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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
VIENNA, AUSTRIA
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION
RABAT, MOROCCO

PROJECT PROFILE ON ELECTRICAL MOTORS

FINAL REPORT

DEVELOPMENT CONSULTANTS INTERNATIONAL LIMITED
MANAGEMENT CONSULTANCY DIVISION
24-B PARK STREET, CALCUTTA 700 016, INDIA

PROJECT PROFILE
ON
ELECTRICAL MOTORS

APRIL 1996

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DCIL-105/AC-5/1113 April 3, 1996

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

Attn : Mr V. Koloskov

Project Profile on Electrical Motors

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

BS	British Standards
CI	Cast Iron
CIF	Cost Insurance & Freight
CNC	Computerised Numerically Controlled
dBA	Decibels
DPR	Detailed Project Report
EOT	Electric Overhead Travelling
FOB	Free on board
IEEE	Institution of Electrical and Electronics Engineers
IRR	Internal Rate of Return
KVA	Kilo volt ampere
NEMA	National Electrical Manufacturers Association
ODP	Outer drip proof
SF	Service Factor
WP-II	Weather Protected Type-II

SECTION - 1
INTRODUCTION

INTRODUCTION

The Sixth Arab Industrial Development Conference held in Damascus in October 1984, stressed on the importance of setting up facilities in the Arab region for manufacture of products used in electricity generation, transmission and distribution. Subsequently, the Arab Industrial Development and Mining Organization (AIDMO), prepared a Sectoral Report on the status of electricity generation, growth prospects in the region and requirement of equipment/facilities thereof. The study covered 21 Arab countries for the period 1986-2010 AD.

Based on the findings of the Sectoral study, the AIDMO, in consultation with the United Nations Industrial Development Organization (UNIDO), shortlisted 8 products for which it wanted to get project profiles prepared. One of the designated products is Electrical Motor. The objective of the project profile is to provide sufficient information so that prospective promoters and sponsors find themselves in a position to evaluate the project.

The Scope of Work for this Project Profile includes the following :

- Description, special characteristics, features and uses of the product
- Identification of major end-user industries
- Assessment of present production capacity
- Assessment of supply and demand for the product in the designated region

- Identification of demand-supply gap and evaluation of the possibility of entering the market
- Description of basic manufacturing process
- Process flow chart
- Brief specifications of plant and machinery, and their indicative 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
- Estimated requirement of space, and plant layout
- Plant location
- Project cost estimate
- Project financial analysis and evaluation
- Project implementation schedule

This study is confined to the following 13 countries -

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

A separate market survey, according to the AIDMO, was not required to be carried out prior to preparing this project profile, since the information and projections contained in the Sectoral study conducted by them was indicated to be adequate for the purpose. Therefore, the Section on 'Market Analysis' is based entirely on the Sectoral study carried out by the AIDMO.

The contents of this Report have been organised in a manner 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 Section presented thereafter 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 recommended locations for establishing the proposed manufacturing facilities are discussed in the next Section.

Manufacturing process is dealt with in a separate Section, titled 'Manufacturing Process'. This is followed by a Section on 'Plant and Equipment'. Estimates of raw materials and other inputs, requirement of utilities, and estimates of space and layout are presented in separate Sections. These are followed by a Section on estimated requirement of manpower and the recommended organisation structure. Financial Analysis and evaluation and project implementation plan of the proposed project is presented in the last two sections respectively.

SECTION - 2
SUMMARY OF FINDINGS

SUMMARY OF FINDINGS

It is recommended that one manufacturing plant with a capacity of 1,400 tonnes per annum (TPA) be set up to manufacture electrical motors within the designated region. This plant will manufacture about 2,000 nos. of motors of varying capacity. Gradually, the product-mix can be modified or expanded to meet the increasing demand. This should be sufficient to cater to the demand for the product right up to 2010 AD

Further, it is suggested that the plant be set up in Saudi Arabia. It will cater to the requirement of entire Arab region.

It is observed that with the increase in demand for power, new power generating stations would be set up, and that by itself will justify establishing the proposed plant.

Summary of basic parameters and significant features of the Project is presented in Exhibit-1.

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 1

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

PROJECT PROFILE ON ELECTRICAL MOTORS

SUMMARY OF FINDINGS

Sl. No.	Particulars	Plant
1.	Location	Saudi Arabia
2.	Plant Capacity (TPA)	1,400
3.	Area Requirement (Square Metres)	15,000
4.	Manpower Requirement (Numbers)	313
5.	Implementation Period (Months)	27
6.	Project Cost (Million $)	13.61
7.	Break-Even Point (%)	49.40
8.	IRR (%)	18.20

SECTION - 3
PRODUCT ANALYSIS

PRODUCT ANALYSIS

Electric motors convert electrical energy, supplied from AC, or DC source, to mechanical energy to a rotating shaft. All electric motors have certain basic features which are common. Motors have a stationary member i.e. the stator and a rotating member i.e. the rotor. They are separated by an air gap. Both stator and rotor have a magnetic core, usually laminated. The core carries copper or aluminium windings in slots or poles. The windings are usually insulated except in the case of squirrel cage motors. The windings carry current which flows due to direct conduction or electro magnetic induction. The currents produce magnetic fields which intersect with each other and thus produce turning effect (Torque) on the rotor shaft.

Electric motors are generally classified based on the type of electromagnetic fields generated in the stator and rotor windings. Most of the motors fall under the following categories :

- Squirrel cage induction motors
- Slip ring induction motors
- Synchronous motors
- DC motors

In all polyphase AC motors the magnetic field in the stator is developed by alternating currents having a supply frequency (f_s). It rotates at synchronous speed $N_s = f_s/p$ revolution/sec. relative to the stator, where p is the number of pole pairs of the winding.

In asynchronous or induction type motors (squirrel cage or slip ring motors) voltages are induced in the rotor windings at a frequency of $f_r = (N_s - N) \times p$ where, N is the speed of the rotor. These voltages produce currents which develop an electromagnetic field rotating at speed $(N_s - N)$ relative to the rotor i.e. at speed $(N_s - N) + N = N_s$ relative to the stator. Thus, regardless of the speed of the rotor, the electromagnetic fields of the stator and rotor remain stationary relative to each other.

In a synchronous motor the rotor rotates at exactly the synchronous speed and therefore no voltage is induced in the rotor windings.

The rotor field is usually developed by a DC, fed to the rotor windings through slip rings. Thus the field is stationary relative to the rotor. Rotor and stator again are stationary to each other.

In a DC motor, field windings on the stator are supplied with DC and therefore the stator field is stationary. The armature winding on the rotor is supplied with DC via brush bracings on commutator. The action of commutator converts DC to AC within the armature and simultaneously maintains the rotor field stationary and in quadrature to the stator field.

The torque, speed and shaft power developed at a motor shaft can be calculated from the following formulae :

$$\text{Torque} \quad T = F\,r = \frac{8.85\ B.l.I.r}{10^8} \text{ pound-feet}$$

where,

T : Torque in pound-feet

F : Force in pounds

r : The arm of the force in feet

I : Current

l : Length of wire

B : Field strength

Shaft Power = P = T. N 5250

where, Power is in hp, Torque is in ft. pound and N is in rpm.

Similarly input electric power can be calculated from the shaft power and is given by :

$$\text{Input Power} = \frac{746\ (\text{Shaft Power})}{\text{Efficiency}}$$

where, Input power is in watts.

Voltage and current is related to the electrical power for a three phase AC motor, as follows :

Input Power = 1.732 x Voltage x Current x p.f.

For calculating power of a single phase AC motor 1.732 is omitted from the above equation. For DC motors the input power is calculated as follows :

Input Power = Voltage x Current

A complete motor specification covers several other electrical and mechanical components in addition to speed, power and torque. These items are given below :

Always Specified	Specified when Applicable
Type of enclosure	Vertical motor shaft type
Altitude	Screens and filters
Ambient temperature	Vertical motor rotation and thrust
Temperature rise	Space heaters
Insulation class	Bearing thermal detection
Starting method	Vibration detection
Mounting	Stator thermal detection
Inertia at motor shaft	Surge protection
Locked rotor current limits	Current transformer
Vibration/balance tolerance	Coupling to driven equipment
Efficiency	Base
Terminal boxes	Grounding provisions
Noise level	Drains
Shaft extension	Testing to be performed
Direction of rotation	
Bearings	

Motors Required in Power Plants

The design of power station auxiliary drives has always received special attention from the point of view of reliability, safety and design parameters. Both coal and oil fired boilers require substantial auxiliary power which in turn needs close control to achieve efficient combustion. The backbone of each of these auxiliaries is squirrel cage motors upto Group IVE sizes.

The emphasis is therefore on squirrel cage motor (single or two speeds) and its design, to meet the specific duties. Generally, most onerous requirements come from high inertia drives resulting in difficult starting conditions with supply capacity limited compared to the motor rating. Starting currents of about 4.5 times the full load current and at 80% voltage against full torque are also specified.

Close matching of the motor to the drive and electrical supply systems is necessary. The special torque requirement of coal mills have resulted in the interposition of hydraulic couplings without speed control facility. Squirrel cage motors can be designed for direct drive also, with proper protection, partiularly stall protection.

Squirrel Cage Induction Motor

The design parameters of squirrel cage induction motor are discussed below.

Torque Requirements

The best way to evaluate torque requirements is to superimpose the speed-vs-torque curve of the driven equipment on the speed-vs-torque curve of the motor. These curves are provided by the respective manufacturers. NEMA has established minimum torque requirements for three basic motor designs i.e. Design B, for normal centrifugal loads; Design C, for loads requiring high starting torque; and Design D, for high-slip high-inertia loads such as flywheel drives on machine tools.

It is important that the speed-vs-torque values are for those voltage which are applied to the motor terminals during acceleration. A motor that is being started across the line, typically draws 650% of its full load current, which reduces the voltage applied at the motor terminals to about 90% of the line voltage. Also, the line voltage will drop if other motors are being started at the same time. For these reasons, the motor curve must reflect the torque produced by the motor during the voltage dip. The most important torque points are :

- Locked rotor torque point : This is the torque generated by the motor when power is applied to the terminals and the rotor is still at rest. To accelerate properly during start up, the motor must generate more torque than the load requires. Otherwise, both the motor and load will remain at rest, and eventually the overload protection will trip the motor off, from the line. If the motor trips too late, it may be damaged.

- Minimum accelerating torque point : The danger of stalling is greatest when the difference between motor torque and load torque is at a minimum. To assure that the load is accelerated quickly enough, the specified motor should develop at least 30% more torque than the load requires at this point.

- Maximum torque point : The coupling between the motor shaft and the load shaft must be able to transmit more than the motor's maximum torque.

- Operating point :The operating point is the intersection of the load and motor curves. The torque requirements of the load at this point should never exceed the rated full load torque. Otherwise, constant overloads will increase the operating temperature and shorten the motor's life.

As long as the motor generates more torque than the load requires, it will accelerate the load. When the motor output matches the load, the motor attempts to operte the load continuously at that speed. Thus, the motor must be selected so that the operating point is at or below the rated full-load torque, and at or above the rated full load speed.

Voltage and Power Supply

There are certain limitations on the power and voltage mix. High power and low voltage requires large conductors (i.e. thick copper wires) to accommodate the high current (current is proportional to power/voltage). Such conductors are difficult or almost impossible to wind. On the other hand, low power and high voltage results in low current and small conductors. The wire in this case may be so thin that it cannot mechanically support itself. NEMA recognised this problem and has recommended certain horse power ranges for various voltages. Exhibit-2 lists these ranges.

Electric motors that use three phase power are deisnged on the assumption that the applied line voltages will be balanced; i.e., that there will be same voltage between the Phases A and B as between Phases B and C and Phases C and A. If the phase voltages are unbalanced, the currents flowing through the three windings will also be unbalanced. A 1% imbalance in voltage can lead to an 8% imbalance in current. The result is that, some parts of the stator will be heated more than others, producing hot spots that could damage the motor or cause it to trip. Further, unbalanced current will try to turn the motor shaft in the wrong direction, reducing the net torque output.

NEMA standards allow 1% imbalance in the phase voltages. Manufacturers take this into account by designing motors to give satisfactory performance without shortening life expectancy as long as the imbalance remains within 1%. If line conditions are such that the 1% limit cannot be met, the motor must be oversized to accommodate the extra heating.

Motor-starting Restrictions

The preferred method for motor starting is "across the line", which means that full voltage is applied to the terminals all at once. This provides the maximum torque for acceleration, and brings the motor and load up to th desired speed in the shortest possible time. Unfortunately, across-the-line starting draws a high current (typically 6.5 times the full-load current), which may have a detrimental effect on other loads supplied by the same power source. As the size of the motor increases, this problem becomes more severe.

The most frequently used approach is to reduce the starting voltage. This can be accomplished by a circuit that includes resistors and/or reactors in series with the motor winding; an autotransformer having adjustable-voltage taps; or a solid-state starter that adjusts the applied voltages to maintain a constant current.

Another approach to reduce starting current is to use a "wye-delta" stator winding, in which both ends of each phase winding terminate in the conduit box. The starter connects the motor winding "in wye" on starting. This reduces the phase voltage by the square root of 3, thus reducing the starting current. Once the motor is up to speed, the starter reconnects the windings "in delta" for proper operation.

Smaller motors can be wound with two separate windings, one of which is energized on startup. In this case, the starter's timing circuit must be adjusted so that the starting winding is not alone on the line for more than three seconds; otherwise, the overload can damage the motor.

As shown in Exhibit-3, all reduced-voltage starting methods also reduce the torque developed by the motor during acceleration. Because of the limitations on duration of each type of starting, the acceleration requirements should be checked before specifying how the motor is to be started.

The formula for determining acceleration time is :

> Time = (Inertia)(Change in Speed)/(308)(Accelerating Torque) where, time is in seconds, inertia is the total inertia of motor and load in lbf ft^2, change in speed is in rpm, and accelerating torque is in ft-lbf.

In practice, it is important to make sure that the motor torque be at least 30% till the motor is nearly at full speed. Otherwise, the acceleration time limit will expire, and the starter timer will take the motor off the line.

Motor Enclosure

The environment in which the motor is installed has a large effect on the life expectancy of the unit. While most motors are built to last for at least 20 years, their life expectancy will be severely shortened if they are not properly protected from dust, moisture and other contaminants. The main difference among various enlosures is in the degree of protection provided to the windings.

The open drip-proof (ODP) enclosures should be the first chọice considering the fact that it is least expensive. It is the basic unit offering a minimum protection from the environment. An open motor uses outside air blown over the windings for cooling. A drip-proof enclosure is designed so that particles approaching the motor within 15° of vertical cannot enter the motor body or strike an inclined surface and roll into the interior.

If the motor is installed indoors, or at least under a roof, and the atmosphere is free of contaminants, the ODP motor will give long, troublefree operation of about 15-20 years. The majority of motors have ODP enclosures.

If the environment is too wet for an ODP motor a WPI (Weather Protected Type-I) enclosure is used.

In the WPI design, the insulation on the motor windings is more moisture-resistant. The insulation may be coated, or made of a nonhygroscopic material. For large, high-voltage motors, form wound sealed insulation is also available. The WPI enclosure includes a screen over the air inlets and exhaust vents, to keep out pests and improve safety of operation. The rotor assembly has a moisture-resistant coating between the bearing fits for greater corrosion resistance.

