Location of the hatch was important otherwise in the succeeding winter more snow would have accumulated. Besides valuable ice core samples of GSI are stored in it. The first attempt to locate the hatch during the third convoy had failed. A determined "Operation Search" was made in the fourth convoy. As a result, the hatch could be located after three days and nights of continuous work. It is now well marked by poles. 25. Construction of Jeevan Jyothi

    A generator-cum-toilet-storage module on 5 KL tank sledge for using as an appendage to Banjara was constructed locally.

26. Improvement to the road from station to Dozer Point involving use of dozer for smoothening and widening at places.

27. Clearing of small boulders and big stones from the helipad areas and making of a broad interconnecting path for quicker and easier movement between the helipads.

28. Shifting of construction stores from old and new workshop areas to the storage yard.

29. Improvement in summer camp arrangements at D.G. by

    a) doing-up of Sankalp and making it available as a living module.

    b) provision of containerised 30 KVA generator for power supply

    c) positioning of Portcabin on new surface and in line with (a) and (b)

30. Installation of Dimplex heaters (6 Nos) in the main station which has served two purposes:

    a) additional heating for the station and

    b) power supply R-Y B phase balancing

31. Shifting of the control of burners of toilets for firing and re-starting to outside the toilet block.

    These were under the toilets earlier and was very inconvenient to operate. Shifting them outside the C-block has made the work of galley duty persons not only easier but also aesthetic since breathing of foul odour has been avoided.

32. Automation of the operation of burners of boilers at preset temperature range. The burners of the boilers were being operated by either the boiler room in-charge or the person on galley duty by monitoring the temperature of the expansion tank. This has been automated and the burners of the boilers are automatically controlled based on the temperature of expansion tank.

33. In continuation of the summertime ETF's environmental cleaning-up work

    a) the wooden path from the eastern end of the main block to Met. observatory was dismantled, and back loaded.

    b) the defunct water pumping platform of the summer camp at lake-bed near Annapoorna hut was dismantled, and back loaded.

    c) picking up of waste material of all sorts scattered around the station by wind action, more so from the northwestern sector which is the lee side of prevailing wind direction.

Return Journey of I4th WOT

The 14th WOT members returned to India in April '98 alongwith XVII Expedition after staying in Antarctica for 14 months and making significcant contribution in the pursuit of science in Antarctica and to the station logistics.

Delineating and demarcating the convoy route using-GPS system

This task was assigned to the Survey of India team in the XVI expedtion. However the team dropped this job since they found that it had been done by the army engineers of XV expedition. In the XVII expedition 3 German scientists (Geodesists) participated for a collabarative work with Indian Geodesist (SOI). The team carried out the delineation of convoy route in February 1998 using .

GPS system. The coordinates of convoy route and a sketch map of the same are shown Table 1 and Figure 3. The points of the Russian route are also added.

Table 1 :

CO-ORDINATES OF THE CONVOY ROUTE (MEASURED IN FEBRUARY 1998) (The points of the Russian route are added. This route itms more west.)

70° 48'59.10" S,	11° 45'00.52" E	Maitri-DG Road Crossing Novo-Airport
70° 49' 06.00" S,	11°49'05.70" E	Russ. Point 1
70° 50'36.89" S,	11°49'37.73" E	
70° 50' 00.80" S,	11°51'00.90" E	Russ. Point 2
70° 50' 33.60" S,	11° 52'24.90" E	Russ. Point 3
70° 51' 57.65" S,	11°55'25.32" E	
70° 51' 17.70" S,	11° 56'04.40" E	Russ. Point 4
70° 51' 54.20" S,	12[c] 00' 52.80" E	Russ. Point 5
70° 53' 02.47" S,	12° 02' 39.90" E	
70° 53' 05.20" S,	12° 06' 16.60" E	Russ. Point 6
70°52'39.56" S,	12° 09' 29.58" E	
70° 52' 29.10" S,	12° 10'01.20" E	Russ. Point 7 Drum
70° 52' 48.50" S,	12° 11'26.60" E	Russ. Point 8
70° 52' 13.00" S,	12° 13' 16.90" E	Russ. Point 9 Stone and Drum
70° 51' 32.00" S,	12° 15'11.30" E	Russ. Point 10 Drum 106
70° 51' 20.74" S,	12° 16' 07.36" E	
70° 50' 19.40" S,	12° 19'05,00" E	Russ. Point 11 Drum 100
70° 49' 30.00" S,	12° 20'45.69" E	
70° 49' 19.60" S,	12° 21' 17.90" E	Russ. Point 12
70° 48' 58.40" S,	12° 21' 50.10" E	Russ. Point 13 Drum 94
70° 47' 29.38" S,	12° 25' 23.39" E	
70° 46' 40.90" S,	12° 26'48.00" E	Russ. Point 14 Drum 88
70° 45'31.00" S,	12° 28' 39.47" E	
70° 45' 29.90" S,	12° 28'48.70" E	Russ. Point 15 Big Sledge
70° 43' 39.80" S,	12° 30' 15.30" E	Russ. Point 16
70° 43' 29.52" S,	12° 31* 37.26" E	
70° 43' 00.10" S,	12°31'24.90" E	Russ. Point 17
70° 42' 24.60" S,	12° 32' 10.60" E	Russ. Point 18
70° 41' 42.30" S,	12[o] 32' 38.90" E	Russ. Point 19 Drums

