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XIIth Winter Report 1995-96

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Abstract

The report contains the logistic tasks and the scientific studies carried out during the XlVth expedition in 1995-96.

Preliminary studies have been carried out in this expedition for examining the impact of climatic conditions of Antarctica on the structures, station building and other sytems like heating, life system and electrical earthing.

Regular monitoring of the structural components, electrical earthing and life systems should be carried out as a long term scientific programme.

Introduction

1. The Research and Development Establishment (Engineers), Pune is one of the Establishments under DRDO. The association of R&DE (Engrs) with the Indian Expedition started from IIIrd expedition, when indigenously manufactured stores/equipments were sent to Dakshin Gangotri (DG) for trials in the extreme conditions of winter. Based on the feedback and requirements projected by the teams, improvements/modifications were carried out and more structures and equipments were offered in the subsequent expeditions.

2. In continuation of the support, R & DE (Engrs) designed and constructed 'MAITRI', India's second permanent station during Vllth and VIIIth expeditions and a powerhouse in Xth expedition with fully indigenous material and equipments. The generating sets were commissioned by XIth expedition; however, due to fire accident in the powerhouse, one more powerhouse 'ADITYA' was erected by XIIth expedition and 'BHASKARA' by XIIIth expedition.

3. During the XIVth expedition, representative of R&DE (Engrs) was assigned the task of providing technical advice, guidance and assistance to the Army Engineers Team in construction of the Shelter for IMD and completion of Vehicle Repair Workshop Shelter. He was also entrusted with carrying out scientific studies during wintering period on behaviour of engineering material

used for the construction of building and effect of Antarctic environment on foundation & structures, heating & ventilation system, in addition to maintenance/repairs of life support services/equipments. Performance evaluation of the new radiators and electrical earthing was also assigned to the representative of R& DE(E).

4. Requirement for an inspection/repair ramp was projected by XIth wintering team. A study was carried out and proposal for a suitable ramp, taking into consideration various requirements and giving detailed drawings, materials, dimensions and other constructional details as shown at Appendix 'A' was made and sent to R&DE(E). This was totally an additional work. Based on the above proposal, inspection/repair ramp was designed and fabricated by R&DE(E) and sent with XVth IAE.

Logistic Tasks

5. Construction of Vehicle Repair Workshop Shelter

5.1 Maitri station does not have a workshop for carrying out routine maintenance/repairs of snow vehicles and other equipments held at station. Presently the repairs/maintenance of all the vehicles are carried out in open, in extreme conditions. Requirement of a Vehicle Repair Workshop Shelter for housing two Piston bully vehicles of size PB-270 with storage facilities was projected by the Department of Ocean Development (DOD) during XIth Antarctic expedition, The Shelter was designed and developed in the form of a modular shelter out of tubular arches with polyester coated GI sheet for roof and end walls. It is a semi-circular shelter having inner diameter of 9.07 m, height 4.44 m and length 20.60 m with total floor area of 187.5 sq.m. A gantry of 3 tonne capacity is also provided for handling various components during repairs.

5.2 XI wintering team had selected a site for the construction of Workshop Shelter approx. 200 m west of the main station on the right side of the road leading to Dozer point (refer plate V) and completed the Floor Girder Assembly and Space Structure.

5.3 XII Wintering team completed the following tasks:

(a) Welding and roofing

(b) End walls and facia

(c) Filling of foundation and concreting of floor

(d) Construction of retaining wall.

5.4 Welding and Roofing: Since the working team of Army Engineers was not conversant with the task of construction of Shelter, the team was apprised

with the entire work explaining the drawings, methodology and sequence of operation. Welding of all the junctions of the cross and longitudinal Floor Girders and the joints of Arches and Floor Girders was carried out to give additional strength and to prevent any relative movement between them.

5.5 Roofing of the semi-circular Shelter has two layers; inner one made of FRP/polyster coated GI trough sheet and the outer one of FRP/polyster coated GI plain sheet. Physical layout of the inner and outer sheets was made on ground with desired overlapping, longitudinally and transversely and at front and rear ends.

5.6 The FRP sheets were fixed as per the layout to the structure frame with 35 mm long 'C clamps. On both the sides of these, GI trough sheets were sequencially placed and fixed. The outer cladding sheets were also fixed to the structrure frame tubing with 'C clamps of 50 mm length.

5.7 **End Wall:** The inner and outer sheets of the semi-circular end walls were fitted sequencially in the descending order with 175 mm 'C clamps after fitment of door and windows. The Facia was then fitted to the end wall and roof sheets along the semi- circular Arch with 'J' bolts.

5.8 **Sealing:** On completion of roof and end walls, all the 'C' clamps were tightened equally ensuring no deformation or rattling of the sheets due to high winds. All the overlaps and holes were sealed using silicon sealant.

5.9 **Filling of Foundation and Concreting:** The foundation of the structure was filled with stones, prior to concreting. This required collection of approx, 120 cu m of stones and more than 300 man hours. Concreting of the floor of size 20 x 9 x 0.05 m was done upto the top level of the Floor Girder at an ambient temperature of +5 to +6 degree C in January 1996.

5.10 **Retaining Wall:** Retaining Wall of size 0.5 x 0.5 x 60 m in masonary work was constructed all around the periphery of the Shelter. An approach ramp in masonary work with 1.8 slope to the Shelter was also constructed.

6. Construction of Balloon Launching Shelter for IMD

6.1 A requirement was projected by the DOD for development of a Pre-fabricated Shelter for Indian Meteorological Department for Launching Balloons. Accordingly a Shelter made of steel columns and framestructure with inner walls having Fibre Reinforced Plastic (FRP) panels, outer sheet cladding and FRP roof was developed and fabricated by R&DE (Engrs). The overall size of the Shelter is 12 x 9 x 6.5 m and provides space for the following:

(a) Storage of hydrogen gas cylinders

(b) Filling of balloons with hydrogen gas

(c) Launching of filled balloons

6.2 The work of construction of the Shelter was commenced by XlVth expedition on 13 Feb '95. The site for the construction of the Shelter was selected in MT Area, about 30 m west of water supply line and 35 m south of bank of lake (refer pl. V), taking into consideration the normal wind direction. The site preparation and levelling of the area was completed by mid of Feb '95. Digging of foundation column pits was commenced; however, it was observed that digging of soil below the depth of 100 mm was not possible as the soil was too hard due to permafrost, as a result of low temperature below -6 degree C. The work, as such, had to be discontinued. However, it was restarted in January 1996 after arrival of XVth expedition.