The weather-protected Type I enclosure is recommended for indoor installations, having small amounts of moisture in the atmosphere, or outdoor instllations that have a roof or similar covering over the motor.

For outdoor instaliations and atmospheres containing dirt and dust, totally enclosed fan cooled (TEFC) or weather protected Type II (WPII) enclosures are advisable. WPII motors are only available for sizes larger than NEMA 440, which is about 500 hp. TEFC is the choice for smaller motors.

The WPII is an open motor enclosure (using outside air for cooling) having moisture-resistant insulation (typically sealed) and screens. Additional features are given below :

- o Blow through passageway : This allows high pressure air to move through the enclosure without coming in contact with the rotor, stator and windings.
- o Low velocity chamber : Airspeed is held below 600 ft/min, which allows solid particles to settle out before contacting the vital internals.
- o Baffles : The baffles help airstream to take three 90-degree turns, which in turn settle out the remaining solid particles.
- o Space heaters : These prevent moisture from condensing inside when the motor is shut down.

A 500 hp WPII motor costs about 65% more compared to ODP.

When the atmosphere contains acids, salts or other chemicals that could damage the windings, a totally enclosed motor should be specified. In such a motor, there is no free interchange of air between the inside and outside of the enclosure.

The most commonly used totally enclosed motor is built with an external fan mounted directly on the shaft to blow air over the ribbed yokes on the motor body. Thus, a TEFC motor must have a greater thermal mass - a larger stator and rotor, on a larger frame - to help dissipate heat.

As motor size increases, heat dissipation requirements also increase until the ribbed-yoke motor body is unable to adequately cool itself. This situation calls for auxiliary cooling. One option is an air-to-air heat exchanger, mounted either above or around the stator. Most modern designs have the heat exchanger above the stator because this provides better cooling. Hot internal air, circulated around the exchanger tubes is cooled by colder outside air blown through the tubes. The tubes are usually made of aluminium, unless a different material is specified.

Because of the external fan, a TEFC motor will be noisier than an open motor - typically 3-6 dBA more. So, a totally enclosed water-to-air-cooled (TEWAC) design, which is available for motors of 500 hp and above is preferable. In this particular design the exchanger is mounted above the stator, and air is blown over the water tubes by a fan, mounted internally on the rotor.

If the motor is to be installed in an atmosphere where explosive gas, dust or fibre is present, the standard TEFC design is modified so that no spark or flame can escape should an explosion occur inside the enclosure, This also limits the surface temperature of the motor to about 80% of the ignition temperature of gases and dusts in the air. In the 500 hp range, such an explosion-proof motor costs almost twice than a comparable ODP motor.

Insulation

In an electric motor, the stator leads, coils and connections are covered with dielectric insulation. The type of insulation used depends on the service conditions, and on the voltage and size of the motor.

Most motors are designed for temperture conditions compatible with Class B insultions, i.e. a maximum internal operating temperature of 130° C. This means an allowed temperature rise of 90° C above ambient for an area that has a 40° C maximum temperature. Class F insulation, suitable for continuous operation to 155° C, is recommended for hot climates and high altitudes. If operated in a Class B environment, such insulation makes it possible to get more power from a motor, or to extend its useful life at normal power. Class H insulation, good to 180° C, is used for the same reasons as Class F is.

These types of insulation can be applied to random or form wound coils. Random wound coils are built up of many strands of thin, round wire; each wire is coated with insulation. Due to the large number of turns, the voltage between adjacent wires is very low, and only a thin layer of insulation is needed. Because this approach is the least expensive, it is recommended for smaller motors operating at lower voltages, and is suitable for voltages up to 600 V and power ratings up to 600 hp.

The higher voltages used in large motors demand greater integrity from the insulation. Therefore, it is necessary to supply form wound coils, though it is more expensive due to increased hand labour. Form wound coils are made up of thick, flat wires shaped to fit the stator slots. Each coil is wrapped with sufficient insulating tape to form a dielectric barrier compatible with the system voltage. The wrapped coils are inserted into slots in the stator, and connected.

Most motor manufacturers offer vacuum pressure impregnated (VPI) coils, which should be considered for motors to be installed in hazardous atmospheres. This Class F (155° C) system utilises form wound coils with mica tape as the insulator. The wrapped coils are inserted into stator slots and connected. Then the complete stator is immersed in epoxy resin and subjected to multiple vacuum and pressure cycles. This fills all the voids in the tape, and between the coils and slots. When the epoxy cures, the result is a very rigid and mechanically strong system that can withstand severe electrical and mechanical surges without harm. Because of the epoxy, the system also resists corrosion.

Temperature rise and service factor

Motors heat up as they run. To operate reliably for a long period of time, say 20 years, the maximum inside temperature must be kept below the limits of the insulation. This will normally be the case, so long as the motor operates at its rated power. However, changes in the load requirements can cause the motor to temporarily exceed its rated power. The motor will deliver the required torque, but its operating temperature will increase.

The maximum operating temperature for Class B insulation is 130° C (266° F). Subtracting a maximum ambient temperature of 40° C (104° F) leaves a 90° C (162° F) limit on temperature rise. In practice, the motor temperature is not measured directly, but is calculated from the change in resistance of the winding. Since parts of the motor can be 10° C hotter than this average value, 80° C(176° F) is the practical limit for temperature rise in Class B motors.

This 80° C limit applies to normal Class B motors, which have a service factor (SF) of 1.0. Motors having SFs of 1.15 are designed for a 90° C temperature rise (as measured by resistance), and can produce 15% more power. Typically, such motors will be operated at increased power only for short periods of time, and at rated power the rest of the time.

Exhibit-4 shows how operating a motor above or below its power and temperature rating affects its insulation life expectancy.

According to NEMA standards, motors rated 1500 hp and larger should be supplied with stator temperature sensors, either resistance temperature detectors or thermocouples. These devices are installed in the stator slots, between the coil sides, so that they measure the hottest part of the stator. Whereas the resistance method yields an average temperature, sensors indicate the hottest temperature. Therefore a greater temperature-rise reading is expected when the motor is equipped with sensors. For 1500 hp motors, having Class B insulation and an SF of 1.0, a 90° C temperature rise by sensor is standard. Beyond that, 85° C is standard.

Bearings and Vibration

For horizontal directly connected motors (upto 500 hp) the most frequently supplied bearings are standard deep-grooved ball bearings. Belt and chain drives exert greater radial forces than direct drives. For these drives, ball and roller type antifriction bearings are used. Ball and roller type antifriction bearings are available in sizes upto 75 mm and is generally used in motors of 500 hp and speeds upto 3600 rpm. If the application calls for more power or greater speed, sleeve bearings are generally used. These sleeve bearings are tin-based babbited liners, bonded to brass or C.I. shells.

Since the rotor is not a homogenous mass, it will cause the motor to vibrate. Maximum vibration levels allowed by NEMA are shown in Exhibit-5.

Efficiency

Electric motors are by far the most efficient drives available. They convert approximately 85-97% of their input power into shaft power (mechanical power) as compared to 40-50% for hydraulic motors and 30% or less for steam or gasoline engines.

The motor's efficiency is improved by cutting the energy losses due to electrical resistance and mechanical friction. Ways of improving mechanical efficiency include :

- Using more copper in the stator windings and thinner laminations of a better grade of steel.
- Changing the rotor material to copper or increasing its copper content.
- Using lower friction bearings, more efficient fans, and larger motor frames to reduce the operating temperature.

All of these improvements cost money but if the additional investment can be recovered quickly these are worthwhile.

Noise

In general, at a particular place of work noise of more than 90 dBA is not allowed. If the motor is the only piece of equipment it's noise must not be greater than 90 dBA, measured 1 metre away from the motor. If other equipments are operated nearby, the motor may have to be quieter. For a standard design of 500 hp, 3600 rpm, 460 V motor noise level, measured 1 metre away are given below :

Enclosure	NEMA Maximum (in dBA)	Standard Design (in dBA)	Low-noise Design (in dBA)
O D P	99	90	82
W P-II	94	85	76
T E F C	103	91	81

Protective Devices

Reliable as eletric motors are, they can be damaged when subjected to overloads and surges, and when bearings or insulation burn out. Fortunately, protective devices that will take the motor off the line before it is damaged are widely available. The kind of protection needed, depends on how often a load or power problem is expected to occur, and how important the motor is. If problems are likely and the motor is critical, it may be necessary to monitor the motor daily. Often, company policies dictate that monitoring and protective devices be installed.

Because they are vulnerable to overheating, the stator windings are the first items to be considered for protection. Resistance temperature detectors (RTDs) and thermocouples are used to monitor stator temperature. If there is no need for monitoring, a more economical approach is to install bimetallic switches on the end-turns of the windings. If the windings get too hot, as from a continuous overload, the switches will open and the relay will take the motor off the line.

Bearing temperature monitoring should also be considered for large motors having sleeve bearings, in case the oil level drops too low to lubricate effectively. Thermocouples can be used for this purpose. Dial-type thermometers, that give direct readings at the bearings are also available, but the operator must keep an eye on them. Automatic protection is provided by bearing relays that switch the motor off when a preset temperature is reached.

In most ODP, WPI and WPII enclosures, filters can be installed to capture large solid particles in the incoming air. Such filters are inexpensive and can be removed for cleaning. If they are used, it is advisable to monitor their performance to make sure they do not plug up. This can be done with a manometer or differential pressure switch so as to measure the pressure on both sides of the filter. Stator temperature detectors are also useful in spotting filter problems. As the filter begins to plug, the stator temperature begins to rise, indicating that the filter should be cleaned.

Protection against excessive vibration can be provided by a seismic type vibration monitor installed on the outside of the motor housing. If vibration starts to increase, the motor needs maintenance. For sleeve bearing motors, shaft vibration can be monitored using proximity probes. These generate a small magnetic field around the rotating motor shaft. As the center of mass of the shaft moves, the magnetic field changes in strength and shape. The probes measure this effect, and transfer the data to a proximeter that indicates the amplitude and frequency of vibration.

Vibration monitoring provides early warning of mechanical failure. If maintenance is started when a pattern of increasing amplitude is first detected, the motor will be off the line for a much shorter time than if maintenance is delayed.

Any such probes (or provisions for mounting them) should be included in the specification and installed by the motor manufacturer. Trying to add probes later on will be more complicated and expensive, because the motor shaft under a proximity vibration probe must be polished.

Testing Requirements

Electric motors are engineered products that need to be tested before they are shipped. Motor manufacturers perform standard commerial tests (using methods laid out by the IEEE) on every motor : no load running test; insulation dielectric test; measurement of winding resistance, inspetion of bearings, and vibration check.

JOB NO. DCIL-105

EXHIBIT : 2

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

PROJECT PROFILE ON ELECTRICAL MOTORS

RECOMMENDED POWER RANGES FOR VARIOUS VOLTAGE CLASS

Rated Voltage (V)	Recommended Power Range (hp)
230 or 460	Upto 100
460 or 575	100 - 600
2300	200 - 4000
4000	400 - 7000
6600	1000 - 12000
13200	3500 - 25000

JOB NO. DCIL-105

EXHIBIT : 3

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

PROJECT PROFILE ON ELECTRICAL MOTORS

RELATION BETWEEN REDUCED VOLTAGE AND TORQUE OUTPUT OF MOTORS

Type of Starting	Relative Starting Current* (%)	Relative Starting Torque (%)	Relative Smoothness of Accelertion	Allowable Acceleration Time (Seconds)
Across the line reduced voltage	100	100	Smoothest	N.A.
Resistor/Reactor (at 65% voltage)	65	65	2nd Smoothest	5 - 15
Autotransformer (at 65% voltage)	42	42	3rd Smoothest	30
Wye-delta Winding	33	33	4th Smoothest	45 - 60
Two-part Winding	50	50	Least Smooth	2 - 3

* Compared with full-voltage across-the-line starting, which typically draws 6.5 times the full-load current.

JOB NO. DCIL-105

EXHIBIT : 4

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

PROJECT PROFILE ON ELECTRICAL MOTORS

RELATIVE LIFE EXPECTANCY OF MOTOR INSULATION

Insulation Class/ allowed temp.rise	Temp.rise °C	Relative life	Temp.rise °C	Relative life
Motors designed for service factor = 1.0				
Class B/80° C	80	1.0	105-115	0.1-0.16
Class F/105° C	105	1.0	140-150	0.1-0.16
Class F/105° C	80	6.0	105-115	0.5-1.00
Motors designed for service factor = 1.15				
Class B/80° C	65-70	2.0-3.0	90	0.5
Class F/105° C	85-95	2.0-3.0	115	0.5
Class F/105° C	65-70	12.0-16.0	90	3.0

Note : Average life is 20-25 years

JOB NO. DCIL-105 EXHIBIT : 5

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON ELECTRICAL MOTORS

MAXIMUM VIBRATION LEVEL ALLOWED FOR MOTORS

Speed (rpm)	Maximum vibration amplitude (inch)
3,000 - 4,000	0.001
1,500 - 2,999	0.002
1,000 - 1,499	0.0025
Upto 999	0.003

SECTION - 4
MARKET ANALYSIS

MARKET ANALYSIS

Electrical motors are an essential part of power generation system. In a typical utility power station motors are required to operate prime movers like pumps, valves, ID and FD fans, blowers, compressors and auxiliary equipment like cranes, hoists, conveyors, etc. Therefore an increase in power generation capacity will cause an increase in demand of electric motors.

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 9,300 MW by 2010 AD. Correspondingly, demand for various electrical equipment, including motors is estimated to increase substantially to match the additional power generation.

Projected additional power generation capacity for the period 1991-2010 is given in Exhibit-6. Exhibit-7 shows the demand for electric motor during the same period. Both these have been extracted from AIDMO report on sectoral study. The demand estimate has been arrived at by the following consumption norm, provided in the report :

- 40 motors per power unit having less than 75 MW capacity
- 100 motors per power unit having less than 250 MW capacity
- 200 motors per power unit having less than 350 MW capacity
- 500 motors per power unit having less than 600 MW capacity

Exhibit-8 shows the additional power generating capacity for four 5-year periods for the 13 countries under the scope of study. Based on these and the consumption norm, mentioned earlier, annual requirement of electric motors in these countries has been shown in Exhibit-9.

All 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 motors have been taken as only 70% of the projections made by AIDMO. The scaled down demand is shown in Exhibit-9.

From the consumption norm furnished in the AIDMO report, it appears that only motors for power house and boiler area have been considered. However, the motors proposed to be manufactured in the plant may also be sold to industrial and water sector after meeting the requirement from power sector. Capacity of these motors varies from as low as 0.006 KW to as high as 4000 KW. Since the AIDMO report have not considered fractional and small motors the product range of the proposed plant shall be from 2 KW onwards. Capacitywise break-up of annual motor requirement is shown in Exhibit-10. This break-up has been arrived at by considering the actual number of motors and their capacity as installed in typical power plants of different capacities.

The overall annual demand for motors for the period 1996-2000 works out to about 4100 nos. At present, important part of the demand is met through imports. Thus, on a conservative basis, it is recommended that manufacturing facilities are set up to manufacture only about 50% of the estimated demand. Thus one manufacturing plant will be set up to produce about 2000 motors annually.

