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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

VIENNA, AUSTRIA

AND

ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

RABAT, MOROCCO

PROJECT PROFILE

ON

UNDERGROUND CABLES

FINAL REPORT

DEVELOPMENT CONSULTANTS INTERNATIONAL LIMITED

MANAGEMENT CONSULTANCY DIVISION

24-B PARK STREET, CALCUTTA 700 016, INDIA

PROJECT PROFILE
ON
UNDERGROUND CABLES

APRIL 1996

DEVELOPMENT CONSULTANTS INTERNATIONAL LIMITED
MANAGEMENT CONSULTANCY DIVISION

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DCIL-105/AC-5/1115

April 10, 1996

United Nations Industrial
Development Organization
Vienna International Centre
P.O. Box 300
A-1400 Vienna
Austria

Attn : Mr V. Koloskov

Project Profile on Underground Cables

Dear Sirs :

We take pleasure in submitting to you twenty (20) copies of our Final Report on the above subject.

We trust that you will find the present report useful and responsive to your requirement.

We look forward to further association with your organisation in future.

Thanking you,

Very truly yours :
DEVELOPMENT CONSULTANTS
INTERNATIONAL LIMITED

Siddhartha Ganguly
Project Coordinator

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LIST OF ABBREVIATIONS

CCV	Continuous catenary vulcanisation
Cmil/ft	Circuit miles/feet
EC (grade)	Electrochemical grade
EHV	Extra High Voltage
g/cm³	Gram/cubic centimeter
HD	High density
HV	High voltage
IRR	Internal Rate of Return
lb/in³	Pounds per cubic inch
lb/mil	Pounds per circuit mile
LD	Low density
MCC	Machine Control Centre
MDCV	Mitsubishi Dainichi continuous vulcanisation
mm²/m	Square meters per meter
MV	Medium voltage
RCC	Reinforced concrete construction
VCV	Vertical catenary vulcanisation

SECTION - 1
INTRODUCTION

INTRODUCTION

The Sixth Arab Industrial Development Conference held in Damascus in October 1984 stressed the importance of setting up facilities for manufacture of products used in electricity generation, transmission and distribution, as the prime priority among the Arab joint venture projects. As a follow-up measure, Arab Industrial Development and Mining Organization (AIDMO), prepared a sectoral study covering the major issues relating to status of electricity generation, growth prospects and requirement of equipment/facilities in the Arab countries upto the year 2010 AD.

Based on the findings of the sectoral study and in consultation with UNIDO, AIDMO has shortlisted 8 products for which it wants to get project profiles prepared. One of these products is **Underground Cables**. The objective of the project profile is to provide sufficient information to attract prospective promoters and sponsors in Arab and other countries to set up manufacturing facilities in the Arab region. This will result in the Arab region achieving self-sufficiency in the production of electrical equipment over a definite period of time.

The Scope of Work for the present study has been summarised in Exhibit-1. A separate market survey, according to AIDMO, was not needed for the purpose of this project profile since the information and projections as contained in the sectoral study carried out by them was considered to be adequate. Therefore, the Section on 'Market Analysis' is, to a large extent, based on the inputs extracted from the report on Sectoral study carried out by AIDMO.

The contents of this report have been organised in a manner so as to present the reader with a logical sequence of analysis and findings.

Salient features of the project have been summarised in the following Section. The next Section describes the product with a view to familiarise the reader with its features, characteristics and uses. The Section on 'Market Analysis', provides demand projections. Plant capacities and the possible locational alternatives for establishing the proposed manufacturing facilities are discussed in the next Section.

Manufacturing process is dealt with in a separate Section followed by a Section on 'Plant and Equipment'. Estimation of raw materials and inputs, requirements of utilities and, estimation of space and laycut are presented in separate sections. This is followed by a section on estimated requirement of manpower and the recommended organisation structure.

Project cost estimates, detailed financial analysis and financial evaluation are presented in the Section titled 'Financial Analysis and Evaluation'. The last Section of the Report presents a plan for implementation of the project.

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PROJECT PROFILE ON UNDERGROUND CABLES

SCOPE OF SERVICE

The Scope of the Project Profile, among others, includes the following :

- Description, special characteristics and features, and uses of the product
- Identification of major end-user industries
- Assessment of present production capacities
- Assessment of supply and demand for the product in the Arab World
- Identification of demand-supply gap and evaluation of the possibility of entering the market
- Description of basic manufacturing processes and selection of a suitable process
- Process flow chart
- Brief specification of plant and machinery, their sources and prices
- Estimated requirements of raw materials, their sources and prices
- Estimated requirements of utilities such as power, water, compressed air, fuel oil, etc.
- Estimated requirement of manpower
- Estimates of space required and plant layout
- Selection of location for the plant
- Project cost estimate

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o Project financial analysis including the following :

- Phased Capital Expenditure Plan
  Costs of Production
  Computation of Working Capital
- Statements of Inventory, Interest & Depreciation
- Tax Computation
- Projected Profit and Loss Statement
- Projected Balance Sheet
- Projected Cash Flow Statement
- Financial evaluation including
  * Break-even analysis
  * Internal rate of return
- Project implementation schedule

The study covers the Arab World consisting of the following countries:

- Algeria
- Egypt
- Jordan
- Libya
- Saudi Arabia
- Syria
- U.A.E.
- Bahrain
- Iraq
- Kuwait
- Morocco
- Sudan
- Tunisia

SECTION - 2
SUMMARY OF FINDINGS

SUMMARY OF FINDINGS

Our findings reveal that there is a large requirement of Underground Cables in the Arab region. However, only a part of this demand is suggested to be met through local manufacture because of the high technology involved. Only one manufacturing plant is recommended to be set up at Libya with a capacity to manufacture 4600 km of EHV/HV/MV cables per annum.

Summary of basic parameters and significant features of the project are presented in Exhibit-2.

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PROJECT PROFILE ON UNDERGROUND CABLES

SUMMARY OF FINDINGS

1.	Plant Location	:	Libya
2.	Plant Capacity (Km/annum)	:	EHV/HV - 600 MV - 4,000
3.	Area Requirement (SqM)	:	49,500
4.	Manpower Requirement (Nos)	:	262
5.	Project Cost ($ Million)	:	37.2
6.	Break Even Point (%)	:	45.0
7.	IRR (%)	:	50.5

SECTION - 3
PRODUCT ANALYSIS

PRODUCT ANALYSIS

The electric power in bulk is transmitted from a power generating plant to various load centres and users either by overhead lines or by underground cables. The overhead lines are extensively used for the transmission and distribution of electric power in rural areas. In urban areas, because of dense population, lack of space, safety and environmental factors and aesthetic considerations, it is a common practice to install underground cables for power transmission and distribution.

Owing to environmental limitations both the electrical and thermal requirements are more severe in the case of underground power cables than for overhead transmission lines.

ELECTRICAL PARAMETERS

Four important electrical parameters concerning underground cables are -

- Insulation
- Capacitance
- Inductance
- Skin Effect

Insulation

The underground cables, as the name implies, are buried in the ground. It is obvious that the system cannot use bare wire conductors. The conductors need insulation all along

their length for preventing direct contact between the conductors and the surrounding objects. In order to protect the conductor and the insulation from any mechanical damages, corrosion, moisture and dangerous chemical or electrochemical attack, the conductors are provided with suitable external converings.

Capacitance

A cable is usually a bundle of conductors separated by a suitable insulation. Capacitance of a cable is the function of the distance between the conductors as well as relative permitivity of insulation and its thickness. When an A.C. cable is energised, its capacitance produces a charging current which can adversely affect not only the current carrying capacity of the cable but also the voltage regulation and electrical stability of the system. Under high load conditions, the capacitance of an extensive cable network could generate considerable reactive power. Neutralisation of the above reactive power needs installation of shunt reactors at regular intervals in the cable network. Such reactive compensation for a 400 KV A.C. oil-filled cable must take place in every 24 kms. The installation of shunt reactors at 24 kms. interval can add upto 25% to the cost of cable installation.

In case of D.C. underground power transmission no steady-state charging current is generated. Therefore, these are no technical limitations on the distance of underground transmission. Consequently, D.C. power cable offers a practical solution in long distance underground transmission systems. However, the cost of conversion from A.C. to D.C. at the point of generation and subsequently from D.C. to A.C. at load centres needs careful study and analysis.

Inductance

Distances between conductors in a cable are less and this results in neutralisation of magnetic fields around them. Hence, inductance in the underground cable is not of much significance.

Skin Effect

Skin effect is an A.C. phenomenon whereby alternating current tends to flow more densely near the outer surface of a conductor than near the centre. This is caused by the fact that the magnetic flux linkages of current near the centre of the conductor are greater than the linkages of current flowing near the surface of the conductor. The net result is that the effective resistance of the cable is greater for alternating current than that of direct current. Resistance increases as the conductor size and the frequency increase. It is also a function of the relative resistance of the conductor material and is less for materials of higher resistance. Thus the skin effect for a given diameter of cable is more in case of copper than for aluminium.

THERMAL PARAMETERS

In an underground power cable, heat is generated because of the resistance of conductors and dielectric losses in the cable insulation and protective coverings. As the transmission voltages increase, the heat generated from the dielectric losses constitute a significant percentage of the total heat generated.

In case of 66 KV and 132 KV power transmission system, heat resulting from the dielectric losses is 15% and 21% of the total heat generated, while in case of 275 KV and 400 KV lines it is 40% and 55% respectively.

In an overhead transmission line heat is dissipated directly into the atmosphere by radiation and convection. Unfortunately in case of underground cable this advantage is not available. Further, insulation and covering materials in the cable and underground environments have low thermal conductivity, leading to a very poor dissipation of heat. In order to avoid carbonisation of the insulant and the converings of the cable, especially in case of higher voltages, it is necessary to deploy mechanical means for controlling cable temperature.

In the absence of any natural means for dissipation of heat, there is no other alternative but to fix the current carrying capacity of the underground cables at a lower level than that of the bare wire conductors in overhead line transmission system.

For a given capacity of power transmission, the cost of underground transmission system is more than that of overhead transmission. The underground cabling cost is more primarily because of heavier conductors and expensive insulation. Comparative costs of the two systems are presented in Exhibit-3.

Underground systems are installed mainly for primary distribution and secondary transmission upto about 132 KV. The system is seldom used in case of transmission voltages 275 KV and above.

However, because of recent developments like artificial cooling system, new type of cables like compressed gas insulated cables, cryogenic resistive cables and super conducting cables with lower capacitance and higher thermal

conductivity of the insulation, the underground systems are being introduced for EHv transmission in many of the developed countries.

CABLE CONSTRUCTION

Various types of electric cables are used for underground distribution and transmission of power. All types power cables consist of three essential components :

- o The metallic conductor which provides an electrical conducting path. Conductor with its insulation but without mechanical protection is known as the core of a cable. A core may consist of one or several wires stranded together.
- o The insulation of a cable, often called dielectric or insulant, prevents direct contact and dangerous proximity between the energized conductor and other objects.
- o The external protection preventing the ingress of moisture, mechanical damage, chemical or electrical attack, fire or any other harmful influences.

TYPES OF CABLES

All power cables can be divided into two distinct groups based on pressure within their insulation :

- o Solid-type cables in which the pressure within their insulation is not boosted above atmospheric, and may even fall below it locally.
- o Pressurized cables in which the pressure is always maintained above atmospheric, either by oil in oil-filled cables or by gas in gas pressurised cables, during all conditions of their operation.

In terms of number of cores, power cables are classified as :

- o Single Core
- o Two or Twin Core
- o Three Core
- o Four Core

Cross sections of typical cables are shown in Exhibit-4.

MATERIALS OF CONSTRUCTION

As mentioned earlier the main components of an underground power cable are :

- o Conductor
- o Insulator
- o Protective Covering

Conductor

Copper and aluminium are the main conducting materials used in power transmission. Copper used for conductors must be of very high purity, copper content being 99.9%. Similarly the aluminium should be of E.C. grade with aluminium content being 99.45%.

The physical and electrical properties of the conducting materials are shown in Exhibit-5.

The conductor may be in the form of a single wire or a group of stranded wires. The stranded conductors are employed to increase the flexibility of the cable. In multi-layer conductors alternate lays are stranded in opposite directions. This form of construction gives tightness as well as a smooth outmost surface to the cable.

In calculating the resistance of the stranded conductors, allowance must be made for the fact that apart from the central strand of wires, the outer wires follow helical path and are slightly longer than the axial length of the cable. The distance measured along the central axis corresponding to one complete convolution of the individual strand is called the lay. The length of lay in a stranded wire is expressed as a ratio of the length of the helix and its pitch diameter which varies usually from 14 to 20 for medium size cables.

As compared with a conductor of equal dimensions but composed of straight wires parallel with the axis, the stranded conductor is slightly heavier. It has more electrical resistance and internal inductance, but less tensile strength.

Insulation

Insulation in an underground cable must have the following characteristics to ensure safer and proper transmission of power :

- High dielectric strength
- High insulating resistance
- Sufficiently low thermal resistivity
- Reasonably low relative permitivity
- Non-hygroscopic
- Immunity to chemical attacks over a fairly wide range of temperatures

- Easy handling from the point of view of manufacturing
- Durability and long life
- Lowest possible cost, consistent with the above requirements

The materials for insulation of modern power cables can be broadly classified as follows :

- Impregnated paper
- Synthetic dielectrics
- Compressed gases

Impregnated Paper

For many years, the preferred choice of dielectric for any voltage range was impregnated paper, protected from the ingress of moisture by metallic sheaths. Despite the fact that medium voltage and high voltage power cables with impregnated paper insulation have a good service record, cables using synthetic dielectrics are steadily replacing the former.

Synthetic Dielectric

At the present time there are many synthetic and plastic insulants employed in manufacturing of power cables. The most commonly used synthetic dielectrics are as follows :

- Polyvinyl-chloride (pvc)
- Polyethylene (pe)
- Cross-linked polyethylene (xlpe)
- Ethylene propylene rupper (epr)

The thermal and electrical properties of the impregnated paper and some of the synthetic dielectrics are given in Exhibit-6. Insulation thickness of the synthetic dielectrics for various cable sizes are given in Exhibit-7.

Compressed Gases

Sulphur hexaflouride, Freon and Nitrogen are known to have good insulating properties and are mostly used in compressed-gas-insulated underground power cables.

Sulphur Hexaflouride Gas : Sulphur hexaflouride is an excellent high voltage cable insulant because of its following characteristics.

- Di-electric strength - Sulphur hexaflouride has a dielectric strength more than twice that of air at normal pressure. It's dielectric strength increases rapidly with pressure and at a pressure of 3 bar (absolute) is equivalent to that of high grade insulating mineral oil.
- Heat transfer co-efficient - The heat transfer co-efficient is roughly 2.5 times better than air under same conditions.
- Non-inflamable
- Non-toxic
- Inert and stable - The gas does not decompose even if it is heated to 500°C in a quartz vessel.
- Contains no carbon which rules out subsequent insulation break-down.

However, it is an expensive gas and thus has to be filtered and re-used.

Freon Gas : The main characteristics of this chlorofluoro carbon gas are :

- high dielectric strength at relatively low pressure
- good heat transfer co-efficient
- possibility for carbon dissociation

Because of the last named characteristic it yields a certain amount of extricated carbon. A similar phenomenon may occur with faint discharges such as corona pulses. Although Freon is less expensive than sulphur hexaflouride, it does not find wide application as a cable dielectric.

Nitrogen : Nitrogen is an inert gas and is normally used in E.H.V. gas pressurised cable system to supress the effect of cable ionisation. It can also be used in compressed gas insulating line as an insulating gas.

The choice of gas is usually between nitrogen and sulphur hexaflouride and, depends on the electrical stress which control the overall dia of the system and its cost.

Protective Coverings

The protective coverings for an underground cable consists of conductor screening, insulation screening and finally armouring of the cable.

Conductor Screening

Stranding of the conductor can increase the maximum electrical stress by about 20%. To alleviate this affect all paper insulated cables with a rating of 5 KV and above are

manufactured with conductor screens in the form of semi-conducting carbon paper tape, lapped over the stranded conductor. For synthetic or polymer insulated power cables of the same rating, conductor screens are employed to preclude excessive electrical stress in voids between the conductor and the insulation.

Insulation Screening

An insulation screen has a number of functions to perform as given below :

- To confine the electric field within the cable
- To obtain strictly symmetrical radial distribution of electrical stress within the dielectric, thereby minimising the possibility of surface discharges by precluding tangential and longitudinal stress
- To reduce the hazard of shock
- To protect the cable connected to overhead lines subject to induced potential
- To limit radio interferance

The most commonly used screens are extruded aluminium. The main advantages of aluminium sheathed cables are as follows :

- 30-60% saving in weight in comparison to lead sheathed cables.
- Greater tensile strength and creep resistance, good vibration withstanding ability without cracking and fatigue.

- Improved mechanical properties thus eliminating the need of armouring.
- Considerable saving in cost.

Armouring

The armour protects power cables against mechanical damage and stresses. As mentioned earlier, cables with aluminium sheath generally do not require any armouring owing to the considerable mechanical strength of aluminium.

The majority of multicore power cables are mechanically protected by their armour which consist of one of the following :

- Two steel tapes applied in an open helix over a bedding in such a way that the second tape covers the gap left by the first.
- Galvanised steel wires applied over the bedding of the cable in one or two layers.
- Aluminium wires and strips used on synthetic insulated cables where there is a need to provide low resistance paths for earth-fault currents.

PRESSURISED HIGH VOLTAGE CABLES

The cables used in high voltage (HV) and extra high voltage (EHV) transmission require insulation of higher electrical strength than required for cables used for medium and low voltages. It is noted that cables impregnated with viscous compounds used for HV and EHV transmission are likely to form voids in their insulation because of higher temperature and electrical and mechanical stresses. The voids in the

insulation thus formed can create excessive ionisation of the gases in them and thereby cause deterioration of the insulation and ultimate cable failure.

To avoid the occurrence of contraction voids, the excess compound resulting from cable heating should be forced back into the insulation by the application of pressure to the compound either directly or indirectly during the cable cooling period. The alternative method of inhibiting these voids is to allow the voids to occur but render them innocuous by filling them with high pressure gas usually Nitrogen.

Nearly all commercial EHV cables are pressure assisted in one way or other. The advantages of these with respect to non-pressurised one are :

- The allowable stresses are much higher resulting in a considerable reduction in dimension and weight of cables for high voltage application.
- Increase in current rating due to higher allowable conductor operating temperatures.

The classification of pressurised cables is shown in Exhibit-8.

There are three main types of oil filled cables, viz. circular and flat type oil filled cables, both of which are self contained and pipeline cables in which cores are in steel pipes. Similarly three types of cables using gas for achieving pressurisation - compressed cables, impregnated cables and gas filled cables.

SELECTION OF CABLE

For many years the preferred choice of cable insulant for any voltage range was impregnated paper protected from the ingress of moisture by metallic sheaths. Despite the fact that the oil impregnated paper insulated cable (solid/pressurised) have good thermal and electrical characteristics, these are being gradually replaced by cables having non-hygroscopic synthetic insulation due to the following reasons :

- o Non-hygroscopic synthetic insulation eliminates the use of heavy and costly metallic sheaths.
- o The simplification of cable jointing and terminating as well as repair work, coupled with the saving in the cost of labour.
- o Complete freedom from compound drainage trouble specially in cable termination.

As can be seen from Exhibit-6, epr and xlpe have superior thermal and electrical characteristics to that of oil impregnated paper insulation. As such these two insulants are the serious contender to the well proven oil impregnated paper insulant.

Epr and xlpe insulants have similar thermal ratings, the latter has got superior electrical properties, in having lower tangent of dielectric loss angle coupled with lower thermal resistivity.

These properties have marked influence on the current rating of the cable e.g. at 132 KV, the current rating of an xlpe cable is 5% greater than that of an equivalent epr cable. The difference is even greater at 275 KV, where it increases to 13%.

The above facts coupled with purer insulant and higher impulse strength of xlpe compared with epr, substantiate that today xlpe does not have a rival at high voltages.

The construction of a typical xlpe insulated cable is given in Exhibit-9.

