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Special Issue on

DRDO in Antarctica

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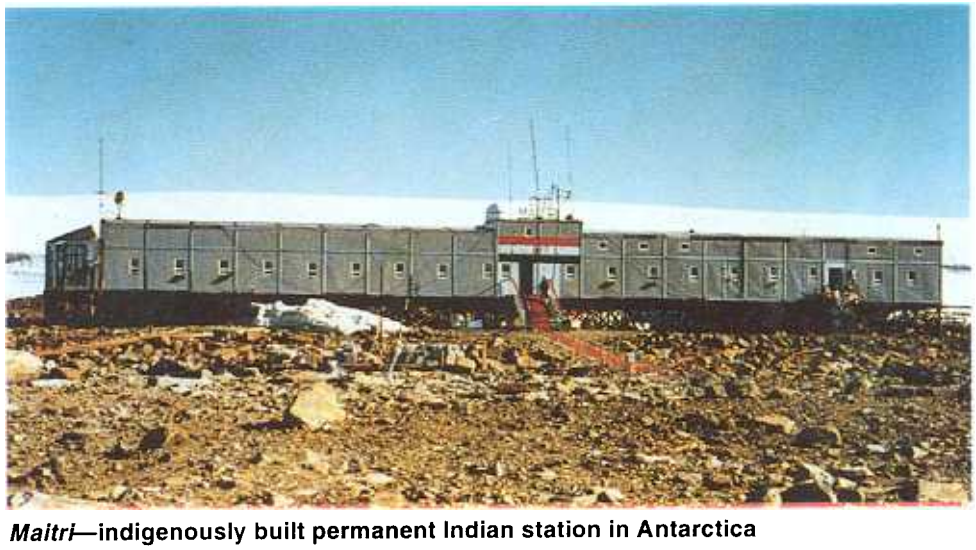
DRDO IN ANTARCTICA

Exploring new areas in pursuit of technological innovations has been a continuing process with the scientists. Searching life in Antarctica and establishing habitat for scientific activities has been one of the Indian missions during the last two decades. DRDO, in collaboration with the Department of Ocean Development and other scientific institutions in the country has been attempting to establish habitat in Antarctica. Establishment of *Dakshin Gangotri* and *Maitri* stations in Antarctica is a creditable achievement of Indian scientists. Every expedition opens a new account in the bank of scientific knowledge.



***Maitri*—indigenously built permanent Indian station in Antarctica**

सत्यमेव जयते

DR. A.E. MUTHUNAYAGAM
SECRETARY

भारत सरकार
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महासागर भवन, ब्लाक १२, सी जी ओ कम्पलैक्स,
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MESSAGE

India's quest for research and scientific work in Antarctica started in 1981. Since then, Indian expedition to Antarctica has been an annual feature. The main aim of these expeditions has been to conduct scientific studies in the contemporary areas of oceanography, meteorology and climatology, geological and physical sciences, biological and environmental sciences, medical and human physiology, and engineering and communication sciences. The Department of Ocean Development (DOD) is the nodal agency for organising these multi-disciplinary and multi-institutional expeditions. The Defence Research & Development Organisation (DRDO) has been actively associated with DOD for providing specialised logistic and other scientific support for the success of these expeditions for maintaining our permanent station *Maitri* in Antarctica.

I am happy that ***Technology Focus,*** a bi-monthly bulletin of DRDO, is bringing out a special issue highlighting the DRDO contributions to the Indian Antarctic expeditions. I am sure that this publication will further foster the interest of DRDO scientists in the frontier areas of polar sciences and technology.

I wish the publication every success and take this opportunity to wish the scientists and other staff success in their current and future endeavours.

(A.E. Muthunayagam)

Editorial

Antarctic expeditions represent a major scientific activity for the nation. Obviously, DRDO cannot be out of such premier scientific activities. To prove this point, right from the second expedition, the scientists of DRDO have been participating practically in every expedition. During the initial phase, it was an experience to get exposed to the new environment with certain spirit of adventure. As the base was being established for a permanent station, the efforts started getting converted into designs, technologies and missions to be accomplished in Antarctica.

DRDO took the initiative not only to construct the first wintering station at *Dakshin Gangotri*, but also to collect data enough to plan the next station as a permanent habitat for Indian Antarctic science. These efforts culminated into a new station, *Maitri* which came up in 1988 and has been acknowledged as one of the well designed and constructed sites in Antarctica. *Maitri* is a modern comfortable station with living accommodation for 25 persons and good scientific amenities for research. It also has facilities for summer camps to accommodate about 35 scientists. It has been supported with modern communication systems so as to make the scientists feel at home even though working 10,000 km away form the mainland.

