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ASSISTANCE IN THE ESTABLISHMENT OF
A PESTICIDES PRODUCTION AND FORMULATION PLANT

SI/URT/86/875

UNITED REPUBLIC OF TANZANIA

Technical report: Construction of Chemical Plants*

Prepared for the Government of the United Republic of Tanzania
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

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CONCLUSIONS

The barchart indicates that the building construction, equipment installations, pipe fabrication, erection and testing, instrumentation, electricals including painting and insulation would be completed by end of October, 1989. The trial runs would be carried out in November - December, 1989 and the plant would be offered for final acceptance by the turn of the year 1989.

The warehouse building (to be used for the storage of equipments, machinery and piping in the construction period) construction was to be started in the beginning of April 1987 and was supposed to be completed by the end of December, 1987, so as to match the delivery programme of equipments, which was to start in February 1988. The work on this building could only be started by end of December, 1987 (about 6 months delay), and is expected to be completed by end of March 1989. Though the completion is expected three months later than scheduled, yet the situation would appear to be manageable.

The construction of plant buildings was scheduled to start by 1st August, 1987 and completed by 31st Dec., 1988 and for non-plant buildings the completion was scheduled for October, 1989.

Till now, the contractors M/s. Tecnimont have not supplied the dimensional drawings of the equipment and machinery, on which the final drawings of plant buildings would be based. This information is expected to be given by contractors by the end of Dec., 1987. Though Mbaga Melvin has already started the work on detailed engineering drawings and are also taking simultaneous action for preparing the bill of quantities and tender documents, but still the construction work can not be started till the receipt of final cutout and loading details from Tecnimont. The final architectural drawings would also need the approval of factory inspectorate. If all out efforts are taken, and all the informations and approvals are received, the earliest possibility of starting the construction is Feb/March 1988. The completion would accordingly get delayed by 7-8 months

Recently M/s Tecnimont has sent the environmental impact data for all the products, their formulations and of Hcl production plant. In that data they have stated that the effluents from Hcl production plant would be water with traces of chlorine,

flow rate about $2 \text{ m}^3/\text{hour}$ and this water could be sent to sewerage system or directly into river. It is also noted that though the contractors have made provision of blowers and dampers in formulation plant but there is no proper dust extraction and collection system, which is required to control the air pollution. This consultant has doubts whether the above would be acceptable to the local pollution Board Authorities.

After studying the drawings/documents and visiting the site this consultant has proposed certain modifications in layout plinth levels, Road levels, drainage system with a view on improvement and economy. All these changes are expected to save NCI about Tshs. Seventy millions or so.

The Road levels, buildings plinth levels have been proposed in accordance with the natural contours of the area. This would reduce the cost of land development, minimise the section of storm water drains and avoid flooding the factory area, In addition this would result in saving of about Tshs. Twenty million.

The plant buildings have been reset which will help in better flow of inputs and outputs and reduce the working cost on material handling.

The area of non plant buildings and warehouse etc. has been worked out on actual requirement basis. This has resulted into reduction in covered area by 1186 m^2 thus saving of about Tshs twenty five million. There is possibility of reducing the areas of plant buildings and their heights, after receiving the sizes of equipments etc. but some changes have been recommended in the plant buildings, like provisions of cutouts for hoisting the equipments, fire escapes and modifications in the R.C.C. columns, slabs and roofs which may add to saving of about Tshs eighteen millions.

The water tank and pumping station were proposed to be underground. This required excavation of 4.25 m depth and in the presence of rock at 2 m depth, the construction would have taken much longer time. The pump house was proposed with a R.C.C. basin and a R.C.C. stair case. Both these have now been proposed to be constructed at surface level. This change would

result into a saving of Tshs seven million without effecting the process. The contractors had proposed to provide 22 Nos. of 200 mm dia intermediate valves in the underground fire fighting ducts. This consultant has proposed to delete all these valves, as these would create obstruction at the time of emergency.

The structural drawings based on the scaled up cutouts have been prepared by Mbega Melvin. This consultant has checked the drawings and given detailed recommendations keeping in view the requirement of chemical industry.

1. INTRODUCTION

The mission has been taken up by the writer as UNIDO Expert (Civil Engineer) to assist the Government of Tanzania (National Chemical Industries) in the establishment of a pesticides plant to be set up at Moshi. The writer is to share the experiences for setting up the above plant, pertaining to the field of Civil Engineering Works.

2. TERMS OF REFERENCE:

To review, in consultation with the project management (both local and contractor) and the local sub-contractor, the designs, sitegrading and drainage utilities, building and structural finishes, ventilation water supply, waste water disposal, storages, safety, fire fighting and need of works required and to submit a report of the findings and recommendations.

3. PRESENT STATUS:

3.1 Site clearing completed, area fenced and construction water supply received.

3.2 Phase I of housing scheme consisting of 4 houses for Senior Staff completed.

3.3 Basic Civil Engineering drawings, consisting of plans, sections and elevations have been received from TECHNIDONT for plant and non plant buildings:-

- General layout, giving the location of plant buildings, utility buildings, non-plant buildings and Roads etc.
- Layout showing the water supply and Fire fighting ducts, Fire fighting ducts, Fire fighting pumps station and water tank.
- Layout showing the Electrical Cables, Sewerage system, effluent waste water sewerage and storm water drains, etc.
- Gate, Administrative and Sales block, lockers showers and canteen.

3.4 Basic Civil Engineering drawings for plant building indicating the dimensions of buildings, heights of each floor and showing the equipment layout along with their weights have been supplied for the following buildings:-

- Insecticides formulation, production and packing oxychloride formulation and packing.
- Herbicides formulation, production and packing.
- Oxychloride production.
- Utilities production.
- Hcl production.

In the meeting held in April, it was recorded that the information on layout of equipments, cutouts in slabs and weight of equipments are tentative and TEM are unable to supply the above information before December, 1987. But Civil Engineering Consultants can do the work using information already supplied to date by TEM for the purpose of preparing Tender documents only.

3.5 Basic Civil Engineering Drawings have also been received for warehouse, bulk raw material stores, workshop, electrical sub-station, laboratory, waste water basin, water storage tank, discharge basin etc.

3.6 M/s Mbega Melvin, in accordance with the layout drawings received from Technimont (for the warehouse finished products and imported raw materials) have prepared the detailed Architectural and structural drawings, Bill of quantities and Tender documents, called the tenders and the construction contract has also been awarded by NCI. The site handed over to Civil Contractor on 15.9.1987 and the work started thereafter.

3.7 M/s Mbega Melvin have prepared the Architectural drawings for all the Non-plant building and structural drawings for plant buildings. These have been based on the tentative loading provided by Technimont. The size of the openings have been scaled up for the purpose

of cutouts for equipment. M/s MACE vide their letter No. 86/408 dt. 26.8.1987 have already sent two sets of these structural drawings to Tecnimont for their comments and approval.

4. From the above, it is clear that a good part of work, i.e. checking of cutouts of equipments layout and structural drawings for the plant buildings can only be done after the contractors M/s Tecnimont have supplied the final data on these matters to M/s Mbega Melvin. This may require an other assignment of about 6 to 8 weeks after December, 1987 onward when the expert can sit with structural consultants and check the design. In the present report, therefore all other aspects regarding general layout, storm water drain, water supply, sewerage system, basic designs and necessity of the buildings and their areas is being taken up along with general comments on plant buildings. The main warehouse is being dealt with in details.
5. For preparing this report, the writer has refered to drawings document and visited various places as below:-
 - 5.1 DRAWINGS:
 - i. All the equipment drawings and basic civil drawings prepared and supplied by M/S Tecnimont.
 - ii. The detailed drawing prepared by M/S Mbega Melvin.
 - 5.2 DOCUMENTS & REPORTS:
 - i. An appraisal study for NCI Pesticides Project made by M/S TISCO.
 - ii. Report and financial analysis prepared by Mr. K.Szabo, UNIDO Consultant.
 - iii. Design information for Tecnimont, prepared by M/S Mbega Melvin.
 - iv. Records notes of meeting held between TCM, NCI and MM. on 8.4.1987.