JOB NO. : DCIL-105 EXHIBIT : 3

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PROJECT PROFILE ON UNDERGROUND CABLES

COMPARISON IN COSTS OF UNDERGROUND CABLES AND OVERHEAD LINES

Voltage in KV (British Standard)	Ratio = Cost of Underground Cable / Cost of Overhead Line
400	18 (23 for heavy duty)
275	13 (17 for heavy duty)
132	8
66	7
33	5
11	3
0.42	2 or less

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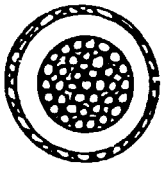
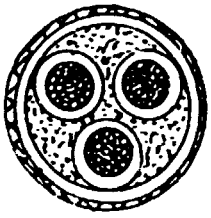
PROJECT PROFILE ON UNDERGROUND CABLES

CROSS SECTION OF TYPICAL CABLES



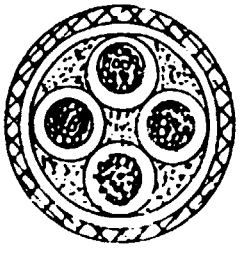
SINGLE CONDUCTOR

TWO CONDUCTOR-DUPLEX

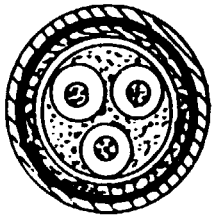


THREE CONDUCTOR-ROUND

THREE CONDUCTOR-SEGMENTAL



FOUR CONDUCTOR-ROUND



THREE CONDUCTOR-PARKWAY

LEAD SHEATH

BRAID OR JUTE SHEATH

JUTE FILLER

COPPER CONDUCTORS

PAPER VARNISHED CAMBRIC OR RUBBER INSULATION

JOB NO. : DCIL-105 EXHIBIT : 5

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PROJECT PROFILE ON UNDERGROUND CABLES

PHYSICAL AND ELECTRICAL PROPERTIES OF CONDUCTING MATERIALS

	Conductivity % IACS, min	Resistivity				Temp. Coefficient of Resistance/°C		Weight at 20°C			Coefficient of linear Expansion	Modulus of Elasticity
	%	Ω/mil/ft		Ω mm²/m								
	0°C	20°C	25°C	20°C	25°C	20°C	25°C	g/cm³	lb/in³	lb/mcmil	per °C	kg/mm²
Commercial 1350 aluminium wire	61.0	17.302	17.345	0.028264	0.028834	0.00401	0.00395	2.703	0.09765	920.3	0.000023	7030
Aluminium alloy wire 6201	52.5	19.754	20.097	0.032840	0.033373	0.00347	0.00340	2.703	0.09765	920.3	0.000023	7030
Commercial hard drawn copper wire	97.0	10.692	10.895	0.017774	0.018113	0.00381	0.00374	8.89	0.32	3027.0	0.0000169	11950
Standard annealed copper wire	100.0	10.371	10.575	0.017241	0.017579	0.00393	0.00385	8.89	0.321	3027.0	0.0000169	11950
Aluminium coated steel core wire	9.0*	115.23*	-	0.19157*	-	-	-	7.78	0.281	2649.0	0.0000115	20400
Zinc coated steel core wire	9.0*	115.23*	-	0.19157*	-	-	-	7.78	0.281	2649.0	0.0000115	20400
Aluminium clad steel core wire	20.33	51.01	51.52	0.0848	0.08563	0.0036	0.00356	6.59	0.238	2243.0	0.0000130	16500

Note: * Typical
IACS International Annealed Copper Standard

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JOB NO. : DCIL-105

EXHIBIT : 6

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PROJECT PROFILE ON UNDERGROUND CABLES

THERMAL AND ELECTRICAL PROPERTIES OF SYNTHETIC DIELECTRICS AND IMPREGNATED PAPER

Sl. No.	Property	Insulant				
		PVC	PE	XLPE	EPR	Impregnated Paper
1.	Density (kg/m^3)	1400	900	900	1200	1250
2.	Thermal resistivity ($°C\ mw^{-1}$)	6.0	3.0 (HD) 3.5 (LD)	3.5	5.0	5.0-6.0
3.	Relative Permittivity	8.00	2.30	2.50	3.30	3.50
4.	Tangent of dielectric loss angle ($x10^{-3}$)	100.10	4.19	4.10	4.10	2.10
5.	Max. temperature for continuous operation (°C)	70	80 (HD) 70 (LD)	90	90	65-80
6.	Max. temperature for short circuit operation (°C)	150-160	160 (HD) 120 (LD)	250	250	160-250

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PROJECT PROFILE ON UNDERGROUND CABLES

INSULATION THICKNESS OF SYNTHETIC DIELECTRICS

Sl. No.	Rated Voltage (KV)	Range of Conductors (mm^2)	Insulation thickness in mm			
			PVC	PE	XLPE	EPR
1.	6/10	16 - 1000	4.0	3.4	3.4	3.4
2.	8.7/15	25 - 1000	5.2	4.5	4.5	4.5
3.	12/20	35 - 1000	6.4	5.5	5.5	5.5
4.	18/30	50 - 1000	-	8.0	8.0	8.0

JOB NO. : DCIL-105 EXHIBIT : 8

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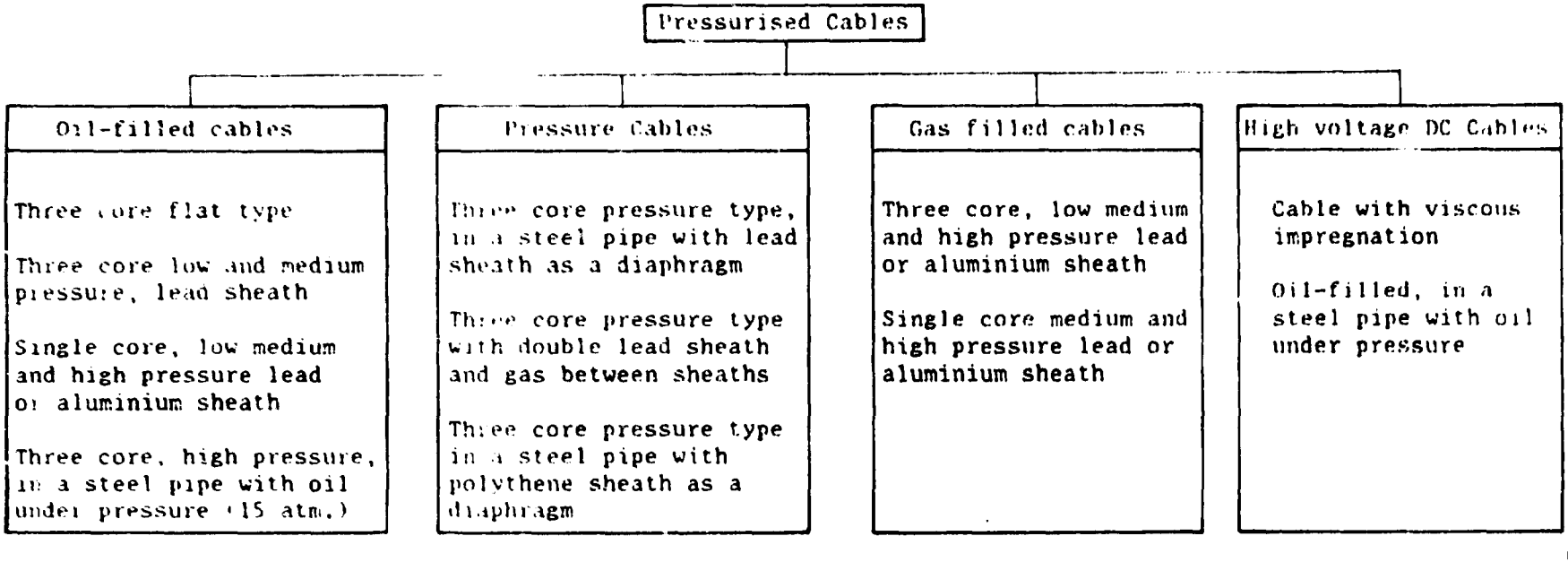
PROJECT PROFILE ON UNDERGROUND CABLES

CLASSIFICATION OF PRESSURISED CABLES



DEVELOPMENT CONSULTANTS

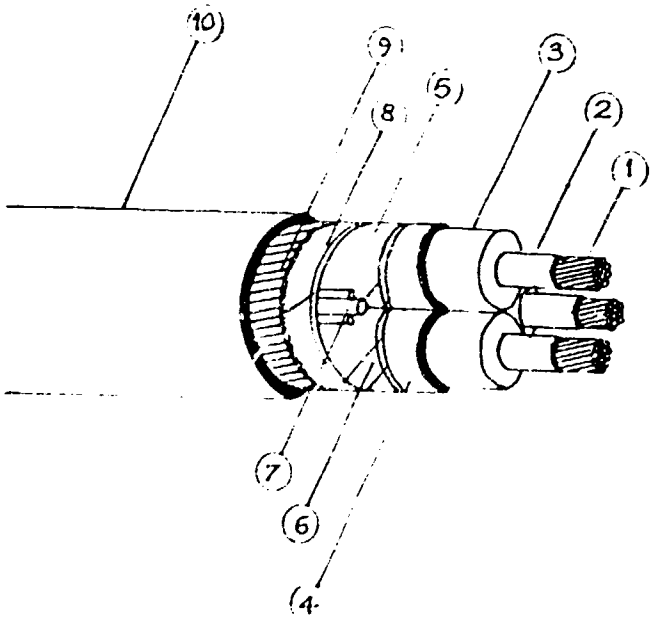
JOB NO. : DCIL-105

EXHIBIT : 9

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

CONSTRUCTION OF A TYPICAL XLPE INSULATED CABLE



LEGEND

1. Aluminium conductor
2. Extruded semi-conducting conductor shielding
3. XLPE insulation
4. Extruded semi-conducting core shielding
5. Copper tape screening
6. Core identification tape
7. Filler
8. Tape wrapping
9. Armour
10. PVC outer shielding

SECTION - 4
MARKET ANALYSIS

MARKET ANALYSIS

Underground cables are used to transmit/distribute electric current where overhead transmission is not desirable or not possible. Any increase in power generation capacities or power consumption is generally accompanied by an increase in the length of transmission and/or distribution network.

According to a Sectoral study carried out by AIDMO, the average annual increase in power generating capacity for the 13 countries covered ranges from 6700 MW in the early 90's to nearly 9300 MW by 2010 AD. Correspondingly, demand for various electrical equipment, including underground cables is estimated to increase substantially to match the additional power generation.

Projected additional length of overhead transmission/ distribution network, as extracted from the AIDMO report on sectoral study, for the period 1991-2010 is given in Exhibit-10. Different transmission/distribution voltages have been grouped in this Exhibit in the following manner.

Ultra High Voltage (UHV)	-	300 KV
High Voltage (HV)	-	60 KV to 225 KV
Medium Voltage (MV)	-	1.1 KV to 33 KV
Low Voltage (LV)	-	$\leq$ 440 Volts

This Exhibit gives country-wise annual additions to overhead transmission/distribution network by different voltage classes for four 5-year periods.

These projections are based on the additional generating capacities projected by AIDMO. As a conservative estimate, it is assumed that only 70% of the additional generating capacity proposed in the AIDMO report may actually be implemented. Accordingly, the annual demand for underground cables is taken as only 70% of the projections made by AIDMO. Exhibit-11 gives the annual demand for overhead transmission/distribution network.

As may be observed from this Exhibit, demand for EHV/HV cables is not large enough to justify establishment of a manufacturing plant. However, if MV cables are also included in the product-mix, it will be possible to establish a commercially viable cable manufacturing plant.

For 3-phase transmission/distribution at EHV only single core cables can be used, whereas at MV, cables can be of multi-core type. Therefore, the suggested product-mix is as given below :

EHV/HV Cables	-	600 km (single core)
MV Cables	-	4000 km (multi-core)

It is obvious that the above product mix does not satisfy the entire demand. It is recommended that only one plant is set up to manufacture the above quality of cable. Once operations in this plant stabilises, more capacity may be added by way of expansion of the existing plant or establishment of new plants.

JOB NO. : DCIL-105 EXHIBIT : 10

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

ESTIMATED ANNUAL REQUIREMENT OF UNDERGROUND CABLES

(In KM)

	1991-95				1996-2000				2001-05				2006-10			
	EHV	HV	MV	LV	EHV	HV	MV	LV	EHV	HV	MV	LV	EHV	HV	MV	LV
Algeria	-	-	285	255	-	-	290	260	-	-	290	260	-	-	290	260
Bahrain	-	71	234	193	-	114	377	310	-	114	377	310	-	114	377	310
Egypt	-	92	3236	1510	-	115	4072	1900	-	115	4072	1900	-	115	4072	1900
Iraq	-	-	6731	896	-	-	7940	1057	-	-	7940	1057	-	-	7940	1057
Jordan	-	-	140	72	-	-	149	74	-	-	149	74	-	-	149	74
Kuwait	18	144	518	518	18	144	518	518	18	144	518	518	18	144	518	518
Libya	-	-	1774	367	-	-	1774	367	-	-	1774	367	-	-	1774	367
Morocco	-	-	440	238	-	-	607	328	-	-	607	328	-	-	607	328
S. Arabia	26	61	2675	1660	32	74	3254	2020	32	74	3254	2020	32	74	3254	2020
Sudan	-	-	81	81	-	-	124	124	-	-	124	124	-	-	124	124
Syria	-	-	2945	2224	-	-	4277	3231	-	-	4277	3231	-	-	4277	3231
Tunisia	-	-	77	-	-	-	75	-	-	-	84	-	-	-	84	-
U.A.E.	-	-	1583	106	-	-	2326	155	-	-	2326	155	-	-	2326	155
Total	44	368	20719	8120	50	447	25783	10344	50	447	25792	10344	50	447	25792	10344

JOB NO. : DCIL-105

EXHIBIT : 11

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

ESTIMATED ANNUAL DEMAND FOR UNDERGROUND CABLES

(in KM)

	1991-95				1996-2000				2001-05				2006-10			
	EHV	HV	MV	LV	EHV	HV	MV	LV	EHV	HV	MV	LV	EHV	HV	MV	LV
Algeria	-	-	200	179	-	-	203	182	-	-	203	182	-	-	203	182
Bahrain	-	50	164	135	-	80	264	217	-	80	264	217	-	80	264	217
Egypt	-	64	2265	1057	-	81	2850	1330	-	81	2850	330	-	81	2850	1330
Iraq	-	-	4712	627	-	-	5558	740	-	-	5558	740	-	-	5558	740
Jordan	-	-	98	50	-	-	104	52	-	-	104	52	-	-	104	52
Kuwait	13	101	363	363	13	101	363	363	13	101	363	363	13	101	363	363
Libya	-	-	1242	257	-	-	1242	257	-	-	1242	257	-	-	1242	257
Morocco	-	-	308	167	-	-	425	230	-	-	425	230	-	-	425	230
S. Arabia	18	43	1873	1162	22	52	2278	1414	22	52	2278	1414	22	52	2278	1414
Sudan	-	-	57	57	-	-	87	87	-	-	87	87	-	-	87	87
Syria	-	-	2062	1557	-	-	2994	2262	-	-	2994	2262	-	-	2994	2262
Tunisia	-	-	54	-	-	-	53	-	-	-	59	-	-	-	59	-
U.A.E.	-	-	1108	74	-	-	1628	109	-	-	1628	109	-	-	1628	109
Total	31	258	14506	5685	35	314	18049	7243	35	314	18055	7243	35	314	18055	7243

SECTION - 5
PLANT LOCATION

PLANT LOCATION

It is suggested that the underground cables manufacturing plant be set up in Libya. The annual demand for cables in Libya itself is not very high. However, the plant in Libya will be able to satisfy the entire demand of its neighbouring countries viz., Algeria, Tunisia, Sudan and partly Egypt, after satisfying its domestic requirement. The countries in the middle east are in a comparatively better position than to the other Arab countries, in meeting their demand through imports, or through indigeneous supply. The Libyan plant may be able to reduce this regional imbalance to a large extent.

Other considerations based on which the plant location is suggested included the following :

- o proximity to sources of raw materials, and the availability of road, rail or sea linkages.
- o availability of essential infrastructural facilities such as power, water, etc.
- o relationships and affiliations among different nations in the designated region.
- o balanced regional development

The plant will manufacture EHV/HV and MV cables. EHV/HV cables manufactured in the plant will partly satisfy the requirement of other Arab countries where demand for such cables exist.

SECTION - 6
MANUFACTURING PROCESS

MANUFACTURING PROCESS

The process involved in the manufacture of underground cables has several stages as shown in Exhibit-12. These manufacturing stages are more or less similar for different materials of insulation such as PVC or XLPE.

Some of the manufacturing stages are briefly described below :

WIRE DRAWING

Both aluminium and copper conductors are used in cable manufacture. However, copper conductors are being used increasingly due to their superior electrical and thermal properties.

The size of wires used in cables vary from 1.4 mm to 4.0 mm. Copper wires are drawn from annealed rods of around 8 mm diameter while aluminium wires are drawn from 9.5 mm rods. The number of dies required usually vary from 6 to 13, depending on the size of finished wire. Tungsten carbide or diamond dies are used to obtain smooth and acceptable quality wires. Dies are lubricated by a stream of suitable compound. Wire drawing speeds of as much as 1200 m/min are possible. Suitable material handling arrangements will have to be made depending on the speed of wire drawing.

ANNEALING

Aluminium wires normally do not require annealing, but copper wires after they are fully drawn, will need to be

annealed to remove stresseses developed during the wire drawing operations. Annealing can be done in batch furnace or continuously by electrical heating or in a steam atmosphere.

STRANDING

The operations of bunching and stranding use the common principle of twisting, as used in rope making. The methods used are decided by the size and number of wires which make up the conductor. Conventional stranding practice is based around a layer of 6 wires laid over one wire and then succeeding layers increasing as 7, 19, 37, 61, 91, etc.

Different types of stranding machines are in use. Some of the principal types are briefly described below :

High Speed Double Twisting Machine : This machine is used for twisting of wires. Single wires in reels, held in fixed frames or 'creels' are drawn through a fixed guide, and then passed through a rotating arm or 'bow' to the take-up reel. The take-up reel rotates about its own axis to give a twist to the wire.

Drum Twisting Buncher : This is similar to the one described above except that the take-up reel rotates about its own axis and also about the principal axis of the machine.

Tubular Strand Twisting : The reels containing single wires are supported by a rotating cage. The reels remain stationary in space while the cage rotates to twist the wires.

There are variations in these machines to give different degrees of twist to the wires and different production speeds.

PAPER LAPPING

Paper insulated cables are insulated with layers of paper tapes applied helically. Paper tapes of specific thickness and suitable widths are applied by paper lapping machine with controlled lay and tension so as to form compact and homogeneous insulation. In high voltage cables, a conductor screen comprising a layer of semi-conducting paper is applied to electrically smoothen out the conductor surface. Similarly, a screening of metallised paper is applied over the core insulation. To identify cores, numerals are printed on the last layer of paper tape wound on each individual core.

IMPREGNATION

Paper insulated core/core assemblies are dried and impregnated using 'mass impregnating non-draining type' (MIND) compounds. This compound possess high viscosity even at operating temperatures and therefore does not migrate due to gravity.

For drying and impregnation core/core assemblies are laid in shallow circular trays and a number of such trays are put in impregnating tanks. In these tanks, drying of the insulation is carried out under vacuum and by controlled heating. Once the drying process is complete, impregnating compound is introduced into the tanks. The impregnation is initially under vacuum and subsequently under pressure.

Heating is done by steam or high pressure water. In modern plants, the cable conductors are heated by passage of direct current. The total drying and impregnation process may take from 10 to 60 hours according to plant, the amount of cable in the tank and the cable voltage.

EXTRUSION OF THERMOPLASTIC MATERIALS

All thermoplastic materials are applied by the extrusion process and PVC is the commonly used thermoplastic. Pellets of thermoplastic material are fed into the hopper of the extruder. They may be fully compounded, including colour, or the colour may be added at the time of extrusion by a metered second feed of coloured master batch.

The hopper feeds by gravity into a long heated barrel through which an Archimedian screw revolves. An extrusion head containing male and female dies is located at the end of the barrel. The dies are usually designed with concentric circular tips through which the conductor passes. Uniform flow of the softened material throughout the whole circumferential aperture between the dies is most important to obtain a concentric tube and freedom from overheating. Different materials require a varying ratio of barrel length to diameter, degree of compression and operating temperature.

Maintenance of optimum temperature for the particular compound being extruded is vital and when the required temperature is reached, the barrel heating may need to be reduced or even forced cooling applied.

EXTRUSION AND CURING OF THERMOSETTING PLASTICS

Commonly used themosetting insulation include cross-linked polyethylene (XLPE) and ethylene propylene rubber (EPR). At the time of extrusion, thermosetting materials are still thermoplastic and the only basic difference in technique is that they have subsequently to be cured (vulcanised). Normally, the curing operation is carried out in line.

Curing process used on commercial scale include the following :

- o Continuous catenary vulcanisation (ccv) with heat transfer
- o Vertical tube vulcanisation (vcv) with heat transfer
- o long land die process
- o liquid curing baths
- o irradiation by high energy electron beams
- o saline chemical cross-linking process

The first four processes mentioned above require the thermal decomposition of peroxides which are either precompounded into the polymer or added directly at the extruder. During extension process, the temperature must be maintained such that curing does not commence.

CCV and VCV Process : These processes involve passing the cable through a long tube filled with high pressure steam or inert gas. The vertical tube has an advantage in that there is no undue sag of thick-walled soft extrudate as it leaves the die. However, very tall vertical towers desirable for curing became uneconomical. In the catenary process, the extruded cable leaves the die at an elevation from the ground and passes through a long tube which is at an angle with ground to match the natural sag of the cable core. Various tension and other devices are employed to maintain the core centrally in the tube.