Antarctic expeditions have thrown challenges for DRDO scientists in many fields ranging from engineering science, communication, life science, agricultural science, earth science, and so on. The scientific teams bringing multi-organisations on one platform have helped strengthen the bonds between different organisations. The growth of science at *Maitri* is just one example of synergy derived from the human resources and the scientific knowledge available across a wide band of disciplines and laboratories in the country. DRDO is proud to be a part of this national endeavour for which it has extended every support and will continue with its contribution in more challenging ways in the years to come .

MR Joshi

DRDO in Antarctica—A Preamble

Indian Antarctic expeditions started in 1981 when the first expedition was launched for its summer tenure under the guidance of its leader Dr SZ Qasim, an eminent oceanographer. The first wintering Indian expedition was launched in 1983. Since then, the Indian Antarctic expeditions have been continuing every year for carrying out scientific activities. DRDO has been actively associated with these activities since the third Indian Antarctic expedition, mainly for providing logistic and scientific support. Besides DRDO, the CSIR, the Armed Forces, the All India Institute of Medical Sciences, IMD, GSI, NIO, DST and several academic institutions are other main participants who have been contributing to the success of these expeditions. The Department of Ocean Development (DOD) is the nodal agency for organising these expeditions every year.

Dakshin Gangotri—First Indian Station in Antarctica

Antarctica is an island continent almost completely covered by ice. This cold and remote continent experiences the coldest temperature up to -89.6 °C (in 1983). Sub-zero temperature prevails throughout the year. Antarctica is inhabitated by primitive life forms like wingless fly, mosses, lichen, algae, and numerous species of birds, seals and penguins.

***Dakshin Gangotri*—First Indian station in Antarctica**

The first permanent Indian station in Antarctica named *Dakshin Gangotri* (DG) was constructed during the third Indian expedition (1983-84). DRDO played a pivotal role in commissioning of this station. For the first time, 12 persons carried out scientific studies during the winter period in this station. Although the DG structure was imported, three containers for living accommodation mounted on sledges were indigenously made and erected. During fourth, fifth and sixth expeditions some new habitats based on insulated enclosures, knockdown containers, etc were provided for living, apart from carrying out regular maintenance of DG station.

Maitri—Second Permanent Indian Station in Antarctica

Based on the experience gained during these expeditions, DRDO could develop a full-fledged indigenous station in Antarctica. As such, the second permanent station *Maitri* with all the life support services was developed by DRDO with total indigenous efforts and was constructed by scientists, engineers, and Army/Navy pilots during 1988-89. Since 1989, *Maitri* has been in use for all wintering expeditions. The DG station was abandoned in 1990.

Maitri is situated at Schirmacher Hills—an ice-free boulderous terrain. It is located in close vicinity of the shore. The nearby Priyadarshni lake provides vital water supply to the station throughout the year. For most part of the Antarctic winters, this lake is covered with 2 m of ice.

The main factors that affect habitat construction in Antarctica are low temperature, high wind speed, snow

An aerial view of *Maitri*—*Priyadarshni* lake in front and Piedmont glacier at back

accumulation and snow drift, regional surface characteristics, poor visibility and accessibility/inaccessibility.

Considering the Antarctic conditions and the restrictions for construction, viz., prefabricated panels for ease in construction by limited available manpower; size and weight of panels/pallets suitable for handling by four men and transporting by MI 8 helicopter; excessive vibrations in structures due to wind up to 200 kmph; material used for construction to withstand sub-zero temperature and low humidity, utmost care was taken to design the structure/ components of *Maitri* station.

Foundation

Maitri is built on stilts having adjustable telescopic columns as foundation. The structure has been designed to withstand low temperature and wind speeds up to 200 kmph. The foundation on adjustable stilts caters for undulations of the rocky terrain.

Superstructure

The station comprises four blocks. The Main Block houses living accommodation, medical facilities, communication control system and laboratory. Block 'A' accommodates workshop, power supply and MI room. Block 'B' houses central heating system, water storage tanks, snow melt plants, kitchen, dining hall and chemical toilets. Block 'C' provides accommodation for incinerator-type toilets. Adequate storage facility has been provided in the loft above the Main Block. Keeping in mind the logistic limitations, modular construction method is used for construction. Pre-fabricated panels used are made of timber framework, with marine plywood on both sides and polyurethane as insulating material sandwiched between them. These panels are interconnected by wooden connectors. Fire-retardant Gypsum board lining is provided from inside, while external finish is provided by plastisol-coated GI sheet.