5.3 PLACES VISITED :

- i. Office of UNIDO/UNDP Dar es Salaam.
- ii. Office of NCI Dar-es-Salaam.
- iii. Design office of Mbega Malvin at Arusha.
- iv. Proposed Pesticides Project site at Moshi.
- v. Paper Mill for match factory at Moshi.

6. GENERAL LAYOUT :

6.1 The first layout was prepared by TISCO and submitted along with their report titled "AN Appraisal study for NCI". The preliminary general layout was prepared by Techimont vide identification code No. 1977 dated 25.9.1986 and finally issued for Civil Engineering development on 25.2.1987. Based on the above general layout drawing, they also prepared the water supply and fire fighting ducts, pumping station and water tank, electrical cables, sewerage system, effluent waste water sewerage, storm water drain etc. and issued these drawings for Civil Engineering developments along with the other drawings

6.2 COMMENTS :

The major aspects to be considered for preparing the layout are as under :-

- i. In the 1st instance the required area of each building is to be calculated. For instance the area of the office building is to be decided after having decided the number of employees to be accommodated therein. The area of canteen will depend, upon the maximum number of employees using it at any given time. Similarly the area of gate, change room, toilets, dispensary and other off site buildings is to be decided. The area of plant buildings is decided depending upon the size and number of equipments, working space, distance between the equipments and other factors like storage, bagging, packing stairways, hoists, fire escape etc.

The area of raw material godown, warehouse is decided on the total quantity of materials to be stored, The type of materials, the type of packing and stacking. All such calculations on which the area of individual building is based should form part of the layout drawing scheme, which in this case is not available.

- ii. The location of each plant building, raw material storage godown, finished goods warehouse should follow the process flow.
- iii. The utilities like water, chilled water, refrigeration system, gas, power, steam should be located in such a way that minimum piping, electrical cables and other duct are used, thus reducing the initial cost as well as running costs.
- iv. The non plant buildings like dispensary, canteen, general stores, Administration Block etc. should be located at a distance from the plant buildings, so that these are not effected by the corrosive atmosphere of the process or formulation plants.
- v. Utomost care is required to be taken in the layout of underground ducts like water, electrical cables, sewerage system and rain water drains etc. to avoid the crossing of waste water lines carrying acidic effluents. Because the effluent drains are designed to carry gravity flow and in case of any obstruction the flow in the ducts get filled and start seeping/leaking and damage the other lines. This type of damages are only noticed when pressure drops in other lines or there is a blast in electrical cables.

Above all, soil data report is to be refered for the purpose of underground structures like pits, water tanks, etc.

- vi. The layout as prepared by Technimont needs reconsideration on the following grounds :-

- The oxychloride production building bearing serial No.6 in the layout drawing has been located in the centre of the southern wing of plant buildings. The raw materials are to be brought from bulk storage godown located sufficiently far off. The product is then to be taken to the formulation buildings No. 5 located on its western side. The packing material is to be brought from warehouse located in North East. Lastly the packed formulated material would be transported from South West End of the plant to warehouse located at North East End. This is against the norms of good layout.
- The Hcl production plant has been located between the contour 100.00 and 101.00. The floor level proposed is 100.00. This plant has got two numbers of pits near contour 101.00. The size of one pit is 5 x 5m and this will have to be excavated up to level 96.20. The second pit having size of 7m x 7m will be excavated up to level of 96.70. From the design information report submitted by M/S M.K.C.E., gryish romb porphy was found to occur at depth of between 2.0 and 2.2 metres in all cases. In this case the rock would approximately be available at 98.50 level. Thus the excavation in these pits would involve rock cutting of 1.80m to 2.30m depth.
- Ist location otherwise also is in the heart of plot surrounded by dispensary, change room, canteen, workshop, utilities and other plant buildings. In case of even small leakage there are chances that the chlorine/Hcl gases may pollute the environment and also effect the surroundings including buildings.
- The sewers carrying the acidic effluent from this plant are crossing all other underground ducts like power cables, water main and storm water drains etc. Therefore its location needs to be changed.

6.3 RECOMENDATIONS :

The location of oxychloride production plant, oxychloride and insecticides formulation building, herbicides formulation building along with Hcl production plant will need relocation.

A fresh layout has been prepared, (Ref. Annexure I). In this drawing all the above points have been considered like, the flow of raw material inputs and finished goods and their transport to warehouse has been maintained. The Hcl plant has been located at South West end between contours of 99 and 100. Thus there will be a very small quantity of rock in excavating the pits which is clear from the data:-

AV. G.Level (Existing)	=	99.50	
FLOOR Level	=	100.00	
Depth of Rock	99.50-2.20	=	97.30
Depth of 5 x 5m Pit	=	96.20	
Depth of 7 x 7m Pit	=	96.70	

Rock depth = 0.6m to 1.1m as against 1.6m to 2.3m.

7. FORMATION LEVELS OF BUILDINGS, ROADS AND RAIN WATER DRAINS:

7.1 Building Levels:

The general layout supplied by M/S Tecnimont indicates the plinth levels of all the plant buildings including warehouse between 100.00 & 100.20. The gate office, welfare block has been proposed to be at 102.00 level and Admn block at 102.64.

M/S Mbega Melvin have retained all the levels except the gate office, which has been raised to 102.35 and the Admn. block has been brought down to 102.00 thus following the natural contour of the area.

Contd....8/-

7.2 The outer Road near entry is at a level of 102.00. Maintaining the same level up to the end of weigh bridge, they have given a gradient of 1:15 and brought down the road level to 100.00 within a distance of 35m approximately. Under instructions of Tecnimont M/s. Mbega Melvin have retained the levels of all the roads and drains as recommended by them.

7.3 STORM WATER DRAINS:

Tecnimont has proposed the pipe drains with chambers at suitable distances and at every corner or junction. Mbega Melvin have proposed open channels with a slope of 1:200. The approximate length of individual drain is 35C..

7.4 COMMENTS

If the surface level of Roads and drains is maintained at 100.00 as proposed by Tecnimont, the position would be as under:-

- i. From gate to the 1st crossing, there is a steep gradient which is dangerous for the vehicles standing inside for security check. Even otherwise the slope of 1:15 is not permissible.
- ii. There would be excavation of 1m depth for full length of the Road in front of Admn. welfare block. The area below all plant building would also need digging from 0.25m to 1.25 m.
- iii. A filling of about one metre is involved in Southern Road.

iv. The position of drains is as under:-

- Length of the individual drain	=	350 m
- Starting level of TOP of drain	=	100.00
- Internal level, with a min. depth of 0.50 m.	=	99.50
- <u>Slope 1:200:</u>		
- Internal level at out fall	=	97.75
- Depth of drain from surface of the Road level.	=	2.25m

- v. The above proposal if followed will increase the cost of cutting and filling of Road area, and will also increase the depth and cross section of storm water drains, thus increasing the cost of the drains to threefold.