6.3 The XVth expedition team was apprised with the construction drill and sequence of operation. The erection of the shelter was resumed again on 9 Jan '96 with the help of XVth expedition team and the following tasks were completed till return of the XlVth expedition to ship:

(a) Remarking and site preparation

(b) Erection of foundation columns, structure and concreting

(c) Construction of floor and erection of columns

(d) Erection of wall structure of:

i) Balloon filling room

ii) Cylinder filling room.

6.4 Marking of the centre lines of foundation pits was done again at place arcady earmarked and digging of foundation pits was completed. No difficulty was experienced in digging the soil upto a depth of 300 mm as there being no permafrost even at this depth since ambient temperature was above +6 degree C. The telescopic type foundation columns were erected, aligned and levelled by adjusting the height of the inner columns. Floor beams and perlins were bolted on them and levelling of entire floor structure was done using water level method.

6.5 Concreting of the columns was done and floor was completed by placing floor trays in the frame of floor beams and supports. The side as well as comer sockets and pillar were bolted to the foundation columns and floor beams. The wall columns were fixed into the sockets and side runners and links were fitted to them to make the structure rigid. The erection of all the wall frame superstructures upto the height of 6 m was completed following the sequence of erection.

6.6 The following guidelines are suggested, while carrying out construction work on ice free surface in Antarctica, based on the experience of the work done in Maitri during the XIVth expedition.

(a) Excavation for foundation should be completed in the summer months of Dec/Jan when normally the temperature is above zero degree C, since the soil becomes very hard due to permafrost and digging is not possible once the temperature falls subzero.

(b) It is advisable to do concreting when the temperature is above zero degree C, as even warm water used for concreting gets cooled very fast and starts freezing resulting in mixing of concrete very difficult.

(c) For curing of concrete, more quantity of warm water at frequent intervals is necessary than required normally because concrete gets dry very soon and working becomes difficult.

(d) Structures should be erected parallel to the wind direction to have minimum wind resistance and wind load.

(e) Structures should be erected on columns to provide adequate ground clearance for drifting of snow and to avoid its accumulation on the leeward side of the structure.

(f) Construction in open is comfortable even at -20 to -24 degree C with wind speed upto 10 knots. However, it is practically difficult to work even at low temperature of -15 to -18 degree C with wind speed more than 18 to 20 knots, due to windchill effect. The windchill equivalent temperatures are indicated at Appendix 'B'.

Scientific Studies

7. Scientific studies in the field of engineering were carried out during the wintering period.

7.1. Evaluation of radiators

7.1.1 Modified water radiators, quantity 14 Nos". were sent by R&DE (Ehgrs) for replacing the existing water radiators installed for room heating.

7.1.2 Pre-installation testing of all the new radiators was done and three old radiators were replaced. Evaluation and comparative performance of these with respect to the old radiators was observed for more than 6 months and was found satisfactory.

8. Electrical Earthing

8.1 Earth provides a common reference potential for electrical instruments. This helps in ensuring protection against any accidental discharge due to unknown relative potential difference existing between the vicinity. Normally in space, i.e. aircraft or flying objects, the main body provides this common reference. At Maitri due to cold temperature, following factors affecting good earthing were observed.

(a) Each generating set was grounded individually and was acting as a floating earth only for the body of the generating set

(b) Maitri station has individual floating earth.

(c) Radio room/Gimar earthing was independent and inadequate

(d) There exists permafrost just a metre below earth surface, even lake water gets frozen in winter.

8.2 Following tasks were completed during XIIth wintering period and along with XVth expedition team to provide earthing (providing large common reference surface) to the station.

(a) All the 119 columns of the main station were connected to each other by copper strip of size 50 x 30 mm.

(b) All the'individual earth points were connected to each other by thick copper wire.

(c) These were further connected to the base columns of the main station by copper strip (refer pl. VI).

(d) Two numbers of grids of size 1.5 x 1 x 0.65 m were fabricated using copper flats. One of these grids, connected by copper cable to the base column of main station, was submerged in the eastern part of the 'Priyadarshini' lake behind Girnar Hut to a depth of about 2.5 to 3 m under the water with the help of a helicopter.

(e) The other grid connected by the braided copper wire to base columns of Maitri was placed in the waste water pond behind kitchen.

9. Structure

9.1 Levelling of the foundation columns of Maitri main block was carried out. The levels were observed with the help of Wild NAR- 2 Automatic Level. A temporary permanent reference point (Bench Mark) was set on the platform