Life Support Services

Power Supply & Electrical System

***Aditya* power house constructed with knockdown type containers and panels**

Maitri station when commissioned in 1988-89 was provided with 4 x 62.5 KVA gen sets for power supply. Since these gen sets have outlived their life, to meet the power requirement, a power house called *Aditya* has been constructed with three knock-down type containers made of prefabricated components and panels. Four specially fabricated 62.5 KVA gen sets were installed and commissioned during twelfth expedition (1992-93). Two more 62.5 KVA gen sets housed in standard ISO containers with proper insulated panels were sent alongwith thirteenth expedition (1993-94), and a power house named *Bhaskara* was commissioned in 1994. Each container has been provided with strengthened floor for direct mounting of gen sets on the floor. Anti-vibration mountings have been provided for mounting of gen sets and reduction of structurally borne noise. Diesel engines, prime mover of the gen sets, have been provided with cold starting devices. Each gen set is provided with a control panel near the gen set and a remote control panel installed at the control room for ease in operation and observation.

Central Heating System

Maitri is provided with a centrally heated system. It consists of hot water generators (boilers), radiators and

***Maitri*—Central heating system**

closed loop piping through which hot anti-freeze mixture is circulated at about 75 to 80 °C. Hot water radiators of 1000 k cal/h capacity have been installed at appropriate places to maintain the inside temperature of the station between 20 ± 4 °C.

Four hot water generators of 2,00,000 k cal/h capacity, connected to the radiators, meet the entire heat load of the station. Out of these, only one is used at a time; the second one is used to meet the peak load. The others are kept standby. Two fuel tanks of capacity 2500 l each, and connected in parallel, from which fuel is pumped to the daily tank of 500 l capacity. Appropriate safety features have been provided with the boilers and fuel tanks.

Water Supply System

Water supply to *Maitri* is ensured by pumping water from the lake approx. 255 m away from the station through a specially designed water supply line. A pump house has been constructed at a distance of about 80 m from the edge of the lake and a submersible pump has been lowered in the lake water. The pump is enclosed in two concentric stainless steel jackets which are heated electrically to ensure continuous pumping of water even at low temperatures up to -40 °C. To further ensure continuous flow from the pump to the boiler room in the main station, the entire copper pipeline is enclosed in a rectangular air tight insulated duct supported on a steel structure. The duct is fabricated out of marine plywood and 100 mm rigid PU foam.

Daily requirement of water is fed from the lake by the submersible pump through a 40 mm diameter pipe. The duct houses two additional pipes of 25 mm diameter which carry hot water mixed with anti-freeze media (monoethylene glycol) to maintain the duct temperature in the pipeline. The water from the lake is pumped into two stainless steel tanks of 2500 l capacity located in the boiler room and distributed to the utility points through laid down pipes and circulation pumps. A control panel with indicators and safety system is installed in the boiler room for observation and operation. A standby centrifugal pump has been installed in the pump house. A snow melt tank of 1000 l capacity has also been provided in the boiler room as a standby during use in winter. The system has been working satisfactorily even during winters when the lake water top layer freezes up to 2 m deep.

***Maitri*—Water supply system**

To avoid any contamination of lake water in case of leakage, an electrical trace heating system was designed. The trace heating tape, installed in January 1997 on fresh water pipeline, has been satisfactorily functioning. Temperature sensors are installed inside the duct to indicate the temperature on the control panel provided in the boiler room to avoid any malfunctioning. The total pipeline is divided into three equal lengths and fitted with trace heating tape to balance the loading of gen set.

Condition/Health Monitoring of Gen Sets

Diesel gen sets constitute lifeline of *Maitri*. Critical spare parts for these gen sets can be brought from India only once in a year during the summer. DRDO has therefore provided for condition-based health monitoring of gen sets by acquiring vibration signatures. Excessive stresses, undesirable noise, looseness of parts and partial or

***Maitri*—Condition monitoring system for gen set**

complete failure of parts are some important effects of vibration. Continuous health monitoring of gen sets can avoid catastrophic failures. Vibration levels are measured through transducers mounted on critical parts and compared with reference levels. If the vibration levels exceed the standard ones, preventive action is taken before the breakdown occurs.

The data collector installed at predefined points on gen sets regularly logs the vibration measurements. Then, the data is transmitted to a DRDO centre in the country where it is stored and analysed. The information on any incipient fault detected, recommended maintenance action, spare parts optimisation, etc. is then directed back to the data collector at *Maitri*. The database of vibration levels of existing machinery also helps DRDO to improve the designs for futuristic requirements.

