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Report on the Indian Antarctic Scientific Station "Maitri" - A Study of the Station and Its Life Support Systems

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Abstract

R&DE(Engrs), Pune, a part of the Defence Research and Development Organisation (DRDO) has been participating in Indian Scientific Expeditions to Antarctica since the Third Expedition, when an officer of the establishment, then Lt Col SS Sharma, was entrusted the task of erection of first permanent station of India in Antarctica, the Dakshin Gangotri station, and also head the first ever Indian wintering team. Since then R&DE(E) has been an active participant in various expeditions, providing living shelters, life support systems, like water supply systems, power generation systems, waste disposal systems, etc. R&DE(E) has been nominated by the Department of Ocean Development (DOD) to act as the Nodal Body for advising them in all matters relating to the

- **Design**
- **Development**
- **Procurement**
- **Installation**
- **Working**

of structural, mechanical (except vehicles), waste disposal, and associated systems required for their Antarctic Programme.

This report contains the details of study of the station and its life support systems.

Introduction

Maitri - the second permanent Indian Scientific Station was designed and developed by R&DE(Engrs), Pune and is operational from 1989 onwards. Since then, it has been providing accommodation and other life support systems to the team of 25 members who winter every year. The basic infrastructural material support is from R&DE(Engrs), and the Army Team, comprising the Engineers and the EME do the running, repairs, maintenance, upgradition and new installations for all kinds of life support systems at Maitri. They are

specifically trained at Pune prior to the sailing off the expedition for getting acquainted with the various systems at Maitri.

In continuation of the study programme undertaken by this establishment, this year a comprehensive study of the station was undertaken, considering that the station has now completed almost 7 years of service. A study of the performance of central heating system, and state of various parts of it, alongwith water supply system, foundation and structure of the station building, etc. was earlier undertaken by another officer, Mr. SS Gaikwad, Scientist 'E', during the summer of XIII Expedition. Supplementing that study, a year long study of various life support systems installed initially and presently being supported by R&DE(Engrs) was also undertaken, mostly from the point of view of assessing the performance of existing design and enhancement in future for such facilities.

The following systems were studied :

(a) Maitri Station building, and its various parts

(b) Generator Sets and Accommodations

(c) Data Acquisition System for Gensets

(d) Boiler System, Central Heating, and Water Supply

(e) Waste Disposal System

(f) Green House

(g) Deep Freezers

(h) Summer Camp Accommodation and Facilities

These systems are described in detail in the following sections.

Maitri Station Building, and Its Various Parts

Maitri is housed in a single building, with all living amenities inside the station, and only the new generator complexes being outside the building. Over a long span of time, a lot of advantages and disadvantages of such a concept of living accommodation have been realised. The staying of people together does bring in a certain amount of harmony, and the ease of work is always there. However, on the other hand, in case of a serious fire accident, there will be no other place remaining with any facility. It was felt that in a place like Antarctica, the resources should be physically kept apart at a safe distance, which also includes human beings.

Over the last 7 years, Maitri has been of outstanding service to the team of scientists and service personnel staying there every year. However, some of the improvements, if they can be made in the existing design or incorporated in

future designs, will make the stay in Antarctica much more conductive to work, and consequently more adaptive to human beings.

The following points are suggested:

(a) Living Cabins: The living rooms are of inadequate size. Most of the scientists have to carry out analysis/computation of data in their cabins in the absence of a central place for such a thing. The ideal size would be about double the existing rooms, with bigger windows. In addition, whatever little space is there, most of it is used by the bulky radiators, almirahs etc. There should also be a small attic sort of thing so that suitcases etc can be stored without hampering the movement inside rooms.

(b) Ventilation: There in no ventilation in the living rooms. In winter, most of the members seal windows as small air gaps allow free entry of cold air from outside and in some cases, snow also during a blizzard, thus cooling the whole room. Due to this, there is no air circulation and unhealthy and stale air remains stagnant inside the rooms for a long time. It is suggested that proper ventilations be incorporated in future designs.