7.5

RECOMMENDATIONS:

To overcome the above situation it is proposed to follow the natural contours and maintain the Road and Storm water drain levels accordingly. The levels as proposed have been mentioned on the sketch at Annexure (I). The summary is as under:-

- The Roads between warehouse and Admn. and in front of welfare block, starting from Eastern End to Western End would be laid at 101.00 level which is the natural Ground level.
- The Central Road would be at 100.20 level, matching to the existing ground levels.
- The Southern road would be 99.75 on Eastern End and 99.50 level on Western End. This would involve filling of 0.50m only.
- The change in above levels would decrease the gradient from 1:15 to 1:30 between the gate and 1st crossing. The 1:30 gradient is normal for plain area Roads.
- This would reduce the level difference between Roads and Admn Block as well as welfare block; thus reducing the cost of Ramps and Steps.
- There would be very little cutting and filling.
- The storm water drains would get the natural slope and the depth and cross section would get reduced to optimum size. Referring the above data the depth of drain would be as follows:-

- South West End level of Existing ground	=	99.00
- Depth of Drain - 0.50m		
Internal level of drain at outfall	=	98.50
- Upward rise to Eastern End near warehouse.	=	1.75
- TOP level of drain	=	100.75
- TOP level of Road at Western End	=	101.00
- Depth of drain	=	0.75

From the above it is seen that the depth of storm water drain is 0.5m to 0.75 in its whole length.

8. FLOOR LEVEL OF BUILDINGS:

8.1 With the change in Roads and Drain levels there would be no change in the floor levels of Gate, Admn. Block and Welfare block.

8.2 There will be some changes in other buildings. The level of the road on Northern side of the warehouse is 101.00 hence the floor level would be 101.20. This change would not only reduce excavation of the area, but would also facilitate the construction of platform for Rly Siding, where the ground level is 100.00. The platform is supposed to be 1m higher than the ground level.

The other plant buildings would need minor changes in floor levels, and the same have been marked over the site plan in Annexure 1.

9. BIOLOGICAL SEWERAGE SYSTEM:

Tecnimont has proposed 6 Nos of septic tanks for individual building having toilets. The treated sewage from all the septic tanks would flow into a common sewerage system to be discharged into the main storm water drain.

9.2 COMMENTS:

Septic tanks work on the basis of biological action brought about by bacteria, which convert the solid matter of sewage into liquid and gases like Hydrogen Sulphide and Carbon Dioxide. They do not digest whole of the organic matter and therefore there would be continuous smell at the discharge point and down stream of storm water drain.

9.3 RECOMMENDATIONS:

This consultant therefore proposes to provide two numbers of Septic Tanks with cess pools by grouping the buildings having toilets.

The treated effluents from these cess pools could be taken away by trucks of Municipal Council. This system is prevalent in this country. The location of these septic tanks has been marked in the layout plan at Annexure I.

10. WATER SUPPLY, FIRE FIGHTING SYSTEM AND SAFETY:

10.1 The technical proposal submitted by Technimont in July, 1984 has not one chapter on this subject. The para 6.6 of that document states that the system would have two circuits. The first circuit will consist of a elevated water tank, from where the water would flow by gravity to another tank provided for fire fighting. From the second tank, the water would be pumped to the buried hydrant main rings through a pumping station equipped with jockey pumps and two other pumps. (One electrical and the other diesel), having capacity to pump 170m^3 of water at total dynamic head of 8 kgf/cm^2 .

10.2 The basic Civil Engineering drawing No. 1997 AQDCAO2 issued by Technimont for Civil Engineering Development indicates one underground storage tank of $18\text{m} \times 9\text{m} \times 4\text{m}$ depth along with a $9\text{m} \times 7\text{m} \times 4\text{m}$ deep underground pumping station in R.C.C. and a 200 dia common buried water pipe meant for fire fighting, process water, and drinking water supply.

10.3 COMMENTS:

- I. As a rule, the Emergency water tank, meant for fire fighting must not form part of any other supply. This emergency water tank should always remain full of water.
- ii. Drawing No.7.108.00/4003 prepared by SADEMI and submitted by M/s Tecnomont alongwith technical proposal indicates 200m dia pipe alongwith 150 dia hydrant risers. This pipe line is served by 22 Nos. of 200 dia valves. Generally, the fire fighting lines are not provided with valves at each point, because in emergency nobody would be able to locate the valves hence the purpose of providing the system would be defeated.

10.4 RECOMMENDATION:

- i. In the presence of Rock it is not advisable to construct the water tank structures underground.
- ii. For the same reason the pump house having 4m depth should not be constructed underground.
- iii. By making RCC Water Tank above ground the necessity of an additional R.C.C. shell of 18 x 8 x 4 m alongwith its staircase is not required for pumping station. Only a shed of 12m x 6m x 3m height would be enough.
- iv. The excavation of both structure gets omitted. Thus saving about 4,000,000 shillings.
- v. The water tank should be constructed of 18 x 16 x 4 m or 20 x 22 x 3 m height with a central partition to keep the Emergency Water Tank independent from the process water supply.
- vi. The Wet Risers of 75 cm dia to be provided in the multistoreyed plant buildings.
- vii. CO₂ cylinder (to be fixed on all floors) in the plant buildings having flammable materials).
- viii. The process water lines should be laid separately. alongwith its plants.

- ix. The fire fighting ducts should be laid independently without intermediate valves. The size of pump should be determined accordingly.
- x. For drinking water supply, a small tank of 20 kl may be provided over the roof of any high rise buildings. The water to this tank would be supplied from the process lines. Thereafter the drinking water lines to canteen, change room, office block etc. would be independent and laid with G.i (medium) pipes. With the provision of this tank, the drinking water supply will be available, even when process water is not there due to shutdowns or failure of power etc.
- xi. Multistoreyed plant buildings need to be provided with fire escapes.

11. AREA REQUIREMENTS:

- 11.1 The appraisal study made by TISCO indicates certain areas for the buildings. Mr. Szabo while updating the financial analysis made some modifications in the area provided by TISCO and prepared the cost estimates.

TECHNIMONT also prepared the basic drawings of non-plant buildings, giving dimensions and area requirement, but in the meeting held in April, 1987 informed, that the basic drawings for non-plant building may be considered as suggestions only. The Civil Engineering Consultants M/s. Mtega Melvin, while developing the Civil Engineering drawings increased considerably the area of most of the non-plant buildings. There is no record available as to how the area of individual building has been arrived at. The statement of area as proposed by various agencies is attached at Annexure IV.

11.2 COMMENTS:

The area of each building is decided on certain principals like:-

- of the office block depending upon the number and type of employees occupying the office.
- of the canteen, after deciding from the manpower as to how many employees would be taking their food at any given time.
- of the change room, depending up on the number of Industrial Employers in each shift.
- of the lockers, up on the strength of employees.
- of the warehouse, after deciding the storage system and period for storage.
- of the plant and utility buildings, after considering the sizes height of equipments, movement, hoists, storages of shift formulation, product aging time, packing etc.

This consultant has prepared a statement (Annexure V) indicating the manpower as provided by TISCO. From the above manpower requirement another statement has been prepared (Annexure VI) which indicates the strenth of employees attending the General and other three shifts.

11.3 RECOMMENDATION:

The area requirement have been worked out after visiting few local offices, paper mill at Koshi and also the standards being followed in India.

1. GATE OFFICE :

The gate has been proposed to have the following facilities:-

- Weigh bridge, with a scale room
- Time Puncing Area
- Security, waiting and a Toilet

For the above facilities an area of 44m² has been proposed which is quiet reasonable.

11. OFFICES BLOCK:

This building would accommodate about 26 employees including General Manager, functional managers, their private secretaries, supervisory and clerical staff, toilets, reception, drawing office and coffee room etc. The details of area requirement have been worked at as under:-

- GM's office with toilet	=	25	m ²
- Managers - 5 x 15	=	75	m ²
- Supervisory and clerical staff 21 x 4.50	=	95	m ²
- Reception	=	10	m ²
- Drawing office/Record Room	=	15	m ²
- Toilets two for men and one for ladies - 3 x 4.50	=	13	m ²
- Cashier	=	8	m ²
- Coffee Room	=	5	m ²
- Cleaner	=	5	m ²
		<hr/>	
		251	m ²
		<hr/>	
Circulation Area 20%		50	m ²
Area occupied by walls 10%	=	301	
		30	m ²
		<hr/>	
Total	=	331	m ²
		<hr/>	

Based on the above requirements a sketch drawing has been prepared and is attached at Annexure VII. The area proposed for this building is 327 sq.m.

iii. WELFARE BLOCK:

The Annexure V on manpower indicates, that maximum 81 employees would be present in the general shift. The general practice in the factories is to segregate the lunch timings. The paper mill at Moshi is observing two lunch timings for shift/office and General Staff and the canteen dining hall is enough for 100 employees to take food. Their total strength is between 350-375.