Environmental Management

Solid and liquid waste disposal in the cold region is a challenging task and poses several problems. An efficient system of waste disposal has been incorporated in the station. A separate block has been constructed as toilet block and five incinerator-type toilets have been installed there. Toilet-ash, ash collected from incinerator, plastics, metal tins, grates and leftover food waste are segregated, sealed in barrels and backloaded for disposal as per the laid down norms.

Waste water produced is directed to two bio-disc treatment plants imported from UK. The effluent, after treatment in both these plants, is collected into a pond of approx. one lakh litre capacity. This water is periodically pumped out to an uphill location, about 300 m away from the pond, where the water is soaked into the ground.

Fire Protection System

Fire hazard is given paramount importance in view of the dry climatic conditions of Antarctica. The station is considered as of Class I fire rating, i.e., provided with self-contained prevention, detection, spread check, fire suppression and evacuation to refuge area inside the building itself. Suitable fire protection devices have been provided in addition to the fire proof Gypsum board lining provided in the Main Block. Fire check doors and fire barrier walls have also been provided at various points to check the spread of fire in case of an accident. Manually-operated fire extinguishers are also provided at fire points near the main entrance of the station building.

DRDO has carried out hazard and risk analysis and implemented the latest fire protection system with fire fighting chemicals to ensure fire-safe environment at the station.

Maintenance

In extreme weather conditions prevailing in Antarctica, the maintenance of structure, building and life support systems is a challenging task. Any minor fault may lead to complete system failure and hamper the scientific activities. All structures and equipment are monitored regularly and relevant data collected to verify any deterioration having taken place in the system and to take remedial action to avoid failure. Utmost care is taken while procuring suitable spares which can withstand the Antarctic conditions and are tested before despatch.

Communication System

Communication is an essential and vital element for the success of an expedition. The adverse climatic conditions of Antarctica like magnetic storms, static electricity, earthing problems and heavy magnetic fields

REAL-TIME PICTURE TRANSMISSION FROM ANTARCTICA

DRDO scientists technically demonstrated to the then Prime Minister Shri HD Deve Gowda, the near real-time picture transmission of the bust of Mahatma Gandhi immediately after its installation at *Maitri* on 26 January 1997. The bust of Mahatma Gandhi, presented by the Indian High Commisssioner to UK to the former Prime Minister Deve Gowda for installation in Antarctica, was taken to Antarctica by the sixteenth Indian Antarctica expedition.

The techniques of video digitising, picture compression and satellite data link with Penitum-based PC were used for the transmission of the picture.

Interview: Dr SZ Qasim

"I feel that DRDO has no equivalent in our country....There is no other organisation which could have helped as much as DRDO did in every field"

Dr SZ Qasim, formerly Secretary, Department of Ocean Development, and the founder of Polar research in India spoke to Maj Gen SS Sharma, Director, SASE, and Shri DS Bedi, Editor, Technology Focus on DRDO Contributions to Indian Antractic Expeditions. Excerpts:

***Q.** What was the prime objective of Indian expeditions to Antarctica?*

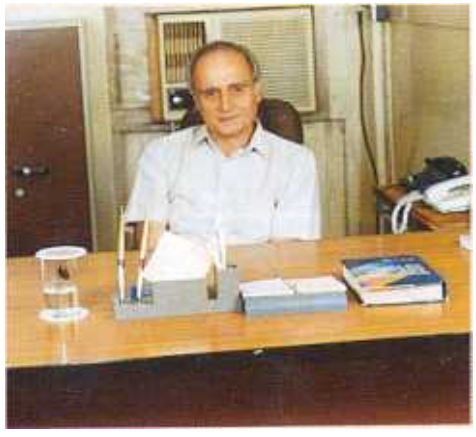
A. Antarctic expedition started because of the interest of the former Prime Minister Smt Indira Gandhi. The main reason was geopolitical, as Antarctica at that time was the monopoly of the rich and developed countries. And she was determined that this monopoly must be broken. The second reason was the adventure part of it and the third was development of polar science which was non-existent at that time in the country.

***Q.** What made you (the DOD) involve DRDO in such expeditions?*

A. I happened to visit most of the DRDO labs and I feel that DRDO has no equivalent in our country for the types of researches they are doing for various kinds of development. There is no other organisation which could have helped as much as DRDO did in every field.