Steam curing involves introduction of high pressure steam at the extruder end and water at the other end to cool the

cable before drumming. In gas curing, the heating of the tube is usually by the attachment of electrical elements to the outside to provide an appropriate temperature gradient. The heated tube is filled with pressurised inert gas, which is bled away at a low rate to prevent accumulation of gases.

Schematic of a typical CCV process plant is given in Exhibit-13.

Long land die process : Developed by Mitsubishi/Dainichi, this process is also known as Mitsubishi Dainichi Continuous Valcanisation (MDCV). This process achieves curing in the absence of steam. The equipment is horizontal and very compact. The die of the extruder is extended to form a heated tube several meters long, to maintain the pressure and prevent void formations. Exhibit-14 presents a schematic diagram showing this process.

Liquid Curing Baths : Pressurised liquid cooling process uses salts for vulcanising rubber cables. The salts consist of a eutectic mixture of potassium nitrate (53%), sodium nitrite (40%) and sodium nitrate (7%).

Irradiation Method : This method does not involve any heating and does not use peroxide or any additive. High energy electron beams, generated by linear accelerators are used for curing. This is economical only for cables of thin walls and hence low voltage class.

Saline Chemical Linking Process : This process uses only conventional type extruders as used in the manufacture of thermoplastic cables. No special curing plant is necessary other than steam or hot water tanks.

LAYING-UP

For multi-core cables, the cores will have to be laid together. This can be done in large diameter machines where bobbins of cores are rotated around a common axis, or in drum twisters in which the cores are run off horizontally from their drums into a die and then proceed on to a take-up drum which revolves on its own axis. Belt insulation or taped bedding is conveniently applied in the same operation.

SHEATHING

Lead sheathing is done using a continuous extrusion machine where liquid lead is fed from the bottom end of a vertical screw. Water is sprayed onto the lead sheathed cable coming out of the extruder to cool the sheath. Aluminium sheaths are formed by direct extrusion over the insulation and special cooling.

ARMOURING

Wire armour is applied on a machine similar to a stranding machine where the reels mounted on a large carriage rotates around the cable at an appropriate speed to provide the correct lengths of lay. Steel or other metallic tape is applied by a conventional taping process.

INSPECTION AND TESTING

All raw materials used in the manufacture of power cables are inspected and tested for compliance with specified standards.

Cables are subjected to inspection at every stage of manufacture. Type tests are required to be carried out to

demonstrate satisfactory performance characteristics to meet the intended application. These tests need not be repeated unless there is a change in the material, design or process which may affect the performance characteristics. Routine tests are carried out on all finished lengths of cables to ensure integrity of the cable. Sometimes, tests are carried out on samples taken from a lot for the purpose of acceptance of the lot.

Some of the routine tests carried out on power cables include :

- o Conductor resistance test
- o Partial discharge test
- o High voltage set

Acceptance tests will include :

- o Conductor resistance test
- o Annealing test
- o Test for dimension of insulation
- o Hot set test for insulation
- o Void and contaminants test
- o Test for thickness of metallic sheath
- o Test for thickness of outer sheath
- o Partial discharge test
- o High voltage test
- o Measurement of capacitance
- o Flammability test
- o Water tightness test

Inspection and testing are carried out with several standard laboratory equipment and some special testing equipment. Some of these include -

- High voltage partial discharge equipment
- Impulse equipment
- Heat cycle equipment
- DC High voltage equipment
- Tensile testing machine
- Melt Index tester
- Differential scanning calorimeter
- Infra-red spectrograph
- Oscillating disc - Rehemeter
- Microtomes
- Blown film extruder

Packing

Cable is wound on drums which are made of steel or wood. Nowadays steel drums are preferred as these provide better protection to the cable while storing and handling. The ends of cable are sealed by means of non-hygroscopic sealing material.

Each cable drum must have a label clearly indicating the details as laid down by the relevant national/international standards.

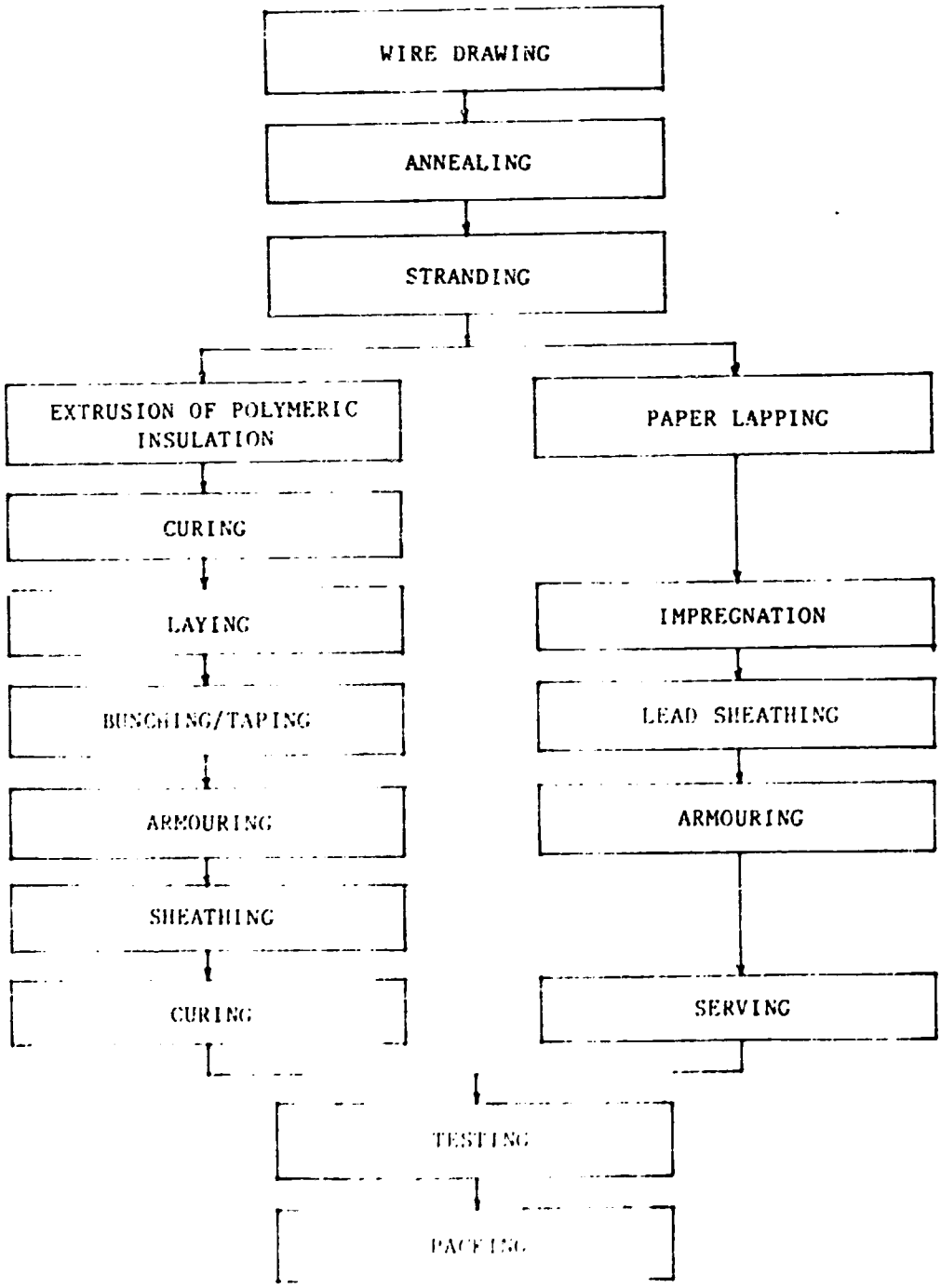
DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 12

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION AND ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

PROCESS FLOW SHEET : CABLES



JOB NO. : DCIL-105

EXHIBIT : 13

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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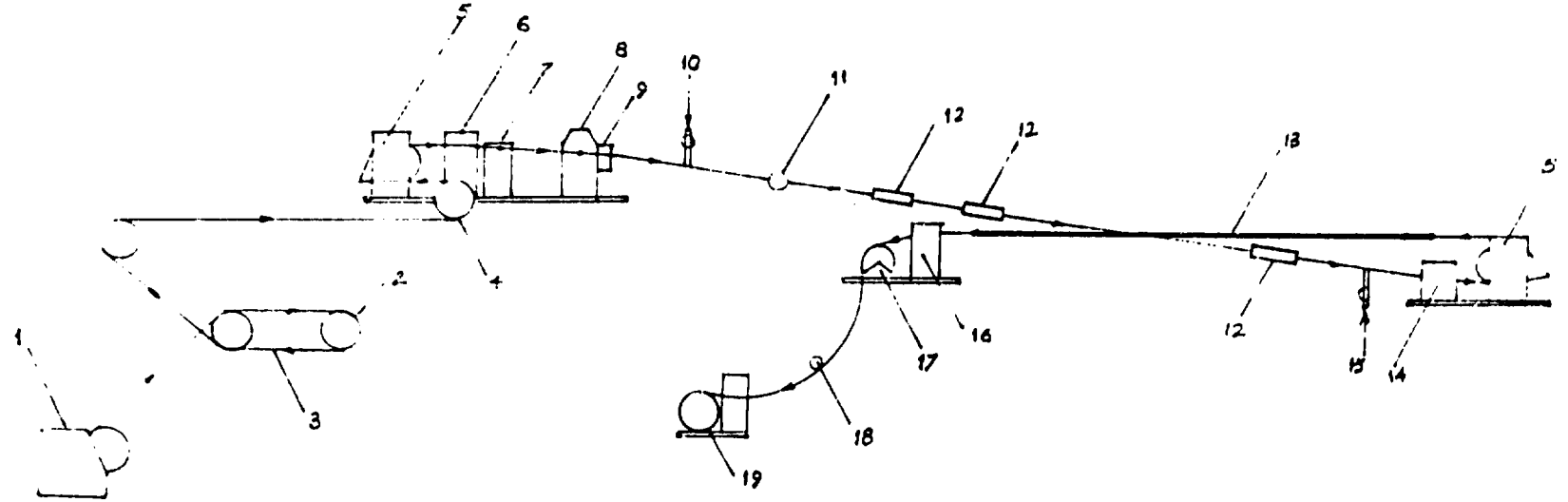
PROJECT PROFILE ON UNDERGROUND CABLES

TYPICAL LAY-OUT OF CCV PLANT



LEGEND

1. Pay-off
2. Pulley
3. Accumulator
4. Entry sheave
5. Belt wrap capistan
6. Tandem drive control panel
7. Semi-conductor extruder
8. Main extruder
9. Motorised splice box
10. High pressure nitrogen inlet
11. Cable position control
12. Water level control
13. Cooling water channel
14. Water seal & air wipe
15. High pressure water inlet
16. Caterpillar
17. Sheave
18. Catenary control
19. Take-up

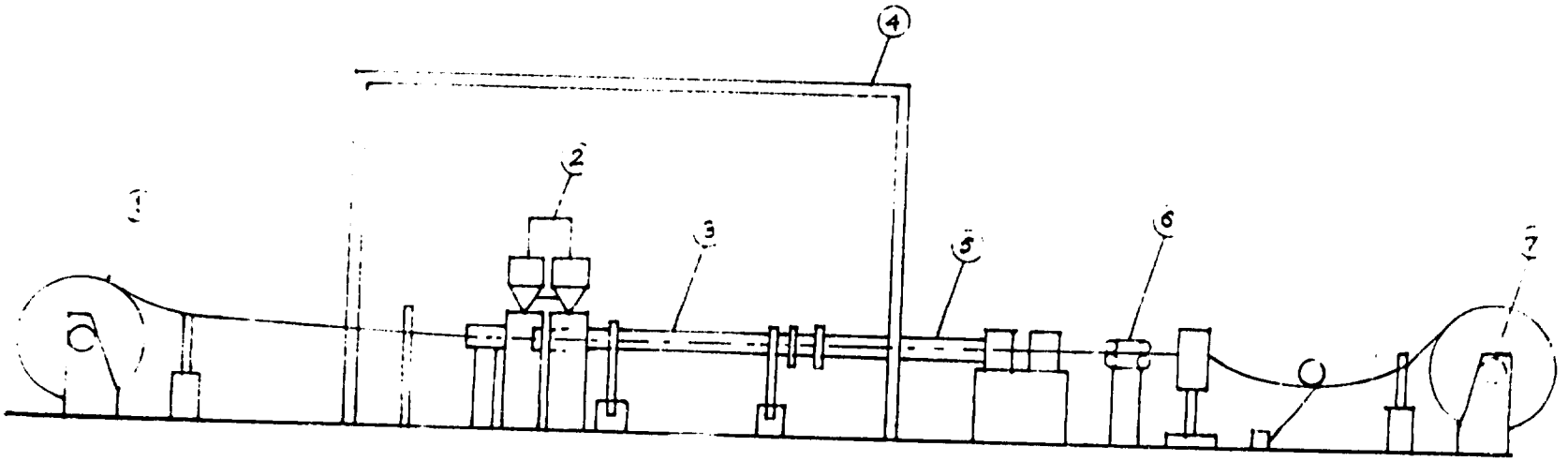
JOB NO. : DCIL-105

EXHIBIT : 14

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

TYPICAL LAY-OUT OF LONG LAND DIE MACHINE



LEGEND

1. Pay-off
2. Extruder for simultaneous extrusion
3. Long land die
4. Dust free enclosure
5. Cooling tube
6. Haul-off caterpillar
7. Core take-up

DEVELOPMENT CONSULTANTS

SECTION - 7
PLANT AND EQUIPMENT

PLANT AND EQUIPMENT

The plant has been designed to manufacture EHV/HV and MV cables. The cables can be manufactured with PVC or XLPE insulation.

MAIN PLANT

It is assumed that the conductor used in cables will be of both aluminium and copper. Suitable wire drawing machine is provided for drawing wires of desired size from a larger size stock. A batch type annealing furnace is also provided to remove internal stresses developed during wire drawing operation.

The plant will have extruders to provide insulation of PVC or XLPE. For PVC insulation, two extruders have been provided to cover different diameter range. XLPE cables will be manufactured using catenary vulcanisation process. Vulcanisation of the cable will be by completely dry curing and cooling method. Curing will be done using nitrogen gas while water will be used for cooling. The equipment can produce XLPE cables of various sizes in the entire range of EHV to MV.

Two separate polymer extrusion lines are also provided to manufacture lower-end MV cables. One of these lines will be based on a superior MONOSIL process to produce superior cables.

TESTING AND QUALITY CONTROL

The plant is equipped with modern facilities to carryout nessary tests on raw materials and finished cables.

MATERIAL HANDLING

Material Handling is an important function in the plant. Wire bobbins and take up reels will have to be transferred from one machine to another to complete the product. For this purpose, fork lifts, mobile jib crane and material transfer trolleys have been provided. The finished cable in drum may weigh as much as 12 tonnes. To handle such heavy loads, EOT cranes of 15 tonne capacity are provided. Finished cable drums will be loaded on to trucks using EOT crane/mobile crane.

TOOL ROOM AND MAINTENANCE

The plant has been provided with equipment and facilities for repair and maintenance of machinery. Wire drawing dies, dies for extrusion, dies for stranding, etc. will have to be procured.

AUXILIARY EQUIPMENT

Auxiliary equipment required at the plants include storage racks, shelves, work benches, surface plates, pellets, cable drums, carpentary tools, etc.

Exhibit-15 gives a list of main plant and equipment.

JOB NO. : DCIL-105 EXHIBIT : 15

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

LIST OF MAIN PLANT AND EQUIPMENT

Sl. No.	Description	Brief Specification	Nos. Reqd.	Power (KW)	Unit Price (US$)	Total Price (US$)
A. MAIN PLANT						
1.	Rod breakdown machine	Type: Wet, slip type, continuous machine along with spooler Inlet wire (mm) : 12.7 - aluminium 10.0 - copper Outlet wire (mm) : 1.5 Motor Power (KW) : 160	2	320	190000	380000
2.	Stranding/Armouring machine	Type: Planetary type complete with pay-off and take-up stands and controls. No.of cages : 5 No.of bobbins : 12/18/24/30/36 Bobbin capacity : Copper 245 kg Motor power (KW) : 80	1	80	378000	378000
3.	Stranding/Armouring machine	Type: Rigid fork type complete with pay-off and take-up stands and controls No.of bobbins: 1+12+18+24 Bobbin capacity : Copper 245 kg Motor power (KW) : 80	1	80	320000	320000

JOB NO. : DCIL-105

EXHIBIT : 15

Sl. No.	Description	Brief Specification	Nos. Reqd.	Power (KW)	Unit Price (US$)	Total Price (US$)
4.	Core laying machine	Type: 1+3, craddle rotating, planetary cage type, including filler reel bobbins Bobbin capacity : 5 tonnes Max. dia of laid-up cores : 125 mm Motor power (KW) : 55	1	55	100000	100000
5.	Tape Lapping Head	Type: Tangential, used for paper, poly-ethylene, PVC, copper, aluminium, etc. No.of tapes : 4 Dia of tape pad : 500 mm Max. tape width : 80 mm Passage through the centre : 120 mm	2	-	50000	100000
6.	CDCC Vulcanising Line	Type: Continuous dry curing and cooling vulcanising line complete with pay-off, caterpillar, conductor preheater, 3 extruders, vulcanising equipment, take-up, line control, XLPE compound preparation equipment, nitrogen plant and cooling water circulation unit. Conductor size (sq.mm) : upto 2000 Insulation thickness - Conductor screen (mm) : 0.5-2.0 Insulation (mm) : upto 28 Insulation shield (mm) : 0.5-2.0 Curing : dry (nitrogen) Cooling : water Tube length (m) : 157 Catenary angle : 27° Extrusion : triple crosshead Line speed (m/min) : 25 Electric Power (KVA) : 1655	1	1325	350000	350000

JOB NO. : DCIL-105 EXHIBIT : 15

Sl. No.	Description	Brief Specification	Nos. Reqd.	Power (KW)	Unit Price (US$)	Total Price (US$)
7.	Polymer extrusion line	Type: Extrusion of thermoplastic polymers, complete with steam curing arrangement Conductor dia (mm) : 6.3 - 22.5 Max. cable dia (mm) : 35.0 Speed (m/min) : 10-270	1	20	160000	160000
8.	Medium Voltage Monosil extrusion line	Type: Extrusion of thermoplastic polymers, complete with steam curing and sheathing arrangement Max. cable dia (mm) : 70.0	1	370	180000	180000
9.	Outer sheathing machine	Cable dia (mm) : 60-160 Speed (m/min) : 5-40 Max. reel weight : 25 tonnes	1	30	40000	40000
10.	Annealing Furnace	Type: Oil/gas fired, batch type furnace Capacity : 2.5 Cu.M.	1	-	12000	12000
11.	Pointing and Threading machine	Type: Complete to prepare conical heads for wire drawing Motor Power (KW) : 7	2	14	30000	60000
12.	Take-up Stand	Type: Motorised Drum flange dia (mm) : 1200-3050 Drum width (mm) : 800 - 1850 Max. weight (tonnes) : 10.0	2	10	6000	12000
13.	Pay-off Stand	Max. weight (tonnes) : 10.0	2	10	6000	12000
14.	Rewinding Unit	Type: Complete unit with pay-off and take-up stands Cable dia (mm) : upto 100 Max. line speed (m/min) : 100	2	40	15000	30000

JOB NO. : DCIL-105 EXHIBIT : 15

Sl. No.	Description	Brief Specification	Nos. Reqd.	Power (KW)	Unit Price (US$)	Total Price (US$)
15.	Package Boiler	Type: Oil fired with DM water plant Capacity : 5 tons/hr	1	-	70000	70000
				Sub-total		2204000
B. TESTING & QUALITY CONTROL						
1.	Tensile Testing machine	Measuring range : 0-250 kgf	1	0.5	1000	1000
2.	High Voltage Partial Discharge eqpt	Type: Series and resonant type Capacity : 400 KV	1	51.0	6000	6000
3.	Impulse Generator	Capacity : 2500 KV Impulse time : 1.2/50 micro sec.	1	26.0	5000	5000
4.	Heat Cycle eqpt	Capacity : 120 KVA Current : 4000 amps Voltage : 30 volts	1	96.0	7000	7000
5.	DC High Voltage Generator	Capacity : 400 KV	1	41.0	6000	6000
6.	Water Bath Apparatus	Type: Electrically heated with thermostatic controls	1	2.0	900	900
7.	Ozone Resistance Tester	-	1	31.0	800	800
8.	Oxygen/Air Bomb Test	-	1	36.0	800	800
9.	Ageing Oven with Air Changing Arrangement	Max. temperature (°C) : 200	2	50.0	650	1300
10.	Heating Chamber	Temperature (°C) : 250	2	-	250	500
11.	Oil Bath	Temperature (°C) : 300	1	16.0	1800	1800