(c) Corridor Planks: Corridor Planks are a permanent problem, both for boiler mechanics and the members. Whenever there is a pipe burst or change, the planks have to be removed and resecuring them becomes a problem. Consequently, any human movement on them causes irritating noise, more so during nights, when galley duty personnel go for hourly rounds of the station. It is suggested that the layout of water pipes be designed in such a way that there is no need for a false flooring.

(d) Toilet Block: Toilet Block is facing severe problems in winters. During a blizzard, snow enters from all the joints of the whole ceiling and the whole block soon gets covered with snow, ice and water. Attempts to seal the joints have remained unsuccessful, since during burning of the toilets, the temperature of the block rises quite high and the sealent comes off the joints.

(e) MI Room: It has been time and again told by the Medical Officers wintering at Maitri that the MI Room is of inadequate size and in case of any real emergency, it will be totally ineffective.

(f) Leader's Office: The Leader's office is the only place besides the lounge, where meetings can be held or guests can be entertained. The size of that does not allow the strength of a gathering to be more than 7 or 8. Since a lot of visitors come during the summer to Maitri, it doesn't look decent to say that the only station of India in Antarctica does not have a proper place where the leader can entertain guests.

(g) Computer Facility: There should be a spacious computer room facility, as most of the scientists and other officers, and the leader himself have felt an

ever increasing need of using computers for their scientific and logistic purposes.

Generator Sets and Accommodations

There are total 10 generators of 62.5 KVA each including two gensets brought by this team. The oldest of the generators are 4 slip ring type, housed in 'A' Block of the Maitri station building. Another 4(all brushless) are housed in a complex known as "Aditya" which was commissioned by the XII Expedition's team. This time another 2 brushless gensets were brought and a complex known as "Bhaskara" was built by this team. Both "Aditya" and "Bhaskara" are containerised accommodations and are physically away from the main station building, being placed on the rear side at a distance of around 50 meters each.

The 4 old generators of 62.5 KVA capacity have all ran for almost more than 12000 hrs and have practically outlived their lives. It is recommended that these 4 gensets be backloaded and the new gensets be of brushless type for the sake of easier inventory stock and maintenance. The space thus created can be converted efficiently into a big scientific lab for all experiments.

"Aditya" complex faced lot of problems of snow ingression during the winters. The same was faced with "Bhaskara" too. A thorough study of both highlighted following shortcomings in the basic design:

(a) The insulation of containers for gensets should be done in India only, as it is much easier to do it and also more efficient. During the commissioning of "Bhaskara", all the three containers had to be insulated in the winter months of Apr and May. The temperature of the metal containers used to drop to -lo deg C or below and it was a difficult task within itself. If the insulation work can be done in India, extra hardships in Antarctica can be avoided.

(b) In the month of Aug 94, a wind speed of 85 knots was recorded and the wind with 70 knots speed continued for 3 days. During the period, one of the containers of the Bhaskara complex got slided on the iron blocks by almost 2 feet to the south and 1 feet to the west. The suspected reason was the lack of any welding/fastening of the container on the iron blocks.

(c) It is very difficult to seal the joints permanently, as the running gensets cause lot of vibrations in the complex. As a result, some minute holes get created through which snow ingression takes place during blizzards. An alternative arrangement for an efficient sealing must be found, which can withstand continuous vibrations.

The complete power supply layout of Maitri was organised in an orderly way during this wintering. The circuit diagram of the layout of the powersupply is shown in Appendix'A'.

Data Acquisition System for Generator Sets

This time a new experiment was tried with the generator sets sent. The two 62.5 KVA gensets sent this year had special design to facilitate Computerised Data Acquisition System. The parameters — Engine Head Temperature, Air Intake Temperature, Exhaust Temperature, Fuel Flow, Oil Pressure, Oil Temperature, rpm, various line voltages, phase voltages, line currents, power factor, actual power and frequency could be monitored on the computer.

