

## TECHNICAL REPORT OF THE ARMY TEAM IN 15<sup>th</sup> INDIAN ANTARCTIC EXPEDITION

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### **Introduction**

The logistics team from Indian Army in the 15<sup>th</sup> expedition encapsulates the tasks undertaken during the expedition and places them on record for ready reference. The army contingent comprised one officer each from EME and Engrs, seven other ranks from EME and three other ranks from Engrs. There was no summer component of the Army team. One NCO from EME and one from Engrs returned with the summer team on medical grounds and one NCO joined the team from EME, as a replacement.

### **Tasks**

Following logistic tasks were identified as per the guidelines given by DOD for the 15<sup>th</sup> expedition :

- (a) Completion of remaining work for balloon launching shelter required for IMD experiments.
- (b) Completion of remaining work on garage cum workshop for vehicle maintenance.
- (c) Erection of ice core drilling shelter on sledge.
- (d) Installation and commissioning of garbage and toilet incinerators.
- (e) Commissioning of four German Gensets.
- (f) Upkeep of electrical and structural aspects of the station and also the fire fighting equipments.
- (g) Proper earthing of Maitri complex.
- (h) Overhauling of cold room and reach-in type deep freezers.
- (i) Preparation of inventory of spares to facilitate logistic work.

Following maintenance tasks were also identified :

- (a) Maintenance of Maitri station structure.
- (b) Maintenance of life support systems.
- (c) Maintenance and repair of vehicles.
- (d) Transportation of fuel and stores for winter use.

The tasks of earthing and overhauling of cold room were undertaken by the R&D (E) and are included in their report.

### Training

A cold region training was carried out at Indo-Tibetan Border Police Establishment at Auli. The training was objective oriented and was a good ground for interaction between the members of the winter team.

Training was also arranged at R&D(E) pertaining to the various construction activities to be carried out. However the training was more of a theoretical nature relying on photographs and slides rather than being practical oriented. The team received no practical training on construction of any structures which were assigned as summer and winter tasks. The training at Thermax India Ltd. and on Ruston engines were educative and practical.

The EME team also underwent training at 512 Army Base workshop on the maintenance, repairs and operation of snow vehicles. Though this was a basic orientation course, it did give an insight into the mechanics and working of these vehicles.

Inspections of containerised accommodation, toilet incinerators and garbage incinerator at the private firm "HiAl tech" were more of a formality, than being of any training value since none of the installations was anywhere near completion stage during inspections.

### **Embarkation and Voyage**

A team comprising 1 JCO and 2 ORs was also left behind at New Delhi for inspection of loading and packaging of stores at Super Bazaar. At Goa, loading was organised by the Army with the help of other members of the expedition. The availability of detailed lists facilitated in loading the containers in a methodical manner and the subsequent stacking in the ship was also done as per priority of use. The effort involved paid rich dividends later providing

easy access to all the stores in the containers in the hold and there was no problem faced in handling of clothing and other essential items during voyage.

The team followed a rigorous schedule of orientation and training during the voyage. Lecture and demonstrations were carried out on various equipments on board the vessel and in Antarctica. Orientation to the newly inducted equipments and vehicles such as Mantis crane, PB-330, containerised accommodation, garbage and toilet incinerators, snow scooters and German gensets were also carried out. The army team was kept in a state of physical fitness by organising PT/yoga on the deck daily. The logistic tasks undertaken during the voyage included :

- (a) Sorting out all medical stores; emergency medical stores were identified and shifted from the hold.
- (b) Summer team rations and summer and winter clothing were distributed.
- (c) Detailed planning regarding the priority of induction of scientists and their equipments, establishment of summer camp and commencement of summer research activities was also carried out.
- (d) The day to day sorties required and the probable day to day induction schedule were also worked out in great detail. Hence the summer camp was established with two days, all 27 persons with their departmental stores were sent to the summer camp in 15 sorties.