JOB NO. DCIL-105

EXHIBIT : 6

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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PROJECT PROFILE ON ELECTRICAL MOTORS

PROJECTED ADDITIONAL ANNUAL INCREASE IN
POWER GENERATING CAPACITY

Period	No. of Units			
	30 MW	150 MW	300 MW	600 MW
1991-1995	5	3	8	5
1996-2000	5	5	10	7
2001-2005	6	5	3	10
2006-2010	1	6	3	11

JOB NO. DCIL-105 EXHIBIT : 7

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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PROJECT PROFILE ON ELECTRICAL MOTORS

ANNUAL REQUIREMENT OF ELECTRIC MOTORS

Period	Nos
1991-1995	4,600
1996-2000	6,200
2001-2005	6,340
2006-2010	6,740

JOB NO. : DCIL-105 EXHIBIT : 8

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

PROJECT PROFILE ON ELECTRICAL MOTORS

COUNTRYWISE ADDITIONS TO THERMAL POWER GENERATING CAPACITY

PERIOD :	1991 - 1995				1996 - 2000				2001 - 2005				2006 - 2010			
COUNTRY	30 MW	150 MW	300 MW	600 MW	30 MW	150 MW	300 MW	600 MW	30 MW	150 MW	300 MW	600 MW	30 MW	150 MW	300 MW	600 MW
Algeria	-	-	8	-	-	-	8	-	-	-	8	-	-	-	8	-
Bahrain	7	-	-	-	3	7	-	-	3	5	-	-	3	-	-	-
Egypt	-	-	-	9	-	-	-	12	-	-	-	12	-	-	-	12
Iraq	-	-	-	10	-	-	-	12	-	-	-	14	-	-	-	14
Jordan	-	4	-	-	-	4	-	-	-	4	-	-	-	5	-	-
Kuwait	-	-	7	-	-	-	3	3	-	-	-	4	-	-	-	4
Libya	-	-	7	-	-	-	7	-	-	-	7	-	-	-	7	-
Morocco	-	5	-	-	-	7	-	-	-	8	-	-	-	-	4	-
Saudi Arabia	-	-	-	4	-	-	-	5	-	-	-	5	-	-	-	5
Sudan	2	-	-	-	6	-	-	-	6	-	-	-	-	2	-	-
Syria	-	-	15	-	-	-	22	-	-	-	-	11	-	-	-	11
Tunisia	12	3	-	-	11	3	-	-	8	4	-	-	8	4	-	-
U.A.E	-	-	5	-	-	-	10	-	-	-	-	5	-	-	-	6
TOTAL	21	12	42	23	20	21	50	32	17	21	15	51	11	11	19	52

DEVELOPMENT CONSULTANTS

DEVELOPMENT
CONSULTANTS

JOB NO. DCIL-105

EXHIBIT : 9

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

PROJECT PROFILE ON ELECTRICAL MOTORS

COUNTRYWISE ANNUAL REQUIREMENT OF ELECTRIC MOTORS

(Figures in Nos.)

COUNTRY	PERIOD			
	1991-1995	1996-2000	2001-2005	2006-2010
Algeria	224	224	224	224
Bahrain	40	115	73	17
Egypt	630	840	840	840
Iraq	700	840	980	980
Jordan	56	56	56	56
Kuwait	196	294	280	280
Libya	196	196	196	196
Morocco	70	98	98	112
Saudi Arabia	280	350	350	350
Sudan	12	34	34	14
Syria	420	616	770	770
Tunisia	110	104	129	129
U.A.E	140	280	350	420
TOTAL	3074	4047	4380	4388

JOB NO. DCIL-105 EXHIBIT : 10

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

PROJECT PROFILE ON ELECTRICAL MOTORS

CAPACITY WISE BREAK-UP OF MOTOR REQUIREMENT

(Figure in Nos.)

CAPACITY (KW)	PERIOD			
	1991-1995	1996-2000	2001-2005	2006-2010
2.01-4.00	689	906	983	983
4.01-5.00	618	814	880	882
5.01-7.00	265	349	378	380
7.01-10.00	389	511	553	556
10.01-30.00	406	535	578	580
30.01-100.00	248	326	355	352
100.00-1000.00	407	534	579	580
1000 and above	52	72	74	75
TOTAL	3074	4047	4380	4388

SECTION - 5
PLANT LOCATION

PLANT LOCATION

It was recommended in the previous section that a single plant be set up to cater to the demand for motors in the designated region.

While selecting suitable location for establishing the manufacturing plant, following factors have been considered :

- size of the domestic market in each of the 13 countries within the designated region
- local availability of major raw material
- proximity to the source of raw material, and the availability of road, rail or sea linkages
- local availability of bought-out auxiliary equipment
- availability of qualified technical personnel and skilled workmen
- availability of essential infrastructural facilities such as power, water, labour, etc.
- relationships and affiliations among different nations within the region
- investment environment in different countries

Based on these factors, it is suggested that the manufacturing unit be set up in Saudi Arabia. It may be observed from Exhibit-9 that more than 60% of the demand is accounted for by 5 countries i.e. Syria, Iraq, Egypt, Saudi Arabia and Kuwait.

The plant at Saudi Arabia will cater to its domestic demand as well as demand from the neighbouring countries of Iraq and Egypt. Bulk of the balance requirement will come from Syria, Kuwait and the UAE which are also suitably connected to Saudi Arabia.

SECTION - 6

MANUFACTURING PROCESS

MANUFACTURING PROCESS

The proposed plant will be manufacturing different types of motors described in the preceeding chapter. Motor sizes range from 100 to 315 mm and 355 mm for the low voltage motors (upto 550 V) and from 355 to 1000 mm for the high voltage motors (upto 13.8 KV). The numbers owe their origin to the Reynold's series of equal percentage steps.

The modern motors are designed, to have a longer core of small diameter and have a low centre height for a given output. This design not only reduces the cost of construction but also helps in replacing the existing motors with newly manufactured motors. The basic idea is that it is always possible to raise a motor centre height by adding an adopter plate under the new motor.

Electric motors must be constructed in a cost-effective way. Its different components are manufactured in parallel with each other to save manufacturing time. The motor is designed on modular construction concept. Thus the manufacture of frames, cores, coolers and bearings can proceed together and in batches and the finished components can be assembled to form a complete motor. Coolers are usually top mounted on the motor, rather than being inbuilt into the motor frame. Stator core units are wound separately from the frame for ease of access and to occupy as little space as possible in the insulating resin tank, particularly where vacuum pressure impregnation (VPI) systems are used.

The motor components are of varied design. Each component needs specific manufacturing processes. Manufacturing processes for different components are discussed below.

FRAME

Frame of a motor provides protection to its current carrying parts and those parts which are in motion, from undesirable contact with the external objects. It also provides mechanism for fixing the stator core as well as support to the bearings for rotor shafts. For smaller sizes of motors its frames are generally made from grey iron castings and the frames for bigger size motors are generally of welded steel construction.

After the frames are cast or fabricated these are machined to take up end shields. The end shields are also either made from grey cast iron or from steel. These are suitably machined to fit into the ends of the motor frame. All components are machined ensuring concentricity and correct alignment.

STATOR CORES

The usual AC motor is connected to a 3 phase supply on its stationary part, the stator. The stator therefore carries a rotating magnetic field and must be constructed of flux carrying material; suitably laminated in planes to carry the flux but to minimise eddy current losses. The laminations are made from low loss high permeability cold rolled electric grade steel. Small motors use a steel of 0.65 mm thickness and losses of 6 watt/kg, medium size high voltage motors use 0.5 mm thickness and 4 watt/kg and large high voltage motors 0.35 mm thickness and 3.3 watts/kg.

Insulation between the laminations for small motors may be accomplished by steam blowing the steel surfaces whereas the larger laminations will employ a phenolic or synthetic resin insulation or one or both sides of the lamination.

Exhibit-11 shows a single stator lamination for an open slot high voltage motor and a single segment for a high voltage motor of slow speed. For motors requiring large back up core lamination, diameter of a circle will be formed from a number of steel segments. Six segments per circle is normal for the standard rate of motors.

The stator core laminations are normally produced by a punching process. As each slot is produced by the same tool they will all be identical, but the action of the punch and die causes a burr to be formed on the underside of the steel. With pre-insulated steel it is important to control the size of this burr such that it will not short to the next lamination and thus forming a short circuited turn inside the core.

The larger motors employ the cooling system where the air passes through radial ducts formed between packets of lamination. These ducts are formed by welding either angles or flats to a thick punched lamination to give air spaces between 8 mm and 12 mm. The ducts will be spaced about 60 mm from each other. So a pack of 1 m core length will comprise some 14 duct spacer plates and 172, 5 mm thick main core plates.

The complete set of stator laminations and duct spacer plates are assembled to form a core unit. The laminations may be assembled directly into the spacer frame or more probably a core pack is created round a stacking device. Lining bars located in the slots are used to ensure careful alignment of diameter and slots. When the stack is complete it is pressed between heavy section end plates and laminations welded together on the back of core.

Depending on manufacturing method a moderate degree of dressing, using a file may be employed to remove any high spots on the laminations which would otherwise damage the winding insulation. Dressing must however be kept to an absolute minimum or short circuits will result between laminations which will show as localised hot spots when the stator is excited. The stators are checked for any damage by carrying out a ring flux test on the stator core before winding. If hot spots are formed, this may require a complete core rebuilt or etching of the area where the lamination insulation has been destroyed.

ROTOR SHAFT AND COUPLINGS

The rotor shaft is that part of the electric motor which transmits the output torque to the driven equipment. The shaft must be capable of transmitting maximum torsional stresses and should have sufficient stiffness to minimise deflection under conditions of unbalanced magnetic pulls.

The rotor shaft consists of a cylindrical steel shaft with either 4 or 6 arms. The arms are rectangular section made from mild steel and are welded to the shaft using deep fillet continuous welds down each side. The shaft is machined from black rolled carbon manganese steel having carbon content of less than 0.25% to ensure ease of sound welding. After the arms are welded the shaft is stress relieved. Subsequently all welds are tested using a magnetic particle technique.

The outer faces of the arms are machined to give an interconnection feed with the bore of the rotor lamination. The shaft is also machined for locating the bearings. Its ends are machined for fitting the coupling. The couplings are fitted to the shaft by a heavy shrink fit by using a shaft key and a slide interference fit.

Machining of the shaft is a precision job with close tolerances and usually CNC machines are employed for the purpose.

The purpose of coupling is to connect the two shaft ends together mechanically so that the motor and the driven member run smoothly. Couplings therefore are designed to have a limited amount of misalignment. Thus the coupling halves, mounted on the shaft should be aligned axially, angularly and radially.

ROTOR ASSEMBLY

The reliability of the induction motor owes much to the construction of its cage rotors. Cage rotors for small motors upto 355 mm centre height are made from cast aluminium rotor bars and short circuiting rings. In case of large motors rotor bars and short circuiting rings are made from copper or copper alloys. The bars are extruded to suit the shape of the slot in the rotor core laminations.

The rotor core is built against a compression plate, located against machined faces at one end of the shaft arms. After build up of the preheated laminations another compression plate is fitted to complete the assembly. Keeping the core under pressure a key is fitted to fix the second plate rigidly. To complete the cage windings, individual rotor bars are inserted into the slots and are cut to size to give the required overhang at each end of the core. The copper or copper alloy end rings are brazed to the bars by the one shot process. This process is superior to individual brazing of each bar and produces consistent and uniform results. The brazing quality is confirmed by a pulse-eco technique.

After the fitting is complete the core pack is machined to give the required air gap. The previously statically balanced internal fans are fitted to the rotor. External fans are also fitted but temporarily. The complete assembly is then dynamically balanced.

WINDING AND INSULATION TECHNIQUES

Windings most commonly used in motors can be divided into three basic groups :

- o Armature Windings
- o Field Windings
- o Other Windings

Armature Winding

Armature windings are embedded into the slots either in single layer or double layers. In the former type each of the two coil sides making up a coil, are assembled in two slots (approximately 1 pole pitch apart) such that they fill almost all the available space for the current carrying conductors. In the double layer type each of the two coils making up a coil is assembled in two slots (approximately 1 pole pitch apart) such that one coil side fills the bottom of one slot while the other coil side fills the top half of the associated slot. These two basic techniques of laying down coils are shown in Exhibit-12. Slot separators enclosures are normally made from either thick slot liner material or strip of laminate. Exhibit-13 shows three types of coils namely mush coil, diamond coil and concentric coil generally used in armature windings.

Mush Winding

Most mush windings consist of a number of simple coils, wound at random with enamel covered round wire. Size and number of turns depend on the voltage, speed and rating of the relevant machine. Mush windings can be either single or double layer. Stator slots can be either open, semi-closed or offset. Mush coils are normally wound into slots lined with flexible insulation.

Diamond Shaped Coil Windings

Most AC and DC machine armatures with medium and high power ratings, use two layer windings made up of either single or multi-turn diamond shaped coils wound with rectangular copper.

Concentric Windings

Concentric windings are normally of the single layer type made up with hair pin shaped coils inserted into semi-closed slots in the armature core. After coil insertion, ends are formed to shape and individual conductors joined together to produce the characteristic concentric shape. Individual hair pins are formed from the specified number of insulated rectangular conductors. Main ground insulation is applied as appropriate for the machine line voltage. Concentric windings can also be manufactured with fully formed and insulated coils, wound into open armature slots.

Field Windings

Low voltage field windings for both AC and DC machines are wound either on formers or directly onto individual pole bodies. Where small section conductors are required either round or rectangular insulated copper is used and where cross sectional area is relatively large, bare copper is used. Bare copper is either wound on the flat or on edge. On low voltage DC machines several different coils are often fitted on the main poles. Main ground insulation can be applied either to the pole body or to each individual coils. Field coils for rotating components must be designed to withstand the maximum centrifugal force.

AC Rotor Windings

On AC rotors, in addition to cage windings, several other basic designs are used. Low voltage mush coils are adopted for small and medium sized wound motors and for rotor feed AC commutator motors. Fully formed diamond coil and bar windings are used for medium and large wound rotors and for pole face windings on salient pole synchronous induction motors.

AC Stator Windings

Mush windings are used for small and medium sized stators. At higher ratings multiturn diamond shaped coils are adopted. On the larger stators, single turn coils and bar windings are used. Slot build up for low voltage multiturn coils and for low voltage single turn coil are shown in Exhibit-14. Typical slot build ups for high voltage stator coil are shown in Exhibit-15.

BASIC INSULATION SYSTEM

The windings of each phase of a rotating machine consists of coils, connected in series and placed in slots. The build up of the stator slots have been explained earlier. In accordance with that slot build up, insulation of the stator winding can be sub-divided in the following parts :

- o Insulation between parallel conductors of a turn
- o Insulation between turns of a coil
- o Insulation relative to frame (major insulation)
- o Interlayer insulation

Insulation of a motor is continuously subjected to vibrations and impact mechanical loads in operation. Therefore the insulation must possess high mechanical strength and proper thickness. The temperature conditions under which the insulation works are of great significance. Depending upon the design parameters like low densities in the active materials, optimum cooling facilities build up in the system and the expected life, motors' insulation class is determined. The motor having class B insulation can have a maximum temperature rise of 105° C.

A typical material for the construction of major slot insulator is continuous mica (tape insulation). Mica tape is not very flexible when cooled but it is quite flexible at working temperature. It consists of one layer of mica flex, glued onto both sides of a high quality thin paper. Bitumin oil laquer serves as a gluing material. Usually tapes 12-35 mm wide and 0.08-0.17 mm thick are used. Bars of coils are wrapped compactly with the mica tape to the required thickness of insulation. This thickness is achieved in a few applications (usually 2 or 3).