COLUMN Vs RECORDED LEVELS

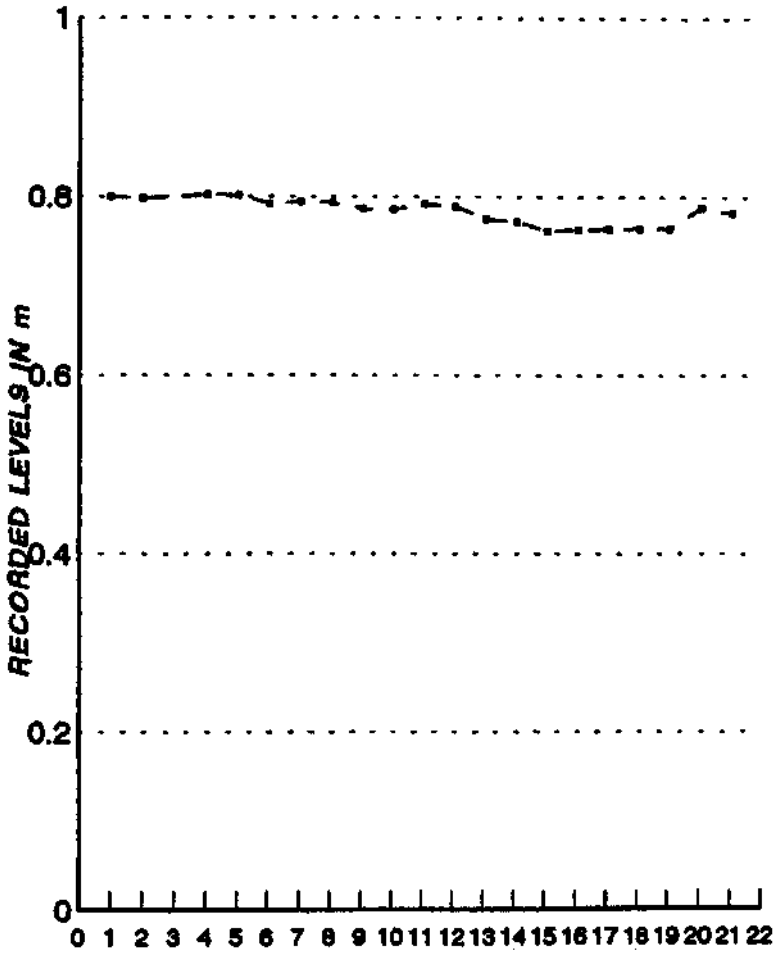
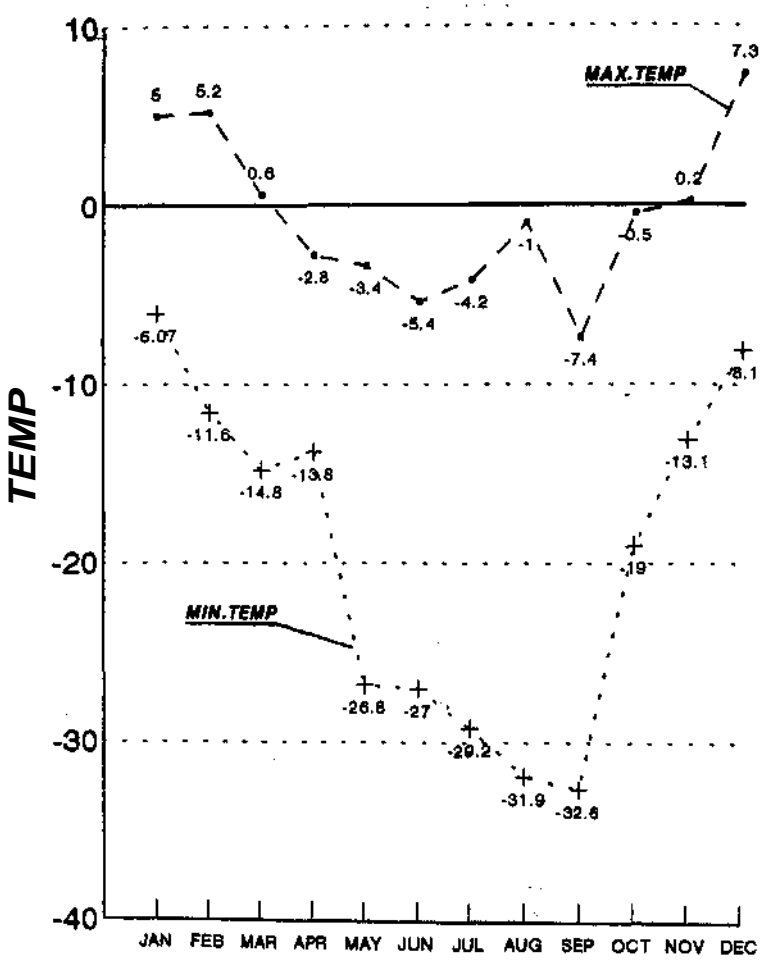