These gensets got installed by mid-June only and were not put on by October. The computer was put inside the genset block inside the control cabin and connected to the Digital Panel of the genset. The temperatures inside the Control Cabin used to dip to -5 to -10 Deg Centigrade, which could have created problems for the computer as it was not a ruggedised or industrial grade PC. Also, the vibrations inside the cabin were enough to damage the sensitive mechanical systems of hard disk of the PC.

The trials were conducted for over 10 days with the PC recording for almost 48 hours non stop on two occasions. The experiment was successful, but with limitations. In case such a setup is planned on a major scale, following considerations will have to be seriously considered:

(a) The sensors attached on the gensets did not have enough wire length. Some of them were too long or too short. Although local adjustments were made, still the sensor cables running all across the floor did add to the disorder. Cables should be secured properly on the gensets and preferably be going through the ceiling and not running on the floor.

(b) The flowmeter unit was tried for the first time. It gives a digital output for the amount of fuel flow that has taken place. It also has a battery backup which keeps the previous reading stored and displays the accumulative reading at any time. The display part and the electronic unit behaved perfectly well. However, the instrumentation part of sensor on the genset fuel supply created some problems, as there were some leaks and the genset mechanics had often to resort to bypass fuel supply. The leaks were in the sealed unit of the sensor. The sensor unit needs some modifications/improvements in this area.

(c) The PC used for Data Acquisition should be industrial grade/ruggedised and should be able to run in temperatures upto atleast -35 deg C, and should be able to work on a platform with vibrations,

(d) In the present software, the recording of only minute values could be done. The recording of values at every second was tried using other software

like PCSERIAL etc., and by trying to modify the programme itself. However, these efforts did not succeed. The monitoring of values at every second, especially during the High Power Transmission will immensely help in analysis the load being drawn in their make-and-break circuit. It is suggested that the software be modified for selective recording of parameters, starting from every value to 10 minutes interval. A copy of the sample data obtained from the gensets is given in Appendix'B'.

Boiler System, Central Heating and Water Supply System

The Boiler Room, situated inside the main building was functional perfectly alright throughout the year. However, some potential problems were realised, which should be rectified in the future designs:

(a) In case, a water tank is to be replaced in the boiler room, there is no way it can be done so without removing the walls of the room, as the doors are too small to accommodate it. In such a situation, it will call for a good job to seal back the planks of the wall and restore the original condition, failing which the whole boiler room will face air leakage, ultimately leading to premature cooling of the hot water pipes, as they run on the floor and are not covered by insulation material (As currently the heat loss is going to station only).

(b) The Central Heating System currently uses hot water to warm the station areas. However, in long usage, this kind of heating creates lot of problems. Air locks, bursting of radiators or water pipes etc., are very common. In some cases, if the radiator is closed for some duration, long enough for the water to freeze, it also causes bursting of radiator, besides the freezing of the radiator.

The following suggestions are made to be incorporated in future designs:

(a) The Boiler Room should be built slightly away from the main building of the station and should have sliding arrangement for opening atleast one side wall or the rooftop. This will not hamper in day to day operations and in case of any major maintenance work, will help in ease of operation.

(b) The Russian station, Novolazarevskaya, uses oil type electrically operated radiators. A sample radiator is brought back and it is suggested that all the existing radiators be replaced with similar kind of Russian radiators. It will work out to be quite economical also, as there is enough surplus power supply in Maitri (with two 62.5 KVA gensets running continuously).

The Water Supply Systems needs a little revamping. During this wintering, the duct pipes froze, which resulted in a massive exercise by all members for a full week to clear the pipeline and also later cleaning the frozen lake, as lot of semi-frozen slurry of anti-freeze mixture was lying on frozen lake surface.

Although the contaminated frozen lake surface was thoroughly cleaned, the incident has raised several questions about the potential dangers of such a system of heating the duct. If the duct pipes leak in the summer and the whole anti-freeze mixture gets into the lake, the consequences will be lery dangerous, as the lake water will become completely imputable. It is also widely known that long term consumption of copper can create cirrhosis of liver and MEG, the principal anti-freeze used there is also harmful chemical for humans, as well as being acidic in nature.