Keeping in view that the lunch timings would be staggered provision of 40 seats is enough.

As a thumb rule area required for small canteens would be 2.5 m ² /person	100 m ²
Toilets etc. (Office)	15 m ²
	<hr/>
	115 m ²
	<hr/>

The area of 115 m² has been provided for canteen in the sketch drawing attached at Annexure VIII.

iv. DISPENSARY:

The proposed factory is located in the vicinity of Moshi Town, which has got the facilities of General Hospital. Therefore a dispensary to provide 1st aid and emergency treatment has been proposed, which will have the provision of a Doctors Room, injection-cum inspection room and emergency and waiting having a covered area of app. 40 m². (Ref. Annexure VIII)

v. PARTY'S CHAIRMAN AND SECY'S OFFICE:

It is understood from consultants at Arusha, that provision of office space and meeting area for about 50 persons is an obligatory requirement. An area of 72 sq.m. has been proposed for this purpose and is indicated in the welfare block sketch at Annexure VIII.

In absence of meetings this area could be used as common/Rest room or for any other welfare activities like board meeting etc.

vi. LOCKERS TOILETS AND CHANGE ROOM:

Excluding Admn and supervisory staff, the employees are nearly 90 in number. It is estimated that the ratio of male and female employees would be about 70-20, provision of locker is to be made accordingly. The male Industrial employees using toilets would not exceed 40 at any time of the day. As per factory Act (India), two Nos of Toilets and four bathrooms would be sufficient. But in view of combination of male and female industrial employees the separate provision is required to be made. Hand wash/foot wash are also required to be provided. All these facilities would need an area of 100 m², and the welfare block sketch attached at Annexure VIII indicates the same. The total area of this block is 327m².

vii. Electric Sub-Station utility production Hcl Production oxychloride production formulation and Herbicides Buildings:

The buildings have been provided with certain equipments: The basic Civil Engineering drawing sent by Tecnimont indicate only line diagram. No dimensions showing the sizes, heights and other details of equipments are available.

COMMENTS.

The areas of these buildings can only be decided after receipt of full dimensional equipment drawings, sizes and exact location of the cut outs etc. Meanwhile the dimensions and sizes of the buildings as supplied by the main contractor are being considered and recommendations made as below:

RECOMMENDATIONS:

- Provision of shafts of 3m x 3m in all floors of Copper Oxychloride Production buildings and insecticides formulation is to be made for hoisting and lowering the equipments.
- Provision of Five escapes be made in both the buildings.
- Provision of steel girders with chain pulley blocks have been made over all the heavy equipments and vessels in both the buildings. These chain pulley blocks would only be required at the time of erection or maintenance and will get corroded if left hanging over the equipments. As an alternative it is recommended to provide holes of 100 to 150 dia in the R.C.C. slabs over the heavy equipments and chain pulley blocks could be installed as and when required. The details of this arrangement have been shown in Annexure IX.
- The height of all the floors of insecticides formulation building is 7.000 m. This height will require R.C.C. framing at mid level of all the columns on all the floors. After studying the equipment drawing as supplied by Tecnimont, this Consultant is of the view, that the height of building could be reduced to 16.5 m. as against the proposed height of 21.00 m.
- All the three plant buildings have been provided with double roofing i.e. R.C.C. roof slab has been covered with C.G.I. sheet roofing. The single storeyed portion of Herbicides and Insecticides formulation buildings could only be provided with A.C. sheet roofing.
- The other roof slabs should be provided with flat terracing. This will not only save the cost, but the roof could be put to some better use.

- The provision of heavy doors have been made in all the plant buildings. These plants are supposed to work round the clock, as such the doors to all the buildings (except Electrical Sub-station) are not required. Hence recommended to be deleted.
- Because of the above reasons the wet process plant building do not require walls at ground floor, and the upper floors would need only parapet walls of one metre height.
- The deletion of walls would improve the internal environment, increase air circulation, thus resulting in better life of equipments and buildings. The above recommendations would reduce the cost of plant buildings to the extent of 12%.

viii. BULK STORAGE AND WARE HOUSE:

In the record notes of the meeting held between contractors, NCI and Mbega Melvin in August, 1986 it is recorded that the areas of both these buildings will be based on the following :-

- 1) There will be an open "warehouse" for local raw materials expected to come at site in bulk (1 month storage time).
- 2) The closed warehouse will contain imported raw materials (3 months storage time) and final products (one month storage time).
- 3) TCM will define the means to transport bulk raw materials from storage site to production units.

COMMENTS AND RECOMMENDATIONS:

While recommending the area of both the buildings contractors have not certified, that these areas are correct as per the guide lines provided to them. Tecnimont may be asked to supply the details of the calculations made for arriving at

these areas. This is important, keeping in view the escalated area requirement given by them, but in any case, the bay proposed to cover the Railway Siding and having an area of 864 m is not required to be constructed for the time being. The work on extension of warehouse could be taken up along with the construction of Railway Siding.

ix. WORKSHOP AND STORES:

The workshop consists of machine shop, electrical/instrument works, Loading/unloading area, toilets and office at first floor. The total area of building is as under:-

GROUND FLOOR	25.23 x 12.23	=	309 m ²
FIRST FLOOR	7.00 x 3.13	=	22
			<hr/>
			331 m ²
			<hr/>

The welfare block has been provided with sufficient number of toilets, the toilets in workshop are not necessary, but still for the convenience of staff working in plant, provision of two water closets and four urinals is sufficient. There is no provision of toilets in the plant area, hence it would be better if the entry to these toilets is from out side.

The space occupied by the second set of toilets could be used for "equipment pool", proposed by Tecnimont in the machine shop hall.

- The work-shop has been provided with E.O.T. crane alongwith a two tonne hoist and one full bay of 12m x 6m has been reserved for loading and unloading. This is not a fabrication shop but only a place to carry out the day to day maintenance of the plant. Hence there is no necessity of providing the hoist as well as loading/unloading area. With the deletion of EOT crane, the height of workshop building could be reduced from 6.8m to 5.50m only. The toilets slab would be at 2.4m ht. and still 3.00 mt. ht. is available

for office at first floor.

- For a small office at first floor, a U shape stair case is not required. A single flight stair with 15 risers is enough. This will, not only save the area in electrical shop but would cost only 40%.
- The loading unloading bay could either be used for electrical instrument shop and renaming the "B" area as General Stores for spares for maintenance of plant or the loading area could itself be used as General Stores after erecting a partition wall.

x. LABORATORY BUILDING:

- A single storeyed building having an area of $125m^2$ has been proposed to accommodate one lab of $12m \times 8m$, an office room for Chief Chemist and a toilet block consisting of two water closets.
- From the manpower placement chart at Annexure VI, it is clear that in general shift, there would be four persons including chief chemist and in other shifts only one. As such there seems to be no justification of providing two water closets, when toilets have already been provided in the workshop near-by.
- There is no provision of a store to keep the product samples to check their shelf life for a year or so.
- The lab is too big for facilities provided therein and considering the number of technicians working therein.
- The width of building may be reduced from $8.23m$ to $6.23m$. The lab. size would be $11 \times 6m$ which can easily accommodate the fume cabinet, working bench and other instruments provided therein. The space left would be enough for persons to work.