***Q.** How and to what extent DRDO has helped DOD to achieve its objective(s)?*

A. Whatever sectors we may look at, starting from putting up structures in Antarctica in very difficult conditions, the standard types of accommodation, because over a period we moved from tents to very sophisticated living conditions. Then ice-sustaining shelters and development in other sectors like clothing. The kind of clothing I wore when I took the first expedition, if you look at the pictures, you will find that they were very heavy but now the clothing are more efficient, much lighter and very easy to manage. Then the kind of footwear I used. They were not very efficient then. Over a period, the DRDO has given us excellent products.



***Q.** What is your impression about the effectiveness of DRDO technologies in providing the logistic support in Antarctica?*

A. I think the effectiveness of DRDO technology is clear from the fact that the design that we have today of our *Maitri* station is entirely developed by the DRDO support. Even the earlier station *Dakshin Gangotri* was constructed by the Defence Forces in which DRDO played a major role. *Maitri*, today is an international station and one of the best stations in Antarctica.

***Q.** What in your view, are the other potential areas where DRDO can contribute to Indian scientific endeavours in Antarctica?*

A. I think this is a very important question you have asked. My own feeling is that DRDO is doing excellent work by largely devoting technologies for Defence. However, the spin-off of the technology of Defence should be used for various other purposes. There are specific areas I would say, oceanography for example, in which they have not been exposed to. DRDO has been using acoustics for signals and underwater signals and also to differentiate noise from signal. We in the oceanography field also use a lot of signalling under water, so this is one area where DRDO can contribute very much.

***Q.** What role has been envisaged for DRDO in the future Indian endeavours in Antarctica?*

A. Actually, the geopolitics of Antarctica has undergone a drastic change. Earlier, they were thinking of developing a minerals regime for the exploitation of minerals of Antarctica of which India is a signatory. If that regime of mineral exploitation would have come through, then of course the DRDO would have had a major role. But, now Antarctica is going to be used for scientific research, for peaceful purposes only. In the changed circumstances, the DRDO will contribute to better construction in Antarctica, better living conditions for making life easier and more efficient.

Q. *How do you think that the activities/contributions of DRDO in Antarctica would help DRDO in improving its support to its immediate users—the three services.*

A. I think it has helped and it will help in the future because the advantage is in terms of experiences that they have gained in Antarctica and the resulting feedback, which are being used in the frontier areas. I think the gain in experience in Antarctica has been very effective—better living and then making people more comfortable, in the food sector, and in all other related filelds.

Q. *Could you recall any personal experience of your association with DRDO technologies in Antarctica?*

A. In the first expedition also DRDO's contribution was there—clothings, footwear, and tents we used they were all from DRDO. We hardly wore imported clothing. Although we had imported clothing, but I made it a point to wear only our indigenous clothing and we found it very good and efficient.

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put a strong challenge to the communication engineers. Till the fourteenth expedition, the following communication systems were maintained by the Indian Navy:

High Frequency Morse/Voice Communication

This was mainly used for communication between Antarctica and India. It was used to maintain communication with other stations in Antarctica and with the ship during voyage.

VHF Communication

This was used for communicating with camp area, convoys and air traffic control between ship helicopter and *Maitri*.

Satellite Communication

Maitri is linked to the rest of the world via satellite communication terminal of INMARSAT (International Maritime Satellite) system. This is mainly used for sending and receiving official messages as well as for making official/private telephone calls and fax messages.

To cope with the scientific activities and to have a global communication, it was felt necessary to have a reliable and faster data communication system to enable exchange of scientific data between the scientists working in Antarctica and parent organisations. During the fourteenth expedition, DRDO successfully installed an electronic mail system on ERNET (Education and Research Network) in Antarctica.

Transportation

Transportation of men and material in Antarctic environment is an uphill task. The ration, fuel and other materials are carried by ship up to the Indian bay in Antarctica. From there, the essential items are transported to the station by helicopter and other items are unloaded on the ice-shelf. During the onset of winter, the water channels along the surface route to *Maitri* get frozen up and become suitable for convoys. The material unloaded at ice-shelf is brought to *Maitri* loaded on containers/trailers towed by tracked vehicles. Loading/unloading is carried out by cranes mounted on tracked vehicles.

***Maitri*—Green house in full bloom**

Protected Vegetable Production

The severe Antarctic climate limits the number of land plants that are able to grow there. Apart from snow algae, plant life is limited to lower species of plant kingdom, viz., moss and lichens. DRDO has developed integrated technology for vegetable production in Antarctica involving green house, hydroponics and photo-period regulation. Concerted efforts by DRDO scientists since 1989 have resulted in successful production of cucumber, tomato, chilli, capsicum, brinjal, spinach, fenugreek, coriander, lettuce, celery, radish, mint, onion, and garlic in Antarctica. The technology has been developed to suit the day length varying from zero to twenty-four hours, facilitating round the year production of certain vegetables. The technology for growing certain ornamental plants has also been developed.