PLATE I

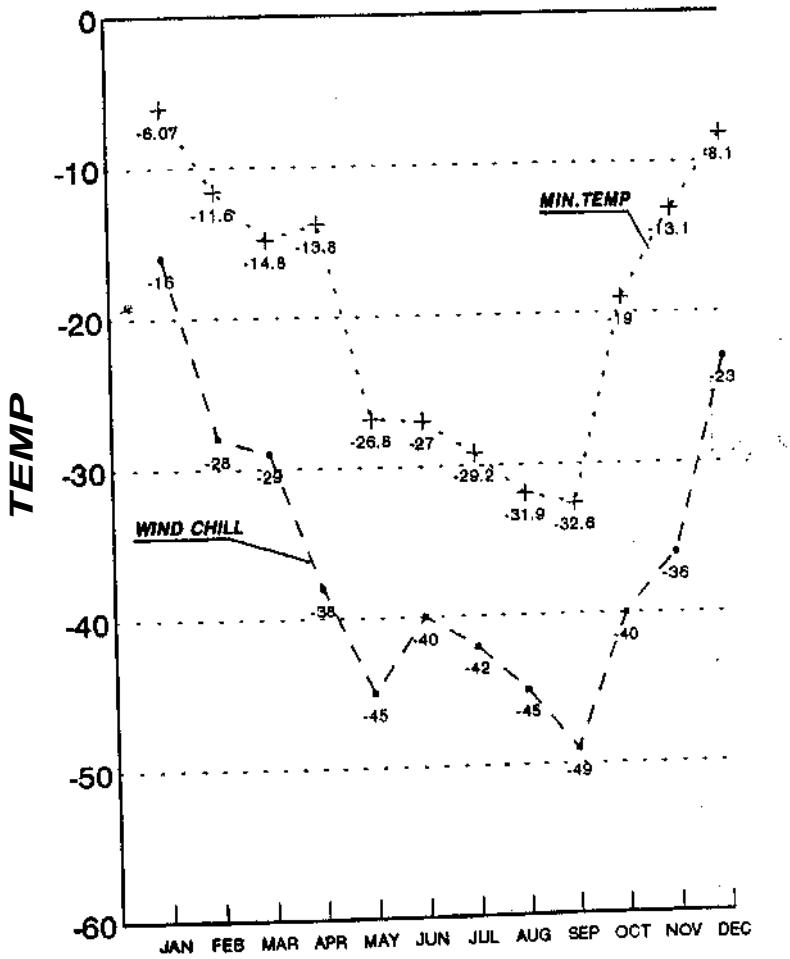
MONTHS Vs MAX. & MIN TEMP



YEAR 1995

PLATE II

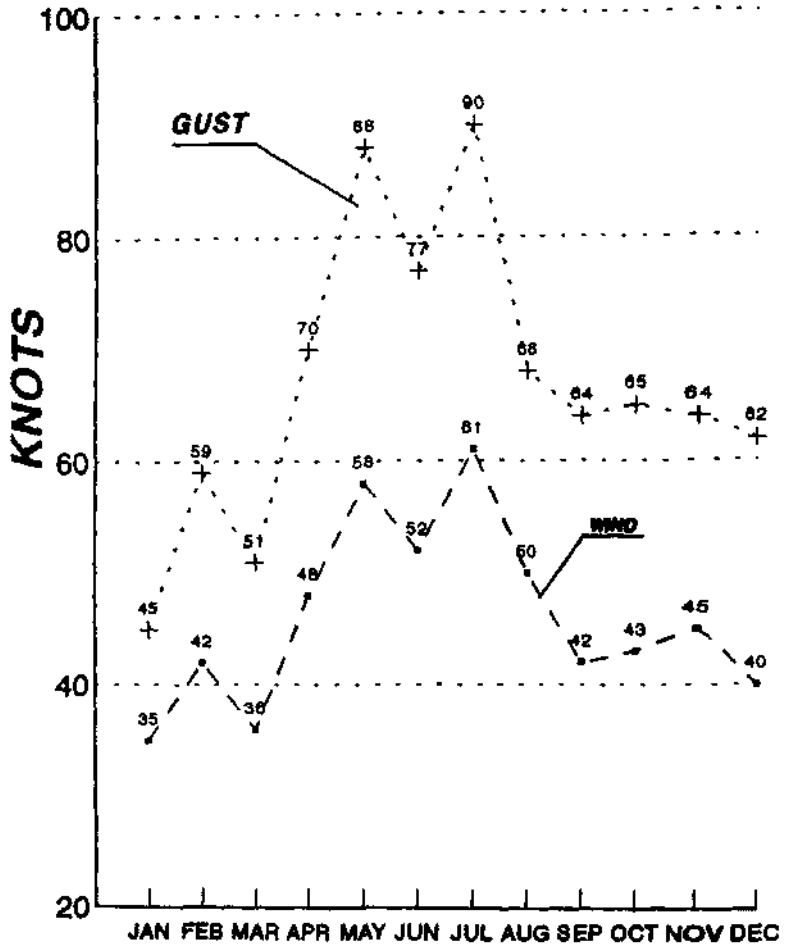
MONTHS Vs MIN TEMP & WIND CHILL



YEAR 1995

PLATE III

MONTHS Vs MAX.WIND & GUST



YEAR 1995

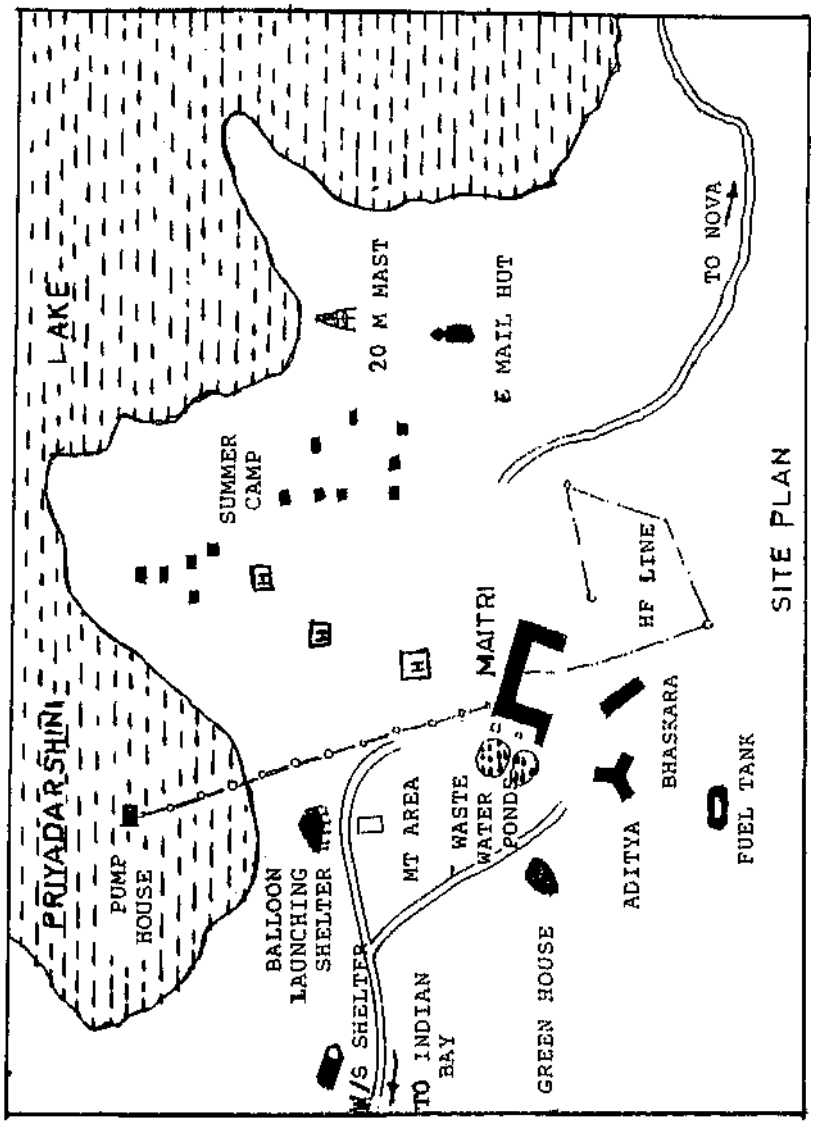

PRIYADARSHINI LAKE
PUMP HOUSE
BALLOON LAUNCHING SHELTER
W/S SHELTER
TO INDIAN BAY
SUMMER CAMP
20 M MAST
E MAIL HUT
TO NOVA
MT AREA
WASTE WATER PONDS
MAITRI
HF LINE
ADITYA
BHASKARA
FUEL TANK
GREEN HOUSE
SITE PLAN