### Summer Tasks

#### 1. Induction and execution of initial tasks

Since the priority of induction was already identified, the induction schedule was carried out smoothly. In the initial sorties, scientists and their equipments were inducted for establishing of summer camp and commencement of scientific activities. Since there was no fuel and construction stores required on priority, the team was able to concentrate on the tasks of making the newly inducted Canadian trailers, PB-330s, Mantis crane operational. Following activities were carried out on shelf and at Maitri.

#### **(a) Shelf**

- (i) Retrieval of sledges, trailers and one PB-270 buried in snow.
- (ii) Fixing of tracks on the new PB-300, carrying on a test run to DG and commissioning of new Mantis crane.

- (iii) Fixing of tracks on the two Canadian trailers. Hooks were fabricated and were welded on to the trailers with the help of the ship's mechanic.
- (iv) Shifting of oil tankers after retrieval and aligning them with new oil tankers for decanting operations to commence.
- (v) Decanting of 391 kL of fuel into fuel tankers.
- (vi) 15 containers, 2 genset containers and 4 half bins were unloaded.
- (vii) containerised accommodation commissioned and named Banjara.
- (viii) Containers were restocked and two containers were emptied.

**(b) Maitri**

- (i) Handing/taking over of all stores and equipments at Maitri.
- (ii) Training on all vehicles/equipments and introductory convoy exercises.
- (iii) Routine maintenance of life support systems including Central Heating System, Water Supply and Power generation.
- (iv) Preparation for joint convoy.

**2. Handing/taking over**

- (a) The EME personnel took over the generators and electrical supply system well in time. Some of the generators required R1 and R2 repairs and R4 repair was carried out on one generator. All the generators were in good working condition except for one in Bhaskara complex which was lying off road for some time due to lack of spares.
- (b) All vehicles were taken over before the first convoy and essential and outstanding repairs carried out as a preparatory measure for the first convoy. The two new PB-330 brought by us were now fully operational and so was the crane. All vehicles were made ready for the first convoy which was carried out from 18<sup>th</sup> Feb.
- (c) Sufficient time was available for the taking over of Central heating system, water supply and waste disposal systems, Adequate training was hence possible and the previous team creditably gave a good orientation course to the technicians. Changing of coil in the boiler room of one of the hot water generators and other routine maintenance tasks were also carried out. Sealing of pump house and ducts to prevent the ingress of snow and icy winds was also completed.

Repairs to leakages in duct and complete maintenance of duct, snow melting and hot water tanks were also carried out.

- (d) At the time of taking over the station, 25 kL of fuel was present in the station. The initial convoys were fully devoted towards the shifting of fuel to Maitri to stock up for the winter; 391 kL of fuel was brought by our team which was placed in fuel tankers at the shelf.

### **3. Joint convoy and departure of ship**

The first joint convoy was carried out from 18<sup>th</sup> Feb 96 to 23<sup>rd</sup> Feb 96 from Maitri to the ice shelf. Two vehicles, one portacabin and one dozer on sledge got stuck in a water channel and hence it took time to recover them. **Our** Russian counterparts helped whole heartedly in the retrieval of the vehicles. At the shelf, loading of containers and fuelling were carried out from 24<sup>th</sup> to 26<sup>th</sup> Feb. The convoy finally returned to Maitri on 28<sup>th</sup> Feb 96 with a load of 23 kL of fuel, 3 containers and the containerised accommodation.

The ship left for India on 27<sup>th</sup> Feb 96 after getting clearance from DOD. HMT R.K.S. Yadav who had sustained a very severe fracture to the femur at MT had to return with the ship. A nagging knee injury forced L/hev Bhal Singh also to return with the summer team.

## **Winter Tasks**

### **1. Power Generation**

Apart from the routine maintenance and operational tasks carried out during the winter, some additional tasks were also carried out inspite of the limited resources of manpower and heated working space.