The walkway to the pump house appears to be in fairly stable shape. The pump house itself is in good condition. However, on one occasion, when the winds soared to more than 75 knots, the door of the pump house got blown off. The reason being opening of the door against the wind direction. The general wind in Maitri is known to be from eastwards. In view of it, adequate planning should undergo in designing such structures.

The insulation of the duct is also in good shape. During this wintering, when the complete duct had to be opened, the insulation of the duct was assessed and the sealing done after closing the duct was satisfactory.

Following suggestions are offered for the water supply system:

(a) The present system of using anti-freeze is dangerous. The Trace Heating is available for only some distance. It is suggested that the whole duct be heated using trace heating. The present system with its pipes can be removed and the remaining space can be filled with more insulating (fireproof) material to provide still better insulation.

(b) The pipes used for water supply (both lake water and anti- freeze) are of copper. The anti-freeze mixture is acidic in nature and hence corrosive. In case of drinking water, the water left overnight in the taps comes out yellowish in the mornings for a considerable length of time, thus indicating a good amount of copper in it. The pipes should all be replaced with those of material more resistant to corrosion.

(c) There should be an alternative water supply pipeline to cater for emergencies. On a normal basis, the existing and proposed alternate water pipeline can be used alternately so that both pipelines are always in working order.

Waste Disposal System

The Waste Disposal System at Maitri needs a major planning. The solid waste at Maitri is burned at a distance of around 50 meters to the leeward side of Maitri, at a place known as Garbage Burning Point. The place is fire safe and

there are no fuel dumps around. Once a week the burning is done and the smoldering continues for next 1 to 2 days.

There are two incinerators at Maitri meant for burning solid garbage, but their size is too small for the requirements of Maitri. The incinerator should be of large capacity and should be able to burn atleast 50 kgs of solid garbage at a time.

The liquid waste discharge from the biodigesters is let go in two small flat bottom ponds adjacent to the boiler room, on the outside. In the winter, they freeze. In summer, it melts and disposing off the water becomes a big problem. The stench of the water sometimes becomes intolerable. The water is pumped from one pond to another, till it evaporates or gets absorbed in the soil (which is very less). The liquid waste from the MI room is just allowed to go out without any treatment.

All other types or non-degradable waste is collected separately and brought back in containers, including tins, glass, plastics and toilet ash.

It is highlighted here that in the wake of the recent concern about stringent ecological measures to be adopted at stations in Antarctica, it is high time that a serious approach be worked out in consultation with environmental and ecological scientists for the complete waste management at Maitri in a better way than the present one.

Green House

Green house was added to the Maitri station building in the IX ISEA, towards the eastside of the building. It remained functional until only next two years, after which, it started facing heavy problems of snow ingression. It was observed that the green house faces the general wind direction and probably due to this, it faced lot of wind impact before finally giving way in the form of small openings in between the wooden panels for glass panes. When XI Winter Team took over the station, it had lot of openings and practically there was no vegetation. During the winter months when blizzards were quite frequent, the snow ingression made it impossible to do any vegetation. In late November the green house was restored to an appreciable state.

However, the problems remain where they were. The Environmental Stimulator is in total disrepair and so is the case with the humidifier and hot air blower system. The air rushing from the openings between glass panes causes the temperature to drop considerably (even during November, December & January, the peak summer months). The temperature was maintained using the Sodium Lamps already installed in Green house.

Following corrective measures are required to be done:

(a) Complete resealing of all joints should be taken at the highest priority. The joining adhesive should be of such a nature that it can withstand wind speeds of the order of 100 knots.

(b) Reflooring using anti-skid rubber mats, as the complete floor is in shabby condition and the loose mats are a possible safety hazard to people walking or working there.

(c) Overhauling of Environmental Stimulator system, so that it can be used for simulating proper and conducive temperature, humidity and light conditions for a healthy vegetation.