PLATE V

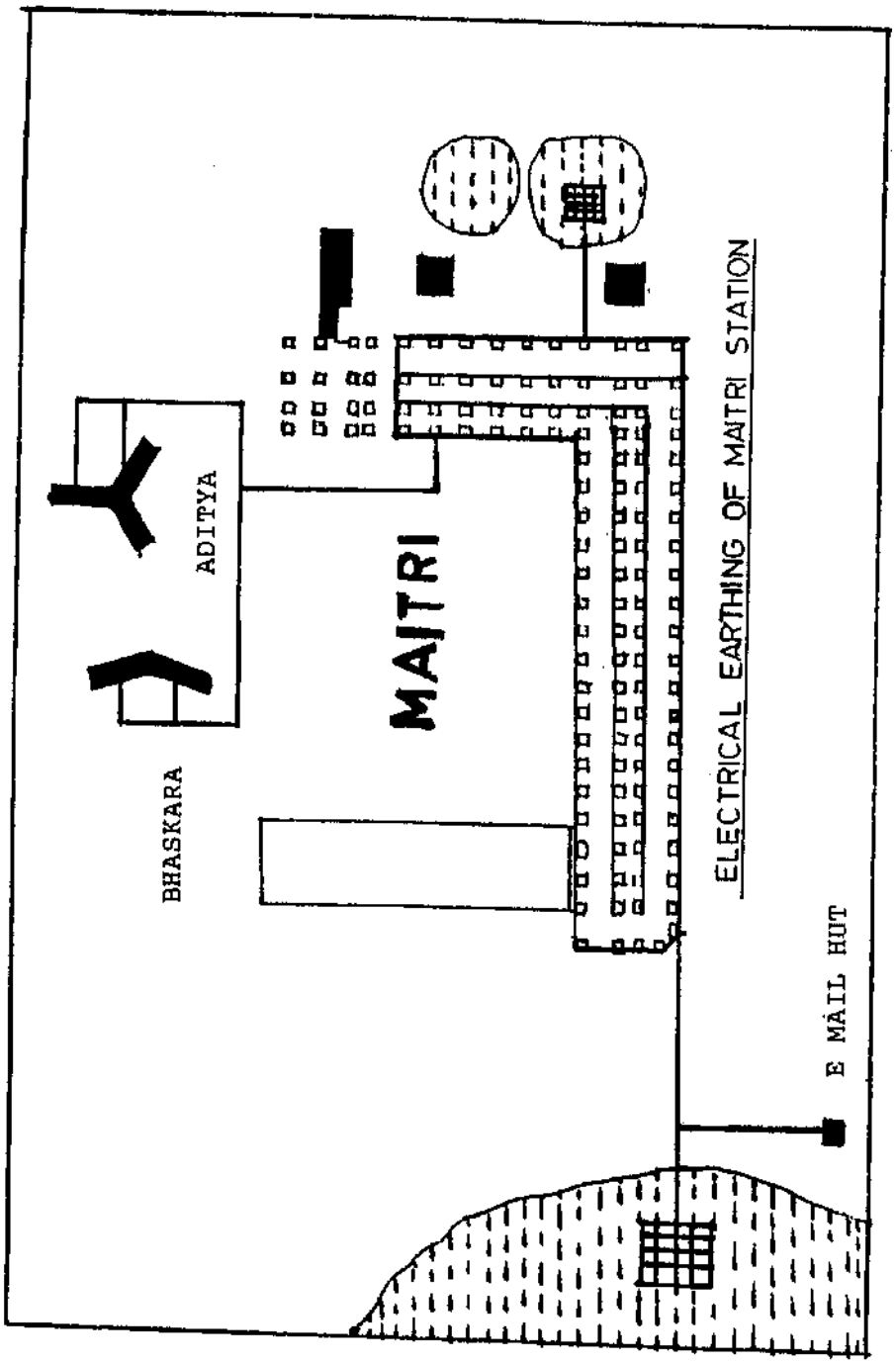

ELECTRICAL EARTHING OF MAITRI STATION
MAITRI
ADITYA
BHASKARA
E MAIL HUT

PLATE VI

near the front door of the luonge in 'B' Block and the levels of the top column plates were observed which are given at Appendix 'C and are plotted at pl. I.

9.2. It is observed that the maximum difference between the levels of the top plates of the columns is 0.04 m which is within the acceptable limits. This may be as a result of initial settlement of columns due to self weight and live loads imposed during installation.

9.3 Study on the effects of Antarctic environment on the structure and 28 m mast was carried out. The foundation columns and framework were visually checked for any defects in the members and cracks in weld joints. No defects were found in the members and no failure of the weld joints observed. Meteorological data, special features of Antarctic weather and climatic data are given at Appendix 'D, 'E, and 'F' and are plotted in plates II, III and IV.

9.4 Visual inspection of the 28 m mast could be done only upto a height of 2 to 2.5 m from the ground. It was revealed during inspection that no external damage to the mast as well as the guy ropes was noticed. However, at some places rusting of the rope had taken place. The tension in some of the wire ropes was required to be adjusted and was done as and where required.

9.5. During extreme winter, difficulty was experienced while using the toilets because of very low temperature inside the block. This was mainly due to heavy ingress of snow through the wall and roof joints and also accumulation of snow outside the rear side of the toilet block.

9.6. In spite of sealing of joints, snow ingress from joints and inlet/exhaust openings in the walls of both the bays of Aditya was noticed due to wind which requires removal of snow before starting the Generating sets. Inside temperature of the control/store room falls down drastically during extreme winter making it difficult to work. As such heating system is considered necessary.

9.7. Openings of both the air intake in Aditya complex have been reduced substantially, by cover plates from inside to prevent ingress of snow. In addition, the doors need to be closed during blizzard. Presently only one exhaust fan has been provided in each bay. All this results in insufficient ventilation. A force ventilation system for drawing fresh air intake and one more exhaust fan is felt necessary.

9.8. The wooden flooring of the main corridor creates lot of noise because it has been supported on small wooden pieces fixed to the foundation. This also does not give proper support to the flooring resulting in tilting of some of the floor panels on both the edges. Wooden grillages should be provided to fix the wooden flooring to the foundation.

9.9. Since both the'A'Block and Toilet Block are constructed on ground, heavy snow accumulation upto exhaust outlet was noticed on their rear side walls after blizzard.

10. Room Heating and Ventilation

10.1 The new radiators are small in size, as such more space is available in the living room. The performance of these is comparable with the old one and maintain comfortable temperature in the room.

10.2. Monitoring of temperatures in some of the rooms on either sides of the main block was done regularly and room/ambient temperature, wind speed and expansion tank water temperature were recorded for evaluation of insulation qualilty of the panels of the structure. It was observed that rooms on the rear side of the corridor of the main block are always cooler by 2 to 3 degree C than the front side rooms as they face direct winds. Especially in winter, the temperature difference increases upto 4 to 5 degree C. Additional heating is required for these rooms.

10.3. There is no natural ventilation in the living rooms as doors and windows have always to be kept closed. In addition, humidity level in all the rooms is very low due to lack of ventilation.

11. Power Supply

11.1. Presently total 10 Nos of 62.4 KVA generating sets are installed in 'A' block, Aditya and Bhaskara. However, all the four generating sets in 'A' block have run for more than 16,000 hours hence they have practically outlived their lives. Therefore they need replacement. Simultaneously two generating sets are run continuously, in the cycle of 96 hours for power supply to the station and life systems. The running hours of the generating sets are shown at Appendix 'G'.

11.2. Since the generating sets are commissioned in phases, the initial electrical wiring and connections have undergone number of additions/alterations. It is, therefore, essential to prepare a new layout of existing and load distribution.