Experimental Green House

The Green House facility at *Maitri* has been created during the ninth expedition (1989) for carrying out experiments in the field of plant growth and agricultural science in Antarctic environment. The shape and variation of the Green House is so selected that it receives maximum sunlight throughout the season by glass house effect.

The size of the Green House is 10.6 m x 2.66 m and height is inclined from 3.9 m to 2.9 m. The principle of modular construction has been adopted for selection of the size and structural components, keeping in mind the futuristic scope of expansion of the station. The superstructure consists of prefabricated sandwich insulated panels. Maximum surface area also has been provided with space window fitted with Teflon toughened glasses to provide adequate insulation and prevent heat losses. An environmental control system to simulate conditions suitable for plant growth in the extreme climatic conditions in Antarctica, has been incorporated. These conditions are mainly temperature, humidity, ventilation, carbon dioxide, illumination, air change, and pH value.

Ration for Antarctic Expeditions

Keeping men in Antarctica poses tremendous logistic problems as entire food supplies for a period of about 15 months have to be planned and carried by the expedition team itself. DRDO helped in planning and processing the rations for the

Ready-to-eat ration

members of the Antarctic expeditions. Sufficient care is taken to ensure that foods remain wholesome and nutritious for more than 15 months, processed and packed in such a way that persons unaccustomed to the art of culinary can prepare tasty meals by simple warming and heating. The range is kept wide enough to design various menus to avoid monotony. Some of the ready-to-eat and ready-to-cook shelf-stable products of Indian dietary made available by DRDO for Antarctic expeditions are:

Freeze-dried Foods: Foods preserved by freeze-drying retain their original colour, flavour and nutritive value, as the entire operation is carried out under frozen conditions and high vacuum.

Retort Pouch Food: Thermally-processed canned foods have been widely used wherever fresh supplies are not feasible. However, this method is suitable for sterilisation of solid/semi-solid materials.

Ready-to-Eat Chapaties/Parothas: No Indian meal is complete without chapaties/parothas/poories. Ready-to-eat shelf-stable chapaties are wholesome and nutritious and require mere warming before consumption.

Bread: Bread wrapped in fungi-static wrapper followed by propylene pack remains in good condition for more than three years.

Quick Cooking Dehydrated Foods: Instant pulav, upma, avial, halwa, kheer and dhal are highly convenient as these can be prepared by mere heating with water for 8 to 10 min.

Survival Ration: Survival rations are ready-to-eat and provide instant energy when consumed. These have long shelf-life and provided for emergency situations when an individual has to perform task away from camp where even limited cooking facilities are not available.

Antarctic Clothing

The Antarctic clothing have been designed and developed by DRDO for use in extreme cold conditions of Antarctica and glacier regions. The clothing constitutes basically a jacket and a pair of trousers designed on multilayer principle with outermost layer as a wind cheater for providing adequate protection against high velocity winds and severe weather conditions. The hood of the jacket outer is detachable and either of them can be used independently (hood as a headgear). Though the integrated waist coat of trousers insulating provides adequate protection to tne vulnerable portions of chest and back, the warmth could be further supplemented by the use of additional waist coat.

Antarctic clothing

The clothing set includes one pair each of cotton terry pile and nylon terry pile socks. In normal condition, only nylon terry pile socks are to be used, whereas for prolonged activities these socks are to be used in conjunction with cotton terry pile socks, which should be in direct contact with the skin.

Biodegradation as a Solution for Waste Management

Human waste disposal is a burning problem in cold regions. The subzero temperature prevailing in these areas results in lowering of natural microbial activity thus causing disturbance of natural ecosystems and hazard of epidemics. Out of several options of waste treatment, biodegradation by microbes seems to be somewhat promising due to low cost, less maintenance and pollution-free methodology. DRDO has addressed to this problem by employing low temperature bacteria selected from colder regions of India.