- (a) Complete overhauling of 30 kVA genset and subsequently placing it next to the workshop for covering the load of workshop area.
- (b) Installation of German gensets: Two coupled 72.5 kVA generators were sent with this team without removing the unserviceable cooling systems as pointed out by the inspection team at Goa. These gensets were installed in the following manner :
  - (i) Site for installation cleared and levelled.
  - (ii) Raised platform placed to minimise deposition of snow.
  - (iii) Both containers aligned, joined and placed over the platform.

- (iv) Both gensets were serviced and started while observing winter precautions, in which it was found that one of the engine coolant was leaking from water jacket of engine block.
- (v) Both gensets were tested and commissioned. However they were found not to be ideal for undertaking permanent load of boiler room and main station since output voltage was 110 V and phase to phase voltage only 220 V and there was no common neutral available.
- (c) One 62.5 kVa genset of Bhaskara complex was made serviceable and upgraded to 75 kVA by changing the generator portion and raising the engine level to align with the drive of alternator. It was tested with load and found to be effective.
- (d) Earth leakage of a naked cable supply power to boiler room, resulted in requirement of laying temporary cable for the boiler room. An earth leakage protection for the power supply to boiler room was incorporated.
- (e) Bhaskara complex, normally shut down from May-Sept for the last two expeditions, was successfully run by this team by rectifying recurring defects of switching panels.
- (f) The no. 1 generator of A block was completely overhauled for the sixth time and made operational.
- (g) Blockage in the fuel line leading to Aditya necessitated laying of an alternate fuel line since the original was buried deep in snow and hence was inaccessible.
- (h) No. 2 genset of Aditya was overhauled and made functional. The alterations made in electrical switch over system with main station were rectified and successfully tested.
- (i) A solar assisted power generation system was installed and four lamps have been put into use.

### ***Problems Faced***

#### *Installation of German Gen Sets :*

- (a) It was found that the two German Gensets sent, were not the ones inspected by the team. While inspecting the team members had written on the control panel English translation of all the German labels of switches and monitors.
- (b) Unnecessary pipes, pumps and other cooling system which were unserviceable, were not removed as suggested by the inspection team.

- (c) One of the Generator had to be declared unserviceable as the engine block water jackets were leaking. Hence the engine portion required replacement.
- (d) These Gensets are not suitable for Boiler Room power supply because of the following reasons :
  - (i) These Gensets' output line voltage is 110 volts and phase to phase voltage is 220 volts and there is no common neutral available.
  - (ii) Boiler room pumps require 440V power supply.

## 2. Convoys :

A total of eleven major convoys, nine before winter and two after the polar nights, and five mini/route marking convoys were carried out during the wintering. The tasks executed during the convoys are enumerated below. Details of Grid references of all the barrels along the convoy route are also affixed as Appx 'A'.

- (a) 391 kL of fuel was shifted to Maitri.
- (b) 15 containers, 5 half bins and 2 genset accommodation were also shifted to Maitri.
- (c) Hauling of Mantis to Maitri: The Mantis crane was transported to Maitri in the following manner.
  - (i) The 24 tonne crane was loaded on the sledge placing it perpendicular to the length of the sledge.
  - (ii) After properly anchoring it, the sledge was towed upto barrel No. 28 by one PB-330.
  - (iii) In the final phase, two PB-330s hauled the sledge upto the station in tandem.
- (d) PB 270 Godhavri and PB 170 Brahmaputra which had broken down at shelf were also backloaded on sledges.
- (e) The complete route was mapped on the basis grid references taken at all the barrels using GPS. GPS was used for the first time in the convoys by this team and was found to be very effective especially during the blizzards.
- (f) Comn was established regularly upto barrel No. 26 and once upto barrel No. 6 by the communication team from DEAL.
- (g) Route marking of the complete route with barrels both with and without fuel were carried out and their grid references noted for updating the route map. 195 barrels, duly marked, were placed en-route.