After partial wrapping of insulation (not to the required thickness) section undergo drying and impregnation by an asphalt compound. After this, additional wrapping of insulation is done which is again dried and impregnated. The initial drying is at first done at atmospheric pressure and then under vacuum. The purpose of drying is to remove the moisture and residues of the solvings of the gluing material from the capillaries of paper and similarly of air from paper and mica. However, even at a very high vacuum, complete removal of moisture from the capillaries cannot be achieved. A part of it is left on the walls. After drying, impregnation by a compound at a temperature of the order of 150° C and 7-8 atmospheric pressure is done. In view of the fact that the compound can penetrate a limited depth, a few cycles of drying and impregnation are done for high voltage machine. In general, the first cycle of drying and impregnation is done after placing the turn insulation (or after assembly of bars in single turn windings). The duration of this cycle is from 11-13 hours. After this the sections on the bars are pressed in special presses. The above cycles of drying and impregnation each of 24-27 hours duration are carried out two times for 3-10.5 KV machines and three times for machines of higher voltage. As a result of this the impregnation penetrates deeply into layers of the mica tapes and helps in the production of a morolithic insulation.

As an alternative to the insulation comprising mica tape and Bitumin oil the recent trend is to use insulation comprising mica paper and thermo reactive resin. The advantages of this thermo reactive insulation over Bitumin (mica insultor) is that its co-efficient of linear expansion is negligible.

Therefore thermal deformation of insulation does not take place which in the former case causes its cracking.

After binding (with mica paper) the section, it is placed in vacuum thermo camera where air and moist··:·· are removed and impregnation is done by a thermo reactive resin which fills the pores in the insulation.

After this the section is placed in a press situated in the oven. The resin turns into a solid substance without liberation of any by-products whatsoever and the section gets correct dimensions corresponding to the dimension of the slots as a result of pressing.

TESTING OF INSULATION

During production of a set of coils on other insulated components, non-destructive electrical tests are used to conform insulation integrity. After coils are wound into the machine, similar tests are used to conform that no damage has occurred during the assembly operation.

Coils are first tested as individual units, then after insertion in the core and finally after connecting up to form the complete winding. It is a sound practice to use the test level in a decreasing order of severity. For example : for an 11 KV motor, the level is 23 KV for one minute. Individual coils for such a motor are tested at 30% above this value prior to coil insertion. Before connecting up, an enhancement of 20% is commonly used. In addition to the standard high voltage AC accpetance tests, manufacturers normally carry out several other electrical checks to conform the quality of insulated components. Some of the important checks are shown in Exhibit-16.

BEARING, LUBRICATION AND BEARING ASSEMBLY

Roller Bearing

Small motors employ a deep groove ball bearing at both drive and non-drive shaft ends. As the motor size increases a roller bearing may be used at the drive end to cater for the radial thrust of the drive belt, the ball bearing being used at the non-drive end to locate the shaft axially. More ideally and on large motors, two roller bearings are used and an additional ball bearing provided at the drive end which is free to move in a radial direction. This bearing solely locates the rotor axially and can withstand moderate amount of axial thrust, such as that produced by a fan in an axially cooled machine.

The use of roller bearings is standardised and well documented in referred books provided by bearing manufacturers. It is normal to choose bearings which will give a life of 50,000 to 100,000 hours running or even 200,000 hours on the larger motors. Exhibit-17 shows a typical layout of roller bearings at the drive end and at the non-drive end.

Generally inner race of the roller bearing is fitted tightly on the shaft journal while the outer race has a smug fit in the bearing housing. For getting a tight fit the bearings are either heated in oil or by induction heating. After the bearings are fitted and cooled the inner race grips the shaft tightly.

Sleeve Bearings

There is a definite limit to the roller bearing rotational speed as bearing diameter increases. For this reason and for extended life, the larger motors of high speed employ sleeve bearings. Sleeve bearings are made of a tin or lead-based white metal.

As sleeve bearings are used in motors using axial ventilation, it is normal to provide a locating bearing at the drive end to take the axial fan thrusts. Such an arrangement is shown in Exhibit-18.

Sleeve bearings may have plain or spherical seats between their shells in the bearing housing.

Lubrication

Roller bearings are grease-lubricated except for a limited use of oil lubrication where high speeds are required. A grease thrower is fitted to the shaft which will pump used grease to a reservoir. It is possible to empty reservoir either when the machine is running or stationary.

Sleeve bearings are oil lubricated. Depedning on the peripheral speed of the journal and to a small extent on the journal bearing on the shell, cooling of bearings is accomplished in the following way :

- o Natural cooling with heat radiated from bearing housing surface. This is possible up to about 13.5 mts/sec. peripheral speed.
- o Between 13-15 mts/sec. water cooling by means of a tube cooler and bearing pump is standard.
- o Above 15 mts/sec. flood oil is provided.

Bearing Insulation

When the design of the flux carrying component of the motor have some interruption which are not symetrical, then flux patterns and e.m.f. will appear across the shaft ends. This e.m.f. causes current to flow through the motor frame via the bearings, unless the circuit is broken permanently at some point. This is achieved by providing insulation to the bearing shells, either where the shells sit in the housing or between a steel addition to the shell and shell itself. With insulted bearing shells, it is preferable to use insulated bearing seals if they are the floating type which may contact the shaft.

Temperature proofs have insulation provided by the motor manufacturers and are tested at the manufacturer's works.

COOLING

The purpose of the cooling process is to stabilise the operating temperatures of the motor windings within the limits set by the thermal classification of the machine insulation under the specified ambient conditions or within more stringent limit, set by the motor users. The most commonly used cooling systems are given below :

- o Surface Cooling
- o Pipe Ventilation
- o Water Cooling
- o Self Cooling
- o Forced Ventilation

In the surface cooling system heat generated within the machine flows through the active iron packet to the external surface. An exhaust fan mounted on the machine shaft blows the atmospheric air over the machine surface, dissipating thereby, the heat into the atmosphere.

In the pipe ventilated cooling system external and internal fans and an air to air heat exchanger are used.

In the water cooled system, motor is provided with built-in water column. Internal cycle of the air is similar to the pipe ventilated cooling system. However, there is no external fan to blow the atmospheric air through the pipes. Internal cool water is circulated through the pipe.

In the self cooled machine, fans are mounted on the machine shaft to draw the atmospheric air through the inlet into the machine. This air is then suitably circulated through the active parts of the machine and then exhausted back into the atmosphere through exit passages.

In force ventilated machines a separate fan is connected to the machine with the help of ducts to the machine frame. Force ventilation can be of two types i.e. open cycle system and closed cycling system.

Main equipment required for the above cooling systems can be summarised below :

- Fans having either radial on angle blades
- Air to air heat exchanger
- Air to water heat exchanger
- Ductings, pipes and other accessories

Fans are normally procured from outside sources.

Air heat exchangers are constructed with large, easy to clear aluminium alloy tubes flared at each end on to headers of mild steel plates. Tubes are located to best advantage and staggered to create turbulence of the external air. Carbon dust filters can be filled for easy withdrawal while the machine is in service.

Water heat exchangers use a cupronickel alloy for the tubes.

All the ductings are fabricated from sheet metal. The sheets are cut to size and formed to shapes. Different components are assembled and then welded. Flanges and other accessories are also fitted either in the plant or at the site to suit various requirements.

TERMINAL AND TERMINAL BOXES

Various terminal arrangements are available to suit different requirements of operating environment, system fault, system voltages and types of supply cables. The standard terminal box for low fault capacity system up to 6.6 KV supply voltage is a steel fabrication with a neoprene gasket to ensure weather and dust proof protection. Epoxy moulded terminal boxes of high dielectric and high mechanical strength are used. For high fault capacity system a double walled terminal box is used. The outer case encloses an inner fabricated steel shell with steel barriers effectively forming three distinct segregated phase compartments, each completely shrouded by solidly arched steel walls.

The inner steel shell prevents any internal arc from damaging the main casing and as an additional precaution, each terminal box is contained within glass reinforced plastic moulded enclosure.

BRUSHGEAR, SLIPRINGS AND BRUSHES

Slipring motor is used whenever the supply voltage is weak. Under such conditions, its starting current can be limited. It can also be used for reduced speed operation by introducing resistance into its rotor circuit. However, its maintenance cost is higher because its insulted winding on the rotor gets contaminated with brush dust, rapid wear of the carbon brushes and in some cases of the sliprings themselves.

Sliprings are constructed of copper-nickel. They are grooved to assist cooling and cleaning out brush dust. They may be shrunk on to an insulted sleeve which is mounted on the shaft or they can be shrunk directly on to the insulated shaft. Connections from the rings to the rotor windings made by rods serve into each of the rings and yet remain insulated from the rings of other phases. Connections from these rods to the windings is made of copper strip, insulated from and firmly clamped to the shaft. Where rings external to the bearings are used the connections will be made with cable passing through a bore in the shaft.

Brushes are made from metal graphite. These are held in firm contact with the sliprings by rigidly mounted brush boxes and sliprings by applying pressure to the top of the brush. The brush box is wound to size to ensure that the brush does not vibrate, yet is free to move radially to allow for brush wear.

PAINT SYSTEM

All the motor parts other than having machined or insulated surfaces are painted. The painting system involves shot blasting or chemical cleaning of all surfaces to be painted. After cleaning, the surfaces are applied a coat of synthetic resin red oxide primer to give a dry fill thickness of 25-40 microns.

The steel tube heat exchangers are chemically cleaned and fully protected on all surfaces by immersing in polyester varnish followed by an extended curing cycle. This primary coating has similar properties to that of paint primer.

The finishing paint is generally of heavy duty half-gloss and cold cured type. The paint is usually applied in two coates by spraying. The thickness of the applied coat should not be less than 90 microns.

TESTING

Test on motors conduted at the manufacturing plant falls under the following three broad categories :

- o Type Test
- o Formal Test
- o Routine Test

Type tests are carried out using the first few motors build to a new design to establish that the specified performance is achieved in all respects.

The programme of formal tests is decided between the purchaser and the manufacturers. This agreement generally follows the norms laid down in specifications such as BS-4999 Part 60 or its equivalent.

Routine tests are carried out to conform that the motion is fault free during all its stages of manufacturing and finally as it leaves the manufacturing plant.

A typical test programme for the above types of tests may include the tests as specified in Exhibit-19.

JOB NO. : DCIL-105 EXHIBIT : 11

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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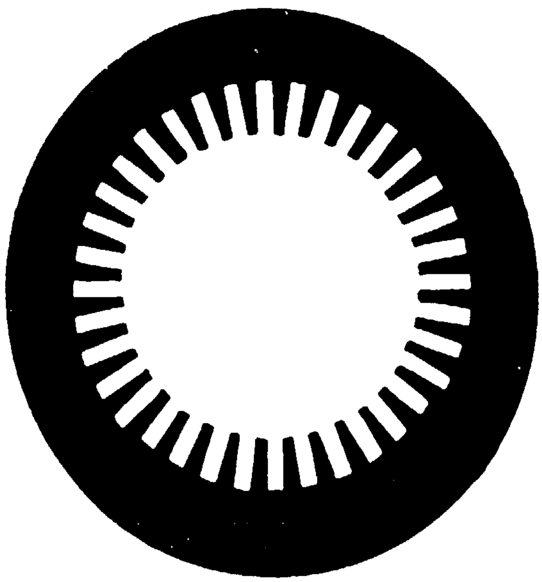
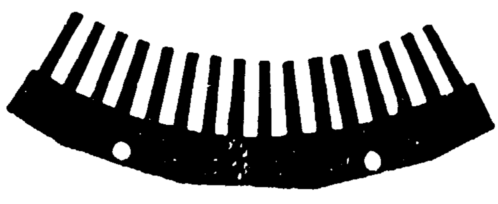
PROJECT PROFILE ON ELECTRICAL MOTORS

A TYPICAL SINGLE STATOR LAMINATION



CIRCULAR STATOR LAMINATION



SEGMENTAL STATOR LAMINATION

JOB NO. : DCIL-105

EXHIBIT : 12

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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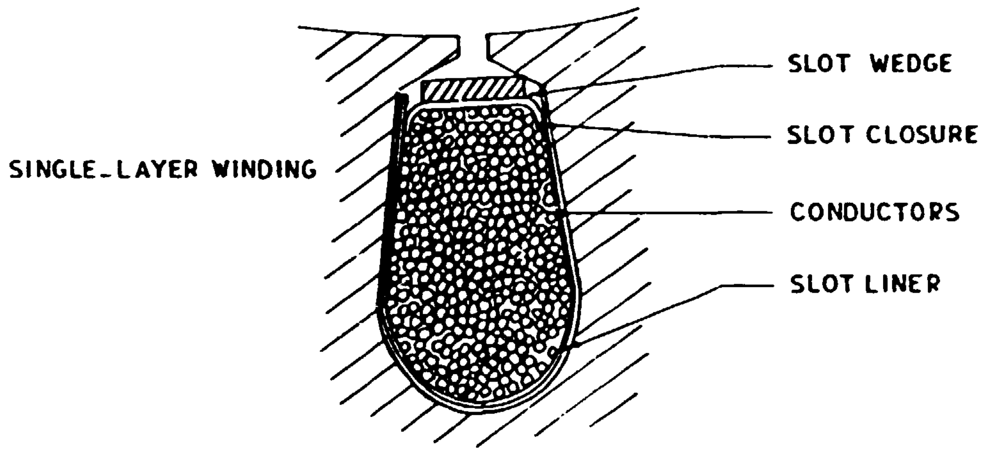
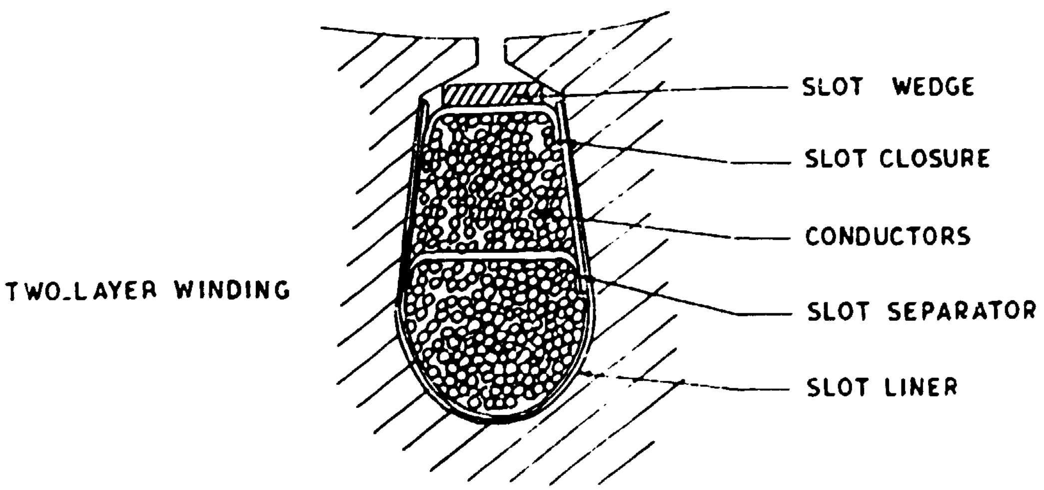
PROJECT PROFILE ON ELECTRICAL MOTORS