The space provided for toilets may be used as store for keeping the product samples for checking their shelf life etc.

12.

BUILDINGS - STRUCTURAL FINISHES; FOUNDATIONS:

12.1

BEARING CAPACITY OF SOIL.

The design information supplied by M/S Mbega Melvin to Tecnimont indicates at Para "D", that seven trial pits were dug and grayish romb prophry was found to occur at depth of between 2 and 2.2 metres in all cases. The report does not specify bearing capacity of soil/rock. This consultant, when discussed with Mbega Melvin at Arusha regarding the above, was informed that the bearing capacity of the soil in this area was generally 15m/sq.m. and they had assumed the same for designing the foundations for all building.

COMMENTS:

The above assumption is good enough for designing the minor structures and single storeyed buildings, but for plant buildings carrying heavy loads of equipment and machinery installed on all floors, the bearing capacity of the soil is required to be established before taking up the final design of these structures.

12.2

STRUCTURAL DESIGNS:

Tecnimont has supplied the basic designs and diagram of all the buildings but informed in the meeting held in the month of April 1987, that size of openings in floors may be scaled off for design, and actual sizes would be communicated to MM, when TCM received the equipment drawings which were expected by the end of December 1987. Meanwhile MM have prepared the detail drawings for most of the buildings to send these to quantity surveyors for preparing the tender documents.

12.2.1

COMMENTS:

The final structure drawings would have to be prepared after having the complete information from Tecnimont on the following:-

- The exact size of equipment, vessel including the jacket if any.
- The thickness of insulation to be provided on any of the vessel.
- positioning of lugs/legs.
- Exact weight of each and every equipment.

12.2.11.

The structural drawings prepared by Mbega Melvin for the purpose of calling tenders need to be redesigned on the following grounds:-

- The independent bases of columns have been provided with same depth throughout their width and length. The depth at edges could be reduced considerably by tapering, thus reducing the volume of concrete from 20% to 35%.

The column size of all the three plant buildings as proposed by Mbega Melvin is 400 x 400. The central columns having maximum load have been provided with re-inforcement more than 6%. Some beams also have depth more than 3 times of its width. These designs are uneconomical and will also create problems at the construction stage.

12.3

RECOMMENDATIONS.

1. The column bases to be designed economically including the central and end depths of footing. The quantity of RCC can be reduced by 30-35% if the stepped or tapered bases are made.

ii. SIZES OF BEAMS AND COLUMNS:

- The concrete covers for columns and beams shall be 40 mm beyond stirrups and binders and of slabs min. 20 mm.
- Breadth and depth of Beams - The International code of reinforcement concrete recommends a minimum depth for rectangular and tee beams to be equal to or greater than $1/12$ of span. The ratio of depth should generally be restricted to $2/3$ to $1/2$ but the very good ratio is 5 : 3.

- Reinforcement in beams:

The maximum area of reinforcement shall not exceed 4% of the total cross sectional area of rectangular beams. In doubly reinforced beams the compression reinforcement shall not exceed 4%. It is desirable that the increase in moment carrying capacity of beams by providing additional compressive steel is limited to 50%.

- Reinforcement in columns:

As per British and Indian code of practice the cross sectional area of longitudinal reinforcement shall not exceed 6% of the gross cross sectional area of any column but max. 4% steel be used in tied columns. In any column having maximum reinforcement, overlaps would be staggered.

- The above is necessary in view of that, if the reinforcement steel is crowded into a concrete member, it would be difficult to ensure sound concreting owing to the difficulty of compacting the concrete properly. Due to mass of steel pockets may form, causing lack of continuity in the member and reducing the bond or adherence between the concrete and steel.

12.4

ROOFING:

The roofing in some building has been proposed with tubular trusses and C.G.I. sheeting. The MM have proposed light tubes for trusses etc.

- Due to corrosive atmosphere it is proposed to have A.C. sheets roofing, and medium duty structural steel tubes trusses.
- The roofing of office & welfare block is projected on all sides beyond the outer walls by 1500 mm. There is no passage-way around the building. Hence these should be reduced to 900 from the centre of outer walls. This much projection is enough for shade and rain.

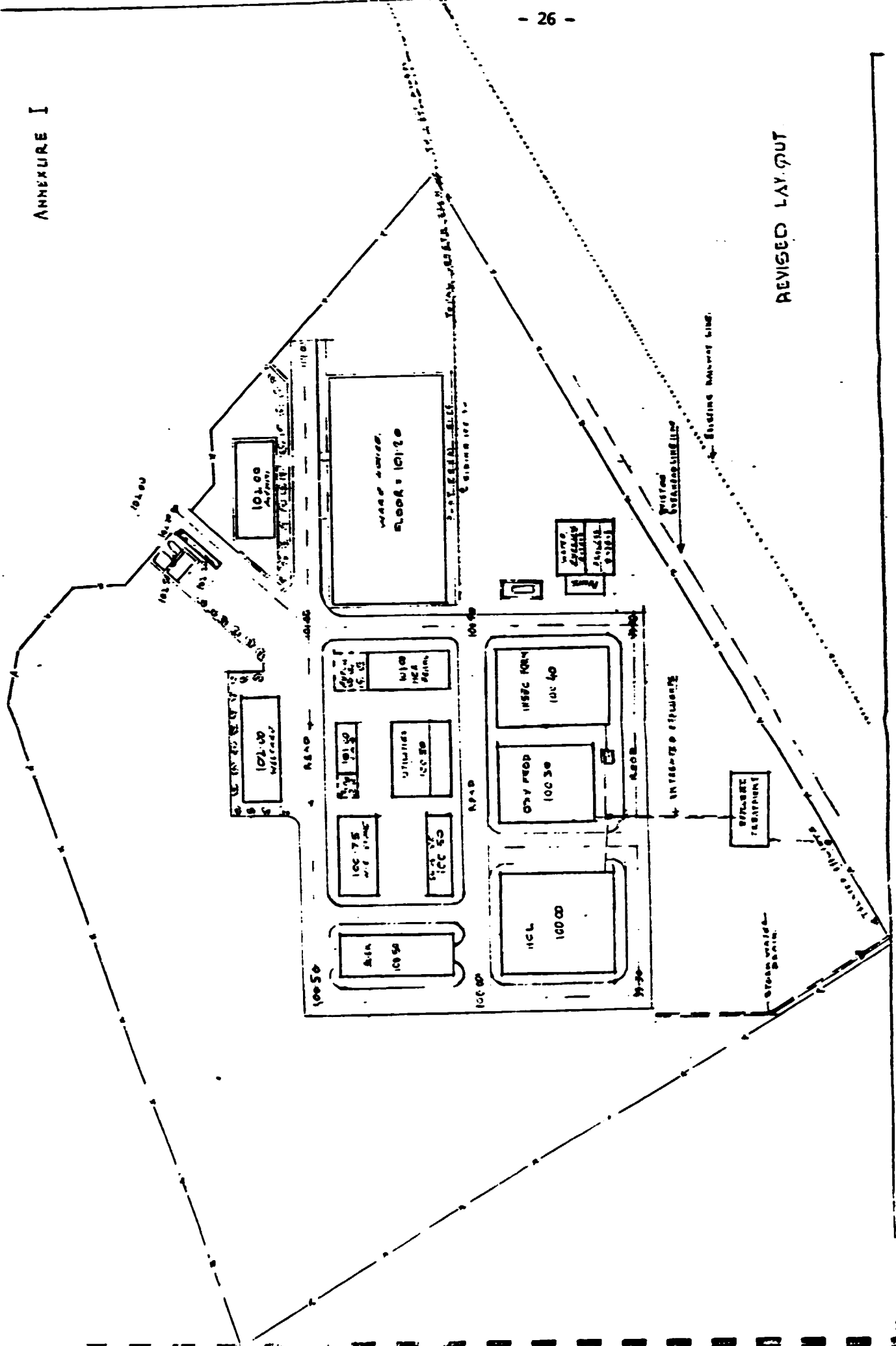
12.5

FINISHES:

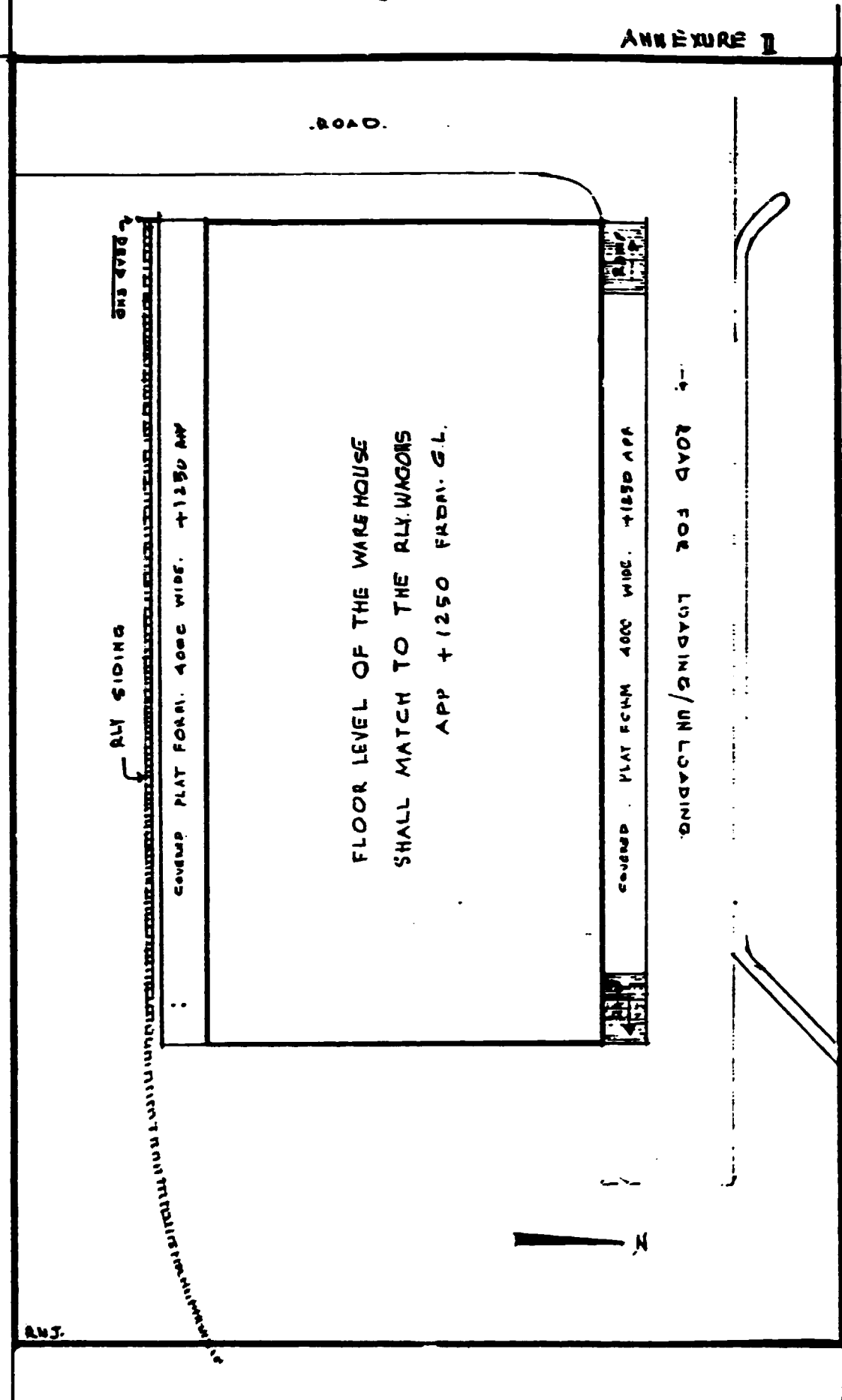
- All the R.C.C. structures of plant buildings shall be shutter finish.
- The Hcl plant building and other plant equipment and structure subjected to Hcl fumes shall be painted with Rubber Chlorinated paint 2 coats.
- All steel member in other plant buildings/non plant building shall be given a coat of Zink Chromide primer and two coats of synthetic enamel paint.
- All plant and non plant buildings like welfare block, lab, workshop, warehouses, utilities, substation and formulation buildings, production buildings etc. shall be given 3 coats of lime wash from inside and decorative cement paint from outside.

ANNEXURE I

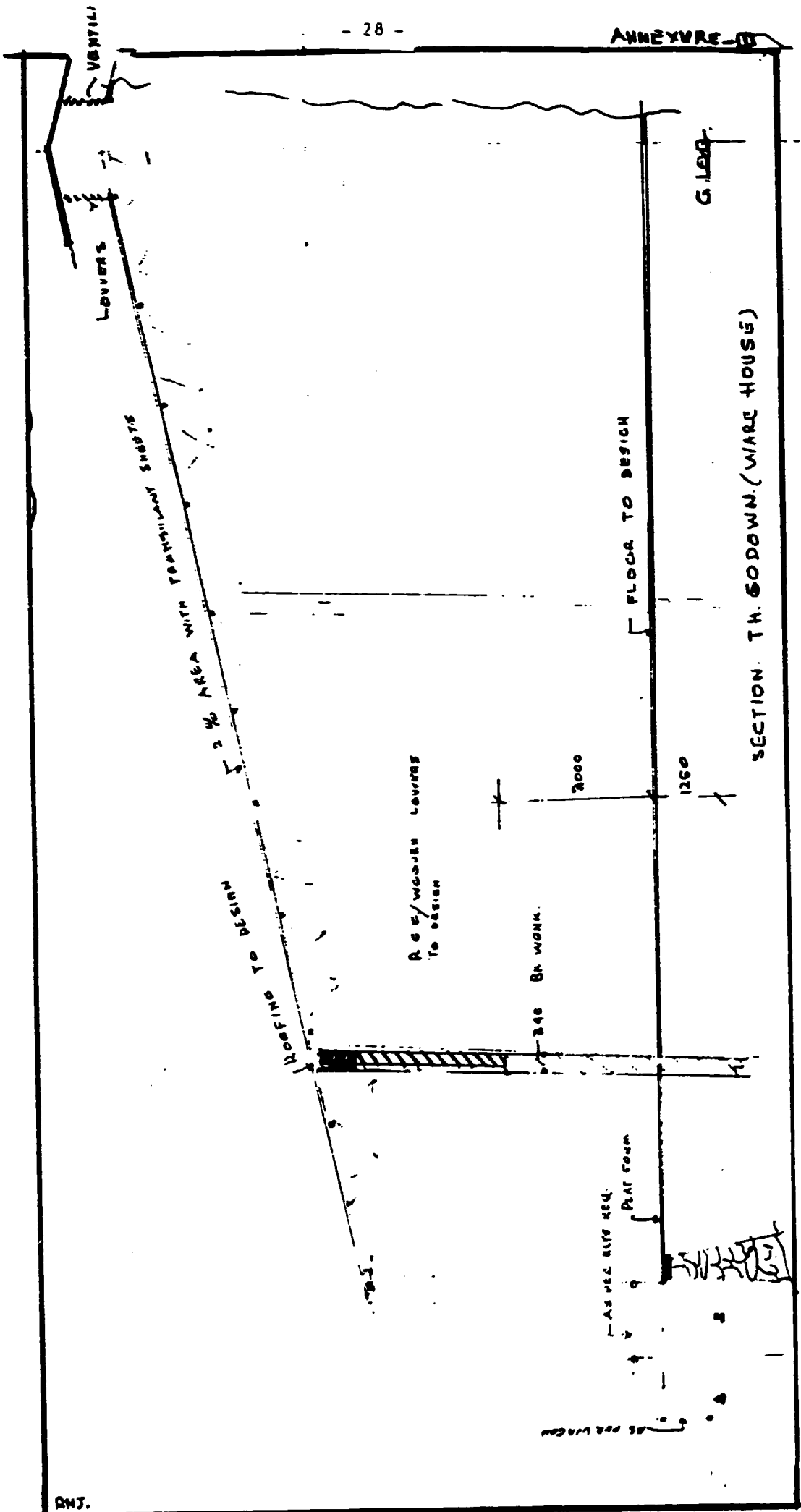
REVISED LAYOUT



ANNEXURE II



SKETCH SHOWING THE RAMPS, PLATFORM AND ALY SIDING INCLUDING WAREHOUSE LEVELS



ANJ.