JOB NO. : DCIL-105 EXHIBIT : 15

Sl. No.	Description	Brief Specification	Nos. Reqd.	Power (KW)	Unit Price (US$)	Total Price (US$)
12.	Deep Freezer	Temperature (°C) : -40	1	4.0	500	500
13.	Torsion/Wrapping Testing machine	-	1	12.0	700	700
14.	Fire Resistance Testing cabinet	-	1	33.0	1000	1000
15.	Other Testing & Measuring Eqpt		1 set		Lump sum	5000
					Sub-total	38300
C.	MATERIAL HANDLING					
1.	EOT Crane	Span : 16 M SWL : 15 tons	3	90	80000	240000
2.	Mobile Crane	Type : Wheel mounted, diesel engine powered Capacity : 15 tons	1		45000	45000
3.	Mobile Jib Crane	Type : Winch type SWL : 1.5 tons Lift from ground level : 2184 mm Overall height : 2762 mm	1		20000	20000
4.	Fork Lift Truck	Type : Counter balanced, battery operated rubber tyred, four wheeled fork lift Capacity : 2 tons Max. lift : 3 M	2		45200	90400

JOB NO. : DCIL-105 EXHIBIT : 15

Sl. No.	Description	Brief Specification	Nos. Reqd.	Power (KW)	Unit Price (US$)	Total Price (US$)
5.	Battery Operated Inter-bay Material Transfer Trolleys	Capacity : 5 tons	2		400	800
6.	Chain Pulley Block	Capacity : 1 ton	4		140	560
7.	Push type Platoform Trolley	Type: Heavy duty, rubber tyred Capacity : 500 kg	4		300	1200
8.	Double-wheeled Tipping barrow	Type: Heavy duty Capacity : 0.2 Cu.M.	4		200	800
				Sub-total		398760
D.	TOOL ROOM & MAINTENANCE					
1.	Precision Lathe	Centre height : 220 mm Centre distance : 1500 mm	1	11.0	3500	3500
2.	Universal Milling machine	Table size : 310mm x 1520mm	1	7.0	22000	22000
3.	Radial Drilling machine	Drilling capacity : 40 mm	1	3.0	25000	25000
4.	Bench Grinder	Type: Double ended Wheel size (mm) : 205x25x19	1	1.0	1000	1000
5.	Arc Welding Set	Current range : 70-450 amps	2	12.0	4000	8000
6.	Rectifier DC Welding Set	Current range : 55-500 amps	2	25.0	6000	12000
7.	Electric Heat Treatment Furnace	Max. temperature : 1350°C Rating : 60 KVA Chamber size (mm) : 300 x 300 x 150	1	7.0	48000	48000

JOB NO. : DCIL-105 EXHIBIT : 15

Sl. No.	Description	Brief Specification	Nos. Reqd.	Power (KW)	Unit Price (US$)	Total Price (US$)
8.	Power Hacksaw	Cutting capacity - round : 320 mm	1	2.2	1600	1600
9.	Screw Jack	Type: Ratchet type, lifting and traversing screw jacks Capacity : 5 tons	2		300	600
10.	Collapsible Ladder	Type: Self-supporting, extendable, all aluminium ladder Closed height : 5 M Extended height : 8 M	1		200	200
11.	Collapsible Ladder	Type: Self-supporting, extendable, all aluminium ladder Closed height : 3 M Extended height : 5.5 M	1		150	150
12.	Battery Charger	No.of Phases : 3 Input voltage : 240 V Output voltage : 36 V	2		100	200
13.	Electrical Testing & Measuring Instruments	Standard	1 set		Lump sum	1000
14.	Portable Electric Tools	Standard	2 sets		Lump sum	10000
15.	Welding Accessories	Standard	1 set		Lump sum	500
16.	Mechanical Measuring Devices & Instruments	Standard	1 set		Lump sum	1200
				Sub-total		134950
B.	AUXILIARY EQUIPMENT	Equipment such as work tubes, storage rack, worker cabinets, lockers, etc.			Lump sum	12000

SECTION - 8
RAW MATERIALS AND OTHER INPUTS

RAW MATERIALS AND OTHER INPUTS

Copper and aluminium conductors are used in the manufacture of underground cables. Electrical grade aluminium and annealed copper for use in conductors are available in the form of rods of 8.0 to 9.5 mm diameter. These will have to be suitably drawn to the desired size before stranding can be done. Apart from these, galvanised steel tape or wires will be required for armouring of cables. Other raw materials required are polyethylene compound, PVC compound, other insulating materials and core identification tapes, etc.

Other inputs required will include colouring pigments, curing chemicals, packing wood, etc.

While estimating the requirement of raw materials and other inputs, the following assumptions have been made :

- EHV/HV/MV cables will be made of XLPE and PVC insulation
- EHV/HV cables will be of single core type while MV cables will be of 3 core type
- Conductor material will be both aluminium and copper
- Armouring will be done with steel tape/aluminium/ copper wire
- The cable drums will be made of steel which can be recycled.

Estimated requirement of major materials and inputs is presented in Exhibit-16.

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 16

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATON

PROJECT PROFILE ON UNDERGROUND CABLES

REQUIRPMENT OF RAW MATERIALS AND CONSUMABLES

Sl. No.	Item	Brief Specification	Annual Requirement (Tonnes)	Price ('000 US$)
1.	Copper	Annealed Copper Rods (8 mm dia)	5500	29,012.50
2.	Aluminium	Electrical Conductor Grade Aluminium Rods (9 mm dia)	9000	40,437.00
3.	Steel	Galvanised Steel tape (4 mm x 0.8 mm coil)	6000	5,556.00
4.	Polyethylene Compound		4600	46.00
5.	PVC Compound		4400	6,600.00
6.	Colouring Pigments and other Chemicals	Lumpsum		3.00
7.	Cable drums	Steel, detachable	2500 nos.	35.00
8.	Packing Wood	-	2000 Cu.M.	400.00
9.	Grease, lubricating oil	Lumpsum		0.10
10.	Misc. items like packing nails, nuts and bolts, cutting tools, cutting oil, etc.	Lumpsum		0.30
			TOTAL	82,089.90

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 16

Basis of Calculation

Product Mix : HV/EHV Cables - 600 km (132 KV XLPE Cable)

MV Cables - 4000 km (PVC - 2000 km, XLPE -2000 km, 1.1-33 KV)

Density (gm/cc) Copper (Special Grade) - 8.94 XLPE (Special Grade) - 0.92

Aluminium (Special Grade) - 2.56 PVC (Special Grade) - 0.99

Steel - 7.8

HV/EHV Cables

Conductor Cross Section : 800 mm² (Single Core)

XLPE Insulation Thickness : 18 mm

PVC Outer Sheating Thickness : 3.9 mm

Weight/Km = Cross Section x Length x Density	Annual Prodn. (KM)	Wastage factor(%)	Total Weight (Tonne)
Cu = $\frac{800\ Cm^2}{100}$ x 1000 m x 8.94 gm/cc = 7.152 Tonne	600	25	5364
XLPE = $\frac{2830\ Cm^2}{100}$ x 1000 m x 0.92 gm/cc= 2.604 Tonne	600	20	1875
PVC = $\frac{880\ Cm^2}{100}$ x 1000 m x 0.99 gm/cc = 0.87 Tonne	600	20	626

MV Cables

Particulars	PVC	XLPE
Conductor (3 cores) Cross Section	3 x 240 mm²	3 x 240 mm²
PVC Insulation Thickness	2.6 mm	5.5 mm
PVC Outer Sheating Thickness	2.2 mm	2.8 mm
Overall cable diameter	54 mm	85 mm

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 **EXHIBIT : 16**

PVC

Weight/Km = Cross Section x Length x Density	Annual Prodn. (KM)	Wastage factor(%)	Total Weight (Tonne)
Al = $\frac{3 \times 240 \text{ Cm}^2}{100}$ x 1000 m x 2.56 gm/cc = 1.843 Tonne	2000	20	4423
PVC* = $\frac{164 \text{ Cm}^2}{100}$ x 1000 m x 0.99 gm/cc = 0.487 Tonne	2000	15	1120
PVC# = $\frac{415 \text{ Cm}^2}{100}$ x 1000 m x 0.99 gm/cc = 0.410 Tonne	2000	15	943
Steel tape = $\frac{122 \text{ Cm}^2}{100}$ x 1000 m x 7.8 gm/cc = 0.952 Tonne	2000	20	2284

* for insulation # for outer sheating

XLPE

Weight/Km = Cross Section x Length x Density	Annual Prodn. (KM)	Wastage factor(%)	Total Weight (Tonne)
Al = $\frac{3 \times 240 \text{ Cm}^2}{100}$ x 1000 m x 2.56 gm/cc = 1.843 Tonne	2000	20	4423
XLPE* = $\frac{3 \times 400 \text{ Cm}^2}{100}$ x 1000 m x 0.92 gm/cc = 1.1 Tonne	2000	20	2640
PVC# = $\frac{740 \text{ Cm}^2}{100}$ x 1000 m x 0.99 gm/cc = 0.733 Tonne	2000	20	1759
Steel tape = $\frac{196 \text{ Cm}^2}{100}$ x 1000 m x 7.8 gm/cc = 1.53 Tonne	2000	20	3672

* for insulation # for outer sheating

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 16

Total Annual Requirement (Tonne)

Copper	: 5364	Say 5500
Aluminium	: (4423 + 4423) = 8846	Say 9000
Steel	: (2284 + 3672) = 5956	Say 6000
Polyethelene (XLPE)	: (1875 + 2640) = 4515	Say 4600
PVC	: (626 + 1120 + 943 + 1759) = 4448	Say 4400

Packing Wood

Drum Diameter : 2 m

Drum Width : 1.5 m

Wood thickness : 1.5 Cm

Drums per Km : 3

Total wood requiremnt = $\tilde{n}$ x 2 x 1.5 x 1.5/100 m^3 x 3 x 4600 = 1950
Say 2000 m^3

SECTION - 9
UTILITIES

UTILITIES

Major utilities required in the plant include power and water. The manufacturing process does not generate any toxic or non-toxic effluent. Therefore, effluent treatment facilities are not required.

Power

Power is required to operate all equipment in the factory, the airconditioning system in the office, and for lighting and air-circulation. As all the equipment will not be operated simultaneously, different load factors have been assumed as shown in the Exhibit-17 on power requirement. It may be observed from this Exhibit that the average demand works out to 2000 KVA. Considering future expansion needs, the connected load for the plant is estimated to be about 3000 KVA. It is assumed that power will be available to the plant from an 11 KV overhead transmission line. Three 1000 KVA transformers have been provided for stepping down this voltage to 440/220 volts.

Water

Process water is required in XLPE cable line and in polymer extrusion line for cooling purposes. Water is also required in boilers for steam generation and in the air-conditioning plant. Water requirement for human needs is estimated at 100 litres per person per day. Exhibit-18 gives a summary of water requirement.

Fuel

The Package Boiler and Annealling Furnace will be oil and gas fired respectively. Fuel requirement will depend upon the frequency of operation of these two equipment. The Package Boiler will require about 350 kg of fuel oil for every hour of its operation. In case of the Annealling Furnace for every annealling process about 17 m^3 of gas will be required. Facilities for oil and gas firing will be provided along with these equipment.

Compressed Air

Compressed air will be required to operate capstan, take-up and other cable handling equipment. Some handtools will also require compressed air for operation. For this purpose two 1000 cfm compressors are provided. Of these, one will be a standby compressor.

Exhibit-19 gives a list of equipment required for utilities.

Other miscellaneous equipment required in the plant are listed in Exhibit-20.

DEVELOPMENT CONSULTANTS

JOB NO. : DCII.-105

EXHIBIT : 17

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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PROJECT PROFILE ON UNDERGROUND CABLES

SUMMARY OF POWER REQUIREMENT

Sl. No.	Description	Max. Power (KW)	Load Factor	Power Required (KW)
1.	Main Plant			
	- CDCC line	1325	0.3	398
	- Monosil line	370	0.6	222
	- Other equipment	659	0.7	461
2.	Testing & Laboratory Eqpt	400	0.4	160
3.	Material Handling Eqpt	90	0.4	36
4.	Tool Room	70	0.4	28
	Sub-total	2914		1305
5.	Water Pump, Compressor, etc.	40	0.4	16
6.	Shop lighting & air circulation	110	0.7	77
7.	Air conditioning & Office lighting	165	0.7	116
8.	Canteen lighting & kitchen eqpt.	24	0.8	19
9.	Lighting in other areas	20	0.6	12
	Sub-total	359		240
	Total	3273		1545

Average total demand based on a power factor of 0.8 : 1932 KVA

Say 2000 KVA

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 18

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

SUMMARY OF WATER REQUIREMENT

Sl. No.	Description	CuM/hour
1.	Process	
	- CDCC equipment make-up cooling water	5.0
	- Boiler make-up water	3.5
	- Other equipment	5.0
2.	Airconditioning plant make-up water	1.5
3.	Human needs	2.6
4.	Gardening and others	2.4
	Total	20.0

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 19

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION AND ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

REQUIREMENT OF EQUIPMENT FOR UTILITIES

Sl. No.	Description	Numbers Required	Total Cost (US$)
1.	Oil cooled transformer 11 KV/440-220 volts, 3 Ph, 50 Hz Capacity : 1000 KVA	3	65,700
2.	Switchgears, MCC, distribution boards, cables	-	4,500
3.	Centralised airconditioning system with 2 airhandling units and cooling tower Capacity : 100 TR	1	1,12,900
4.	Lights with fittings, air coolers and air circulators	-	3,500
5.	Air compressor with after cooler, air receiver, safety devices, etc. Capacity (cfm) : 1000 Pressure (kg/sq.cm) : 7	2	72,380
6.	3 nos. borewell pumps with 2 booster pumps each of 50 CuM/hr capacity, pipes, fittings, valves and overhead RCC water storage tank of 200 CuM capacity	1	10,500 9,600
	TOTAL		2,79,080

JOB NO. : DCIL-105 EXHIBIT : 20

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION AND ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATON

PROJECT PROFILE ON UNDERGROUND CABLES

REQUIREMENT OF MISCELLANEOUS EQUIPMENT

Sl. No.	Description	Total Cost (US $)
1.	Fire fighting system with hydrant, piping, etc.	6,000
2.	Telecommunication systems with EPABX facilities, telephone instruments, cabling, etc.	22,000
3.	Office equipment and furniture	16,000
4.	Weighbridge (Lever type, Road transport, 25 tonnes) - 1 no.	3,700
5.	Goods transport truck - 1 no.	27,000
6.	Passenger transport vehicle - 1 no.	25,800
7.	Ambulance - 1 no.	19,300
8.	Car - 1 no.	9,700
	TOTAL	1,29,500

SECTION - 10
SPACE AND LAYOUT

SPACE AND LAYOUT

The main plant has the following major work centres :

- o Wire drawing
- o Wire stranding
- o XLPE cable plant
- o Monosil cable plant
- o Polymer extrusion line

The shop will also have material storage area, material testing laboratory and high voltage test stations. Other facilities in the main plant building will include shop offices, toilets, workers' cabinets, nitrogen plant, boiler house and aircompressor room.

Floor space in the main plant has been worked out based on the following :

- o area occupied by each machine
- o working area
- o area for smooth and sequential flow of materials and material handling equipment
- o area for movement of men
- o area for temporary storage of materials

Other buildings in the plant include :

- o Office building
- o Canteen

- Time office & security
- First-aid centre
- Garage
- Transformer room
- Pump house

Summary of space requirement is given in Exhibit-21.

Plant Building

Plant building has been designed in such a way to ensure smooth and continuous flow of materials. All the three bays are serviced by EOT cranes to facilitate easy handling of materials.

In XLPE cable plant, the extruders are at an elevation of about 15 M from the ground level. The EOT crane in this bay will service only the portion from the curing section of the plant upto the finished cable take up reels. The roof of this bay will be raised to 18.0 M level near the extruder section and the remaining portion of the bay will have roof at 13.5 M level. The roof level of HV Test Station will be at 25.0 M from the ground level.

Layout of the plant building is given in Exhibit-22 enclosed in a pouch at the end of this report. Shop offices will be located beside HV testing station while material testing laboratory will have two storeys. Both the office and the material testing lab will have glass panelled walls.

The plant building will be of reinforced concrete construction. The columns, roofing, floor, etc. shall be of RCC. The building design will ensure natural light and ventilation to the extent possible.

Office Building

This will be a two-storied RCC brick construction building with central airconditioning arrangement.

Other Buildings

All other buildings will be of masonry brick construction.

Exhibit-23, enclosed in a pouch at the end of this report shows the block layout of the plant, showing relative location of different buildings.

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 21

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION AND ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

SUMMARY OF SPACE REQUIREMENT

		Sq.M.
1.	Main Plant	
	o Raw Material & Consumable Store (covered area)	416
	o Main Production Equipment	7028
	o Nitrogen Plant, Boiler, Compressor Room	600
	o Intermediate Goods Storage Area	400
	o Finished Goods Storage Area	1[illegible]
	o Tool Room	130
	o Workshop Office	128
	o Material Testing Lab.	1[illegible]4
	o HV Testing Station	19.2
	o Toilets	1[illegible]7
	Sub-total	9307
	Aisles & Gangways (20%)	1998
		11305
	Say	11000
2.	Office Building (Two Storied)	
	o Office	140
	o Conference Room	60
	o Lecture Room	72

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 2:

o	Reception & Lobby	80
o	Tea Room	15
o	A.C. Unit & Electrical Distribution	24
o	Toilets	72
	Sub-total	953
	Add 30% for staircase and aisles	286
	Total	1239
	Plinth area	640

3. Other Buildings

o	Time Office & Security	36
o	First Aid Room	24
o	Garage & Driver's Rest Room	176
o	Canteen	480
o	Electrical Substation & Transformer Room	80
o	Pump House	20
	Sub-total	676

4.	Total Building area	12816
5.	Open Storage area (7x20) (Raw material and finished Goods)	1560
6	Area for future expansion (80% of plant built-up area)	8055
7.	Area for roads	8900
	Sub-total	32131
	Total land area (330 x 150)	49500

SECTION - 11
MANPOWER AND ORGANIZATION

MANPOWER AND ORGANISATION

The plant will manufacture EHV/HV XLPE cables and MV XLPE/ PVC cables. These products are fairly high technology products with sophisticated testing/quality control systems.

Estimates of manpower requirement have been developed, based on the following considerations :

- o plant capacity
- o nature and scope of activities involved
- o process and material handling equipment
- o plant layout and proximity to areas of supervision

The plant will operate for 300 days in a year, on an average, and will carry out all the activities performed by a manufacturing unit. It will operate in two shifts per day.

In order to plan, organise, coordinate, execute and control, all the necessary activities are grouped under different functions. The major functional areas in the plant under which manpower is categorised, include -

- production
- quality control
- materials
- marketing
- accounts
- personnel & administration

The plant will be under the overall supervision and control of a General Manager. Each of the above-mentioned functions

will be carried on by separate departments, headed by the departmental managers. These managers will report to the General Manager.

Production

The production operations will be carried out in two shifts per day. In each shift, production will be under the overall supervision of a shift-in charge, who will report to the Production Manager. Tool room will work in only one shift. Production planning and coordination will be handled by a Planning Engineer. Maintenance will also be under the control of Production Manager and will be looked after by a Maintenance Engineer. Since the product design and other parameters are fairly standardised, a separate design engineering department is not necessary. However, a Technical Assistant has been included in the Production Department to handle design drawings, if necessary.

Exhibit-24 presents the total requirement of workmen in the plant, categorised by equipment/section and level of skill.

Quality Control

Quality control in cable manufacture is a high technology/ sophisticated activity. Quality control will be looked after by a Manager. In each shift, testing and quality control will be under the supervision of a Shift Supervisor.

Materials

The materials function will be handled by a Materials Manager. Stores will function in both the shifts while physical despatches will be done in only one shift. Stores issue and despatch/packing will be looked after by separate supervisors in each shift.

Marketing

Cables manufactured in the plant are meant for both domestic and export markets. The marketing function will be headed by a Marketing Manager who will be assisted by two Marketing Executives.

Accounts

The Accounts Department will be headed by a Chief Accountant-cum-Company Secretary, assisted by an Accountant, accounts assistants and cashier.

Personnel and Administration

This department will handle all activities relating to personnel, labour and welfare, security and other administrative functions. This department will be headed by a manager.

Exhibit-25 gives a comprehensive list of requirement of managerial, supervisory and other staff for the plant.

Organisation structure for the entire plant is given in Exhibit-26. The designations and salary levels in the organisation structure may be observed from relevant serial numbers in Exhibits 24 and 25.

Exhibit-27 presents the monthly statement of salaries and wages.