70° 40' 47.96" S,	12° 32' 44.50" E	
70° 40" 08.40" S,	12° 32'43.50" E	Russ. Point 20 Pole
70° 38' 16.12" S,	12° 31' 13.79" E	
70° 37' 04.10" S,	12° 31'44.00" E	Russ. Point 21
70" 35' 51.45" S,	12° 30'09.43" E	
70° 35' 16.60" S,	12° 29' 23.90" E	Russ. Point 22 Drum 52
70° 33'55.90" S,	12° 26' 14.10" E	Russ. Point 23 Drum 48
70° 33' 47.07" S,	12° 25'58.69" E	
70° 32' 25.70" S,	12° 23'07.60" E	Russ. Point 24 Drum 45
70° 32' 00.27" S,	12° 21'57.24" E	
70° 31' 19.10" S,	12° 21'03.50" E	Russ. Point 25 Drum 41
70° 29' 43.00"S,	12° 20'07.50" E	Russ. Point 26 Drum 37
70° 29' 30.33" S,	12° 20' 10.62" E	
70° 27' 04.40" S,	12° 19' 30.60" E	Russ. Point 27 Drum 31
70° 27' 00.59" S,	12° 19'50.05" E	
70° 24'51.74" S,	12° 18' 21.30" E	
70° 22' 53.80" S,	12° 18' 32.60" E	Russ. Point 28 Drum 24
70° 21' 07.37" S,	12° 19' 02.04" E	
70° 19' 57.00" S,	12° 19' 15.10" E	Russ. Point 29 Drum 20
70° 18' 38.54" S,	12° 19' 17.61" E	
70° 16' 54.40" S,	12° 70'27.70" E	Russ. Point 30 Drum 15
70° 16' 03.60" S,	12° 17'47.48" E	
70° 15' 07.10" S,	12° 14'57.50" E	Russ. Point 31 Drum 12
70° 13' 39.51" S,	12° 15'55.25" E	
70° 13' 09.30" S,	12° 12'32.60" E	Russ. Point 32 Drum 32
70° 11' 09.08" S,	12° 13'07.43" E	
70° 10' 54.20" S,	12° 09' 34.00" E	Russ. Point 33 Drum 10
70° 08' 51.51" S,	12° 08'20.29" E	
70° 08' 36.40" S,	12°OS'30.70" E	Russ. Point 34 Drum 7
70° 07' 38.70" S,	12° 04' 17.40" E	Sortie to Russian Barrier
70° 04' 40.83" S,	12° 00'21.74" E	DG
70° 01' 09.56" S,	12° 01' 15.62" E	
69°58'48.51" S,	12°00'03.02" E	
69° 56' 49.04" S,	11°55'07.45" E	Indian Discharge Base

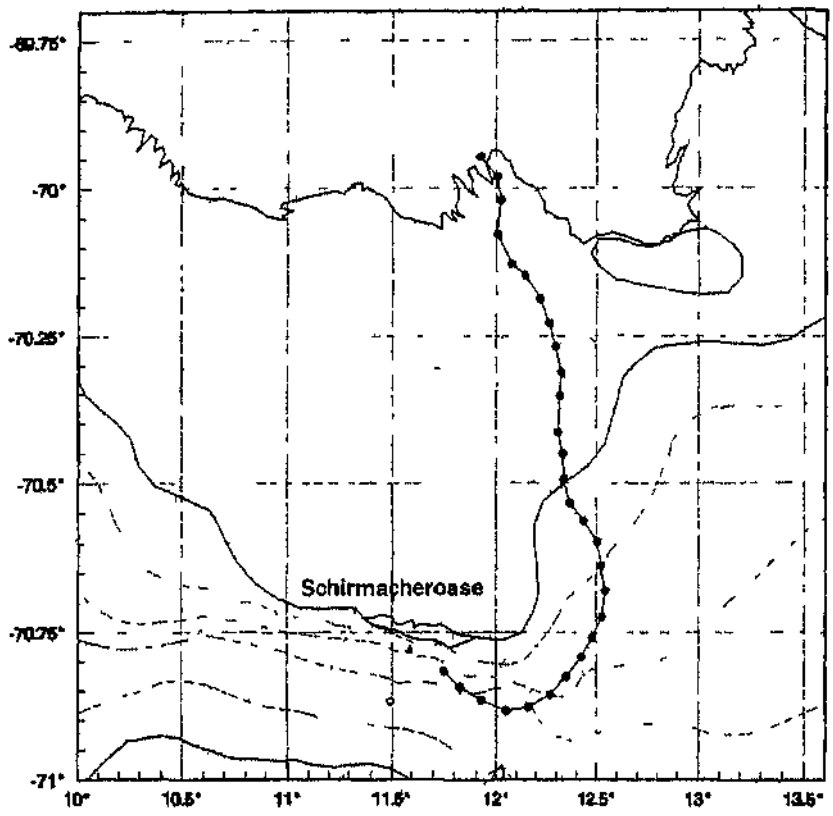


Fig.3 :Indian Convoy Route from Sankalp Point to Discharge Base

Expedition Ship: "Polar Bird" Sailing on the tropical India Ocean during onward cruise-Dec.1996.

Ice brugs, fast-ice, Polyna-Typical land scape at the Antarctic Coastline

Discharge operations in full swing at India Bay

Celebration of Republic Day- 26th Jan. 1997

Maitri Station charge handing/taking over ceremony

Aerial survey of Penguins and Seals-A project of wild-life Institute of India

Inflatable Boat Sailing on Priyadarshini Lake at Maitri for collecting sediment samples for II T K project.

Container complex in the making at Maitri Station (April 1997)

Container complex with Snow accumulation (Oct 1997)

View of the frozen Priyadarshini Lake-Oct 1997
Freezing of lake under calm conditions presents mirror like surface

XVI IAE Team

XIV WOT Team