BUILDING AREA REQUIREMENT STATEMENT

SNO.	Name of the Buildings	Area Proposed By TISCO	Area Proposed By TECNIMONT FINANCIAL	Area Considered By Mr. Szabo in Financial Analysis	Area By Mbega Melvin	Areas As Proposed now By This Consultant
1.	GATE	72	45	40	50	45
2.	Administration and Sales Officer Block	350	400	425	425	327
3.	Welfare Block					
	A. Canteen	240				115
	B. Dispensary	150	400	300	510	40
	C. MCE/Board	-				72
	D. Change Room	150				100
4.	Workshop	-	309	300	309	234
.	General Stores	-	-	-	-	75
6.	Laboratory	70	125	78	125	95
7.	Ware House and Bulk Store	720	3950	970	3950	3080
8.	Sub Station	-	167	12	167	167
9.	Utilities	450	445	400	445	445
10.	Copper Oxychloride production	1400	1450	1219	1450	1450
11.	Insecticides & Oxychloride Formulation	1000	1800	1704	1800	1800
12.	Herbicides Formulators	700	600	674	600	600
13.	Hcl Production	1000	1000	-	1000	1000
		6302	10691	6122	10831	9645

THIS CONSULTANT HAS RETAINED THE AREAS OF PLANT BUILDINGS AS PROPOSED BY TECNIMONT IN ABSENCE OF DIMENSIONS OF EQUIPMENTS, FINAL LAYOUTS AND CUT OUTS.

ANNEXURE. V

MANPOWER STATEMENT AS PROVIDED BY TISCO IN APPRAISAL STUDY

NO.	NAME OF OFFICE/DEPT	GM	MANAGER	Sr Sup Staff	Sup Staff	Clerks Typist	Transport Officer	Drivers	Security Guards	Nurse's Attendant	Techni- tion	US.SI's	P.S	Total
1.	GM's office	1	-	1	-	-	-	-	-	-	-	-	1	3
2.	Chief Engineers Office:	-	1	-	-	-	-	-	-	-	-	-	1	2
	a) Office	-	-	-	-	-	-	-	-	-	-	-	-	-
	b) W/shop	-	-	3	4	-	-	-	-	-	15	8	-	30
3.	Production Managers Office:	-	1	4	12	-	-	-	-	-	27	15	1	2
	a) Office	-	-	-	-	-	-	-	-	-	-	-	-	-
	b) Plant	-	-	1	-	-	14	-	-	-	3	3	2	20
	c) Lab	-	-	-	-	-	-	-	-	-	-	-	-	7
4.	Manpower & Adm Manager	-	1	1	1	3	-	-	-	-	-	2	1	9
	a) Office	-	-	1	2	-	-	-	6	-	-	-	-	9
	b) Security	-	-	-	1	-	-	8	-	-	-	-	-	9
	c) Transport Office	-	-	-	1	-	-	-	-	4	-	-	-	5
	d) Dispensary	-	-	1	-	-	-	-	-	-	-	-	-	7
5.	Finance Manager Office	-	1	1	-	4	-	-	-	-	-	-	1	7
6.	Sales & Marketing Manager:	-	1	1	1	3	-	-	-	-	-	-	1	7
	a) Officer	-	-	-	1	3	-	-	-	-	-	-	-	4
	b) Stores	-	-	-	1	3	-	-	-	-	-	-	-	4