- (h) 5 kL tanks, some full, were placed en-route to serve both as landmarks and as fuelling points during convoys. A total of 10 X 5 kL tanks were placed.
- (i) APC Topaz which was lying in a state of disuse, was backloaded to shelf partly on its own steam and partly by towing.
- (j) Ice cores from the GSI drilling site were shifted to DG for preservation till final loading onto the ship.

#### *Problems Encountered*

- (a) The area around barrel No. 18 is a huge lake which does not freeze till March. In spite of an aerial recce, the first convoy got stuck in the partially frozen lake. A detour must be taken to avoid this stretch.
- (b) The stretch from barrel No. 153 to barrel No. 169 created lots of problems for our drivers due to the steep slope.
- (c) Constant leakage of hydraulic oil/coolant and fuel from Satluj, Yamuna and Jhelum necessitated frequent halts for topping up which broke the momentum of the convoys. The tanks were beyond repair and tanks demanded were not sent with this team.
- (d) The quality of ATF was questionable since it regularly clogged the fuel pipes of the new PB-300 D, due to separation of paraffin.
- (e) Engine of Godavri seized during the fourth convoy and had to be backloaded on sledge. Similarly the PB-170 Brahmaputra also developed axle problems due to which it had to be brought back on sledge.
- (f) Rope of Mantis crane snapped when it was lifting the load of a 10 kL tank. Fortunately, no one was injured, and the rope was shortened and repaired.

Apart from these, the following vehicle tasks were undertaken in the station:

- (a) All snow scooters were made fully functional and were regularly used. This included the one brought from DG.
- (b) The two snow cats were made functional and regularly used for scientific tasks and for visits to Novo.
- (c) Bucket of PB-270 Satluj was changed and new one put.
- (d) PB-270 Jhelum placed in shelf for carrying out training of new team.
- (e) Brahmaputra which had broken down in the first convoy was fully repaired and made on road by changing the bent axle.



- (f) Repairs of brake pipe lines with FIP lines and utilising tyres of PB-170 for PB-270, replacement of eight tyres of Canadian trailer without jigs and jacks were also carried out successfully.

All members of the wintering team whole heartedly participated in the convoys and their assistance and co-operation were instrumental in completing the convoys in a record least number.

### **3. Central heating, water supply and waste disposal**

Apart from the routine maintenance tasks, the following were also carried out:

- (a) Coil of No. 2 hot water generator was changed and decarbonising of the rest done.
- (b) Heating of video room in the loft was resumed by placing a single phase pump at the entrance to A block.
- (c) A power failure alarm was installed in the lounge to warn the galley in case of power failure.
- (d) Trial radiators brought by R&D (E) were tried out but found to be ineffective.
- (e) Leakages in the duct were repaired immediately when noticed.
- (f) Pump house effectively sealed to prevent ingress of snow.
- (g) A automatic temperature controlling blower was installed in the pump house to maintain the temperature.
- (h) Two new washing machines were installed and water supply line laid for the machines.
- (i) Toilet incinerators of two toilets No. 1 and No. 5 were completely changed since they had served their useful life.
- (j) Motor of B1 Klargestester was changed.
- (k) A level indicator alarm for MEG tank was also installed to warn the technicians of sudden fall in the level of MEG in the tank.
- (l) The complete boiler room was repainted with specific colour codes and name plates for easy identification.

### **4. Construction Tasks**

Construction tasks undertaken during the expedition were:

- (a) Balloon Launching shelter.
- (b) Garbage Incinerator.

- (c) Ice core drilling shelter on sledge.
- (d) Toilet incinerator modules.
- (e) Erection of gantry and 10-T winch in workshop.