TWO BASIC TECHNIQUES FOR COIL LAYING





SLOT BUILD UPS FOR LOW-VOLTAGE WINDINGS

JOB NO. : DCIL-105 EXHIBIT : 13

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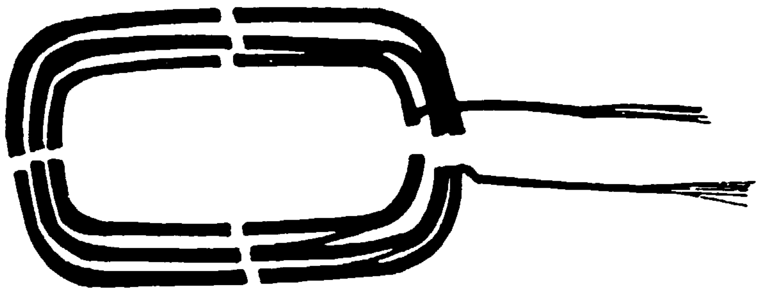
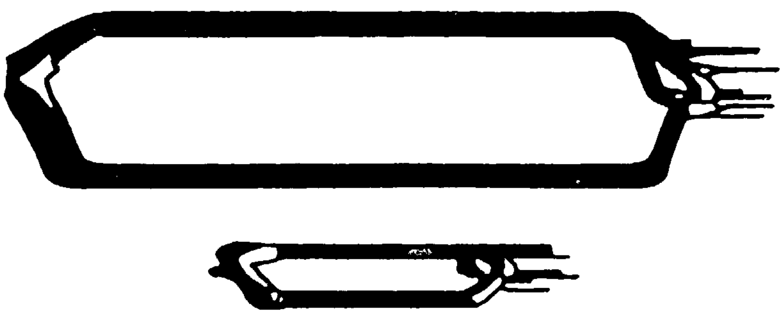
PROJECT PROFILE ON ELECTRICAL MOTORS

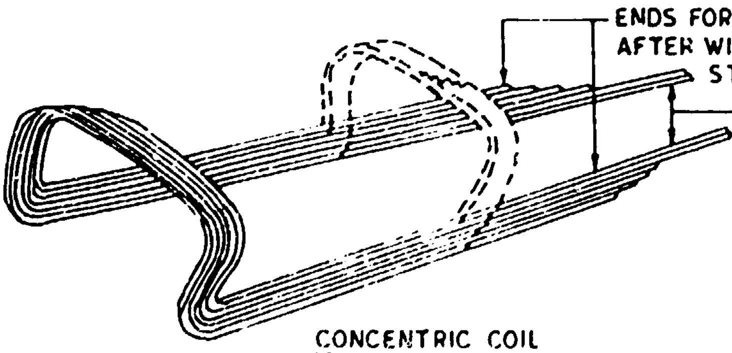
TYPICAL COILS USED IN ARMATURE WINDING



MUSH COIL



DIAMONDCOIL



CONCENTRIC COIL

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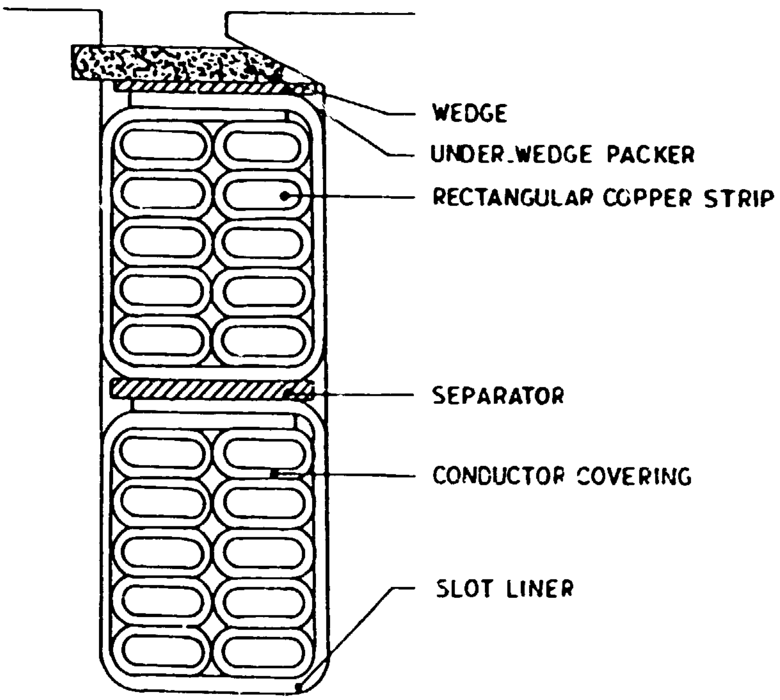
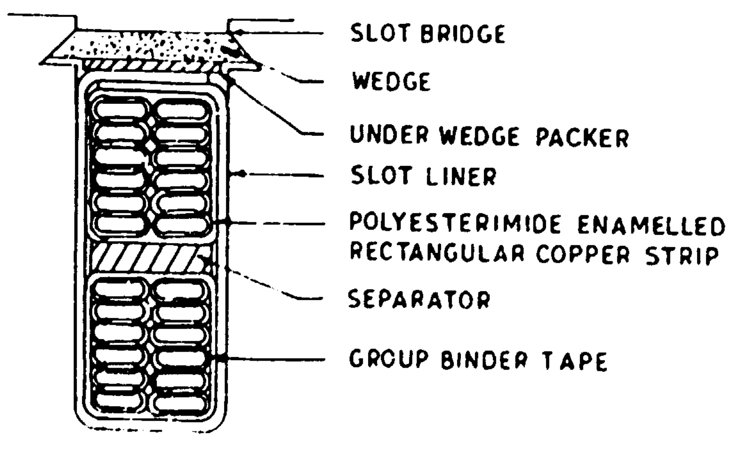
PROJECT PROFILE ON ELECTRICAL MOTORS

TYPICAL SLOT BUILD UPS FOR LOW VOLTAGE STATOR COILS



SLOT BUILD UP FOR LOW VOLTAGE
MULTI TURN COIL



SLOT BUILDUP FOR LOW VOLTAGE
SINGLETURN COIL

JOB NO. : DCIL-105

EXHIBIT : 15

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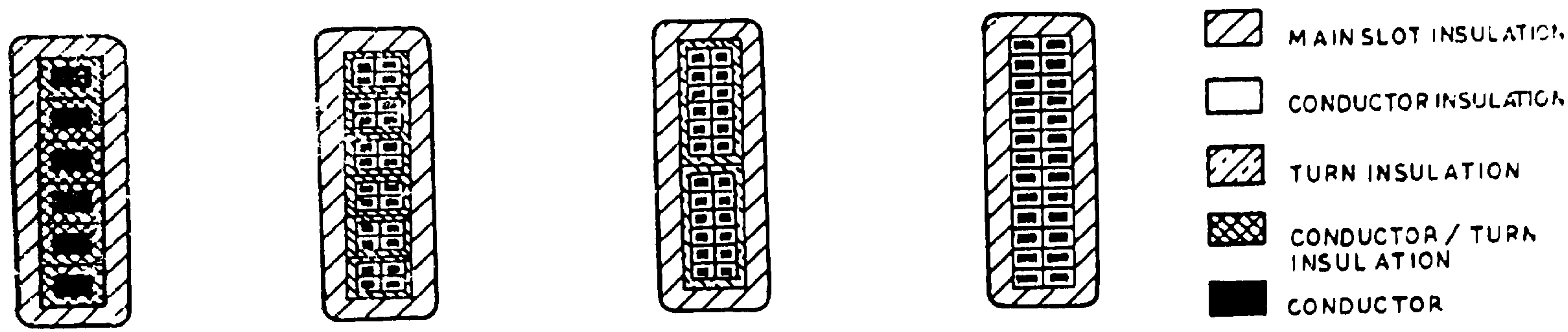
PROJECT PROFILE ON ELECTRICAL MOTORS

TYPICAL SLOT BUILD UPS FOR HIGH VOLTAGE STATOR COILS



6.TURN COIL
1.CONDUCTOR / TURN.

6.TURN COIL
4.CONDUCTORS / TURN

2.TURN COIL
12.CONDUCTORS/ TURN

SINGLE.TURN COIL OR BAR
26.CONDUCTORS/ TURN

JOB NO. DCIL-105 EXHIBIT : 16

**UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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PROJECT PROFILE ON ELECTRICAL MOTORS

LIST OF IMPORTANT CHECKS FOR COILS/WINDINGS

Test	Machine Type					
	A C Stator		A C Rotor		D C Machines	
	Low Voltage	High Voltage	Wound Rotor	Salient Pole Rotor	Armature	Field
COILS AND BARS						
interstrand	*	*	-	-	*	-
interturn	-	*	*	*	*	*
loss-tangent	-	*	-	-	-	-
corona shield resistance	-	*	-	-	-	-
high voltage	-	*	-	-	-	-
insulation resistance	-	-	-	*	-	*
WOUND STATOR/ROTOR						
interstrand	-	*	-	-	-	-
interturn	-	*	-	-	*	-
loss tangent	-	*	-	-	-	-
dielectric loss analyser	-	*	-	-	-	-
high voltage	*	*	*	*	*	*

JOB NO. DCIL-105

EXHIBIT : 16

Test	Machine Type					
	A C Stator		A C Rotor		D C Machines	
	Low Voltage	High Voltage	Wound Rotor	Salient Pole Rotor	Armature	Field
insulation resistance	*	*	*	*	*	*
polarisation index	-	*	-	-	-	-
electromagnetic probe	-	*	-	-	-	-
contact resistance (Coil-to-core)	-	*	-	-	-	-

* Required

- Not Required

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JOB NO. : DCIL-105 EXHIBIT : 17

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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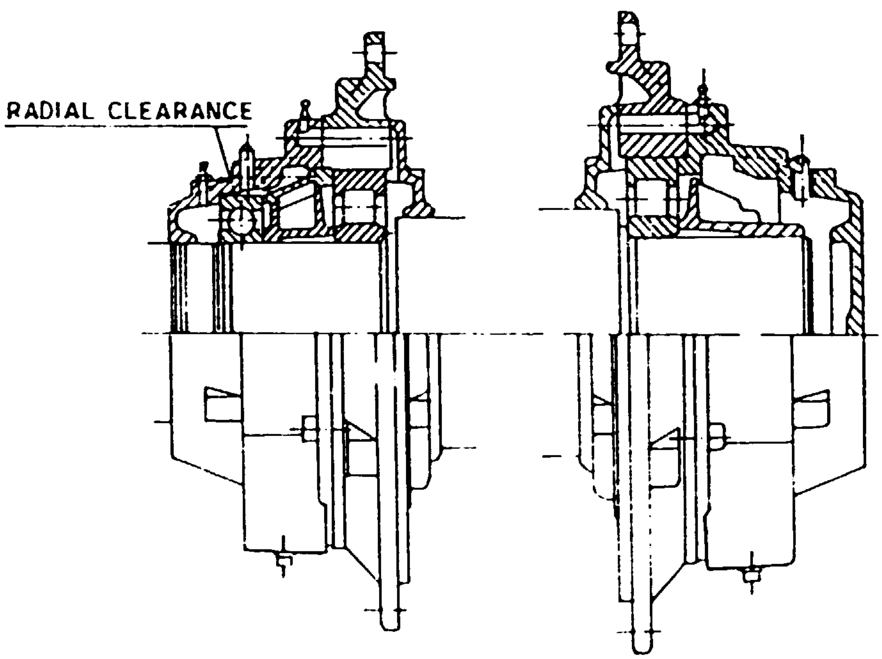
PROJECT PROFILE ON ELECTRICAL MOTORS

SCHEMATIC DIAGRAM OF ROLLER BEARINGS



TYPICAL ROLLING BEARING

A DRIVE END

B NON-DRIVE END

JOB NO. : DCIL-105 EXHIBIT : 18

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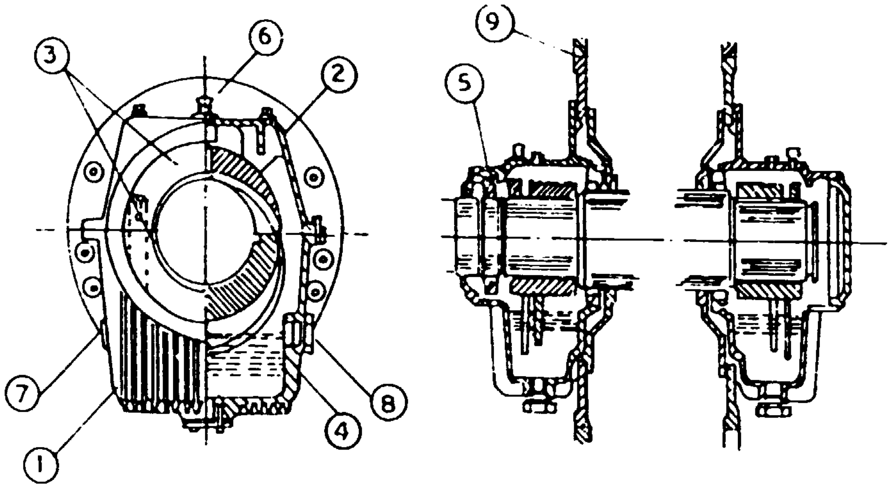
PROJECT PROFILE ON ELECTRICAL MOTORS

A TYPICAL SLEEVE BEARING



SLEEVE BEARINGS WITH LOCATING BALL BEARING AT DRIVE END

LEGEND

1 BOTTOM HOUSING WITH COOLING FINS
2 TOP HOUSING COVER
3 BEARING SHELLS
4 LUBRICATING RING
5 AXIAL GUIDE BEARING
6 VENT
7 OIL SIGHT WINDOW
8 PLUG
9 BEARING INSULATION

JOB NO. DCIL-105 EXHIBIT : 19

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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PROJECT PROFILE ON ELECTRICAL MOTORS

A TYPICAL TEST PROGRAMME

Sl. No.	Test	Type Test	Formal Test	Routine Test
A.	SYNCHRONOUS MACHINES (INCLUDING SYNCHRONOUS INDUCTION MACHINE)			
1.	Resistance of windings (cold)	Yes	Yes	-
2.	No load losses	Yes	Yes	Yes
3.	Locked Rotor - current	Yes	Yes	-
	- torque	Yes	-	-
4.	Open-circuit secondary induced voltage at standstill (wound rotor)	Yes	Yes	Yes
5.	Temperature rise	Yes	-	-
6.	Tests to establish efficiency	Yes	-	-
7.	Momentary overload	Yes	-	-
8.	High voltage	Yes	Yes	Yes
9.	Vibration	Yes	-	-
10.	Short-circuit saturation	Yes	Yes	-
11.	Short-circuit losses	Yes	-	-
B.	INDUCTION MACHINES			
1.	Resistance of windings (cold)	Yes	Yes	-
2.	No load losses and current	Yes	Yes	Yes
3.	Locked rotor - current	Yes	Yes	-
	- torque	Yes	-	-

DEVELOPMENT CONSULTANTS

JOB NO. DCIL-105 EXHIBIT : 19

Sl. No.	Test	Type Test	Formal Test	Routine Test
4.	Open circuit secondary induced voltage at standstill (wound rotor)	Yes	Yes	Yes
5.	Temperature rise	Yes	-	-
6.	Power factor and any tests to establish efficiency	Yes	-	-
7.	Momentary overload	Yes	-	-
8.	High voltage	Yes	Yes	Yes
9.	Vibration	Yes	-	-
C.	**D C MACHINES**			
1.	Resistance of windings (cold)	Yes	Yes	-
2.	No load losses and current	Yes	Yes	Yes
3.	Temperature rise	Yes	-	-
4.	Tests to establish efficiency	Yes	-	-
5.	Momentary overload	Yes	-	-
6.	Commutation	Yes	Yes	-
7.	High voltage	Yes	Yes	Yes
8.	Vibration	Yes	-	-

SECTION - 7
PLANT AND EQUIPMENT

PLANT AND EQUIPMENT

In order to make the estimated number of electrical motors of various ratings, the plant will need nearly 1,400 tonnes of steel castings, forgings and sections. Manufacturing the above items in a single plant will offer considerable economies of scale. The plant will have the following facilities :

- o Production and Tool Room
- o Quality Control
- o Material Testing Laboratory
- o Maintenance
- o Material Handling
- o Utilities

Exhibit-20 presents the recommended product-mix of various types of motors that may be taken up for manufacturing. These figures have been arrived at by applying the norms of consumption of motors installed in various thermal power plants. In terms of weight, these add up to around 1200 tonnes.