11.3. Previously all the supply cables laid from the main block to summer camp were not conduited which resulted in frequent damages due to excessive rubbing against stone and ground during blizzard and high wind. On the other hand, the cables laid between main block and Girnar for E-Mail are conduited and no damage was noticed.

12. Water Supply Systems

12.1. The average daily water consumption is around 2900 to 3000 litres and is pumped from 'Priyadarshini' lake about 250 m away from the main station. The duct temperature is maintained between 8 and 15 degree C by an automatic temperature control system and no difficulty was experienced even during the extreme winter in maintaining the duct temperature.

12.2. The boilers and burners are required to run everyday. All the boilers and burners gave satisfactory performance and no repairs were required.

12.3. The lake started freezing in Feb and reached its maximum in September. The maximum ice thickness observed was around 1.85 m. The lake ice started melting in October and was over in January. A rain fall was experienced in Maitri on 01 February '96 and the temperature noted on that day was +11 degree C. In Antarctica this rain was after 25 years. The water level in the lake raised by about 300 mm due to the stream of rain water and waterflows due to melting of ice shelf on the rear side of Maitri station.

13. Environmental Engineering

13.1 The waste water from kitchen, bathrooms, etc. is processed through Klargester and the outlet is collected in two ponds. Presently out of the two Klargesters, only one is operating. During summer, foul smell was noticed in the MT area since this area is at a lower level compared to the pond area. It is also felt that there may be percolation of water from the lower pond to the 'Priyadarshini' lake.

13.2 Kitchen waste, ashes from toilet incinerator, other waste like metal/plastic cans, glass bottles and other items are stored in containers and brought back to the ship for disposal. Since there is no machine for crushing and compacting the cans and plastic bottles, the volume of the waste collected at the end of the year is huge. Therefore, there is a need of suitable arrangement for compacting these waste items.

14. Maintenance and Repairs of Maitri Station

14.1 As a part of Winter task, painting of Main station was done by the XIVth Expedition team. I associated with painting of the Lounge, MI Room and Kitchen along with other members.

14.2. Maintenance/repairs of the station were done as and when required and cracks/openings in the joints, leakages in the roof, loft and flooring developed due to high winds and vibrations as a result of blizzards were sealed with silicon sealant.

15. Maintenance and Repairs of Systems/Equipments

15.1. Repairs of generating set: The generating set No. 1 in the 'A' block became non-functional because of seizing of the crankshaft big end bearings as a result of failure of lubricating pump. The generating set was put in operation after carrying out paste grinding of the crankshaft and replacing the crankshaft bearings.

15.2. Repairs of walk-in-type deep-freezer.: One of the walk-in-type deep-freezer units (Zanotti make) used for storing frozen vegetables and food items stopped functioning. Since it was an essential support system, immediate repairs of the same was inescapable. The task of repairs was entrusted to the team of R&DE(Engrs).

15.3. The cause of the failure was investigated as mal-functioning of the 3 phase voltage stabiliser resulting in failure of the deep-freezer. Pre-installation checks were carried out on the new unit and initial running of 48 hours was done.

15.4. New unit was commissioned in place of the old one after removal of the defective stabiliser and installation of SSP (Single Phase Preventer) in the circuit, as no voltage stabiliser (3 phase) was available. The new unit was run to achieve the required temperature of -18 degree C inside the container. This working temperature was set and the auto de-frost cycle was also tested for proper functioning. The deep-freezer unit gave trouble-free performance for the remaining period of our stay.

15.5. Repairs of Washing Machine: The only washing machine in the station failed in April 95; as such, it was essential to put the machine in order. This work was also entrusted to R&DE (E) team. There were no spare parts available and repairs had to be carried out with the available resources. The drive shaft of the motor was modified, coupling discs for the drier drum was fabricated and new coupling was made. The machine gave satisfactory performance throughout the balance period of 9 to 10 months.

15.6. The pipeline carrying the waste water from kitchen to klargester was found totally blocked resulting in stoppage of disposal of waste water. This was due to failure of trace heating coil, which caused accumulation and freezing of oil, butter and other food substances in the pipe. The clogged pipeline had to be cut at both the joints and was repalced with a new one after cleaning operation of pipes and joints on either side. New trace heating coil was installed, pipe was properly insulated and put in operation. The total exercise lasted for more than six hours of continuous efforts in the thick winter of August.

15.7. Prior to handing over of the station, overhauling of one of the boilers was carried out along with the Army Engineer team of XVth Expedition to apprise them with the entire system and maintenance/repairs.

16. Other Activities

In addition to the above, I was entrusted with the duty of Quarter Master of the Station and was responsible for receipt, stock and issue of the following items:

(a) Clothing and linen

(b) Food (restricted items)

(c) General/furniture items

(d) Kitchen items

16.1. After taking over the charge of Quarter Master, the entire stores was separated categorically. Its codification was also done and new inventory was prepared incorporating computer system for the first time. Introduction of Stock/Receipt/Issue Register incorporating the above accounting system was found very useful in handling/taking over of more than 600 items to the next expedition.

16.2.I had a privilege of looking after Mandir and the religious activities which helped me in keeping high morale, congenial atmosphere, peace and harmony in the station.

Observations

17.1 Observations made during the period of expedition are as follows:

(a) When the temperature falls below subzero, even the upper layer of soil becomes very hard because of permafrost. Digging even upto a small depth in subzero temperature becomes practically impossible. Such type of work should, therefore, be taken up when the temperature is above 0 ° C.

(b) Steel for general engineering purpose has been used for construction of the Station, whereas it is facing the extreme weather conditions for the last number of years. Though no external defects/damages are noticed in the structural members, it is quite natural that the steel used must have been by now degraded due to constant fatigue load and stress developed due to very cold temperature for long duration.

(c) The life systems in the Station, viz. water supply, boiler and room heating commissioned along with the station are running continuously for the last more than 7/8 years and so far have not developed any major defect affecting the working of the Station. However, it is obvious that these systems also must have worn out due to normal wear and tear and extreme conditions.

(d) The stability of the 28 m mast depends on good condition of the wire ropes. These ropes are designed and manufactured for use at normal working conditions. However, in Antarctica, these are subjected to sub-zero temperatures and high winds over number of years and as such are prone to be fast deteriorated. It is not possible to check the hidden defects like inner breakage of strands and rusting of core by visual inspection.

(e) Levelling of the foundation columns of the main station indicates that the level difference between top of the columns is within acceptable limit and there is no settlement of the foundation.

(f) The performance of the new radiator was found satisfactory and comparable with the old one. The old radiators can be replaced with new ones.