A brief description of each task undertaken is written herewith :

**(a) Balloon Launching Shelter**

Stores for the balloon launching shelter were already placed next to the pre-decided site. It was impressed upon the new team that this site was the best though there were some reservations from our side due to possibility of excessive snow accumulation. The construction was carried out as follows :

- (i) The stores which had earlier been dumped haphazardly were segregated and placed as per requirement during construction.
- (ii) The site was levelled and foundation pits dug. HF tools provided by R&D (E) were not suitable due to entry of water into the pits. The pits were dug manually.
- (iii) The foundation telescopic columns were placed and concreting carried out after checking the levels. Particular care was taken to ensure proper levelling at foundation stage and this facilitated easy erection subsequently.
- (iv) The superstructure was then constructed according to the available drawings.
- (v) Skeleton roofing of small cabin and flooring was then taken up and completed. The skeleton roof of larger room was assembled and placed next to the shelter but could not be placed due to non-availability of crane.
- (vi) Further construction work was halted due to non-availability of adequate FRP roofing materials and demand for the same placed to be procured by the new team.

**(b) Jwala Incinerator Complex**

After arrival of stores through convoy, the work on Jwala complex was taken up in the earnest.

- (i) The site was first levelled and the foundation was assembled as per the drawings supplied.
- (ii) The erection of superstructure, instalment of incinerator and roofing was then carried out,
- (iii) Visible leakage sites were sealed and electrification carried out.

- (iv) The incinerator was test fired using the burners provided for the purpose. However a series of problems cropped up both during construction stage and while testing.

During construction, adequate nos. of nuts and bolts were not supplied with the shelter and the same had to be managed from local resources. Bolts welded to the top and bottom channels were bent during transportation. While straightening these, it was found that they broke very easily. The welding of various joints were far from satisfactory and the final structure needed extensive sealing to stop leakages. Three nos. of MS plates were not placed with the stores meant for Garbage incinerator and the same were finally located with the toilet incinerator stores.

Following shortcomings were noticed while test firing the incinerators :

- (i) The grill meant for placing food waste was too high as compared to the burner flame.
- (ii) The food waste needed to be constantly churned and pushed towards the flame to hasten burning.
- (iii) Lot of smoke leakage occurred around the top loading door thereby making it impossible for anybody to stay inside the cabin while the incineration was in progress even though the exhaust fans were functional.

#### **(c) Ice Core Drilling Shelter**

The stores for ice core shelter to be constructed on sledge were shifted into the workshop and the sledge was also taken into the workshop. The task was then undertaken :

- (i) After placing the foundation timber and joining them, they were secured to the sledge by the welding angles provided for the purpose.
- (ii) The aluminium channels were then screwed to the timber and erection of panels commenced.
- (iii) The panels of large cabin were opened at the joint to facilitate erection within the workshop.
- (iv) The panels were strengthened using angles and flats provided for the purpose.
- (v) The sledge was then taken out of the workshop and the structure was completed by raising the large cabin and placing of roof panel and doors.

However the cabin could not withstand the wind thrust and was ripped off from the sledge inspite of placing it next to the workshop to minimise wind pressure. The following shortcomings were noticed :

- (i) The construction stores had been brought to Antarctica a few years back and were placed in the open due to which the panel ends were found to be splayed and the PUF had come off at the edges. This created a lot of problems while erecting the panels.
- (ii) Shortage of nuts and bolts was a common problem with most construction tasks and had to be managed from local resources.
- (iii) The excessive height of structure vis-a-vis the strength of base was a fundamental cause responsible for the failure of the structure. The aluminium channels were hardly capable of securing the panels to the foundation timber.
- (iv) The panels themselves were made with thermocol packing within the FRP panelling. This was hardly adequate to withstand the severe wind conditions of Antarctica.

(d) *Toilet Incinerators*

Both the toilet incinerators were successfully constructed and the toilets commissioned as per the details given by the manufacturer. The shelter was much more sturdier and easy to construct as compared to the garbage incinerator and there were no problems faced during its construction. However it is advisable that the electrical figments should not be done before erection as was done by the manufacturer, since they were found to be in a broken condition and the electrification had to be done all over again.