The proposed facilities can manufacture motors above 1000 KW capacity as a single unit. However, higher capacity motors are fewer in numbers. It is assumed here that the maximum weight of the component to be transported by road will not exceed 6 tonnes.

The main production processes involved in manufacturing motors are :

- o Fabrication
- o Machining
- o Welding

- o Coil winding
- o Vacuum Pressure Impregnation
- o Assembly
- o Testing

Based on the design parameters and the demand for the product, the manufacturing workload is estimated in Exhibit-21.

Production and Tool Room

The production shop will have equipment for the following sections :

- o Cutting
- o Metal Forming
- o Machining
- o Welding
- o Drilling
- o Coil Winding
- o Commutator Manufacturing
- o General Machinery Section for production, tool repair and maintenance
- o Shot Blasting and Painting
- o Assembly, Testing and Despatch

List of equipment for production and tool room is presented in Exhibit-22.

Material Handling

List of equipment for material handling is included in Exhibit-22. Material handling facilities have been designed in such a way that the production area, raw material stores, general stores and finished goods despatch area are all within the reach of overhead EOT cranes. Capacity of the cranes have been determined by considering the maximum weight of a single piece which is to be handled at each stage of production.

For inter-bay material movement, 4 Hand Push trolleys are provided. Besides, 3 fork lift trucks and 3 mobile cranes are also provided. Material movement outside the plant will be done by hired vehicles. However, 2 trucks have been provided for general purpose use and for emergency.

Material Testing Laboratory

To ensure that the motor and motor parts function as specified by the designer of the equipment, these must be manufactured from quality raw material. Suitable facilities have been suggested in the material testing laboratories to check the physical and chemical properties of incoming materials. Equipment have also been recommended for destructive and non-destructive testing of the finished components. Electrical testing plays an important role in manufacturing of motors. It requires sophisticated testing facilities like Surge Tester and Ultraviolet Ray Recorders which have also been included in the above section.

Auxiliary Equipment

List of auxiliary equipment is included in Exhibit-22.

Maintenance

List of equipment for maintenance shop and tool room is also shown in Exhibit-22.

JOB NO. : DCIL-105 EXHIBIT : 20

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PROJECT PROFILE ON ELECTRICAL MOTORS

RECOMMENDED PRODUCT-MIX

KW Rating	No. of Motors
2.01 - 4.00	453
4.01 - 5.00	407
5.01 - 7.00	175
7.01 - 10.00	256
10.01 - 30.00	268
30.01 - 100.00	163
100.01 - 1000.00	268
1001 and above	36
TOTAL	2026

DEVELOPMENT
CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 21

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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PROJECT PROFILE ON ELECTRICAL MOTORS

ANNUAL PRODUCTION LOAD

Capacity Range (KW)	No. of Motors	Rotor Weight Unit (Kg)	Rotor Weight Total (Tonnes)	Motor Weight Unit (Kg)	Motor Weight Total (Tonnes)
2.01 - 4.00	453	14	6.34	45	20.38
4.01 - 5.00	407	22	8.95	75	30.52
5.01 - 7.00	175	30	5.25	100	17.50
7.01 - 10.00	256	39	9.98	130	33.28
10.01 - 30.00	268	60	16.08	200	53.60
30.01 - 100.00	163	165	26.89	550	89.65
100.01 - 1000.00	268	1050	281.40	3500	938.00
1001 and above	36	1800	64.80	6000	216.00
Total	2026		419.69		1398.93

JOB NO. : DCIL-105

EXHIBIT : 22

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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PROJECT PROFILE ON ELECTRICAL MOTORS

LIST OF MAJOR EQUIPMENT AND HANDTOOLS

Sl. No.	Name of Equipment	Brief Specification	Nos. Required	Power Consumption (KW)	Unit Price ($)	Total Price ($)
	FABRICATION SHOP					
1.	Plate Shearing Machine	Type : Hydraulic	1	25	49,590	49,590
		Shearing Length : 2500 mm				
		Max.Plate Thickness : 10 mm				
2.	3 Roll Plate Bending Machine	Working Width : 3000 mm	1	90	1,22,800	1,22,800
		Max.Plate Thickness : 10 mm				
3.	Cross Carriage Profile Cutting Machine	Type of Fuel Gas : Acetylene	1	1	18,000	18,000
		Tracing Width : 2000 mm				
		Tracing Table Length : 1500 mm				
		Cutting Width : 25000 mm				
		Cutting Length : 2000 mm				
4.	Rectifier DC Welding Set	Type : Forced Air Cooled	1	40	10,300	10,300
		Range of Welding Current : 70 - 900 Amps				
		Rated Current : 600 Amps				

DEVELOPMENT CONSULTANTS

JOB NO. : DCIS-165

EXHIBIT : 22

Sl. No.	Name of Equipment	Brief Specification		Nos. Required	Power Consumption (KW)	Unit Price ($)	Total Price ($)
5.	MIG Welding Set complete with DC rectifier power source, servo wire feeder unit, CO_2 regulator cum flow meter, and heater with core assembly	Type	: Semi Automatic	2	34	3,185	6,370
		Rated Current	: 400 Amps				
		Open Circuit Voltage	: 55 V DC				
6.	Heat Treatment Furnace with Quenching Tank	Type	: Electrically heated, batch type, bogie hearth Furnace	1	7	30,000	30,000
		Chamber Dimension:	300 x 300 x 150 mm				
		Temperature Range:	700 - 1250°C				
		Cycle time for heating to full temperature	: 2 hours				
7.	Stress Relieving Furnace	Chamber Dimension: (L x W x H)	4.5 x 2.5 x 1.5 mts	1	90	90,000	90,000
							3,27,060
	MACHINE SHOP						
1.	Centre Lathe	Centre Height	: 850 mm	2	70	35,000	70,000
		Centre Distance	: 3100 mm				
		Maximum Load	: 5 Tonne				
2.	Vertical Turret Lathe	Maximum Swing over bed	: 2100 mm	2	25	50,000	1,00,000
		Distance between Spindle Nose and Turret	: 1936 mm Min. 390 mm				
		Maximum Load	: 15 Tonne				

DEVELOPMENT
CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 22

Sl. No.	Name of Equipment	Brief Specification	Nos. Required	Power Consumption (KW)	Unit Price ($)	Total Price ($)
3.	CNC Vertical Machining Centre	Table Dimension : 1500 x 600 mm	1	20	1,60,000	1,60,000
		Maximum Dimension: 1050 x 560 x 610 mm of the job				
		Maximum Load : 1.8 Tonne				
4.	CNC Horizontal Machining Centre	Table Dimension : 630 x 630 mm	1	15	1,35,000	1,35,000
		Maximum Dimension: 850 x 700 x 750 mm of the job				
		Maximum Load : 1.2 Tonne				
5.	CNC Horizontal Machining Centre	Table Dimension : 2400 x 1300 mm	1	25	1,18,000	1,18,000
		Maximum Dimension: 2400 x 2500 x 1000 mm of the job				
		Maximum Load : 3 Tonne				
6.	Horizontal Milling Machine	Table Dimension : 1200 x 1200 mm	1	11	25,000	25,000
		Maximum Dimension: 1600 x 1200 x 1400 mm of the job				
		Maximum Load : 4 Tonne				
7.	Keyway Milling Machine	Maximum Length : 1400 mm of Keyway	1	7.5	22,000	22,000
8.	Cylindrical Grinding Machine	Admit between : 3000 mm Centres	1	25.0	1,82,000	1,82,000
		Swing over table : 600 mm				
		Maximum Load : 4 Tonne				
9.	Surface Grinding Machine	Working Surface : 250 x 1000 mm	1	7	39,000	39,000
		Maximum Grinding : 700 mm				
10.	Radial Drilling Machine	Drilling Capacity: 80 mm dia in Steel	2	16	20,000	40,000
		Arm Length : 2.7 m				

JOB NO. : DCIL-105

EXHIBIT : 22

Sl. No.	Name of Equipment	Brief Specification	Nos. Required	Power Consumption (KW)	Unit Price ($)	Total Price ($)
11.	Deep Hole Drilling Machine	Drilling Capacity: 75 mm dia in Steel	2	9	18,000	36,000
		Admit : 2500 mm				
12.	CNC Key Seiting Machine	Table Dimension : 550 x 770 mm	1	15	1,50,000	1,50,000
		Keyway Length : 750 mm				
		Keyway Width : 3 - 125 mm				
		Keyway Bore : 10 - 500 mm				
		Maximum Weight of the job : 35 Tonne				
						10,77,000
	MOTOR MANUFACTURING SHOP					
1.	Vertical Metal Cutting Circular Band Saw (Do all Saw)	Type : Contour Band Sawing Machine	1	5	40,000	40,000
		Blade Width : 12.5 mm				
		Admit between centres : 300 mm				
2.	3 Column Dishing and Flanging Press	Capacity : 50 Tonne	1	15	21,000	21,000
		Size of Bed : 1500 x 1500 mm				
3.	4 Column Dishing and Flanging Press	Capacity : 150 Tonne	1	10	45,000	45,000
		Size of Bed : 1500 x 1500 mm				
4.	Hydraulic Press	Capacity : 500 Tonne	1	75	85,000	85,000
		Size of Bed : 600 450 mm				
5.	Rotor Banding Machine	Maximum dia of Rotor 4000 mm	1	15	25,000	25,000
		Swing over bed : 900 mm				
		Maximum allowable tension : 400 kg/cm²				

DEVELOPMENT
CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 22

Sl. No.	Name of Equipment	Brief Specification	Nos. Required	Power Consumption (KW)	Unit Price ($)	Total Price ($)
6.	Dynamic Rotor Balancing Machine	Nominal Weight Capacity : 10 Tonne Maximum diameter of Rotor : 2500 mm Maximum Rotor Length : 5500 mm Speed : 3000 rpm	1	[illegible]	32,000	32,000
7.	TIG Welding set complete with Argon Arc Torch and accessories, DC Supressor unit, high frequency unit, water circulation unit and DC rectifier power source	Type : Semi automatic Range of Welding Current : 40 - 350 Amps	1	20	4,400	4,400
8.	Vaccum Pressure Impregnation Chamber (VPI)	Chamber Dia : 1000 mm Length of the Chamber : 2000 mm	1	10	12,000	12,000
9.	Oven for Vaccum Pressure Impregnation	Chamber Dimension: 6000 x 2000 x 2000 mm	1	2	2,000	2,000
10.	Varnish Tank for Vaccum Pressure Impregnation	Chamber Dimension: 5000 x 3000 x 2000 mm Maximum dia of Rotor : 1750 mm Maximum Length of Rotor : 5740 mm	1	5	3,000	3,000
11.	Blanking Press for manufacturing stampings	Type : Hydraulic Capacity : 400 Tonne	1	60	75,000	75,000
						1,44,400

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 22

Sl. No.	Name of Equipment	Brief Specification		Nos. Required	Power Consumption (KW)	Unit Price ($)	Total Price ($)
	COIL WINDING SHOP						
1.	Coil Tapping Machine	Type	: Automatic Vertical Condutor	1	20	30,000	30,000
		Taping Capacity	: 6 layers of insulation tape on base copper strips				
2.	Layer Winding Machine	Type	: Suitable for providing layer to both armature and field coils	1	5	9,000	9,000
3.	Storip-on-edge Coil Winding Machine	Type	: CNC, Suitable for field coils of large motors	1	10	22,000	22,000
4.	Continuous Conductor Tapping Machine	Capacity	: Straight Coils upto 3500 mm length	1	5	6,000	6,000
5.	Coil Looping and Stretching Machine	Type	: Suitable for spreading high voltage diamond coils upto 2 mts span	1	10	12,000	12,000
6.	Hot Coil Pressing Machine	Type	: Hydraulic	1	25	19,000	19,000
		Capacity	: 30 Tonne				
7.	Armature Branding Machine	Swing over bed	850 mm	1	20	22,000	22,000
		Admit between Centres	: 3100 mm				
8.	Stator Rotator for Winding	Capacity	: 10 Tonne	2	-	16,000	32,000
9.	Rotor Rotator for Winding	Capacity	10 Tonne	2	-	16,000	32,000
		Maximum Dia of Rotor	1000 mm				
10.	Rotor Rotator for Brazing	Capacity	: 10 Tonne	2	-	16,000	32,000
		Maximum Dia of Rotor	: 1000 mm				
							2,16,000

JOB NO. : DCIL-105

EXHIBIT : 22

Sl. No.	Name of Equipment	Brief Specification		Nos. Required	Power Consumption (KW)	Unit Price ($)	Total Price ($)
	COMMUTATOR SHOP						
1.	Draw Bench	Type	: Suitable for cold drawing of profiles	1	10	10,000	10,000
		Maximum Dia of workpiece	: 600 mm				
		Maximum Length of workpiece	: 400 mm				
2.	L-Cut Shearing Press	Maximum Size of flat to be sheared	: 120 x 12 mm	1	2	6,000	6,000
		Length of blade	: 245 mm				
3.	Hydraulic Press	Maximum Capacity	: 50 Tonne	1	7.5	10,000	10,000
4.	Oil fired Annealing Furnace	Size of heating Chamber	: 600 x 600 x 1500 mm	2	-	8,000	16,000
5.	Pickling Tank	Size of Chamber	: 4 x 1.5 x 1.5 mts	2	-	7,000	14,000
6.	Automatic Commutator Seasoning Equipment including ovens	Chamber Dia	: 600 mm	6	-	100	600
		Chamber Height	: 400 mm				------
							64,600
	TOOL ROOM AND MAINTENANCE						
1.	Wire cut EDM Machine	Maximum Thickness of Wire	: 5 - 10 mm	1	2.5	8,000	8,000
		Length of Wire to cut Automatically	: 30 - 1000 mm				
2.	Profile Grinding Machine	Height of Centres	: 175 mm	1	1	13,000	13,000
		Distance between Centres	: 625 mm				
		Internal Grinding Dia	: 25 - 200 mm				
		Depth of Grinding	: 125 - 200 mm				