Polar Research on Physiological Adaptation

Indian subjects by virtue of their tropical residency are scarcely exposed to extremes of environments especially cold and altitude. DRDO has conducted several studies to understand the effects of extreme cold, altered geo-magnetic field, solar periodicity (light/darkness period) and prolonged isolation in the Antarctic environment on the physiological adaptation of the tropical subjects stationed in Antarctica. Assessment of changes in body weight, skin fold thickness, heart rate, blood pressure,

oral temperature, respiratory rate resting tidal volume, minute ventilation, basal metabolic rate, cold pressure response and physical fitness were studied on 20 wintering team members during their 13 months stay in Antarctica during fourth expedition. The studies indicated a progressive increase in the body weight with associated increase in body fat. Most of the physiological variables showed rhythmic changes with season and polar nights with decrease in winter and increase in summer. There was lack of evidence with regard to physiological cold acclimatisation even with 13-month stay due to overprotection by clothing and living in temperature-controlled environment. Also a decrease in physical fitness of the numbers was observed during dark winter months. Sleeplessness, muscle pain, headache, fatigue, anxiety and intellectual inertia were found to be more common during polar nights.

Other Facilities

Mast Portable Aerial 28 M

A 28 m Mast was erected at Maitri to accommodate various types of sensors and instruments. The Mast

28 m mast

was erected during eleventh expedition and is still in use. It has satisfactorily withstood many blizzards, some of which exceeded 200 kmph wind speeds.

Dome Shelter

One experimental green house of dome shape shelter was constructed at Maitri during tenth expedition. It is made of steel tubes, nodal joints and transparent FRP panel cladding. Racks have been provided around the periphery and at the centre for keeping plant trays.

Walk-in-Type Cold Storage

Different items of food require different temperatures to preserve their food value, nutrition and taste. Therefore two walk-in type cold storage units were established at Maitri to preserve food items for the wintering period. These refrigeration units have a working range of +5 to -15 °C. The units are of knockdown type, consisting of prefabricated insulated panels having a cladding of plastic-coated GI sheets and polyurethane foam as insulation.

Harnessing Non-Conventional Energy Sources

DRDO is considering the use of fuel cells as an alternative to diesel engine driven gen sets. Fuel cells are highly efficient having high power-to-weight and volume ratios, reliable, noiseless and generate negligible amount of heat. DRDO has proposed to carry out studies on proton exchange membrane fuel cell with hydrogen as fuel for using it as an environment-friendly power source in Antarctica.

Antarctica Club of India

Having been a part of practically every Indian expedition to Antarctica, DRDO took one more initiative to form the Antarctica Club of India—ANCOI. ANCOI was formed primarily to foster knowledge about Antarctica amongst the members of the society and to provide an informal forum for all the Indian Antarcticans to come together and revive their memories, share knowledge and experience and to help create a good resource on Antarctic-related material. By now, ANCOI has been receiving good response from its members and others interested in Antarctic science. Traditionally, ANCOI observes the most important festival of Antarctica Winter Solstice, on 21 June—the Antarctica mid-winter day—and sends greetings to the members of the expeditions on this day. By now the strength of the Indian Antarcticans has crossed 1000. ANCOI aims to provide a common thread to bring all Antarcticans together, even after their retirement from active service.

ANCOI—A forum for gettogether of Indian Antarcticans

Antarctica Recalled

Maj Gen SS Sharma, KC, Director, Snow & Avalanche Studies Establishment, Manali, who was the leader of the first wintering Indian expedition to Antarctica narrates one of his experiences in Antarctica.

Snow accumulation due to blizzard behind the snow vehicles. Maj Gen Sharma is seen standing at the middle. Inset : Sastrugis on Dakshin Gangotri ice shelf

Antarctica always fascinated me by the many mysteries attached to it. My desire to be in Antarctica turned into reality as I joined DRDO and specialised in the field of snow and avalanche. My exposure to cold region engineering and science in DRDO, with the background of being part of the Indian Army (Corps of Engineers) helped me in becoming the leader of the first Indian wintering party to Antarctica in 1983, with a unique mission of establishing the first-ever Indian over-wintering station, Dakshin Gangotri.

Many of the decisions which I took while constructing Dakshin Gangotri, starting from digging the foundation for station in snow for commissioning of various engineering systems and then running the station with my eleven colleagues, contributed to the success of the mission. I recall one of my significant contributions that has been the development of standard operating procedures (SOP) for day-to-day conduct in and around the station and how they helped me survive one blizzard. Later, SOP became the standard drill for the future wintering parties.