(e) *Erection of Gantry and 10-T winch*

Gantry construction and placing of the 10-T winch on foundation was undertaken in the workshop. The task required sensitive levelling and foundation details to avoid problems later. The construction was carried out in the following manner:

- (i) The pits were dug by using HF tools supplied by R&D(E) to break the concrete floor. After accurate levelling and marking, the columns were placed and concreting carried out.
- (ii) Only six columns were erected since it was seen that erection of additional columns would only reduce the working space and in no way could contribute to the efficacy of the gantry.

- (iii) As the concrete was left for curing, the foundation of 10-T winch was carried out by providing a concrete platform one feet high with the foundation bolts.
- (iv) The 10-T winch was placed after curing the foundation bolts were bolted using nuts.
- (v) The supporting gantry girders with rails were then manually lifted and placed on the columns and the distances were checked.
- (vi) The gantry was shifted to the workshop and end carriages were then bolted to the gantry girder.
- (vii) Roof of the workshop was then opened to allow the rope of the Mantis crane into the workshop and the gantry girder was then lifted and placed over the rails. Subsequently the sky light roofing was closed.
- (viii) The supporting gantry girders with rails were then welded to the columns and the columns then braced. The chain pulley block was fixed to the gantry and the whole structure was commissioned.
- (ix) The ramp was then assembled within the workshop.

Following problems were faced while erecting the gantry :

- (i) After erection of gantry, it has been found that the maximum ground clearance available was only 3 m without carrying out flooring using precast slabs. This height was expected to reduce further if the slabs were to be used and hence they were not placed on the floor.
- (ii) It is not possible to use the gantry after placing the vehicle on ramp. Hence it is advisable to dig a pit within the shelter to facilitate repairs.

(f) *Miscellaneous Tasks Undertaken*

Other logistic tasks undertaken were as follows:

- (i) Environmental clean up was undertaken on a war footing and with the co-operation of all members of the wintering team, the food dumps were shifted to a new containerised facility, where they have been segregated and methodically arranged.
- (ii) The loft was completely rearranged and junk items cleared for back loading.
- (iii) 'A' block was completely emptied of all vehicle and generator spares and the spares were shifted to the workshop.

- (iv) The MT was relocated by placing spare store, battery charging and lathe machine containers next to the workshop for easy accessibility. MT junk was segregated and loaded into containers for back loading.
- (v) The summer camp was established for the use of the 16<sup>th</sup> expedition.
- (vi) MT shed was painted to give it a new look to go with the newly cleaned vehicle parking area.
- (vii) Garbage generated during the course of the expedition was filled into the barrels and the same were backloaded.
- (viii) Electrification of the workshop was completed and the load was taken by the 30 kVA genset placed next to the workshop.
- (ix) Logistic assistance was also provided to GSI, NPL and DEAL for carrying out their scientific tasks. These included power supply during drilling and transportation backup, commissioning of Nitrogen plant and erection of antennae on concrete foundation.

### **5.Recommendations**

Following points are strongly recommended for consideration in future expeditions.

- (a) Any major construction tasks and R4 repairs to vehicles to be executed should be undertaken during the summer and a special team must be sent to carry out these activities. During the winter, Nov. and Dec. are the only months available for such activities and this also depends on the wind condition.
- (b) Inspection team for any equipments to be newly inducted must include the logistic team members of the previous expedition. They are the persons who will be able to make the best possible comments on the equipments. The new team members are not in a position to judge the effectiveness of the equipments in Antarctica. Moreover, to make the inspection more practical, it is suggested that they must be carried out well in advance so that sufficient time is available for the manufacturers to incorporate any changes.