Deep Freezers

Our team was unfortunate that both kinds of deep freezers, the walk in type and normal faced problems, due to which lot of frozen food got wasted. At a time, almost half of the normal deep freezers were out of order and one one of the walk in type deep freezer giving frequent problems. This continued throughout the wintering. The repairs and maintenance of the deep freezers could not be done, as there was no trained personnel. The work could be accomplished in Jan'95 by the refrigerator mechanic came with XIV Expedition. However, the systems were working normally after the repairs.

Summer Camp Accommodation and Facilities

The Summer Camp is essentially the assortment of huts between Maitri & Priyadarshini lake. It consists of English, R&DE(E) designed and Hial Tech huts. R&DE(E) huts are essentially similar to English huts in appearance and are quite big. They can accommodate around a dozen people and also have space for setting up of small experiments. Hial Tech huts are smaller in size and can be used only by maximum 4 people for purely residential purposes.

Except for Nandadevi, which is the scientific hut, none of the huts have any arrangements for heating. It is felt that if small capacity encased radiating type electric radiators can be put in the huts, they will ease the problems for inhabitation. The usage of encased radiating type electric radiators will also not pose any possible threats of fire.

Most of the Hial Tech huts suffer from the problems of air tight sealing of entrance doors, the lack of which causes hardships for people who are new to Antarctica and are not so acclimatised to the weather, adding to which is the lack of heaters.

The kitchen area is housed in a residential hut, Annapurna. Around 8 to 10 summer team members stay in the loft section and the main hut is used for

cooking and dining purposes, alongwith the small recreation possible in that area, in the form of television. The fumes and gases are let to go from the hut through small ventilation holes in the ceiling planks and they all directly go the loft section and in the absence of a proper wind draught, more or less remain there. This causes the smoke and fumes to get filled there and the people staying there are forced the breathe the contaminated air.

There is no ecologically planned waste disposal system in the Summer Camp. In fact, the liquid waste from kitchen, bathrooms and urinal is just allowed to flow freely down the slope.

All the solid wastes are disposed by open burning, once a week or so, near the kitchen hut. Toilets of summer huts are fired daily. The ash is collected in a barrel, and later on sent back with other garbage, at the end of the expedition.

The following recommendations are suggested for implementation in future:

(a) Summer Camp needs more bigger huts, including one or two huts exclusively for setting up of sensitive electronic instruments, with all facilities of anti-static floor paddings, temperature control, fluctuation free power supply, writing tables, wash basin (for setting up of chemical or biological labs) etc.

(b) Residential huts need to be provided with fire-safe radiators for a comfortable human stay.

(c) The waste disposal management in Summer Camp has to be scientifically planned and executed, unlike the present adhoc system.