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 22

Sl. No.	Name of Equipment	Brief Specification		Nos. Required	Power Consumption (KW)	Unit Price ($)	Total Price ($)
3.	Fine Boring Machine	Type	: Vertical	1	11	25,000	25,000
		Useful Table Area:	400 x 630 mm				
		Reading Accuracy :	0.001 mm				
		Positioning Accuracy	: 0.003 mm				
		Bore Tolerance	: 175/176 (ISC Standard)				
4.	Heat Treatment Furnace with Quenching Tank	Type	: Electrically heated, batch type, bogie hearth Furnace	1	7	48,000	48,000
		Chamber Dimension:	300 x 300 x 150 mm				
		Temperature Range:	700 - 1250°C				
		Cycle time for heating to full temperature	: 2 hours				
5.	Precision Lathe	Centre Height	: 220 mm	1	11	3,500	3,500
		Distance between Centres	: 1500 mm				
6.	Bench Grinder	Wheel Size	: 250 x 25 x 25 mm	4	4	1,000	4,000
7.	Universal Milling Machine	Table size	: 310 mm x 1520 mm	1	10	22,000	22,000
8.	Column Drilling Machine	Drilling capacity:	40 mm	1	7	1,400	1,400
9.	Arc Welding Set	Current Range	: 70-450 Amps.	1	5	4,000	4,000
10.	Rectifier DC Welding Set	Current Range	: 55-500 Amps.	1	30	6,000	6,000
11.	Screw Jack	Type	: Ratchet type, lifting and Traversing	2	-		600
		Capacity	: 5 Tonne				

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 22

Sl. No.	Name of Equipment	Brief Specification		Nos. Required	Power Consumption (KW)	Unit Price ($)	Total Price ($)
12.	Collapsible Ladder	Type	: Self-supporting extendable all aluminium ladder	1	-	150	150
		Closed Height	: 5 m				
		Extended Height	: 9 m				
13.	Collapsible Ladder	Type	: Self-supporting extendable all aluminium ladder	1	-	200	200
		Closed Height	. 3 m				
		Extended Height	: 5.5 m				
14.	Battery Charger	No.of phases	: 3	2	-	100	200
		Input voltage	: 240 V				
		Output voltage	: 36 V				
15.	Weigh bridge	Type	: Electronic, Road Transport	1	-	3,700	3,700
		Capacity	: 25 Tonne				
		Platform size	: 8 m x 3 m				
16.	Portable Platform Weighing Scale	Type	: Arm	1	-	1,200	1,200
		Capacity	: 500 Kg				
		Platform size	: 1.25 m x 1.25 m				
17.	Work Bench	50 mm laminated top in angle iron frame with four angle iron legs		2	-	Lumpsum	
		Size of Top surface	: 2000 x 850 mm				
		Floor to Top height	: 900 mm				

JOB NO. : DCIL-105 EXHIBIT : 22

Sl. No.	Name of Equipment	Brief Specification	Nos. Required	Power Consumption (KW)	Unit Price ($)	Total Price ($)
18.	Surface Plate	Surface plate made of close grained cast iron of 200 BHN sturdy angle iron frame and adjusting jacks	1	-		
		Top surface size : 1000 x 600 mm				
19.	Steel Tote Box	Welded steel construction covered with heavy duty wire mesh	30	-		
		Size : 1000 x 1000 x 450 mm				
20.	Closed Storage Shelves	-	-	-		
21.	Open Storage Shelves	-	-	-		
22.	Workers' Tool Cabinet	-	-	-		
23.	Lubrication Equipment	-	-	-		
24.	Other Hand Tools	-	-	-	Lumpsum	5,000
						1,45,950
	MATERIAL HANDLING					
1.	E.O.T. Crane	Capacity : 5 Tonne	1	15	39,000	39,000
		Span : 16 M approx.				
		Class : III				
2.	E.O.T. Crane	Capacity : 10 Tonne	1	30	56,660	56,680
		Span : 16 M approx.				
		Class : III				
3.	E.O.T. Crane	Capacity : 25 Tonne	1	45	1,29,000	1,29,000
		Span : 16 M approx.				
		Class : III				
4.	E.O.T. Crane	Capacity : 50 Tonne	1	50	1,95,000	1,95,000
		Span : 16 M approx.				
		Class : III				

JOB NO. : DCIL-105

EXHIBIT : 22

Sl. No.	Name of Equipment	Brief Specification		Nos. Required	Power Consumption (KW)	Unit Price ($)	Total Price ($)
5.	Engine Driven Mobile Crane	Overall Jib Length	: 11.5 mts	1	-		
		Maximum lifting Capacity at 3 m radius	: 1 Tonne	1	-	15,000	15,000
			: 2 Tonne	1	-	22,000	22,000
			: 5 Tonne	1	-	25,000	25,000
6.	Forklift Truck	Type	: Battery operated				
		Load Centre	: 500 mm				
		Maximum lift	: 3.66 mts				
		Capacity	: 1 Tonne	1	-	40,000	40,000
			: 2 Tonne	1	-	45,200	45,200
			: 3 Tonne	1	-	49,000	49,000
7.	Hand Push Trolley	Capacity	: 1000 kg	2	-	100	200
			500 kg	2	-	70	140
8.	Double Wheel Barrow	Type	: Heavy Duty	4	-	200	800
		Capacity	: 0.2 m³				
9.	Truck	GVW	: 14,000 Kg	2		8,000	16,000
							6,33,020

INSPECTION AND TESTING

Mechanical Measuring Instruments

Sl. No.	Name of Equipment	Brief Specification	Nos. Required	Power Consumption (KW)	Unit Price ($)	Total Price ($)
1.	Vernier Calipers, Depth Vernier, Height Vernier, Outside Micrometer, Inside Micrometer, Feeler Gauge	Suitable for measuring upto 1500 mm	-	-	Lumpsum	2,000
2.	Dial Indicator	Suitable for measuring 0.01 mm to 10 mm	-	-		100
3.	Stroboscope	Suitable for measuring speed upto 19,000 rpm	-	-		100

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EXHIBIT : 22

Sl. No.	Name of Equipment	Brief Specification	Nos. Required	Power Consumption (KW)	Unit Price ($)	Total Price ($)
4.	CNC Co-ordinate measuring machine	Table Size : 1100 x 1100 x 750 mm	1	15	12,000	12,000
		Maximum Load : 2 Tonne				
		Accuracy : 0.002 mm				
5.	Vibration Surveyor	Standard	-	-		500
6.	Brinell Hardness Testing Machine	Type : Power operated	1	1	11,170	11,170
		Applied Load : 250 - 3000 kgs				
7.	Rockwell Hardness Testing Machine	The machine shall use both steel ball and diamond cone	1	1	9,080	9,080
		Minor Load : 10 kg				
		Major Load : 100 kg, 150 kg				
8.	Universal Testing Machine	Type : Hydraulically loaded	1	6	18,000	18,000
		Capacity : 100 tonnes				
9.	Crack Depth Detection and Die Penetrant Test Equipment	Standard	1	-	600	600
10.	Impact Testing Machine	Type : Pendulam type impact charpy system	1	1	1,000	1,000
		Capacity				
		With Complementary : 30 kgm weights				
		Without Comple- : 15 kgm mentary Weights				
11.	Metallographic Specimen Mounting Bakelite Press	Capacity 8 tonnes	1	1	800	800

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Sl. No.	Name of Equipment	Brief Specification		Nos. Required	Power Consumption (KW)	Unit Price ($)	Total Price ($)
12.	Surface Grinder	Type	: Swing type, floor modle with cup wheel	1	2	50	50
		Sample Size					
		Diameter	: 30 - 50 mm				
		Thickness	: 3 - 35 mm				
13.	Specimen Grinding and Polishing Machine for Metallography	Disc Size	: 200 mm	1	1	500	500
14.	Electrolytic Polishing Apparatus	Type	: Laboratory type electrolytic polishing apparatus	1	1	200	200
		Max Sample Diameter	: 250 mm				
		Max Sample Height	: 40 mm				
15.	Metallographic Microscope	Type	: Projection-cum-Photomicrograph laboratory type microscope	1	-	100	100
		Magnification	: 50 - 1800 dia				
16.	Material Testing Spectroscope	Used for qualitative and quantitative analysis of samples using microphotometer and photographic plate or film for recording		1	-	500	500
17.	Apparatus for Determination of Carbon and Sulphur	Max Carbon Content	: 4.5%	1	-	100	100
		Max Sulphur Content	: 0.15%				
18.	Ultrasonic Testing Equipment	Type	: Ultrasonic, pulse reflection portable type	1	-	26,000	26,000
		Measuring Range in Steel	: 1 - 1000 cm				
		Frequency Range	: 0.5 - 10 Mc/s				

JOB NO. : DCIL-105 EXHIBIT : 22

Sl. No.	Name of Equipment	Brief Specification	Nos. Required	Power Consumption (KW)	Unit Price ($)	Total Price ($)
19.	Magnetic Crack Detector	The detector shall produce both longitudinaland circular magnetic fields	1	-	21,390	21,390
		Current Range : 250 - 1200 amps				
		Voltage Range : 4 - 8 volts				
20.	Abrasive Cutting Machine	Type : Submerged type, wet oscillating cutting machine for laboratory use	1	12	8,000	8,000
		Max Cutting Capacity : 100 mm				
		Dia of Cutting Wheel : 450 mm				
21.	Weighing Machine	Type : Analytical balance	1	-	150	150
		Capacity : 200 gms				
		Sensitivity : 0.1 mg				
Portable Testing Tools						
1.	Portable Hardness Tester	Type : Rockwell	1	-	500	500
2.	Portable Hardness Tester	Type : Poldi type hardness tester (ferrous and non-ferrous) consisting of , tester standard test bar and measuring magnifiscope	1	-	500	500
		Indentor : 10 mm dia Brinell Ball				
3.	Portable X-Ray Equipment	Type : Industrial	1	-	600	600
		Max Thickness : 100 mm				
		Sensitivity : 1 - 2 %				
						1,14,020

SECTION - 8

RAW MATERIALS AND OTHER INPUTS

RAW MATERIALS AND OTHER INPUTS

The basic materials, consumables and bought out items required for manufacturing norms are classified under the following main groups :

- o Steel/Grey Iron Castings for motor base frame
- o Forged Steel Shaft for Rotors
- o Phenolic Resins
- o Cast Aluminium Bars
- o Copper Alloy Bars
- o Fasteners like nuts and bolts, gaskets, expansion joints and neck joints
- o Steel grits for shot blasting
- o Primer and paints
- o Welding electrodes
- o Furnace oil
- o Auxiliary equipment like Bearings, Fans, Heat Exchangers, Ducting, Pipes, etc.
- o Hardware and other miscellaneous items including cutting oil, lubricants, soaps, cotton waste and electrical consumables.

Technical specifications of these materials and their annual requirement are presented in Exhibit-23.

While estimating the requirement of motor plates, a wastage factor of 10% has been assumed. In case of rotors, however, wastage has been assumed as 5%.

All auxiliary equipment shall be bought-out. The cost of these has not been taken into consideration while estimating the production cost of the motor. Roughly, these represent about 10% of the total price of a motor.

All locally purchased materials may be stocked for two months' use. The materials to be imported may be stocked for four months' use.

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JOB NO. : DCIL-105 EXHIBIT : 23

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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PROJECT PROFILE ON ELECTRICAL MOTORS

REQUIREMENT OF RAW MATERIALS, CONSUMABLES AND BOUGHT-OUT ITEMS

Sl. No.	Item	Material Specification	Yearly Requirement (MT)	Price ('000 US $)
1.	Steel Plates (1 mm to 3 mm)	As per BS : 1449 Part I and II	2,150	2,988.50
2.	Forged Mild Steel Shaft Carbon Content 0.25%	As per BS : 4670	880	985.60
3.	Angles and Channels	Rolled Section as per BS : 4868 Part IV	235	323.70
4.	Phenolic Resin	Standard	350	1,820.00
5.	Cast Aluminium Bars (for 350 mm Centre height motors)	As per BS : 1474	25	104.80
6.	Copper Alloy Bars (for large motors)	Commercial Grade	1.9	9.10
7.	Insulating Material	Continuous Mica (for tape insulation), paper, bitumin, oil laquer, asphalt, polyester varnish	Lumpsum	11.70
8.	Fasteners like nuts, bolts, gaskets, etc.	As per BS : 6104	2.5	2.60
9.	Steel Grits	Chilled Steel Angular Shots Grade 8-14 mesh As per BS : 2451	0.95	0.25
10.	Primer & Paints	As per BS : 2523	815	12.60

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Sl. No.	Item	Material Specification	Yearly Requirement (MT)	Price ('000 US $)
11.	Welding Electrodes	As per BS : 2493	18.7	1.30
12.	Furnace Oil	As per BS : 2869	120	113.20
13.	Auxiliary Equipment like Fans, Heat Exchangers, Ducting, Pipes, etc.	Standard Bought-out Items	Lumpsum	310.00
	TOTAL			6,483.35

SECTION - 9
UTILITIES

UTILITIES

Utilities in the plant will include power, water, compressed air. Apart from the above, facilities have been suggested for air-conditioning of the administrative building and for fire-fighting.

Power

A summary of power requirement is presented in Exhibit-24. While calculating the total load, power required for general lighting, air-conditioning, dust collection and fume control units and for other utilities have also been considered. The lighting load for the office building has been computed based on the assumption that it will merely supplement the natural light which will otherwise be sufficient. As all the equipment will not be operated simultaneously, different load factors have been considered for various types of equipment. Based on the different load and power factors, total requirement of power is estimated as 1300 KVA. Since the power rating required for production equipment and services is 415/220 volts, 2 transformers, each of 1000 KVA rating are recommended. It is assumed that the power will be tapped from a 11 KV overhead transmission line. Thus the transformer will have a step down ratio from 11 KV to 415/220 volts. Further, to reduce the fault level and fluctuations in the lighting line, 1 lighting transformer of 100 KVA capacity is also recommended.

Water

Water in the plant will be needed for the following purposes:

- production
- heat treatment
- as coolant for metal cutting tools
- for cooling the central air-conditioning system
- for cooling air compressors

Average rate of requirement of water for the above functions is about 5 m^3 per hour.

The plant will also need water for :

- drinking and cooking
- sanitation, gardening and shop floor washing

Requirement of water for the above mentioned needs is shown in Exhibit-25. The total average requirement is estimated at 8 m^3 per hour. For human and sanitary needs, the water consumption has been estimated at 100 litres per person per 8 hour shift.

It is proposed that the plant be equipped with a 4" dia deep tubewell, 2 pumps - each of 12 m^3 per hour capacity, and one overhead tank of 25 m^3 capacity.

Compressed Air

Compressed air is needed in the plant for the following purposes :

- operating hand tools like chipping hammers, hand grinders, etc.
- operating spray guns in the painting booth
- operating shot blasting guns in shot blasting booth

Connected load of compressed air as shown in Exhibit-26 for all these purposes is estimated as 5.6 m^3 per minute. Considering a demand factor of 0.5, maximum rate of consumption is estimated as 2.8 m^3 per minute. Considering delivery losses and compressor efficiency, the compressor capacity required is about 6 m^3 per minute. Therefore it is recommended that 2 compressors of 3 m^3 per minute capacity delivering air at 7 Kg per cm^2 pressure be provided.

Air-conditioning

It is proposed that the administrative building be centrally air-conditioned to create a conducive atmosphere for efficient working of the personnel housed in the building. For this purpose, a centralised air-conditioning system of 80 tonnes of refrigeration (TR) capacity with individual air handling units for each floor is recommended. The system shall have a separate cooling tower of the induced draft type for water cooling. The workshop shall be provided with room coolers for circulation of air.