### **Conclusions**

It has been the endeavour of the Army team to provide high quality logistic support to the 15<sup>th</sup> Indian Antarctic Expedition. A whole hearted attempt has been made to complete all the tasks assigned to the team and the credit for successful completion of most of the tasks goes to the team spirit and dedicated

hard work carried out by each and every member of the Army team. But for their untiring efforts throughout the winter, notwithstanding the extreme conditions prevailing, the outcome would have been totally different. The Army team would also like to lay on record the assistance and co-operation extended by each and every member of the expedition without whom completion of all assigned tasks would not have been possible. Our logistic counterparts from DEAL, R&D (E) and both the Doctors from ITBP and LHMC have worked shoulder to shoulder with us in all our endeavours and we are specially indebted to them for their selfless assistance. Last but not the least, the co-operation and guidance given by the Leader in carrying-out most of the logistic tasks has also gone a long way in ensuring the successful completion of the expedition.

## COORDINATES OF BARRELS ON THE CONVOY ROUTE

Barrel Number	Southing deg min sec	Easting deg min sec	Remarks
-	70 40 46	12 00 17	Dakshin Gangotri
1	70 05 16	12 00 56	
2	70 05 56	12 01 52	
3	70 06 26	12 02 31	
4	70 06 54	12 03 12	
5	70 07 09	12 03 33	
6	70 07 36	12 04 30	
...	70 08 14	12 05 26	Empty 5 kL tank
7	70 08 37	12 06 06	
8	70 09 39	12 07 39	
9	70 10 32	12 09 13	
10	70 11 31	12 10 46	
11	70 12 23	12 11 52	
12	70 13 23	12 13 04	
13	70 14 05	12 13 50	
—	70 14 33	12 14 12	Empty 5 kL tank
14	70 14 51	12 14 19	
15	70 15 45	12 15 38	
16	70 15 58	12 16 09	
17	70 17 11	12 17 43	
18	70 18 42	12 19 09	
19	70 19 11	12 19 20	Full 5 kL tank
20	70 20 68	12 19 11	
21	70 20 47	12 19 05	
22	70 21 40	12 18 51	
23	70 21 58	12 18 50	
24	70 22 43	12 18 36	
25	70 23 63	12 18 27	Empty 5 kL tank
26	70 23 44	12 17 57	
27	70 24 14	12 18 06	
28	70 24 51	12 18 25	

*Contd.*



Appendix 'A' — Contd.

Barrel Number	Southing deg min sec	Easting deg min sec	Remarks
29	70 25 29	12 18 40	
	70 25 49	12 18 55	Unmarked barrel
30	70 26 00	12 19 03	
31	70 26 07	12 19 42	Full 5kL tank
32	70 27 05	12 19 30	
33	70 27 21	12 19 34	
34	70 27 30	12 19 48	
35	70 27 57	12 19 56	
36A	70 28 42	12 20 10	
36	70 29 23	12 19 58	
37	70 29 55	12 19 42	
39	70 30 21	12 19 53	
40	70 30 56	12 20 05	
41	70 31 18	12 20 57	
42	70 31 27	12 21 10	
43	70 32 34	12 21 55	
44	70 32 27	12 22 58	
45	70 32 47	12 23 44	
46	70 33 16	12 24 28	
47	70 33 29	12 25 26	
48	70 33 46	12 26 07	
49	70 34 18	12 27 06	
50	70 34 37	12 27 35	
51	70 34 59	12 28 30	
52	70 35 14	12 29 02	
53	70 35 29	12 29 34	
54	70 35 35	12 29 34	
55	70 35 48	12 29 57	
56	70 36 38	12 31 28	
57	70 37 31	12 31 30	
58	70 37 56	12 31 30	
59	70 38 20	12 31 18	

Contd.