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 24

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION AND ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

REQUIREMENT OF WORKMEN IN THE PLANT

Equipment/Section	Skilled	Unskilled
a. Main Plant	31	35
b. Testing & Quality Control	8	4
c. Material Handling	17	12
d. Tool Room	8	-
e. Carpentry & Packing	3	3
f. Electrical Maintenance & Transformer Room	4	4
g. Plumbing	1	1
h. Boiler	3	-
i. Compressor Room	2	-
j. Pump House	2	-
k. Sweeper & Gardner	-	10
l. Helpers	-	10
Sub-total	79	79
Add 10% for absenteeism	8	8
	87	87

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 25

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

REQUIREMENT OF MANAGERIAL, SUPERVISORY AND OTHER STAFF

Designation	Level	Nos. Required
General Manager	1	1
Personal Secretary to GM	4	1
Production		
A. Production Manager	2	1
B. Planning Engineer	3	1
C. Shift-in-Charge	3	2
D. Maintenance Engineer	3	1
E. Production Supervisor	4	9
F. Technical Asst-cum-Draftsman	4	1
G. Steno-typist	5	1
Sub-total		16
Quality Control		
A. Quality Control Manager	2	1
B. QC Supervisor	4	2
C. Steno-typist	5	1
Sub-total		4
Materials		
A. Materials Manager	2	1
B. Stores Supervisor	4	2
C. Despatch Supervisor	4	1
D. Purchase Assistant	4	2
E. Stores Assistant	5	4
F. Steno-Typist	5	1
G. Helper	7	4
Sub-total		15

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 25

Designation	Level	Nos Required
Marketing		
A. Marketing Manager	2	1
B. Marketing Executive	3	2
C. Steno-typist	5	1
Sub-total		4
Accounts		
A. Cheif Accountant-cum-Company Secretary	2	1
B. Accountant	3	1
C. Accounts Assistant	4	3
D. Cashier	4	1
E. Steno-typist	5	1
Sub-total		7
Personnel & Administration		
A. Personnel Manager	2	1
B. Personnel Officer	3	1
C. Security Officer	3	1
D. Labour & Welfare Officer	3	1
E. Personnel Assistant	4	1
F. First Aid Assistant	4	2
G. Steno-typist	5	1
H. Typist	6	1
I. Canteen-in-Charge	4	1
J. Security Guards	6	9
K. Drivers	6	4
L. Office Boy	7	2
M. Tea Boy	7	14
Sub-total		40
TOTAL		88

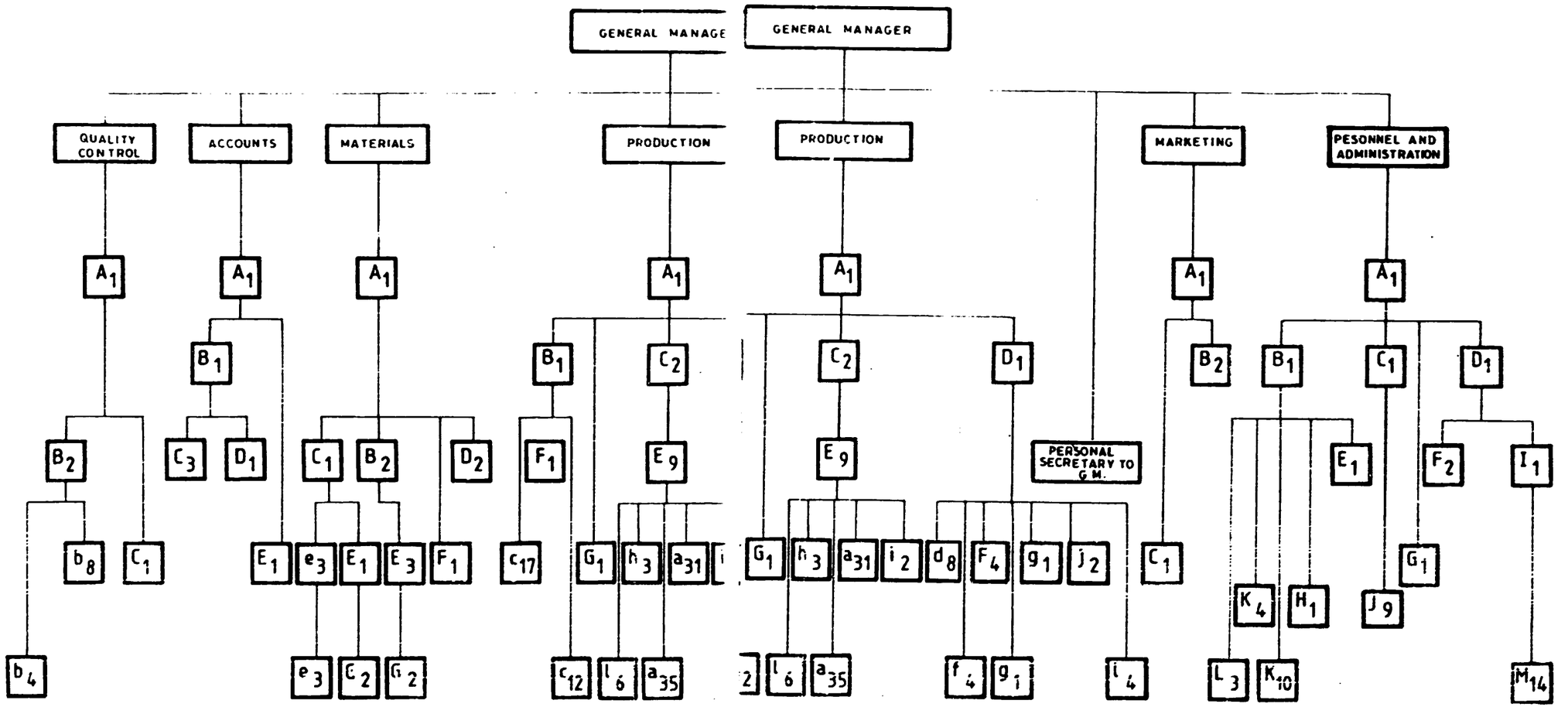
JOB NO. : DCIL-105

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

EXHIBIT : 26

PROJECT PROFILE ON UNDERGROUND CABLES

ORGANISATION CHART



JOB NO. : DCIL-105 EXHIBIT : 27

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION AND ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

STATEMENT OF MONTHLY SALARIES AND WAGES

Level	Nos. Required	Monthly Salary Per Person (US$)	Total per Month (US$)
1	1	9,000	9,000
2	6	6,000	36,000
3	10	5,223	52,230
4	26	3,358	87,308
5*	97	1,791	1,73,727
6	14	900	12,600
7**	108	746	80,568
TOTAL	262		4,51,433

* includes skilled workers
** includes unskilled workers

SECTION - 12
FINANCIAL ANALYSIS AND EVALUATION

FINANCIAL ANALYSIS AND EVALUATION

COUNTRY : LYBIA

The financial analysis and evaluation of the proposed project for setting up the Underground Cables plant in this country are based on the capacity utilisation, price and costs.

Project Cost

The estimated cost of the project of setting up the plant is around US $ 37.2 million as can be seen from Exhibit-28. The project cost includes the expenditure towards

- Land and land development
- Building and civil work
- Plant and machinery
- Miscellaneous fixed assets
- Preliminary expenses
- Pre-operative expenses
- Technical know-how fees

Preliminary expenses have been assumed on a lumpsum basis on the project cost. Pre-operative expenses have three components, viz., establishment, travelling expenses and miscellaneous expenses. Establishment costs have been computed on the basis of salaries payable and overheads to various personnel who have to be recruited at various levels, during the construction period. Travelling expenss have been taken as approximately 10% of establishment costs from second to the last quarter of the construction period. Miscellaneous expenses have also been taken on a lumpsum

basis. Technical know-how fees have been taken as 3.5% of the project cost excluding interest during construction and margin money for working capital.

5% cushion has been provided towards contingency. This cost also includes interest during construction and margin money for working capital.

Phasing of capital expenditure is based on implementation plan, and interest during construction has been computed based on the phasing. These two are presented in Exhibits 29 and 30 respectively.

Margin money for working capital is presented in Exhibit-31. In computing margin money it is assumed that adequate provisions have to be kept towards storage of raw materials and consumables required to be imported.

The project is assumed to be financed by Debt-Equity Ratio of 1:1.

Production, Sales and Revenue

Statement of production and sales of various product range and the revenue that will be generated from the sales of the products over the 10-year period are presented in Exhibits 32 and 33 respectively. Capacity utilisation is assumed at the rate of 70% in the first year, 80% in the second year and 90% from the third year onwards.

Costs

The annual costs of production and sales computed over 10 years are presented in Exhibit-34. In estimating these costs it is assumed that the salaries and wages will increase at the flat rate of 5% every year.

Profitability

Projected profitability statement is presented in Exhibit-35. The average profit before tax works out to 15.4% of average revenue.

Statement of fixed assets and depreciation under straight line method is presented in Exhibit-36. Tax computation and depreciation for tax are presented in Exhibits 37 and 38 repspectively.

Working capital requirements are shown in Exhibit-39.

Projected cash flow statement and balance sheet over 10-year period are shown in Exhibits 40 and 41 respectively.

The project breaks even at around 45% and shows internal rate of return of 50.5% as can be seen from Exhibits 42 and 43 respectively. In computing internal rate of return, outflow is taken as the project cost and inflow is taken as the profit before interest, depreciation and tax.

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 28

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

ESTIMATED PROJECT COST

('000 US $)

Sl. No.	Items	Value	Total
1.	Land and Land Development (@ US$ 261 per m² for 32,131 m²)	8386.19	8386.19
2.	Building and Civil Work		
i)	Workshop Building (@ US$ 1268 per m² for 11,300 m²)	14328.40	
ii)	Administrative Building (@ US$ 1530 per m² for 640 m²)	979.20	
iii)	Auxiliary Buildings (@ US$ 1530 per m² for 676 m²)	1034.28	
iv)	Open storage Yard (@ US$ 1268 per m² for 1560 m²)	1978.08	
	Sub-total (2)		18319.96
3.	Plant and Machinery		
i)	Imported		
	- Production shop equipment	2204.00	
	- Material handling equipment	398.76	
	- Tool room and maintenance equipment	134.95	
	- Auxiliary equipment and handtools	12.00	
	- Testing and Quality control equipment	38.30	
	Total F.O.B. Value	2788.01	
ii)	Insurance & Freight (@ 10% of FOB Value)	278.80	
iii)	C.I.F. Value	3066.81	
iv)	Import duty @ 6% on CIF value	184.01	
v)	Transportation @ 1% of CIF Value	30.67	
	Landed Cost at Site [Sub-total (3)]		3281.49

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('000 US $)

Items		Value	Total
4.	Miscellaneous Fixed Assets		
i)	Transformers	65.70	
ii)	Switchgears	4.50	
iii)	Central Airconditioning system	112.90	
iv)	Illumination,Fans and Room Coolers	3.50	
v)	Water Pumps and Tank	20.10	
vi)	Compressors	72.38	
vii)	Fire fighting system	6.00	
viii)	Telecommunication system	22.00	
ix)	Office Furniture and Equipment	16.00	
x)	Vehicles	81.80	
xi)	Weighbridge	3.70	
	Sub-total (4)		408.58
5.	Preliminary Expenses	25.00	25.00
6.	Pre-operative Expenses		
i)	Establishment	1299.99	
ii)	Travelling Expenses	128.00	
iii)	Miscellaneous	45.00	
			1472.99
7.	Technical Know-how Fees	1217.00	1217.00
8.	Sub-total (1 thru 7)	-	33111.21
9.	Contingency @ 5% on above	-	1655.56
10.	Sub-total (8 & 9)	-	34766.77
11.	Interest during Construction	-	1859.09
12.	Margin Money for Working Capital	-	568.49
	TOTAL COST	-	37194.35

JOB NO. : DCIL-105 EXHIBIT : 29

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

PHASING OF CAPITAL EXPENDITURE

('000 US $)

	Total	Construction Period in Quarters								
		1	2	3	4	5	6	7	8	9
1. Land and Land Development	8386.19	0.00	1677.23	3354.48	3354.48	0.00	0.00	0.00	0.00	0.00
2. Building and Civil Work	18319.96									
i) Workshop Building	14328.40	0.00	0.00	0.00	3582.10	3582.10	3582.10	3582.10	0.00	0.00
ii) Administrative Building	979.20	0.00	0.00	0.00	0.00	391.68	391.68	195.84	0.00	0.00
iii) Auxiliary Buildings	1034.28	0.00	0.00	0.00	0.00	344.76	344.76	344.76	0.00	0.00
iv) Open Storage Yard	1978.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	989.04	989.04
3. Plant and Machinery	3281.49									
i) Ordering	984.45	0.00	0.00	0.00	0.00	0.00	984.45	0.00	0.00	0.00
ii) Supply, delivery and installation at site	2297.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2239.61	57.43

JOB NO. : DCIL-105

EXHIBIT : 29

('000 US $)

	Total	Construction Period in Quarters								
		1	2	3	4	5	6	7	8	9
4. Miscellaneous Fixed Assets	408.58									
i) Transformers	65.70	0.00	0.00	0.00	0.00	0.00	13.14	0.00	52.56	0.00
ii) Switchgears	4.50	0.00	0.00	0.00	0.00	0.00	0.90	0.00	3.60	0.00
iii) Central Airconditioning system	112.90	0.00	0.00	0.00	0.00	0.00	22.58	0.00	90.32	0.00
iv) Illumination,Fans and Room Coolers	3.50	0.35	0.00	0.63	0.63	0.63	0.63	0.63	0.00	0.00
v) Water Pumps and Tank	20.10	0.00	0.00	0.00	10.05	10.05	0.00	0.00	0.00	0.00
vi) Compressors	72.38	0.00	0.00	0.00	0.00	0.00	14.48	0.00	57.90	0.00
vii) Fire fighting system	6.00	0.00	0.00	0.00	0.00	0.00	3.00	0.00	3.00	0.00
viii) Telecommunication system	22.00	0.00	2.20	0.00	0.00	2.20	4.40	4.40	4.40	4.40
ix) Office Furniture and Equipment	16.00	0.00	0.80	0.80	1.60	1.60	1.60	1.60	1.60	6.40
x) Vehicles	81.80	0.00	9.70	9.70	0.00	0.00	0.00	0.00	0.00	62.40
xi) Weighbridge	3.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.70	0.00
5. Preliminary Expenses	25.00	12.50	12.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6. Pre-operative Expenses	1472.99									
i) Establishment	1299.99	0.00	26.46	65.87	99.54	99.54	151.95	151.95	151.95	552.73
ii) Travelling Expenses	128.00	0.00	2.00	6.00	10.00	10.00	15.00	15.00	15.00	55.00
iii) Miscellaneous	45.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
7. Technical Know-how Fees	1217.00	60.85	243.40	243.40	121.70	121.70	121.70	121.70	121.70	60.85
8. Sub-total (1 thru 7)	33111.21	78.70	1979.29	3685.88	7185.10	4569.26	5657.37	4422.98	3739.38	1793.25
9. Contingency @ 5% on above	1655.56	3.94	98.96	184.29	359.25	228.46	282.87	221.15	186.97	89.66
10. Sub-total (8 & 9)	34766.77	82.64	2078.25	3870.17	7544.35	4797.73	5940.24	4644.13	3926.35	1882.91

JOB NO. : DCIL-105

EXHIBIT : 30

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

ESTIMATION OF INTEREST DURING CONSTRUCTION

('000 US $)

	Construction Period in Quarters									Total
	1	2	3	4	5	6	7	8	9	
Capital Expenditure	82.64	2078.25	3870.17	7544.35	4797.73	5940.24	4644.13	3926.35	1882.91	34766.77
Margin Money	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	568.49	568.49
Total	82.64	2078.25	3870.17	7544.35	4797.73	5940.24	4644.13	3926.35	2451.40	35335.26
Equity	41.58	1046.19	1960.93	3834.25	2500.53	3106.83	2493.77	2164.00	1449.10	18597.18
Loan	41.58	1046.18	1960.94	3834.24	2500.53	3106.83	2493.78	2163.99	1449.10	18597.17
Total	83.16	2092.37	3921.87	7668.49	5001.06	6213.66	4987.55	4327.99	2898.20	37194.35

JOB NO. : DCIL-185

EXHIBIT : 30

('000 RS $)

	Construction Period in Quarters									Total
	1	2	3	4	5	6	7	8	9	
Interest on loan										
- @ 10% p.a.	0.52	13.08	24.51	47.93	31.26	38.84	31.17	27.05	18.11	232.47
		1.04	26.15	49.02	95.86	62.51	77.67	62.34	54.10	428.69
			1.04	26.15	49.02	95.86	62.51	77.67	62.34	374.59
				1.04	26.15	49.02	95.86	62.51	77.67	312.25
					1.04	26.15	49.02	95.86	62.51	234.58
						1.04	26.15	49.02	95.86	172.07
							1.04	26.15	49.02	76.21
								1.04	26.15	27.19
									1.04	1.04
Total	0.52	14.12	51.70	124.14	203.33	273.42	343.42	401.64	446.80	1859.09
Debt/Equity	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

MEANS OF FINANCING :

EQUITY	18597.18
LOAN	18597.17
TOTAL	37194.35

DEVELOPMENT CONSULTANTS

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 31

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

MARGIN MONEY FOR WORKING CAPITAL

('000 US $)

Sl. No.	Item	Period (Days)	Cost	Bank Finance Available (%)	(Amount)	Margin Money
1.	Raw materials & Consumables	120	19814.79	100%	19814.79	0.00
2.	Finished Stock	30	5320.52	100%	5320.52	0.00
3.	Sundry Debtors	30	6476.44	100%	6476.44	0.00
Sub-total			31611.75		31611.75	0.00
4.	Expenses	30	568.49	0%	0.00	568.49
	Total		32180.24		31611.75	568.49

JOB NO. : DCIL-105 EXHIBIT : 32

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

STATEMENT OF PRODUCTION AND SALES

(in Nos)

	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
Working Days/Year	300	300	300	300	300	300	300	300	300	300
Utilisation	70%	80%	90%	90%	90%	90%	90%	90%	90%	90%
XLPE HV Cables (Single Core)										
Capacity (KMs)	600	600	600	600	600	600	600	600	600	600
Annual Output (KMs)	420.00	420.00	420.00	420.00	420.00	420.00	420.00	420.00	420.00	420.00
Output/Day (KMs)	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
Opening Stock	0.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00
Production	420.00	420.00	420.00	420.00	420.00	420.00	420.00	420.00	420.00	420.00
Total	420.00	455.00	455.00	455.00	455.00	455.00	455.00	455.00	455.00	455.00
Closing Stock	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00
Sales	385.00	420.00	420.00	420.00	420.00	420.00	420.00	420.00	420.00	420.00
MV Cables (Multi Core)										
Capacity (Kms)	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
Annual Output (Kms)	2800.00	3200.00	3600.00	3600.00	3600.00	3600.00	3600.00	3600.00	3600.00	3600.00
Output/Day (Kms)	9.33	10.67	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
Opening Stock	0.00	233.33	266.67	300.00	300.00	300.00	300.00	300.00	300.00	300.00
Production	2800.00	3200.00	3600.00	3600.00	3600.00	3600.00	3600.00	3600.00	3600.00	3600.00
Total	2800.00	3433.33	3866.67	3900.00	3900.00	3900.00	3900.00	3900.00	3900.00	3900.00
Closing Stock	233.33	266.67	300.00	300.00	300.00	300.00	300.00	300.00	300.00	300.00
Sales	2566.67	3166.67	3566.67	3600.00	3600.00	3600.00	3600.00	3600.00	3600.00	3600.00

JOB NO. : DCIL-105

EXHIBIT : 33

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANISATION

PROJECT PROFILE ON UNDERGROUND CABLES

STATEMENT OF REVENUE

('000 DS $)

	Selling Price (US $/KM)	OPERATING YEARS									
		1	2	3	4	5	6	7	8	9	10
EHV/HV Cables	38000.00	14610.00	15960.00	15960.00	15960.00	15960.00	15960.00	15960.00	15960.00	15960.00	15960.00
MV Cables	25000.00	64166.67	79166.67	89166.67	90000.00	90000.00	90000.00	90000.00	90000.00	90000.00	90000.00
Total		78796.67	95126.67	105126.67	105960.00	105960.00	105960.00	105960.00	105960.00	105960.00	105960.00

JOB NO. : DCIL-105

EXHIBIT : 34

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANISATION

PROJECT PROFILE ON UNDERGROUND CABLES

COST OF PRODUCTION AND SALES

('000 US $)