(g) The rooms on the rear side of the corridor face cold winds and temperature in these rooms is always 2 to 3 degree C lower than the front side rooms. The difference in temperature further increases during winter.

(h) There is no natural ventilation in the living rooms as doors and windows have to be kept closed. In addition, humidity level in all the rooms is very low due to lack of ventilation.

(i) Wooden flooring of the main corridor creates lot of noise because it has been supported on small wooden pieces fixed to the foundation frame.

(j) The toilet block needs strengthening proper sealing and some additional heating arrangement,

(k) Snow ingress in both the bays of Aditya was noticed, which required removal of snow before starting the generating sets. Inside temperature of the control/store room falls down drastically during extreme winter, making it difficult to work.

(l) The generating sets in 'A' block have run more than 16,000 hrs and outlived their lives.

(m) Number of additions and alterations have been made over a period of years in the wiring of main station. A new layout drawing of the wiring is, therefore, essential to guide during maintenance and repairs.

(n) The leakage voltage between phase and earth was noticed upto 70 to 80 volts because of no proper electrical earthing to generating sets as well as main station. With the earthing now provided, it was observed that the leakage voltage has reduced to 2 to 3 volts.

(o) Structures should be constructed on columns with sufficient ground clearance for allowing drifting of snow and preventing its accumulation.

(p) Presently, space available for storage of food items on loft is very limited. Large number of food packings have to be stored in open area. Due to snow, high wind and blizzard, these packed food items get spoiled and become nonconsumable.

(q) Large quantity of stores, unserviceable clothings and old spares are lying on the left and in open area which occupies lot of space, A survey may be carried out to ascertain their serviceability, utility and decide further disposal to have more storage space and cleanliness.

18.Recommendations

Based on the above observations the following recommendations are made:

(a) The monitoring of the structure is being done visually; however, it is necessary that instrumentation be introduced to check the metallurgy of the structural members and weld joints of the entire structure to find out the hidden defects if any, and to decide the percentage of degradation. A study to check the insulating properties and strength of the wall and roof panels be also carried out. Based on the above studies, the life of the entire structure can be decided and necessary time programme for strengthening and renovation of the structures be taken up.

(b) Since the life systems are running over a number of years, it is felt necessary that a phased programme to renovate the systems be worked out to avoid any sudden failure of these systems which may affect the total functioning of the station.

(c) It is suggested that working life of the guy ropes of 20 m mast under present Antarctic conditions be assessed and action to replace these ropes be taken accordingly.

(d) The levels of the foundation columns should be observed during subsequent expeditions.

(e) Additional heating arrangement should be provided for rooms at rear side of the main block.

(f) A central humidifier and forced air ventilation should be provided to each living room for comfortable living.

(g) Wooden grillage should be provided to fix the existing wooden floor to foundation.

(h) Major repairs should be carried out in toilet block to strengthen and suitable heating arrangement be provided.

(i) Forced ventilation system for drawing fresh air intake and one more exhaust fan should be provided in Aditya. Heating arrangement should also be provided in control/store room.

(j) A new layout drawing of the wiring in main station should be prepared for proper guidance during maintenance.

(k) Individual earth point of every electrical instrument/equipment installed should be connected to the grid of the structure base columns by a copper strip/thick wire.

(l) All the power supply cables lying open should be conduited to avoid accidents and to increase their life.

(m) A survey may be carried out to ascertain the serviceability, utility and to decide further disposal of the stores lying in large quantity.

(n) Suitable arrangement for compacting the metal cans and plastic bottles should be made.

(o) Containerised accommodation for storage of food items should be provided for proper storate and to avoid wastage of food

Acknowledgements

19.1. I am really grateful to Shri M R Joshi, Director, R&DE (E) for providing me the opportunity to participate in the XIVth Antarctic Expedition. I am also indebted to Brig. S S Sharma, KC for his encouragement and guidance.

19.2.1 am thankful to Dr S D Sharma, Leader, XIVth expedition for his valuable guidance, support and help extended during the expedition. I sincerely thank Lt Cdr R Ravindran, Indian Navy, for his help in carrying out levelling of the Maitri station.

19.3.1 gratefully acknowledge the kind co-operation and assistance rendered to me, directly or indirectly, by Maj P.M Meena, Army Team Leader, Maj M.V Kumar, EME, Sqn Ldr S Anant and Surg Maj Alok Sharma, DGAFMS, Lt Vikas Dhasmana, Indian Navy, Shri K S Hosalikar & Shri P M Machnurkar, M) and all other Summer and Wintering team members.

19.4. Last but not the least, I would also like to express my sincere thanks to Dr A.E. Muthunayagam, Secretary, DOD, Shri Prabh Das, Director, DOD and all known and unknown individuals responsible for making this expedition a success.

APPENDIX 'A'
(refer para 4)

Main Data of the Snow Vehicles

S. No.	Particulars	Snow Vehicle	
		PB 170	PB 270
1	Overall length	4400 mm	4400 mm
2	Overall width	3600 mm	3860 mm
3	Overall height	2800 mm	2800 mm
4	Length of the track	4400 mm	4400 mm
5	Width of the track	1150 mm	1550 mm
6	Width of the track resting on ground	850 mm	950 mm
7	Inner gap between the tracks	800 mm	800 mm
8	Centre to centre distance between tracks	2250 mm	2330 mm
9	Ground clearance	250 mm	310 mm
10	Total weight (approx).	4550 kg	7000 kg

Main Dimensions of the Proposed Ramp

S.No.	Dimensions	In mm
1	Total length	6200
2	Total height	650
3	Total width	4000
4	Length of straight ramp	5100
5	Length of tapered ramp	1100
6	Total ground clearance	960(650+310)
7	Total weight when vehicle placed on ramp	3445
	CONSTRUCTIONAL REQUIREMENT	
1)	Load Classification MLC 20	
2)	Portable individual modules	
3)	Provision to join the modules lengthwise, by means of nut & bolt or other suitable arrangement	
4)	Provision to fix ramp assembly to the ground using steel pins or other suitable means	
5)	Provision of interlocking both the ramp assemblies to prevent relative movement	

APPENDIX 'B'
(refer para 6.6)