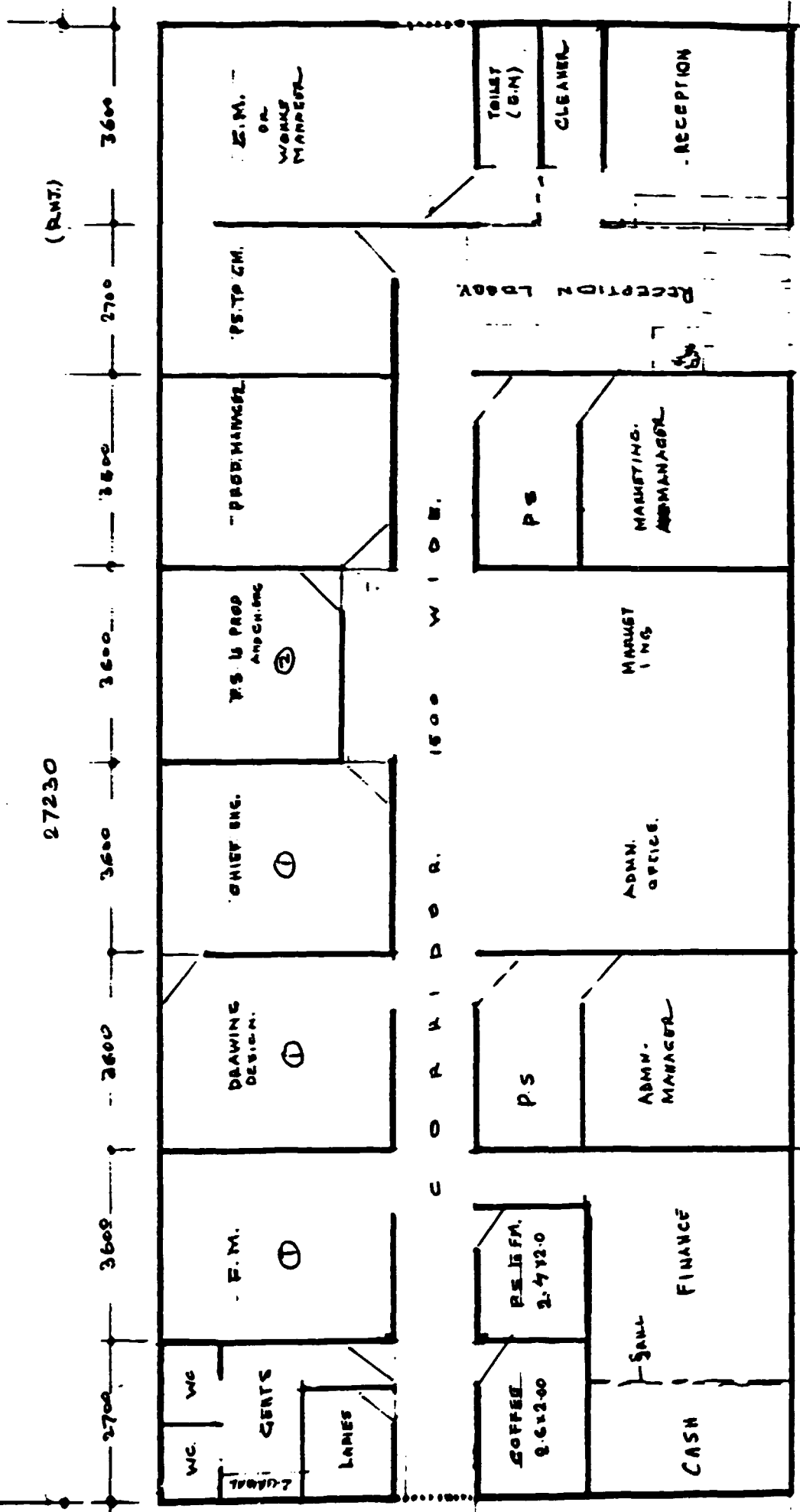
ANNEXURE VI

STATEMENT SHOWING ESTIMATED PLACEMENT OF STAFF

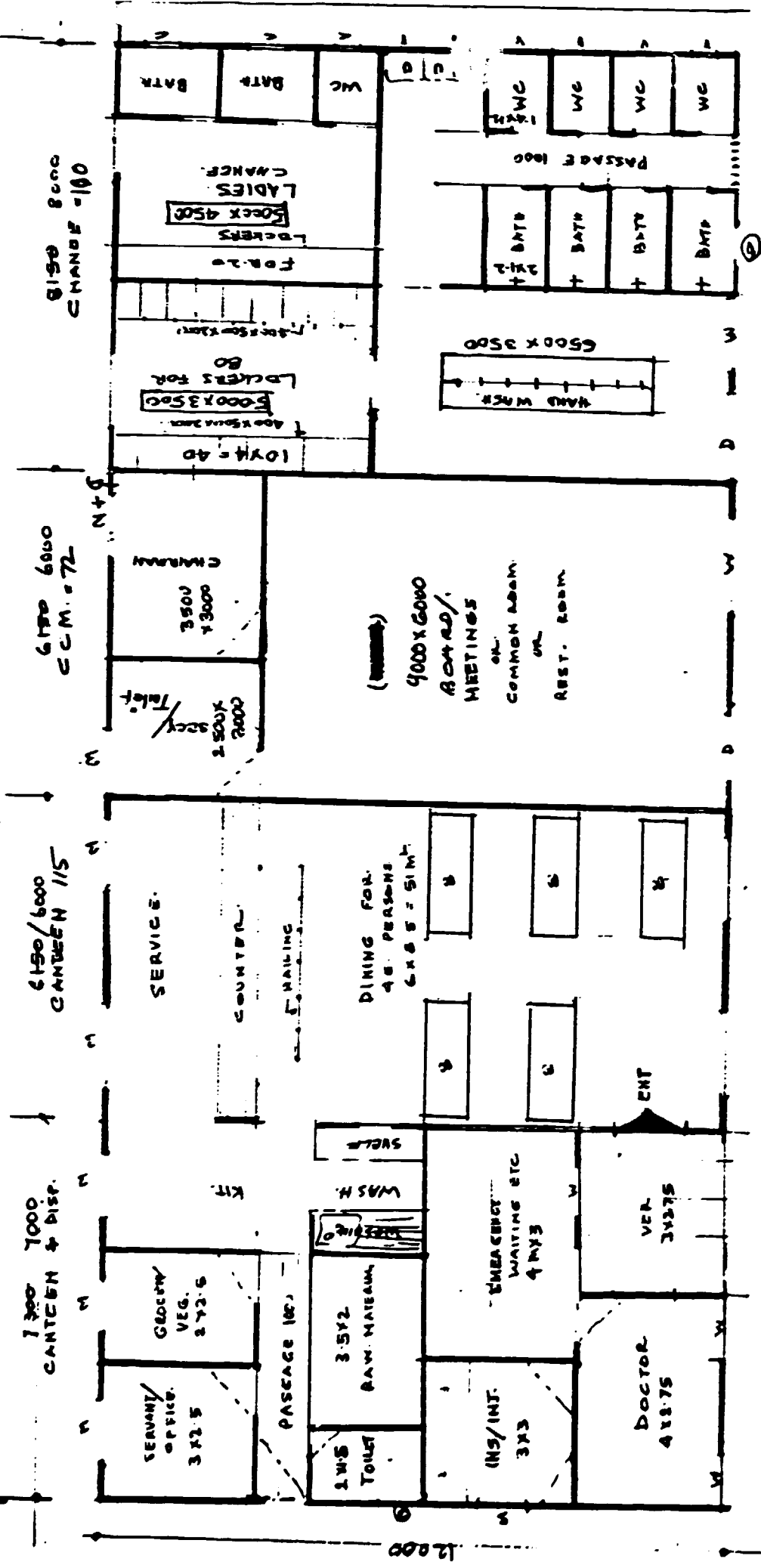
	OFFICES		STORES		WORKSHOP			PRODUCER'S Depth IN PLANT			LAB		DISPENSARY			TRAINING (OT/VIS)			ESSENTIAL CARE						
	GENERAL SHIFT	GENERAL SHIFT	I	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III			
1) GM's Office	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3		
2) Chief Engineer Deptt.	2	-	21	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	38		
3) Production Deptt.	2	-	-	-	-	13	15	15	15	-	-	-	-	-	-	-	-	-	-	-	-	-	60		
4) Lab	-	-	-	-	-	-	-	-	-	4	1	1	1	-	-	-	-	-	-	-	-	-	7		
5) a. Adm.	7(2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9		
b. Security	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9		
c. Transport	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9		
4. Medical	-	-	-	-	-	-	-	-	-	-	-	-	-	8	1	1	1	-	-	-	-	-	-	5	
6) Finance	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7		
7) a. Marketing/Sales	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7		
b. Stores	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4		
General Shift	29	4	21	-	-	13	-	-	-	4	-	-	-	2	-	-	-	-	-	5	-	1	-	81	
1st Shift	-	-	-	3	-	-	-	-	-	1	1	-	-	-	1	-	-	-	-	-	-	2	-	83	
2nd Shift	-	-	-	-	3	-	1	15	-	1	1	-	-	-	1	1	-	-	-	-	1	-	3	24	
3rd Shift	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	3	
TOTAL	31	4	21	3	3	13	15	15	15	4	1	1	1	8	1	1	1	1	1	5	1	1	2	3	158

ADMINISTRATION BLOCK AND SALES OFFICE: 27.23 X 12 - 327 M²

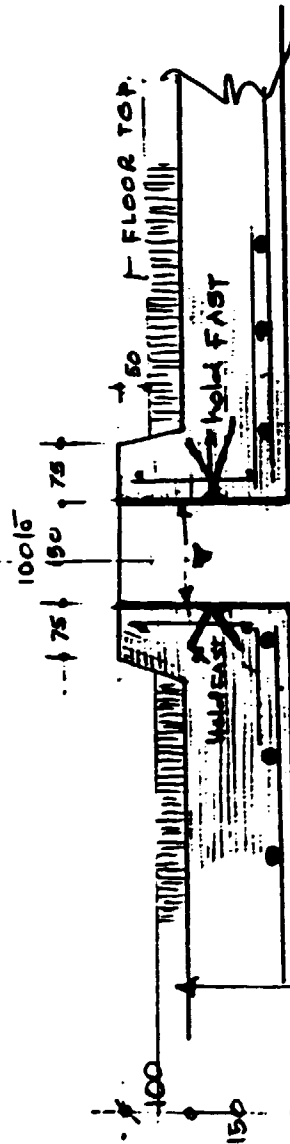
AMSTERDAM



WELFARE BLOCK. CONSISTING (DISP. 40 M², CANTEN 115, C.C.M. MEETINGS/Common 72 M² & CHANGE 100 M²)
 TOTAL = 27230 X 12 = 327 M²



100/125/150 ϕ PVC PIPE SLEEVE.



R.C.C SLAB TO DESIGN. THE SLAB TO BE DESIGNED TO TAKE CARE OF THE LOAD OF LIFTING EQUIPMENT.

125/150 DIA HOLES OVER THE HEAVY EQUIPMENTS FOR ERECTION/LIFTING.