## Appendix 'A' — Contd.

Barrel Number	Southing deg min sec	Easting deg min sec	Remarks
60	70 38 27	12 31 23	
61	70 38 42	12 31 25	
62	70 38 55	12 31 22	
63	70 39 01	12 31 55	
64	70 39 08	12 31 57	
65	70 39 14	12 32 14	
66	70 39 48	12 32 31	
67	70 40 10	12 32 44	
68	70 41 20	12 31 40	
69	70 42 01	12 32 36	
70	70 42 01	12 32 36	
71	70 42 11	12 32 37	
72	70 42 25	12 32 43	
73	70 43 00	12 34 04	
74	70 43 00	12 34 04	
75	70 43 17	12 31 56	
76	70 43 22	12 31 38	
78	70 44 36	12 30 19	
79	70 44 36	12 30 19	
80	70 44 36	12 30 19	
81	70 44 56	12 29 50	
82	70 45 12	12 29 22	
83	70 45 27	12 28 57	
85	70 45 23	12 28 30	
86	70 45 23	12 28 30	
87	70 46 12	12 27 39	
88	70 46 20	12 27 10	
89	70 46 44	12 26 51	
90	70 46 44	12 26 51	
91	70 47 04	12 26 25	
92	70 47 25	12 25 46	
93	70 47 42	12 25 01	

Contd.

Appendix 'A' — Contd.

Barrel Number	Southing deg min sec	Easting deg min sec	Remarks
94	70 48 01	12 24 27	
95	70 48 17	12 23 56	
96	70 48 39	12 23 07	
97	70 48 48	12 22 46	
98	70 49 01	12 22 23	
99	70 49 14	12 21 49	
100	70 49 23	1221 19	
101	70 52 22	12 20 30	
102	70 49 58	12 20 08	
103	70 50 10	12 1941	
104	70 50 26	12 18 50	
105	70 50 51	12 18 36	
106	70 53 45	12 17 54	
107	70 51 09	12 17 92	
108	70 51 17	12 16 62	
109	70 51 39	12 16 06	
110	70 51 56	12 13 36	
111	70 52 14	12 1223	
112	70 52 55	12 11 09	
113	70'52 36	12 09 58	
114	70 52 44	1208 32	
115	70 52 59	12 07 00	
116	70 53 30	12 06 29	
117	70 53 08	12 05 46	
118	70 53 07	12 03 55	
119	70 53 30	12 02 56	
120	70 52 55	12 01 27	
121	70 52 46	12 00 07	
122	70 52 41	11 59 13	
123	70 52 36	11 58 30	
124	70 52 19	11 57 01	
125	70 52 51	11 55 50	

Contd.

## Appendix 'A' — Contd.

Barrel Number	Southing deg min sec	Easting deg minsec	Remarks
126	70 51 36	11 53 53	
127	70 51 23	11 52 49	
130	70 51 12	11 51 31	
132	70 51 01	11 50 54	
133	70 50 47	11 50 38	
134	70 50 30	11 49 32	
135	70 50 29	11 49 03	
137	70 51 13	11 48 20	
139	70 49 53	11 47 27	
141	70 49 36	11 46 57	
142	70 49 28	11 46 35	
143	70 49 22	11 46 19	
-	70 49 13	11 45 47	
144	70 49 00	11 45 39	
145	70 48 42	11 44 43	
146	70 48 36	11 44 20	
147	70 48 23	11 43 45	
148	70 48 11	11 43 19	
149	70 48 68	11 42 52	
150	70 47 54	11 42 36	
151	70 47 34	11 41 11	
152	70 47 36	11 40 31	
153	70 47 24	11 40 23	
154	70 47 09	11 39 39	
155	70 47 06	11 39 17	
156	70 46 50	11 28 53	
157	70 46 46	11 38 42	
158	70 46 42	11 38 29	
159	70 46 39	11 38 06	
160	70 46 30	11 37 37	
161	70 46 22	11 37 32	
162	70 46 16	11 37 37	

Contd.

**Appendix 'A' — Contd.**

Barrel Number	Southing deg min sec	Easting deg min sec	Remarks
163	70 46 13	11 37 57	
164	70 46 14	11 38 25	
165	70 46 11	11 38 59	
166	70 46 07	11 39 21	
167	70 46 10	11 39 58	
168	70 46 09	11 40 25	
169	70 46 05	11 40 59	
170	70 46 08	11 41 24	
171	70 46 07	11 41 42	