Wind-Chill Equivalent Temperature

Temp in °C	Wind speed in knots							
	10	20	30	40	50	60	70	80 to 100
+20	18	16	14	13	13	12	12	12
+16	14	11	09	07	07	06	06	05
+12	10	05	03	01	00	00	-01	-01
+08	05	00	-03	-05	-06	-07	-07	-08
+04	00	-05	-08	-11	-12	-13	-14	-14
00	-04	-10	-14	-17	-18	-19	-20	-21
-04	-08	-15	-20	-23	-25	-26	-27	-27
-08	-13	-21	-25	-29	-31	-32	-33	-34
.12	-17	-26	-31	-35	-37	-39	-40	-40
-16	-22	-31	-37	-41	-43	-45	-46	-47
-20	-26	-36	-43	-47	-49	-51	-52	-53
-24	-31	-42	-48	-53	-56	-58	-59	-60
-28	-35	-47	-54	-59	-62	-64	-65	-66
-32	-40	-52	-60	-65	-68	-70	-72	-73
-36	-44	-57	-65	-71	-74	-77	-78	-79
-40	-49	-63	-71	-77	-80	-83	-85	-85
-44	-53	-68	-77	-83	-87	-89	-91	-92
-48	-58	-73	-82	-89	-93	-96	-98	-99
-52	-62	-78	-88	-95	-98	-102	-104	-105
-56	-67	-84	-94	-101	-105	-109	-111	-112
-60	-71	-89	-99	-107	-112	-115	-117	-118

APPENDIX 'C'

(refer para 9.1)

Observations on Levelling of Top Column Plates

S. No.	Location	Recorded level	Difference in m
1	Bench mark	1.470	-
2	Column 1	0.800	0.670
3	2	0.798	0.672
4	3	Reading could not be taken	
5	4	0.802	0.668
6	5	0.801	0.669
7	6	0.792	0.678
8	7	0.794	0.676
9	8	0.793	0.677
10	9	0.786	0.684
11	10	0.785	0.685
12	11	0.792	0.678
13	12	0.789	0.681
14	13	0.775	0.695
15	14	0.772	0.698
16	15	0.762	0.718
17	16	0.763	0.717
18	17	0.764	0.716
19	18	0.765	0.715
20	19	0.765	0.715
21	20	0.788	0.682

APPENDIX 'D'
(refer para 9.3)

Met Data during the Year 1995

s. No.	Month	Temp (Degree)			Wind (Knots)				No. of Blizzard
		Max	Min	Avg	Max	Avg	Max gust	Above 23 days	
01	Jan	+05.0	-06.07	-00.4	35	12	45	8	-
02	Feb	+05.2	-11.60	-02.7	42	17	59	1	1
03	Mar	+00.6	-14.80	-07.2	36	15	51	15	-
04	Apr	-02.8	-13.8	-10.2	48	21	70	23	2
05	May	-03.4	-26.8	-14.2	58	23	88	23	10
06	Jun	-05.4	-27.0	-16.9	52	14	77	11	2
07	Jul	-04.2	-29.2	-15.3	61	22	90	22	3
08	Aug	-01,.0	-31.9	-18.0	50	16	68	15	-
09	Sep	-07.4	-32.6	-18.3	42	13	64	18	4
10	Oct	-00.5	-19.0	-09.7	43	20	65	26	2
11	Nov	+00.2	-13.1	-05.9	45	21	64	23	3
12	Dec	+07.3	-08.1	-00.4	40	16	62	15	-

APPENDIX 'E'
(refer para 9.3)

Special Features of Antarctic Weather of Year 1995

* Min temperature	-32.6 degree C	18 Sep
* Max -do-	+7.03 -do-	27 Dec
* Max wind (112 km/hr)	61 knots	14/15 Jul
* Max gust (166 km/hr)	90 knots	14 Jul
* No. of days wind more than 23 knots (42.6 km/hr)	210 days in year	23 days each in Apr/May
* Total No. of blizzards	-	27
* Longest blizzard	3 days	29 Apr to 01 May
* Blowing of snow	26 days	-
* Drifting of snow	38 days	-
* Snow fall	29 days	-
* Aurora	37 days	-

APPENDIX 'F'
(refer para 9.3)

Climatic Data of Antarctica during the Year 1995

S. No.	Month	Dates of				
		Snowfall	Blowing of snow	Drifting of snow	Blizzard	Aurora
1.	Jan	8	-	-	-	-
2.	Feb	14,17, 19,20, 21,22, 25 & 26			28	
3.	Mar	9,28	-	-	-	1,3,27 30,31
4.	Apr	11,12, 16,19, 20,21, 22 & 23	23,24, 25,26, 27 & 28		11 & 29	6 &27
5.	May	-	1,2,16, 17,18 & 27	23,24, 26 & 30	1,2,16 17,18,26,27, 28,30 & 31	5 & 8
6.	Jun		11	27	26&27	1,3,4 5, 22 & 30
7.	July	29 & 30	11	5,7, 8,9 10,12 &13	14,15 &16	1,17, 18,20 & 25
8.	Aug	1,20, & 31	2,12, 13 & 28	1,3,4 7,8,9, 25 & 27	-	10,14,21,22, 23,24 & 30
9.	Sep	18 & 19	2,12, 13,26 & 28	1,3,4 7,8,9 25 & 27	9,10 13 & 14	10,14, 18 & 20 22,23, &24
10.	Oct			1,2,5 6,7, 23 & 24	22 & 29	5,8 & 9
11.	Nov	17,25 & 26	11 & 12	3,4,6 & 13	1,7 &8	-
12.	Dec	-	8	-	-	-

APPENDIX 'G'
(refer para 11.1)

Data on Generating Sets at Maitri Station

S. No.	Type of generator	Date of commission	Running during XIVth Expedition	Total run
'A' Block				
1	Brushtype	02 Feb 89	903	16,621
2	-do-	01 Feb 89	1,714	16,410
3	-do-	31 Jan 89	1,930	14,012
4	-do-	01 Jan 89	1,257	13,941
ADITYA				
1	Brushless	18 Feb 93	1,803	7,188
2	-do-	-do-	1,567	7,125
3	-do-	-do-	2,739	6,431
4	-do-	-do-	2,862	5,207
BHASKARA				
1	Brushless	Jul 94	593	1,406
2	-do-	-do-	2,568	3,412

VEHICLE REPAIR WORKSHOP SHELTER

1. SPACE STRUCTURE

2. INNER ROOFING

3. OUTER ROOFING

4. SHELTER AFTER ROOFING

5. WELDING AND FILLING OF FOUNDATION

6. PITCHING OF FOUNDATION STONES

BALLOON LAUNCHING SHELTER

7. ERECTION OF FOUNDATION STRUCTURE

8. ERECTION OF FOUNDATION STRUCTURE

9. 28 M MAST