In Antarctica, blizzards are very frequent. During one such blizzard on 13 September 1984, when the wind was blowing at 120 kmph, I along with my colleague Ram went out to study snow accumulation pattern during the blizzard. The light snow drift was 3 to 4 m high with a high density drift along the ground level. The visibility was not more than 4 to 5 m, but it was manageable to walk outside by taking proper precautions. The drift along the ground level was forming Sastrugi (a conical ridge like snow structure aligned along the wind direction with its apex facing the wind). The newly-formed Sastrugis were 1 to 2 m in length and 20 to 30 cm in height. The pattern was all along uniform. I was moving at a distance of 20 m from Ram, who was also counting the number of new Sastrugis formed per 100 m. When we were about 1 km away from the station, I slipped and fell down, and by the time I got up, I had lost sight of Ram. Meanwhile, the wind velocity increased and with that the snow drift density too. Undaunted by this, I continued moving in the same direction, but I was not able to locate the barrels which were the direction indicators to me. I lost count of the Sastrugis, my worry remained to locate Ram and to reorient myself. I struggled for some time and then got panicky.

I again made a determined effort, but to no avail. I shouted for some time, but in the blizzard noise, nobody could hear anything, even at a whispering distance. I struggled, and with that, panick gripped me and uncertainty started surrounding me. Would I have to die? How long would it take to get choked? What would happen to Ram?

With all my might, I made a real last determined effort, with all my senses alive for seeing any known object, for feeling anything which I could recognise. I moved in one direction and returned. Time passed and my struggle continued. During this struggle for survival, I tried to remember the SOP which I had evolved for such occasion.

I could recollect that when one is left alone in a blizzard, he should try to remain at one place without getting panicky. I did this for some time, and then I felt the drift intensity reducing and visibility improving. Then I saw some faint object in the distance. I went near it, and found that it was the crane vehicle which was left in the old fuel dump in an off-road condition for retrieval after the blizzard. I opened the vehicle and sat inside. Now, I knew I would not die, but what about Ram? I could recall Ram's excellent sense of direction, and I was sure that he would not get lost.

I waited in the vehicle for half an hour, and gradually the grip of uncertainty loosened. After some time, I saw an object coming towards the vehicle. It came nearer, and I was relieved to see Ram. I now wonder that how close I was to a disaster, but my remembering the SOP in time saved me.

Contd from page 7 col. 3

Dr Qasim on DRDO Contributions in Antarctica...

Q. What is your impression about the effectiveness of working links between DOD and DRDO as far as Antarctic expeditions are concerned?

A. It has been extremely cordial. Without the help of DRDO, all Antarctic expeditions would not have achieved such success. Also, they have enhanced the image of the country in the international circle. It is so difficult to identify and isolate DRDO. In fact, whenever I went abroad, people used to ask: you people belong to a hot country how you are staying in Antarctica? They thought that we would back out from Antarctica, but now we have made a permanent existence there. So it's a big compliment India has received and it is largely because of DRDO's work.

Q. How do you rate the overall competence of Indian scientists and technologists involved in scientific activities in Antarctica vis-a-vis those of the other countries operating in Antarctica?

A. Well, the Indian scientists, engineers and technicians and all the three services have demonstrated that Indian technology and work is second to none. In fact you can compare it very favourably with developed countries. We have had no mishaps there till now. And this is a proof that our technology, which we have indigenously developed, is as good as the technology of developed countries.

Q. What message you would like to give to the readers of Technology Focus, particularly to the DRDO scientists and the Armed Forces?

A. Antarctic programme has been a very unique example of cooperation in Indian science. You will not find an equivalent of that. This unique example of cooperation in Indian science must continue. Antarctica is a place which is known to kill people mercilessly. So in those conditions the best experience which I have learnt from my own exposure is never to accept defeat, and that is my message.

DRDO Patents

Process for Diffractive Optical Elements

In the optical instruments based on lenses, mirrors, etc, the wavefront propagates in free space due to which considerable free spaces are required between different optical elements. Such instruments are bulky and have considerable weight. Besides, these instruments involve complexity of tubes, fixtures, spacers, baffles, etc due to which the instrument is prone to misalignment which degrades its performance considerably. There is also loss of light at different surfaces and this loss could be as high as 90 per cent in a multiple element instrument.

The optical instruments based on optical waveguide have the limitation that these instruments can carry very small size wavefronts of the order of 0.2 microns. They are not suited to carry wavelengths of size several mm as required in imaging devices. Holographic optical elements (HOE) are also used in optical instruments which enable reduction in size and weight. However, these HOE-based instruments also have severe misalignment problems.

DRDO has developed a process for fabrication of diffractive optical elements for use in thick waveguide-based optical instruments which eliminate the misalignment problems associated with optical instruments. These diffractive elements enable enormous reduction in size and weight of the instruments. The instruments based on diffractive optical elements ensure higher diffraction efficiency and can carry large size of image wavefront of the order of several mm.

N O T E

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