	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
A. Variable Cost										
Raw Materials and Consumables	57400.00	65600.00	73800.00	73800.00	73800.00	73800.00	73800.00	73800.00	73800.00	73800.00
Power	457.44	522.71	587.98	587.98	587.98	587.98	587.98	587.98	587.98	587.98
Water	51.07	58.37	65.66	65.66	65.66	65.66	65.66	65.66	65.66	65.66
Sub-total	57908.52	66181.08	74453.65	74453.65	74453.65	74453.65	74453.65	74453.65	74453.65	74453.65
Contingency (10 % on above)	2895.43	3309.05	3722.68	3722.68	3722.68	3722.68	3722.68	3722.68	3722.68	3722.68
Total 'A'	60803.94	69490.13	78176.33	78176.33	78176.33	78176.33	78176.33	78176.33	78176.33	78176.33
B. Fixed Cost										
i) Labour & Plant Overhead :										
a) Direct labour	2235.92	2347.72	2459.51	2571.31	2683.10	2794.90	2906.70	3018.49	3130.29	3242.08
b) Indirect labour	966.82	1015.16	1063.50	1111.84	1160.18	1208.53	1256.87	1305.21	1353.55	1401.89
c) Supervision	1047.70	1100.08	1152.47	1204.85	1257.24	1309.62	1362.00	1414.39	1466.77	1519.16
Sub-total	4250.44	4462.96	4675.48	4888.00	5100.52	5313.05	5525.57	5738.09	5950.61	6163.13

JOB NO. : DCIL-185 EXHIBIT : 34

('000 US $)

	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
ii) Other Factory Expenses										
a) Maintenance @ 3%										
on Plant & Equipment	98.44	98.44	98.44	98.44	98.44	98.44	98.44	98.44	98.44	98.44
b) Maintenance @ 1%										
on Building & Civil Works	183.20	183.20	183.20	183.20	183.20	183.20	183.20	183.20	183.20	183.20
c) Miscellaneous	56.33	56.33	56.33	56.33	56.33	56.33	56.33	56.33	56.33	56.33
Sub-total	337.97	337.97	337.97	337.97	337.97	337.97	337.97	337.97	337.97	337.97
iii) Administrative & Sales Expenses										
a) Salaries *	1166.76	1225.10	1283.44	1341.77	1400.11	1458.45	1516.79	1575.13	1633.46	1691.80
b) Overheads	233.35	245.02	256.69	268.35	280.02	291.69	303.36	315.03	326.69	338.36
Sub-total	1400.11	1470.12	1540.12	1610.13	1680.13	1750.14	1820.15	1890.15	1960.16	2030.16
Total (i+ii+iii)	5988.52	6271.05	6553.58	6836.10	7118.63	7401.16	7683.69	7966.21	8248.74	8531.27
Contingency (@ 5% on above)	299.43	313.55	327.68	341.81	355.93	370.06	384.18	398.31	412.44	426.56
Total 'B'	6287.95	6584.60	6881.25	7177.91	7474.56	7771.22	8067.88	8364.51	8661.18	8957.83
Total Cost of Production and Sales (A+B)	67091.89	76074.73	85057.58	85354.24	85650.89	85947.54	86244.21	86540.84	86837.50	87134.16

* Assumed to increase at the flat rate of 5% straight line every year

JOB NO. : DCIL-105 EXHIBIT : 35

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

PROJECTED PROFITABILITY STATEMENT

('000 US $)

Elements	OPERATING YEARS 1	2	3	4	5	6	7	8	9	10
Raw Materials and Consumables	57400.00	65600.00	73800.00	73800.00	73800.00	73800.00	73800.00	73800.00	73800.00	73800.00
Power	457.44	522.71	587.98	587.98	587.98	587.98	587.98	587.98	587.98	587.98
Water	51.07	58.37	65.66	65.66	65.66	65.66	65.66	65.66	65.66	65.66
Labour & Plant Overhead	4250.64	4462.96	4675.48	4888.00	5100.52	5313.05	5525.57	5738.09	5950.61	6163.13
Other Factory Expenses	337.97	337.97	337.97	337.97	337.97	337.97	337.97	337.97	337.97	337.97
Administrative & Sales Expenses	1400.11	1470.12	1540.12	1610.13	1680.13	1750.14	1820.15	1890.15	1960.16	2030.16
Sub-total	63897.03	72452.13	81007.21	81289.74	81572.26	81854.80	82137.31	82419.85	82702.38	82984.90
Contingency	3194.84	3622.61	4050.36	4064.49	4078.61	4092.74	4106.87	4120.99	4135.12	4149.25
Total	67091.87	76074.74	85057.57	85354.23	85650.87	85947.54	86244.20	86540.84	86837.50	87134.15
Stock Variation	-5320.52	-726.01	-726.01	-18.34	-18.34	-18.34	-18.35	-18.34	-18.34	-18.34
Cost of Production and Sales	61771.35	75348.73	84331.56	85335.89	85632.53	85929.20	86225.85	86522.50	86819.16	87115.81
PROJECTED REVENUE	78796.67	95126.67	105126.67	105960.00	105960.00	105960.00	105960.00	105960.00	105960.00	105960.00
Profit before Interest and Depreciation	17025.32	19777.94	20795.11	20624.11	20327.47	20030.80	19734.15	19437.50	19140.84	18844.19

JOB NO. : DCIL-105 EXHIBIT : 35

('000 DS $)

Elements	OPERATING YEARS 1	2	3	4	5	6	7	8	9	10
Interest										
On Term Loan										
- @ 10% p.a.	1859.72	1859.72	1859.72	1594.04	1328.37	1062.70	797.02	531.35	265.67	0.00
On Working Capital Loan										
- @ 12% p.a.	3793.41	3793.41	2845.06	1896.70	948.35	0.00	0.00	0.00	0.00	0.00
Sub-total	5653.13	5653.13	4704.78	3490.74	2276.72	1062.70	797.02	531.35	265.67	0.00
Profit before Depreciation	11372.19	14124.81	16090.33	17133.37	18050.75	18968.10	18937.13	18906.15	18875.17	18844.19
Depreciation and Amortisation	1374.83	1374.83	1374.83	1374.83	1374.83	1374.83	1374.83	1374.83	1374.83	1374.83
Profit before Tax	9997.36	12749.98	14715.50	15758.54	16675.92	17593.27	17562.30	17531.32	17500.34	17469.36
Tax	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Distributable Profit	9997.36	12749.98	14715.50	15758.54	16675.92	17593.27	17562.30	17531.32	17500.34	17469.36
Dividend	1859.72	1859.72	2789.58	3719.44	3719.44	3719.44	4649.29	4649.29	4649.29	5579.15
Retained Earnings	8137.64	10890.26	11925.92	12039.10	12956.48	13873.83	12913.01	12882.03	12851.05	11890.21
Add Back : Depreciation & Amortisation	1374.83	1374.83	1374.83	1374.83	1374.83	1374.83	1374.83	1374.83	1374.83	1374.83
NET CASH ACCRUAL	9512.47	12265.09	13300.75	13413.93	14331.31	15248.66	14287.84	14256.86	14225.88	13265.04

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 36

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

STATEMENT OF FIXED ASSETS AND DEPRECIATION UNDER STRAIGHT LINE METHOD

('000 US $)

Description	Value	Technical Know-how Fees	Sub-Total	Contin-gency	Sub-Total	Interest during Construct	Sub-Total	50% of Pre-op Expenses	Total	Rate (%)	Amount
1. Land & Land Development	8386.19	0.00	8386.19	0.00	8386.19	0.00	8386.19	0.00	8386.19	0%	0.00
2. Building & Civil Work	19319.96	1012.97	19332.93	1378.00	20710.93	1547.40	22258.33	613.43	22871.76	4%	914.87
3. Plant & Mahinery	3291.49	181.44	3462.93	246.83	3709.76	277.17	3986.93	109.88	4096.81	8%	327.74
4. Miscellaneous Fixed Assets	408.58	22.59	431.17	30.73	461.90	34.52	496.42	13.68	510.10	11%	56.11
5. Preliminary Expenses	25.00	0.00	25.00	0.00	25.00	0.00	25.00	0.00	25.00	10%	2.50
6. Pre-operative Expenses	1472.99	0.00	1472.99	0.00	1472.99	0.00	1472.99	-736.99	736.00	10%	73.60
7. Technical Know-how Fees	1217.00	-1217.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0%	0.00
Sub-total	33111.21		33111.21		34766.77		36625.86		36625.86		1374.83
8. Contingency	1655.56	0.00	1655.56	-1655.56	0.00	0.00	0.00	0.00	0.00		
Sub-total	34766.77		34766.77		34766.77		36625.86		36625.86		
9. Interest during Construction	1859.09	0.00	1859.09	0.00	1859.09	-1859.09	0.00	0.00	0.00		
Total	36625.86		36625.86		36625.86		36625.86		36625.86		

JOB NO. : DCIL-105

EXHIBIT : 37

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

TAX COMPUTATION

('000 US $)

	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
Profit before Depreciation	11372.19	14124.81	16090.33	17133.37	18050.75	18968.10	18937.13	18906.15	18875.17	18844.19
Less : Current Depreciation	1374.83	1305.84	1241.09	1104.19	1047.04	993.30	942.74	895.13	850.27	807.99
Balance	9997.36	12818.97	14849.24	16029.18	17003.71	17974.80	17994.40	18011.03	18024.90	18036.21
Less : Unabsorbed Depreciation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Taxable Income	9997.36	12818.97	14849.24	16029.18	17003.71	17974.80	17994.40	18011.03	18024.90	18036.21
Tax @ 0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

JOB NO. : DCIL-105 EXHIBIT : 38

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

DEPRECIATION FOR TAX

('000 US $)

	WDV Rate	Building & Civil Work 4%	Plant and Machinery 8%	Misc. Fixed Assets 10%	Amortisation 10%	Total
Value		22871.76	4096.81	510.10	761.00	
Depreciation Year 1		914.87	327.74	56.11	76.10	1374.83
Balance		21956.89	3769.06	453.99	684.90	
Depreciation Year 2		878.28	301.53	49.94	76.10	1305.84
Balance		21078.61	3467.54	404.05	608.80	
Depreciation Year 3		843.14	277.40	44.45	76.10	1241.09
Balance		20235.47	3190.14	359.60	532.70	
Depreciation Year 4		809.42	255.21	39.56	76.10	1180.29
Balance		19426.05	2934.93	320.05	456.60	
Depreciation Year 5		777.04	234.79	35.21	76.10	1123.14
Balance		18649.00	2700.13	284.84	380.50	
Depreciation Year 6		745.96	216.01	31.33	76.10	1069.40
Balance		17903.04	2484.12	253.51	304.40	
Depreciation Year 7		716.12	198.73	27.89	76.10	1018.84
Balance		17186.92	2285.39	225.62	228.30	
Depreciation Year 8		687.48	182.83	24.82	76.10	971.23
Balance		16499.45	2102.56	200.80	152.20	
Depreciation Year 9		659.98	168.20	22.09	76.10	926.37
Balance		15839.47	1934.36	178.72	76.10	
Depreciation Year 10		633.58	154.75	19.66	76.10	884.09
Balance		15205.89	1779.61	159.06	0.00	

WDV : Written Down Value

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 39

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANISATION

PROJECT PROFILE ON UNDERGROUND CABLES

WORKING CAPITAL REQUIREMENTS
(Excluding Cash and Bank Balances)

('000 US $)

Items	OPERATING YEAR									
	1	2	3	4	5	6	7	8	9	10
1. Raw materials & Consumables	19814.79	22645.48	25476.16	25476.16	25476.16	25476.16	25476.16	25476.16	25476.16	25476.16
2. Finished Stock	5320.52	6046.53	6772.54	6790.88	6809.22	6827.56	6845.91	6864.25	6882.59	6900.93
3. Sundry Debtors	6476.44	7818.63	8640.55	8709.04	8709.04	8709.04	8709.04	8709.04	8709.04	8709.04
TOTAL	31611.75	36510.64	40889.25	40976.08	40994.42	41012.76	41031.11	41049.45	41067.79	41086.13
Increase/(decrease)	31611.75	4898.89	4378.61	86.83	18.34	18.34	18.35	18.34	18.34	18.34
Stock Variation	5320.52	726.01	726.01	18.34	18.34	18.34	18.35	18.34	18.34	18.34

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 40

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANISATION

PROJECT PROFILE ON UNDERGROUND CABLES

PROJECTED CASH FLOW STATEMENT

('000 US $)

	Construction Period	Y 1	Y 2	R 1	R 4	R 5	A 6	A 7	R 8	R 9	R 10
A. SOURCES											
Increase in Share Capital	18597.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Increase in Term Loan	18597.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Increase in Bank Loan	0.00	31611.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Profit before Tax with Interest added back	0.00	15650.49	18403.11	19420.28	19249.28	18952.64	18655.97	18359.32	18062.67	17766.01	17469.36
Depreciation	0.00	1374.83	1374.83	1374.83	1374.83	1374.83	1374.83	1374.83	1374.83	1374.83	1374.83
TOTAL 'A'	37194.35	48637.07	19777.94	20795.11	20624.11	20327.47	20030.80	19734.15	19437.50	19140.84	18844.19
B. APPLICATIONS											
Increase in Capital Expenditure	34766.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Increase/(Decrease) in Working Capital	0.00	31611.75	4898.89	4378.61	86.83	18.34	18.34	18.35	18.34	18.34	18.34

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 40

('000 US $)

	Construction Period	Y 1	2	3	R 4	5	A 6	7	R 8	9	10
Interest											
On Term Loan - @ 10% p.a.	1859.09	1859.72	1859.72	1859.72	1594.04	1328.37	1062.70	797.02	531.35	265.67	0.00
On Working Capital Loan - @ 12% p.a.	0.00	3793.41	3793.41	2845.06	1896.70	948.35	0.00	0.00	0.00	0.00	0.00
Total Interest	1859.09	5653.13	5653.13	4704.78	3490.74	2276.72	1062.70	797.02	531.35	265.67	0.00
Tax	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dividend	0.00	1859.72	1859.72	2789.58	3719.44	3719.44	3719.44	4649.29	4649.29	4649.29	5579.15
Repayment of Term Loan	0.00	0.00	0.00	2656.74	2656.74	2656.74	2656.74	2656.74	2656.74	2656.73	0.00
Repayment of Working Capital Loan	0.00	0.00	7902.94	7902.94	7902.94	7902.93	0.00	0.00	0.00	0.00	0.00
TOTAL 'B'	36625.86	39124.60	20314.68	22432.65	17856.69	16574.17	7457.22	8121.40	7855.72	7590.03	5597.49
Opening Balance	0.00	568.49	10080.96	9544.22	7906.68	10674.10	14427.40	27000.98	38613.73	50195.51	61746.32
Surplus /(Deficit) during the Year (A - B)	568.49	9512.47	-536.74	-1637.54	2767.42	3753.30	12573.58	11612.75	11581.78	11550.81	13246.70
Closing Balance	568.49	10080.96	9544.22	7906.68	10674.10	14427.40	27000.98	38613.73	50195.51	61746.32	74993.02

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 41

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANISATION

PROJECT PROFILE ON UNDERGROUND CABLES

PROJECTED BALANCE SHEET

('000 US $

		Y	E	A	R					
		1	2	3	4	5	6	7	8	9	10
	Share Capital	18597.18	18597.18	18597.18	18597.18	18597.18	18597.18	18597.18	18597.18	18597.18	18597.18
Add:	Reserves & Surplus	8137.64	19027.90	30953.82	42992.92	55949.40	69823.23	82736.24	95618.27	108469.32	120359.53
	SHAREHOLDERS' FUND	26734.82	37625.08	49551.00	61590.10	74546.58	88420.41	101333.42	114215.45	127066.50	138956.71
Less:	Intangible Assets	684.90	608.80	532.70	456.60	380.50	304.40	228.30	152.20	76.10	0.00
	TANGIBLE NET WORTH	26049.92	37016.28	49018.30	61133.50	74166.08	88116.01	101105.12	114063.25	126990.40	138956.71
Add:	Term Loan	18597.17	18597.17	15940.43	13283.69	10626.95	7970.21	5313.47	2656.73	0.00	0.00
	CAPITAL FUND	44647.09	55613.45	64958.73	74417.19	84793.03	96086.22	106418.59	116719.98	126990.40	138956.71
Less:	Net Fixed Assets	34566.13	33267.40	31968.67	30669.94	29371.21	28072.48	26773.75	25475.02	24176.29	22877.56
	NET CURRENT ASSETS	10080.96	22346.05	32990.06	43747.25	55421.82	68013.74	79644.84	91244.96	102814.11	116079.15
A.	CURRENT ASSETS										
	Working Capital	31611.75	36510.64	40889.25	40976.08	40994.42	41012.76	41031.11	41049.45	41067.79	41086.13
	Cash & Bank Balance as per Cash Flow Statement	10080.96	9544.22	7906.68	10674.10	14427.40	27000.98	38613.73	50195.51	61746.32	74993.02
	TOTAL 'A'	41692.71	46054.86	48795.93	51650.18	55421.82	68013.74	79644.84	91244.96	102814.11	116079.15
B.	CURRENT LIABILITIES										
	Bank Loan	31611.75	23708.81	15805.87	7902.93	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL 'B'	31611.75	23708.81	15805.87	7902.93	0.00	0.00	0.00	0.00	0.00	0.00
	NET CURRENT ASSETS (A-B)	10080.96	22346.05	32990.06	43747.25	55421.82	68013.74	79644.84	91244.96	102814.11	116079.15

DEVELOPMENT CONSULTANTS

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 42

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION AND ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

BREAK-EVEN ANALYSIS

('000 US $)

Sl. No.	Particulars		Amount
1.	Raw Materials and Consumables		82000.00
2.	Power		653.31
3.	Water		72.96
4.	Sub-total (1 thru 3)		82726.27
5.	Contingency		4136.31
6.	VARIABLE COSTS		866 ..58
7.	REVENUE		117733.33
8.	CONTRIBUTION (7 - 6)		30870.76
9.	Labour & Plant Overhead*		5206.78
10.	Other Factory Expenses		337.97
11.	Administrative & Sales Expenses*		1715.14
12.	Sub-Total (9 thru 11)		7259.89
13.	Contingency		362.99
14.	Sub-Total (12+13)		7622.89
15.	Interest**		4887.05
16.	Depreciation		1374.83
17.	FIXED COSTS		13884.76
	BREAK-EVEN SALES	17*7/8	52953.00
	BREAK-EVEN POINT		45.0%
	CASH BREAK-EVEN SALES		47709.76
	CASH BREAK-EVEN POINT		40.5%

* Average over 10 years
** Average over 5 years

JOB NO. : DCIL-105 EXHIBIT : 43

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

INTERNAL RATE OF RETURN

('000 US $)

Year	Outflow	Inflow	Net Inflow
0	-37194.35	0.00	-37194.35
1	0.00	17025.32	17025.32
2	0.00	19777.94	19777.94
3	0.00	20795.11	20795.11
4	0.00	20624.11	20624.11
5	0.00	20327.47	20327.47
6	0.00	20030.80	20030.80
7	0.00	19734.15	19734.15
8	0.00	19437.50	19437.50
9	0.00	19140.84	19140.84
10	0.00	18844.19	18844.19

IRR 50.5%

Outflow - Project Cost
Inflow - Profit before Interest, Depreciation and Tax

SECTION - 13
PROJECT IMPLEMENTATION PLAN

PROJECT IMPLEMENTATION PLAN

The Underground Cable manufacturing plants will be set up in Libya. The implementation schedule of the key activities involved in setting up the plant is presented in Exhibit-44.

The programme covers a time span of 27 months starting from the preparation and finalisation of Detailed Project Report (DPR) and ending on the commencement of commercial production. It allows adequate time for procurement and erection of the equipment. Erection of heavier equipment will become easier if procurement and installation of EOT crane is speeded up. The total time span of 9 to 12 months for delivery of equipment at site have to be strictly adhered to, as this will involve international competitive bidding. Any delay in this stage will adversely affect the commissioning of the plant in time.

Recruitment of personnel has been shown in various key points during the implementation stage. Experienced personnel will be recruited within the first seven quarters for senior levels.

Though not included in the key activities, it is important that the client applies for and obtains the necessary funds from the concerned financial institution well in time.