Acknowledgements

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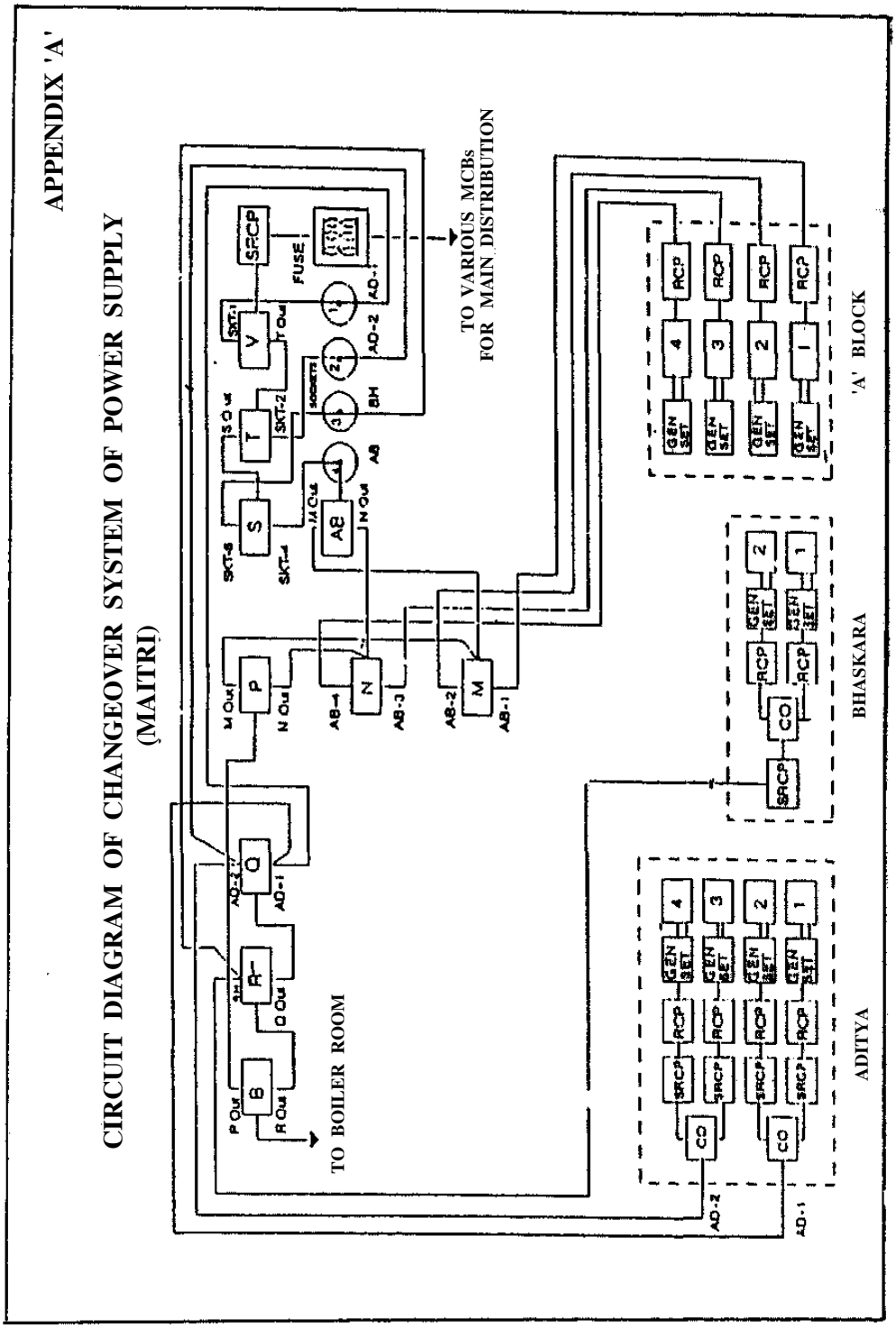
I would like to thank Brig RG Wastrad, JD, FD Group, and Col(Dr) RC Pathak, DD, FD Group for their support before and throughout the expedition. I would also like to thank Mr K P Rajagopalan, JD, TB ASE Group for extending all the help for my Antarctic Expedition preparations.

In the end, I would like to extend my most sincere thank to all the team members of XI Winter Over Team, for giving me incomparable moral and physical support in carrying out my tasks.

APPENDIX 'A'

CIRCUIT DIAGRAM OF CHANGEOVER SYSTEM OF POWER SUPPLY (MAITRI)



APPENDIX 'B'

Observation Sheet: Data Acquisition System for Generator Set

Channel	**1**	**Voltage (R)**
Channel	**2**	**Voltage (Y)**
Channel	**3**	**Voltage (B)**
Channel	**4**	**Voltage (RY)**
Channel	**5**	**Voltage (YB)**
Channel	**6**	**Voltage (RB)**
Channel	**7**	**Current (R)**
Channel	**8**	**Current (Y)**
Channel	**9**	**Current (B)**
Channel	**10**	**Frequency**
Channel	**11**	**Speed(RPM)**
Channel	**12**	**Powerfactor**
Channel	**13**	**Power (KW)**
Channel	**14**	**Fuel consumption**
Channel	**15**	**Cyldr. Head temp.**
Channel	**16**	**AIR intake temp. -1**
Channel	**17**	**AIR intake temp. - 2**
Channel	**18**	**Exhaust Temp.**
Channel	**19**	**Oil temp.**
Channel	**20**	**Oil Pressure**
Channel	**21**	**Recording time**
Channel	**22**	**Date**

Sample Recorded Data

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