JOB NO. : DCIL-105

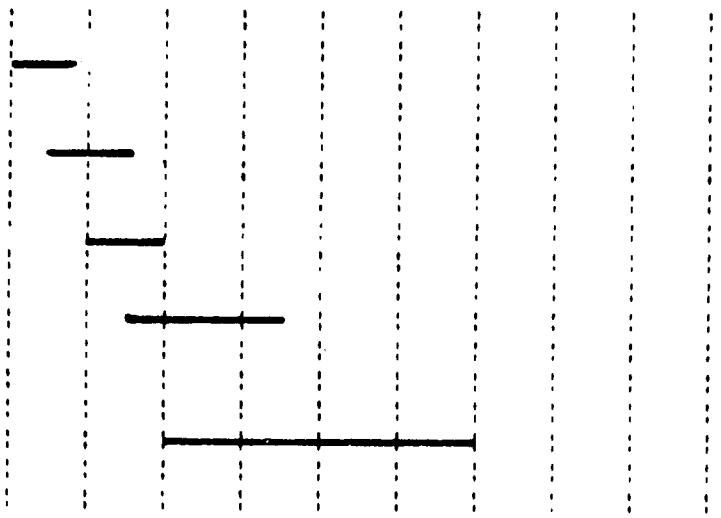
EXHIBIT : 44

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON UNDERGROUND CABLES

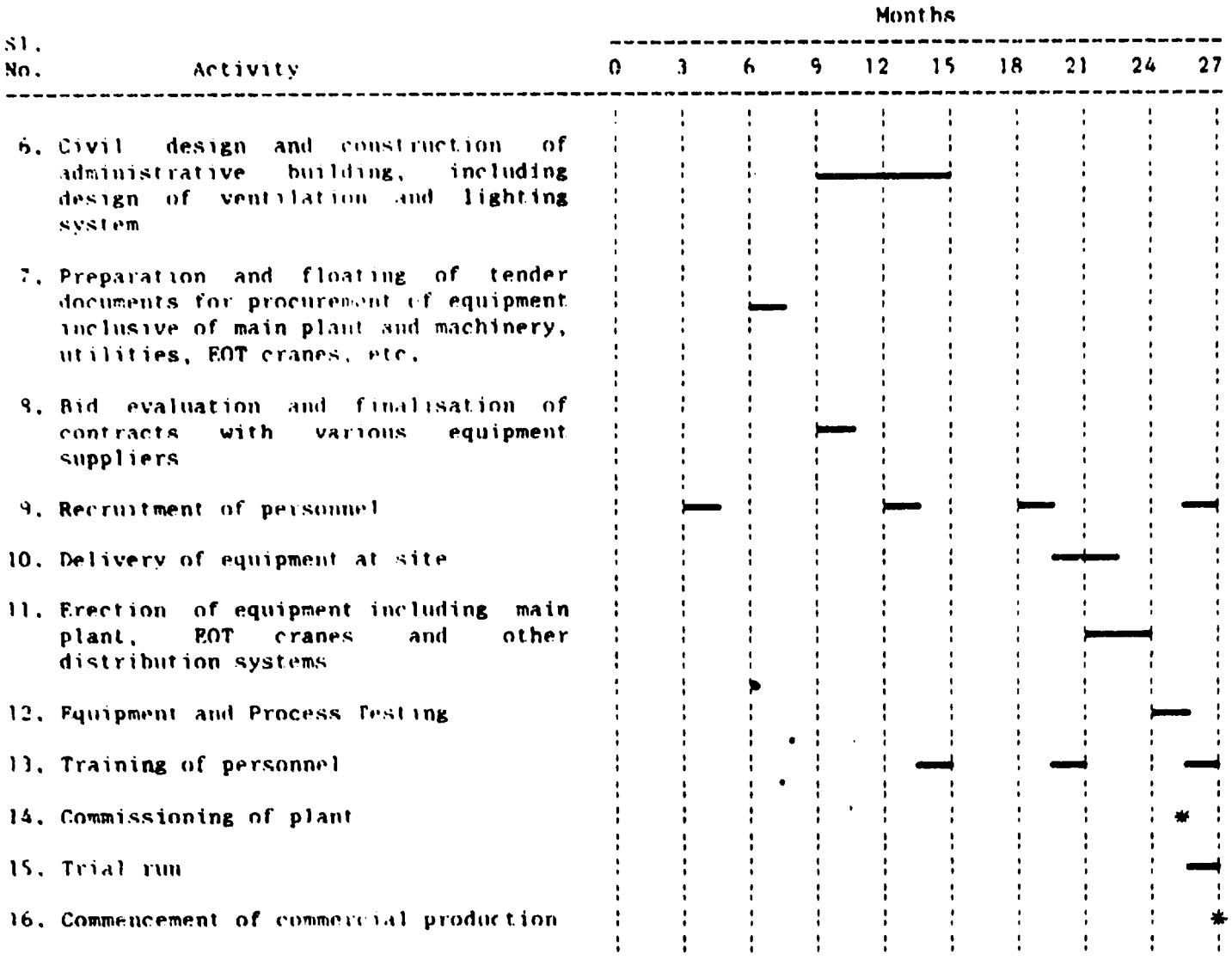
PROJECT IMPLEMENTATION SCHEDULE

Sl. No.	Activity	Months 0 3 6 9 12 15 18 21 24 27
1.	Finalisation of Detailed Project Report	
2.	Entering into agreement for collaboration	
3.	Finalisation of detailed engineering Report	
4.	Land development at site	
5.	Civil design and construction of workshop and auxiliary building, etc., including detail engineering for distribution of water, compressed air and power systems	



JOB NO. : DCIL-105

EXHIBIT : 44



DEVELOPMENT CONSULTANTS

AC·5

SEC 1

REV. NO. | DWG. NO. | JOB NO.

6.0 | 12.0 | 8.0

B

H V. TESTING STATION

SHOP OFFICE

16.0

16.0

64.0

CABLE DESPATCH PLATFORM

16.0

3.0 M. W

MATERIAL TESTING LABORATORY

16.0

B

MATERIAL RECEIVING PLATFORM

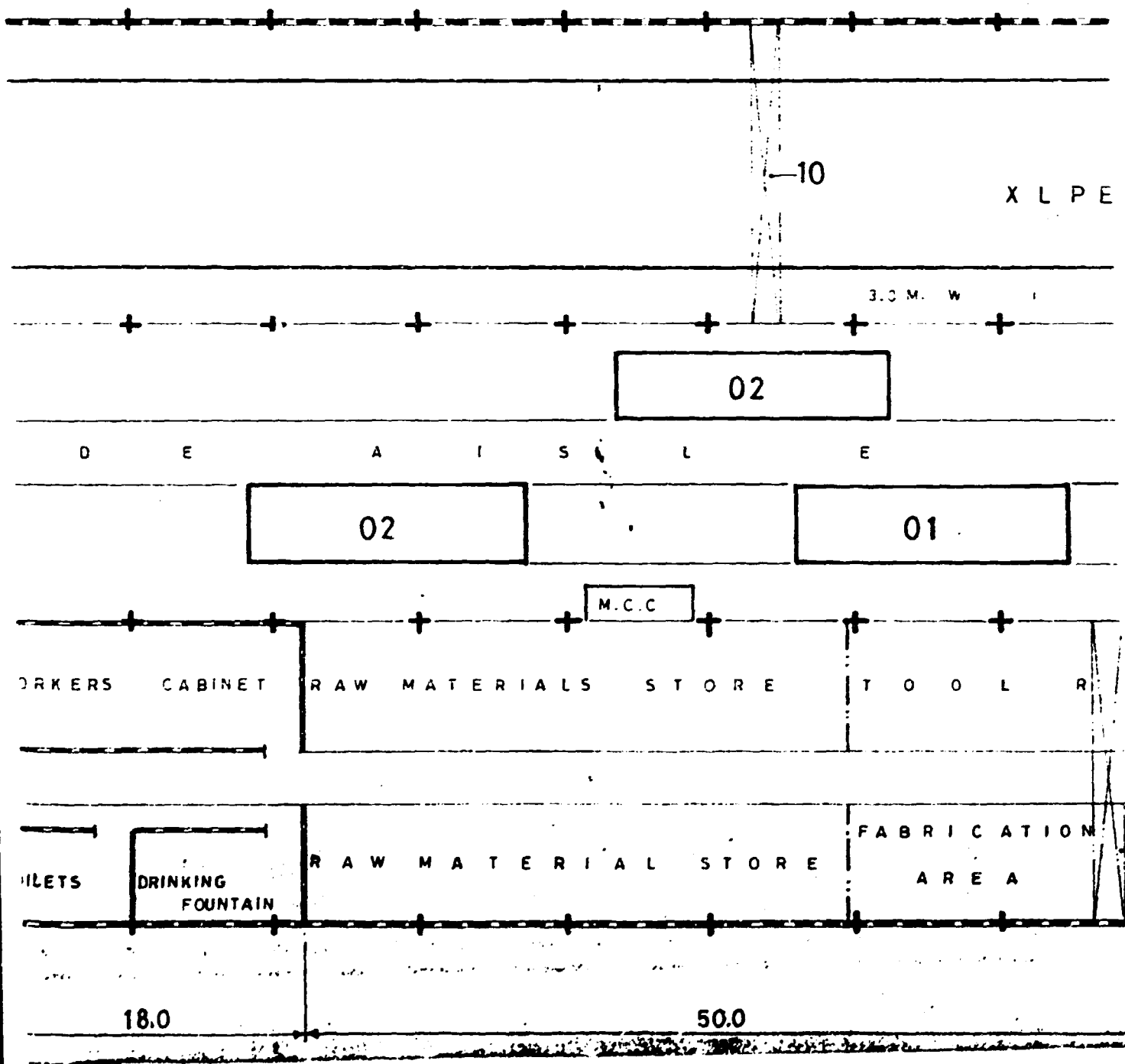
WORKE

TOILETS

6.0 | 4.0 | 10.0 | 6.0

H G F E

SEC. 2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01
M.C.C
ORKERS CABINET
RAW MATERIALS STORE
T O O L R
ILETS
DRINKING FOUNTAIN
RAW MATERIAL STORE
FABRICATION AREA
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50.0

SEC 3

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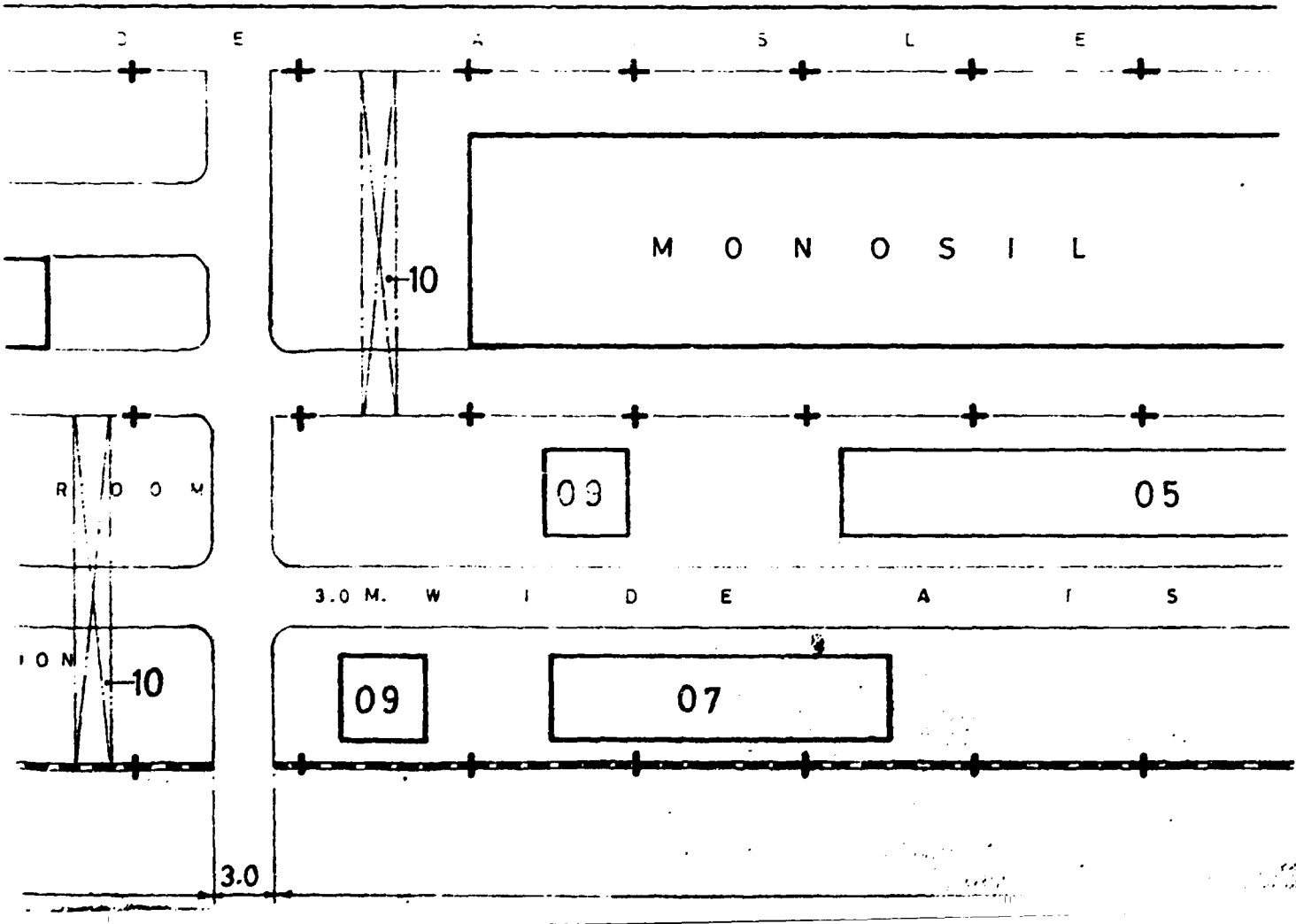
L P E. C A B L E L I N E



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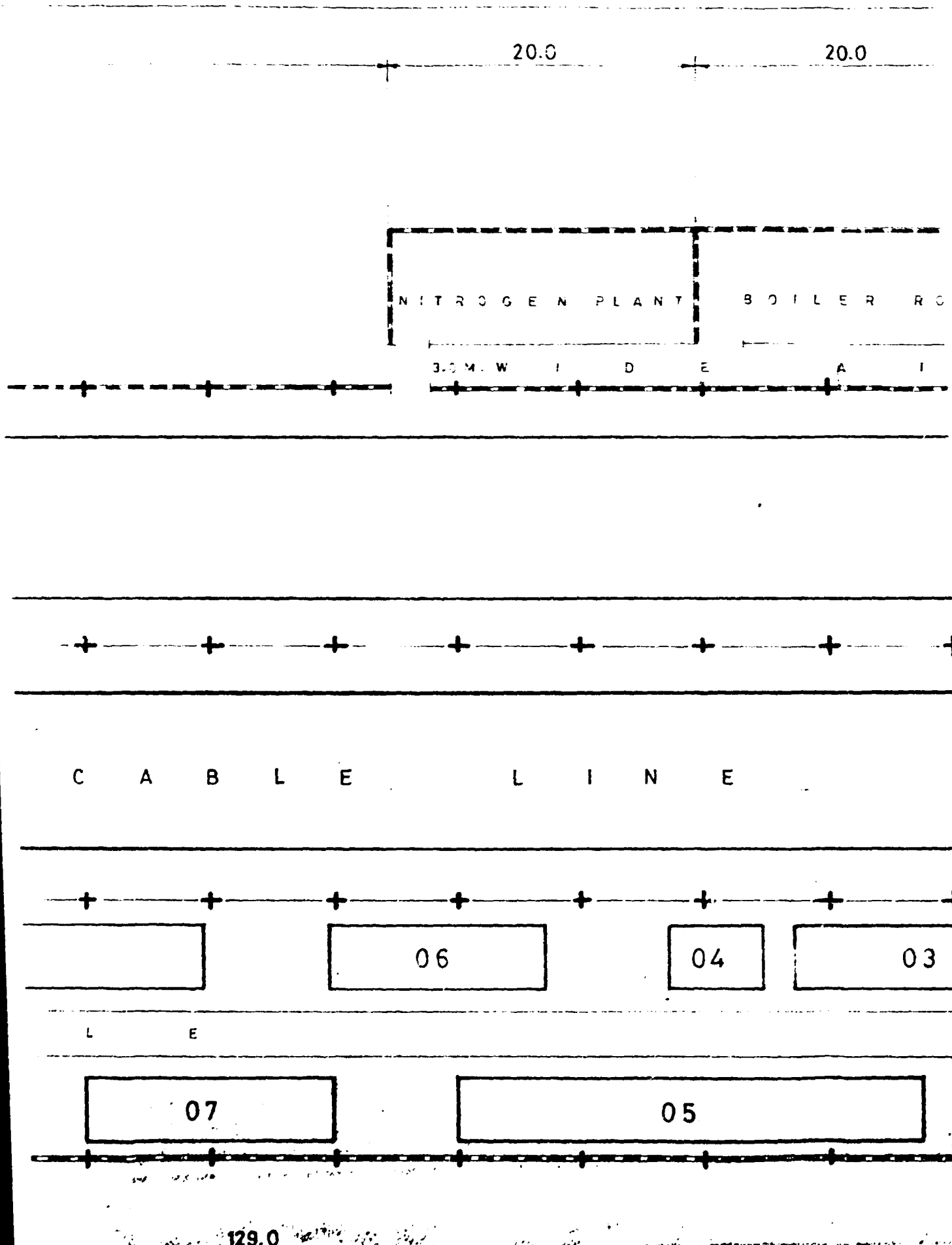
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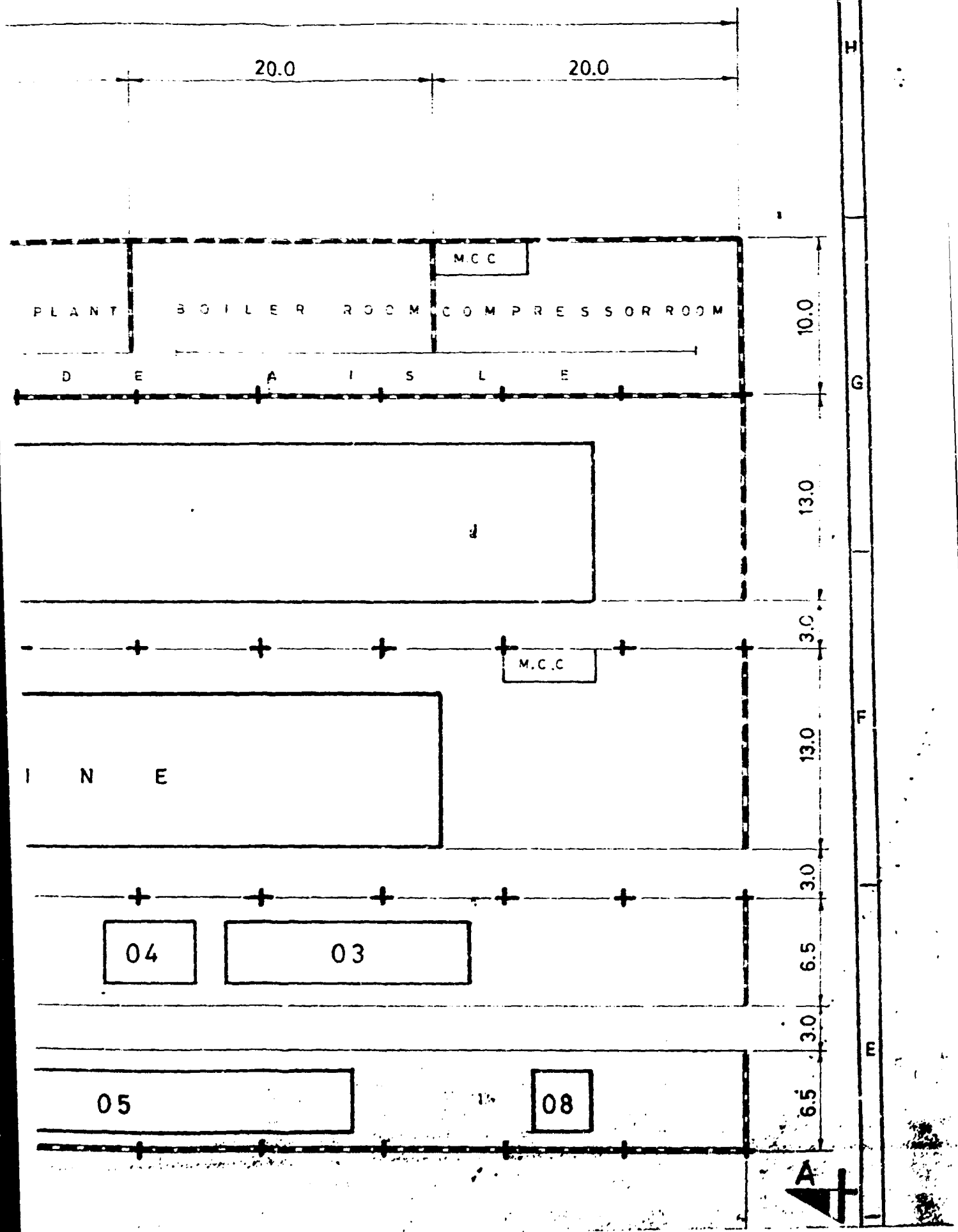
SEC 5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M.C.C
PLANT
BOILER ROOM
COMPRESSOR ROOM
D E A I S L E
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M.C.C
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05
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A
H
G
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E

Rec 5

SEC 6

10.0 | 8.0

D

C

B

A

LEGEND

01 OUTER SHEATHING MACHINE

02 CABLE REWINDERS

03 POLYMER EXTRUSION LINE

04 POLYMER PREPARATION AREA

05 STRANDING / ARMOURING MACHINE

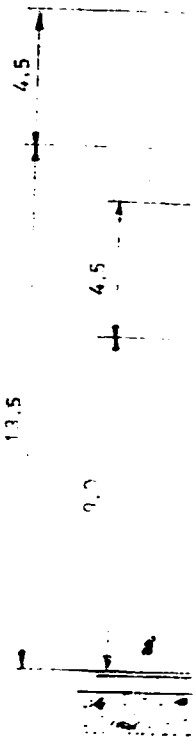
06 CORE LAYING MACHINE

07 ROD BREAKDOWN MACHINE

08 ANNEALING FURNACE

09 POINTING AND THREADING MACHINE

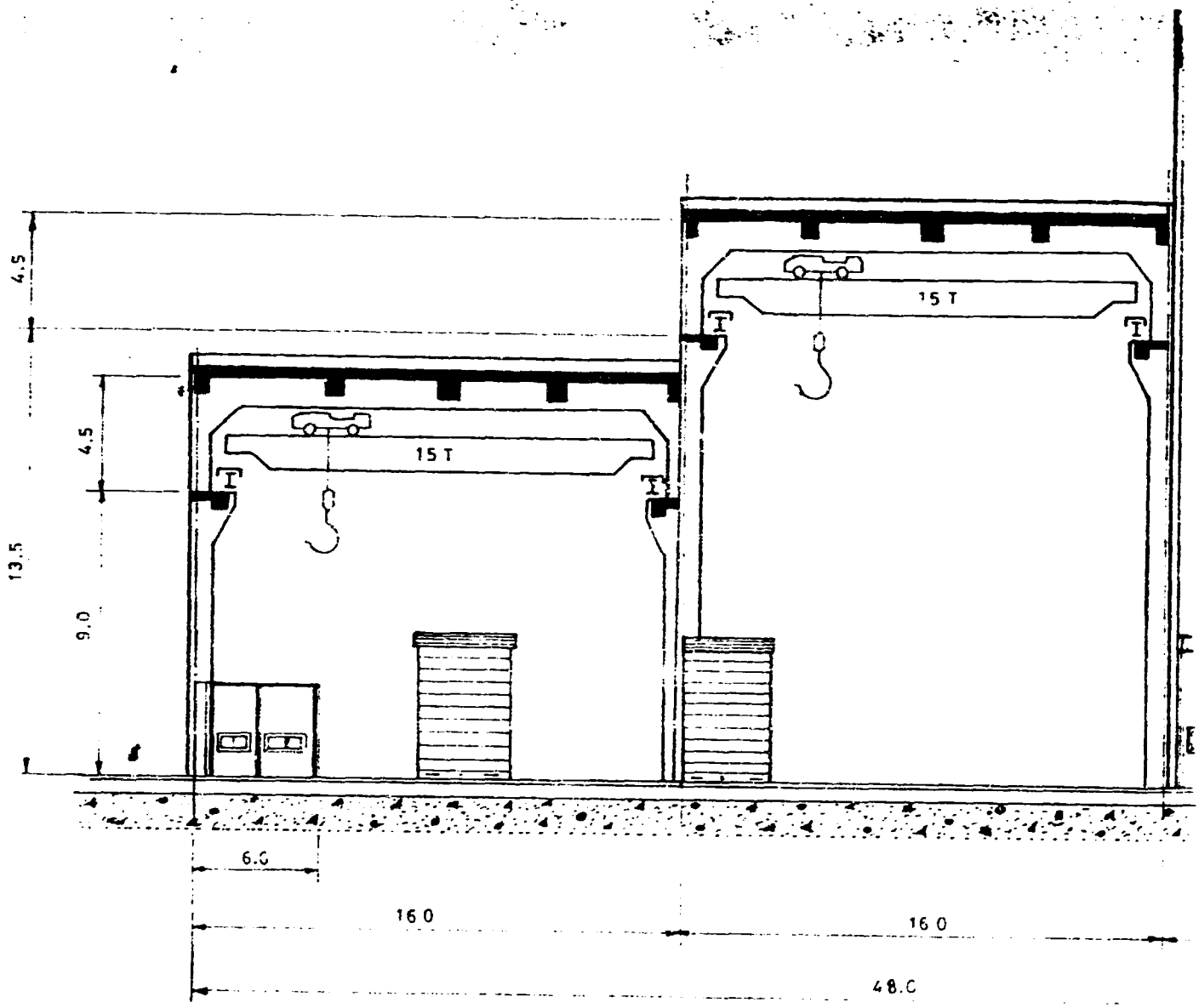
10 E.O.T CRANES



REVISIONS					
REV. NO.	RELEASE DATE	LOCATION & MARK	APPROVED BY		
			ARCH.	STR.	MECH	ELEC

SEC 6

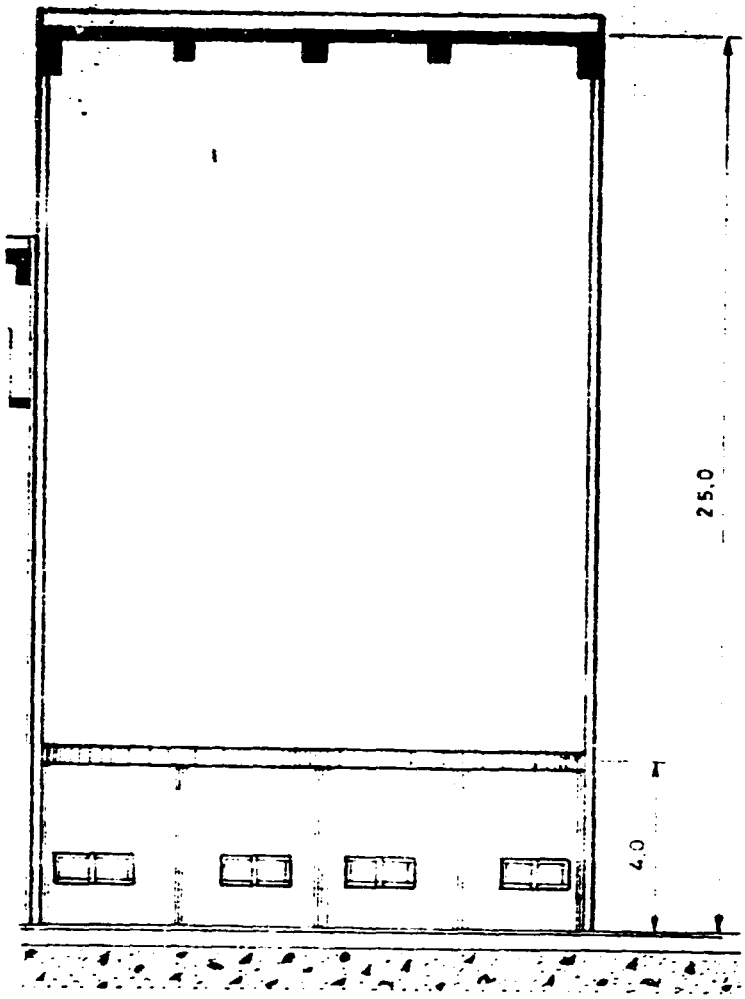
12 | 11

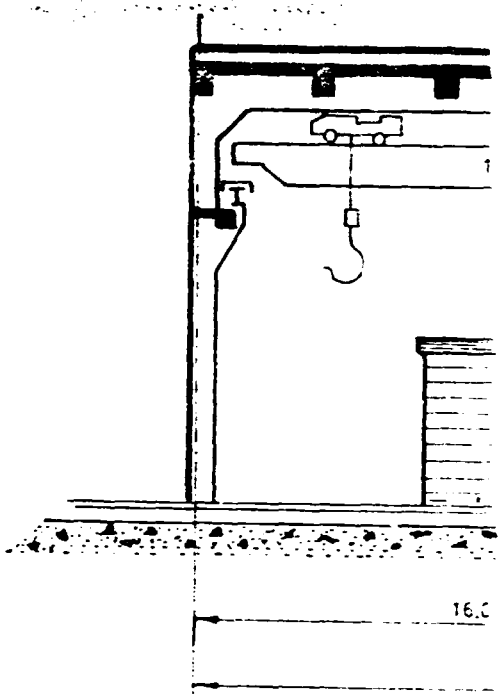


SECTION_BB

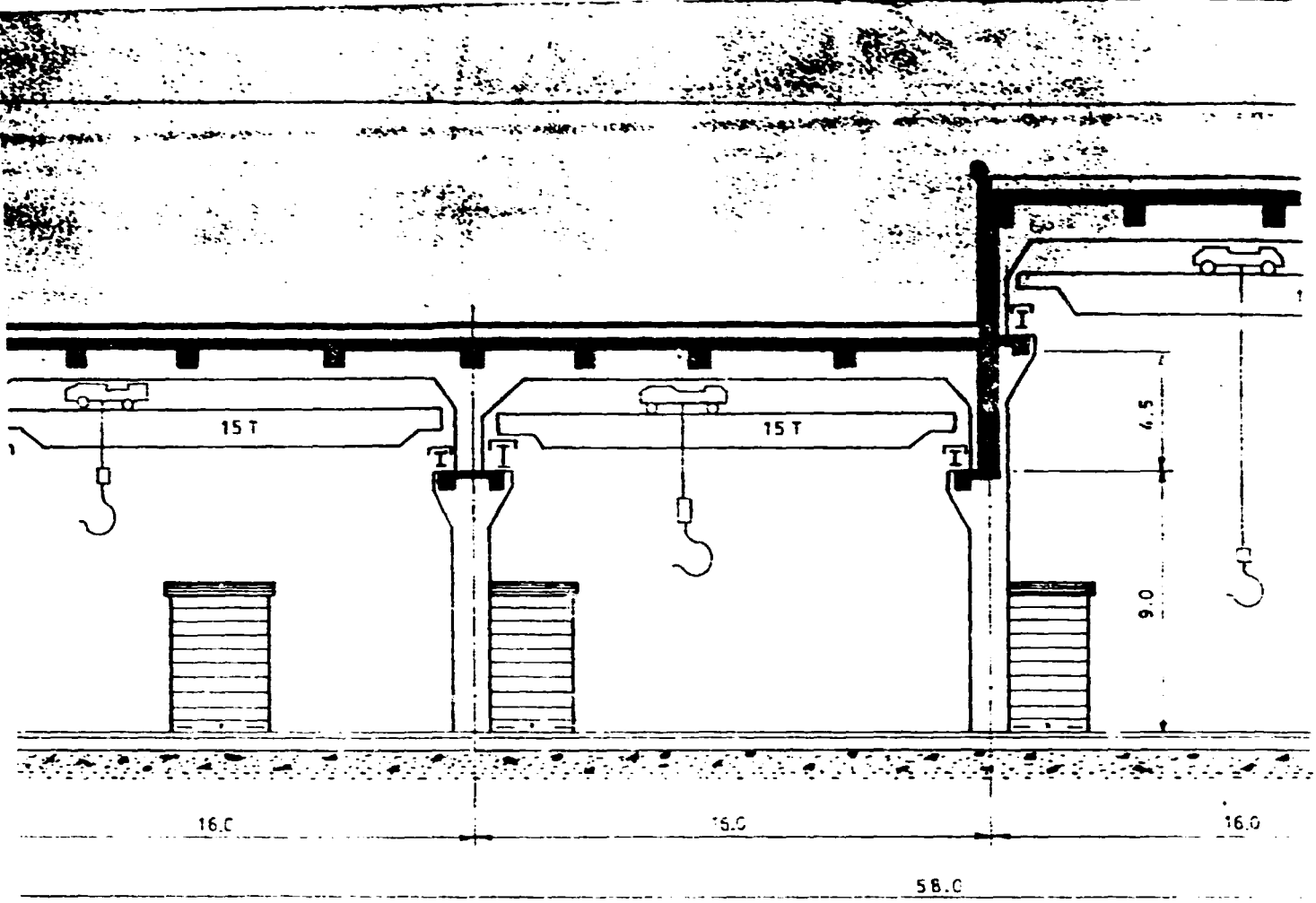
SEC 7

208.0





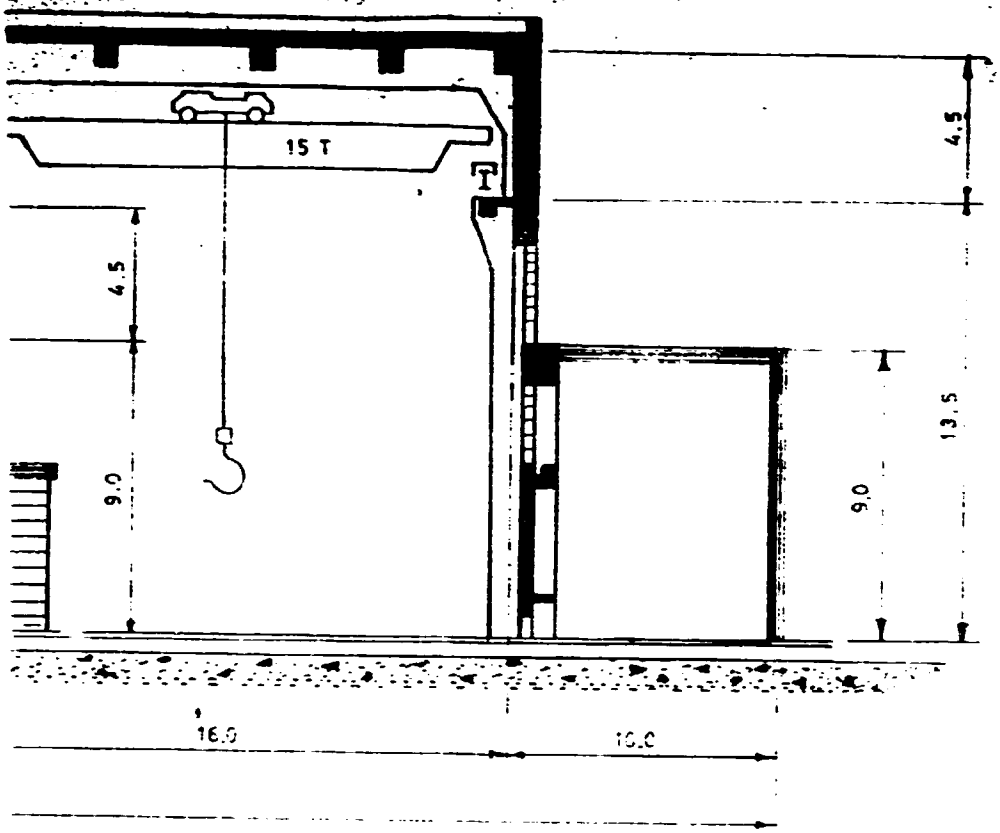
SEC 8



VIEW_A

RELEASE STATUS	DATE	SIGNATURE
PRELIMINARY		
FOR TENDER ONLY -		
FOR CONSTRUCTION		
CHECKED BY: ARCH.		

SEC 9



ALL DIMENSIONS ARE IN METRE

LAYOUT OF CABLE MANUFACTURING PLANT

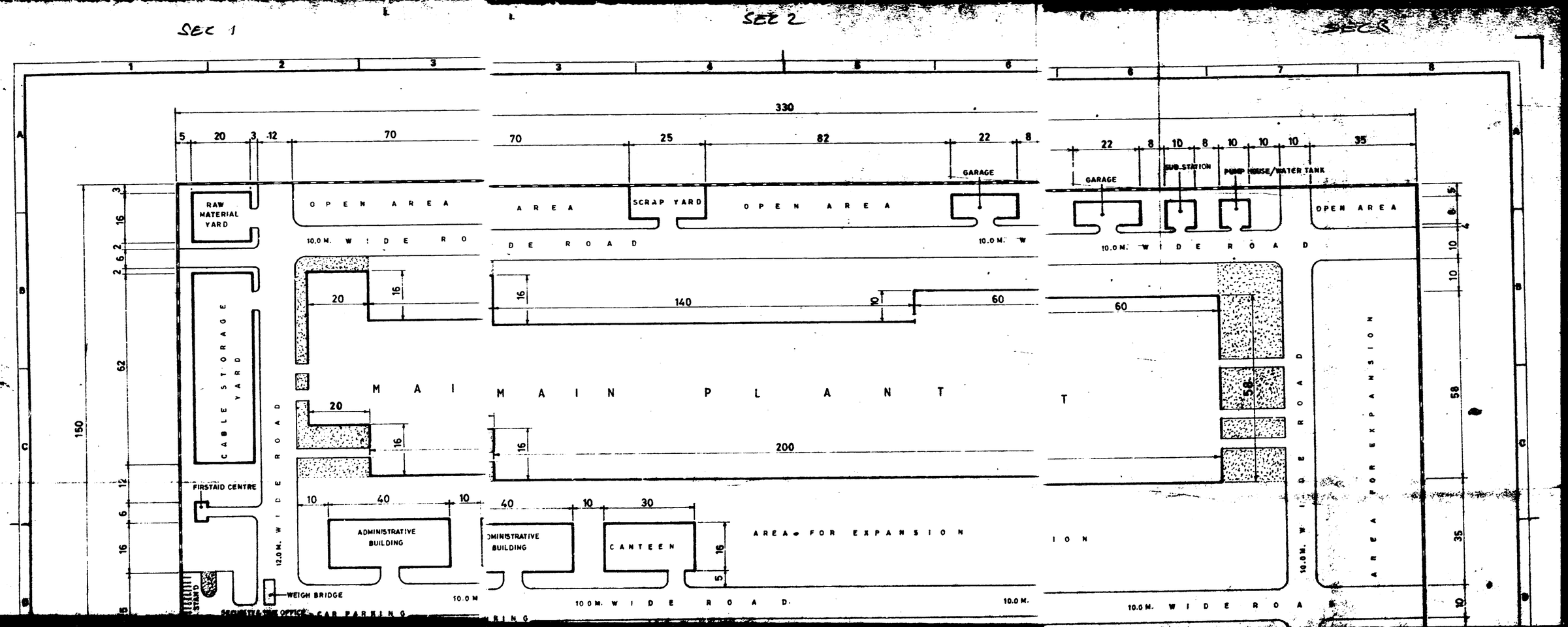
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

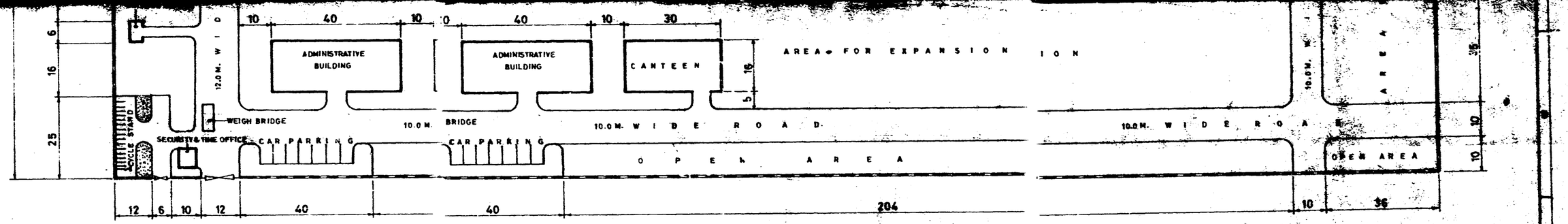
DATE	SIGNATURE

DEVELOPMENT CONSULTANTS
LIMITED
CONSULTING ENGINEERS
BOMBAY • CALCUTTA • MADRAS • NEW DELHI

DRAWN MUKUL	DESIGNED SR / MC	SCALE 1:500 , 1:200
PROJ. ENGR.	ISTC ENGR.	DATE 9 . 9 . 84
DEPT. HEAD		

DWG. NO. EXHIBIT 22 SEC 10


SEC 1
SEC 2
SEC 3
330
70
25
82
22
8
GARAGE
AREA
SCRAP YARD
OPEN AREA
DE ROAD
10.0 M. W
22
8
10
8
10
10
10
35
GARAGE
SUB STATION
PUMP HOUSE/WATER TANK
OPEN AREA
10.0 M. WIDE ROAD
5
8
10
10
5
5
20
3
12
70
RAW MATERIAL YARD
OPEN AREA
10.0 M. WIDE ROAD
3
16
2
6
2
20
16
16
140
10
60
60
CABLE STORAGE YARD
62
150
M A I
M A I N P L A N T
T
20
16
16
200
58
58
FIRSTAID CENTRE
12.0 M. WIDE ROAD
10
40
10
40
10
30
ADMINISTRATIVE BUILDING
ADMINISTRATIVE BUILDING
CANTEEN
AREA FOR EXPANSION
I O N
12
6
16
16
5
35
10
10.0 M. WIDE ROAD
AREA FOR EXPANSION
WEIGH BRIDGE
10.0 M
100 M. W I D E R O A D.
10.0 M.
10.0 M. W I D E R O A D
STAIRS
ARCHITECT'S OFFICE
CAR PARKING
RING



NOTES

ALL DIMENSIONS ARE IN METER

BLOCK LAYOUT
CABLE MANUFACTURING PLANT

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION AND ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

[redacted] CONSULTANTS LIMITED
[redacted]
[redacted]

DRAWN [illegible]	DESIGNED [illegible]	DATE 25.9.84
PROJ. ENGR. [illegible]	ENGR. [illegible]	SCALE 1:750
DEPT. HEAD		JOB NO. DCR 4501
		DWG. NO. EXHIBIT 23

ELEC.	MECH.	CIVIL	ARCH.	REVISION OR ADDENDUM DESCRIPTION	REVISION	RELEASE STATUS	DATE	DWG. NO.