Major equipment and accessories for all utilities are listed in Exhibit-27.

Fire Protection System

Sufficient number of fire extinguishers of different types will be required for fighting fire within the workshop premises. The entire fire fighting system/appliances is classified into three major categories, viz., portable extinguishers, wheeled extinguishers and fixed systems. Apart from these, other appliances like fire detector, alarms, sand/water buckets, etc., will also be needed.

Transport

The company may provide cars only to the top personnel belonging to levels 1 and 2. Therefore, in all, 2 cars and 2 buses should be sufficient.

JOB NO. : DCIL-105

EXHIBIT : 24

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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PROJECT PROFILE ON ELECTRICAL MOTORS

SUMMARY OF POWER REQUIREMENT

Sl. No.	Description	Connected Load (KW)	Demand Factor	Max Demand (KW)	Power Factor	KVA Demand
	Voltage - 415/220 Volts					
1.	Production Equipment inclusive of Material Handling Equipment	1070	0.7	750	0.8	938
2.	Material Testing Laboratory	48	0.6	29	0.8	36
3.	Tool Room	45	0.6	27	0.8	34
4.	General Lighting	120	0.5	60	0.8	75
5.	Air-conditioning, Air Circulation, Environment Dust and Fume Control Unit	130	0.7	91	0.8	114
6.	Miscellaneous (Water Pumps and Compressors)	100	0.4	40	0.8	50
					Total	: 1247
					Say	: 1300 KVA

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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON ELECTRICAL MOTORS

SUMMARY OF WATER REQUIREMENT

Sl. No.	Description	Water Consumption (M^3/Hour)
1.	Water for Technical Purposes (average)	3.0
2.	Average Requirement of Cooling Water for Central Air-conditioning Plant	2.0
3.	Average Requirement for human consumption and Sanitary Purposes for 313 Persons	3.0
4.	Peak Consumption for (3)	15.0
5.	Total Average Consumption (1+2+3)	8.0
6.	Total Peak Consumption (1+2+4)	20.0

JOB NO. : DCIL-105 EXHIBIT : 26

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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PROJECT PROFILE ON ELECTRICAL MOTORS

SUMMARY OF COMPRESSED AIR REQUIREMENT

Sl. No.	Description	Air Consumption (m^3/Minute)
1.	Production Equipment & Tool Room	3.1
2.	Painting Booth	2.5
	TOTAL	5.6

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JOB NO. : DCIL-105 EXHIBIT : 27

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON ELECTRICAL MOTORS

MAJOR EQUIPMENT AND ACCESSORIES FOR UTILITIES

Sl. No.	Description	Price ($)
1.	**Electrical System**	
	o 2 x 1000 KVA step down Oil Cooled Transformer (Step down ratio 11 KV : 415/220 volts, 3 phase, 50 Hz)	43,800
	o 1 x 100 KVA lighting Transformer	4,000
	o 11 KV Switchgears, Isolator, Accessories, MCC, Distribution Boards, Cables and Grounding Materials	4,000
	o Lighting, Fans and Room Coolers	8,500
	o Intercommunication System	20,000
2.	**Water Supply System**	
	o Two Water Pumps (12 m^3/hour capacity each), One Overhead Tank (25 m^3 capacity each), Valves and Other Fittings for water distribution and cost of digging 4" dia Tubewell	4,400 1,200
3.	**Compressed Air System**	
	o Two compressors of 3 m^3 per minute capacity delivering air at 7 kg per cm^2 pressure	13,000
4.	Air-conditioning System for two storied Administrative Building - 80 TR Central Air-conditioning Unit with individual Air Handling Unit for each floor	90,300

JOB NO. : DCIL-105 EXHIBIT : 27

Sl. No.	Description	Price ($)
5.	Fire-fighting Equipment	1,800
6.	Furniture, Fittings, Drawing Equipment, File Cabinets, Phones, Office Equipment, etc.	18,000
7.	Transport (2 Cars and 2 Buses)	70,900
	TOTAL	2,79,900

SECTION - 10
SPACE AND LAYOUT

SPACE AND LAYOUT

Space required for various sections in the plant is shown in Exhibit-28. Each section of the plant comprises a number of work centres. The space for each work centre has been worked out based on the following requirements :

- o area occupied by equipment
- o working area
- o area for movement of men and materials
- o area for temporary storage of incoming and outgoing materials

The total built up area is estimated at about 5,200 m^2, while the total land area is estimated as 15,000 m^2. This includes about 4,000 m^2 of land area for possible future expansion.

Buildings in the plant are divided into the following three categories, depending on their functions and constructional features :

- o Workshop building
- o Administrative building
- o Auxiliary buildings

Workshop Building

Layout of machine tools and equipment in different production shops are presented in Exhibit-29, enclosed in a pouch at the end of this Report.

While preparing the layout of machines in different shops, care has been taken to ensure unidirectional flow of material to the extent possible. The machines are also placed in a way that will facilitate easy movement of men and material handling equipment. Gangways of 3.5 metres width have been provided between different production shops.

It is envisaged that the workshop buildings will be of reinforced concrete construction. The columns, roofing, floor, etc., shall also be of RCC structure. Height of the workshop building from the floor to the top of the gantry level has been considered as 13.5 metres. The building should be so designed as to make maximum use of natural lighting and ventilation. Sound proof glass panes are recommended for shop offices to aid supervision and control.

Administrative Building

The administrative building shall be made of two storeyed RCC brick construction. Space for workshop office, administrative office and auxiliary buildings have been worked out based on the manpower requirement.

Auxiliary Buildings

Auxiliary buildings include toilets and wash rooms, security office, transformer house, pump house, material testing laboratory, etc. All these have been located at appropriate places. These shall be built with masonry bricks and cement.

For effective operation the workshops, utility centres and other buildings are so located that they are not far from each other. The administrative building has been located a little far away so that it is least affected by the noise, and the hustle and bustle of the workshops.

Exhibit-30, enclosed in a pouch at the end of this Report, shows the relative location of different shops and buildings. Estimated cost for civil work including land development, fencing, drainage, roads and building construction are shown in Exhibit-31.

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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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PROJECT PROFILE ON ELECTRICAL MOTORS

ESTIMATE OF SPACE REQUIRED

Sl. No.	Description	Area (sq m)
1.	**Workshop**	
	o Raw Materials Store	180
	o Fabrication Shop	300
	o Machine Shop	430
	o Motor Manufacturing Shop	480
	o Coil Winding Shop	370
	o Commutator Shop	215
	o Maintenance, Tool Room & Repair	445
	o Shot Blasting and Painting Booth	135
	o Aisles & Gangways	685
	Sub-total	3240
2.	**Administrative Building - Double Storeyed**	576
3.	**Auxiliary Buildings**	
	o Transformer House and Distribution Centre	144
	o Pump House	36
	o Compressor House	36

JOB NO. : DCIL-105

EXHIBIT : 28

Sl. No.	Description	Area (sq m)
	o Canteen & Wash Room	108
	o Material Testing Laboratory	936
	o Security Room	144
	Sub-total	1404
4.	Total Built up Area (1+2+3)	5220
5.	Open Area Required	5220
6.	Total Land Area provided inclusive of Area for future expansion	15000

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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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PROJECT PROFILE ON ELECTRICAL MOTORS

ESTIMATED COST OF CIVIL WORK

Sl. No.	Description	Area (sq m)	Cost ('000 US $)
1.	Land and Land Development including fencing, drainage and road construction	15,000	1,879.20
2.	Workshop Building having a height of 8 metres from floor to top of crane rail	3,240	2,925.72
3.	Administrative Building - double storeyed	576	627.26
4.	Auxiliary Buildings comprising workshop offices, toilets and washrooms in workshop, refreshment centres, transformer house, pump house, first-aid centre, security, garage and control room	1,404	1,528.95
	TOTAL		6,961.13

SECTION - 11
MANPOWER AND ORGANIZATION

MANPOWER AND ORGANISATION

The organisation has been designed to meet the functional needs of a plant in which about 1,400 tonnes of grey iron castings, forged steel bars, etc., will be processed annually to manufacture motors of varying capacity. The organisation will carry out all the activities performed by a typical manufacturing unit. In order that the plant can plan, execute, co-ordinate and control all the necessary activities, the deployment of manpower has been categorised under the following heads :

- Production
- Maintenance
- Quality Control
- Engineering
- Materials
- Marketing
- Finance and Accounts
- Personnel and Administration

Based on the above eight activities/functions, the organisation has been divided into six departments. Production and maintenance have been put together, while engineering and quality control will be looked after by a single person. Each department will be under the charge of a departmental head. Four departmental heads shall report to the General Manager, while the remaining two shall report to the Works Manager. Organisation chart for the senior level management is presented in Exhibit-32.

Production

All the Sections within the Production Department will work in double shift.

Production and Maintenance have been placed under overall supervision of a Production Manager, who will report to the Works Manager. Production Manager will be assisted by a Production Engineer, who will be in charge of both production and maintenance functions.

Manpower requirement in the production department is estimated in Exhibit-33.

Manpower requirement and organisation chart for different Departments are shown in their respective exhibits as indicated below.

Sl. No.	Shop	Exhibit for Manpower	Exhibit for Organisation Chart
1.	Production	33	35
2.	Maintenance	34	35
3.	Quality Control	36	37
4.	Engineering	38	39
5.	Materials	40	41
6.	Marketing	42	43
7.	Finance and Accounts	44	45
8.	Personnel and Administration	46	47

Inspection and Quality Control

This department will be headed by a Manager, who will be in charge of both the Quality Control and Engineering Department with one Engineer (Inspection and Quality

Department with one Engineer (Inspection and Quality Control) reporting to him.

Manpower requirement and organisation chart for this department are shown in Exhibit-36 and Exhibit-37, respectively.

Engineering

Manpower requirement and organisation chart for Engineering Department are shown in Exhibit-38 and Exhibit-39 respectively.

Materials

The Materials department will be headed by a Materials Manager who will be assisted by a Materials Engineer and a Purchase Officer.

Manpower requirement and organisation chart for this department are shown in Exhibit-40 and Exhibit-41 respectively.

Marketing

The marketing department will be under the charge of a Marketing Manager, who will be assisted by one Area Manager. Three Sales Engineers will report to the Area Manager. Manpower requirement and organisation chart for Marketing Department are shown in Exhibit-42 and Exhibit-43 respectively.

Finance and Accounts

Manager (Finance & Accounts) will head this department. He will be supported by a Senior Cost Accountant.

Manpower requirement and organisation chart for this department are presented in Exhibit-44 and Exhibit-45 respectively.

Personnel and Administration

Exhibit-46 presents the requirement of manpower for this department. Organisation chart is presented in Exhibit-47.

Exhibit-48 presents a summary of manpower requirement for the entire plant.

Manpower has been grouped into eight salary levels. The designations, salary levels and number of personnel in the organisation structure of each department may be observed from relevant serial numbers given in the exhibits relating to manpower requirement for the respective departments.

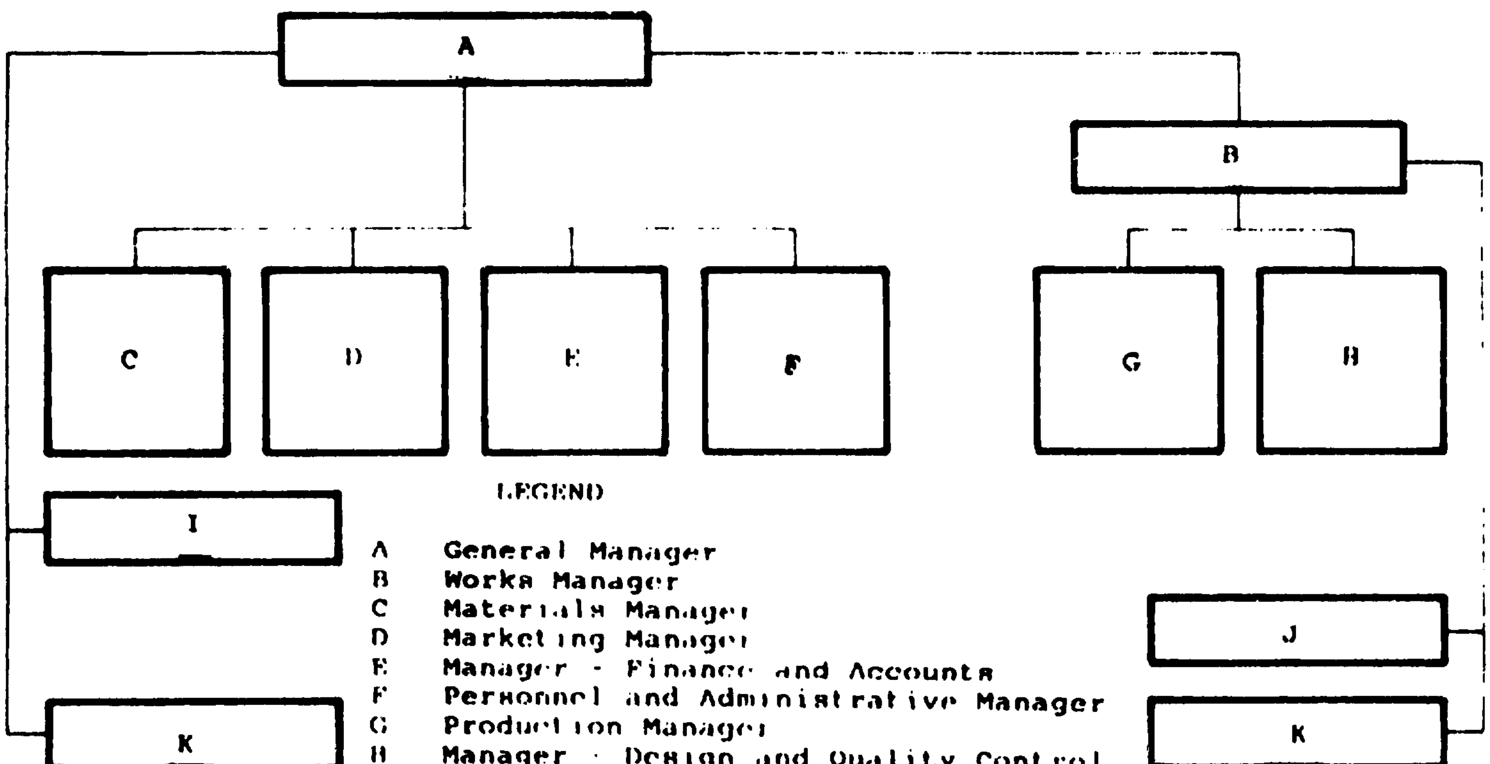
The statement of monthly salaries and wages is presented in Exhibit-49.

JOB NO. : DCIL-105 EXHIBIT : 32

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

PROJECT PROFILE ON ELECTRICAL MOTORS

ORGANISATION CHART : SENIOR LEVEL MANAGEMENT



LEGEND

A General Manager
B Works Manager
C Materials Manager
D Marketing Manager
E Manager - Finance and Accounts
F Personnel and Administrative Manager
G Production Manager
H Manager - Design and Quality Control
I Secretary
J Personal Assistant
K Stenographer

JOB NO. : DCIL-105 EXHIBIT : 33

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

PROJECT PROFILE ON ELECTRIAL MOTORS

MANPOWER REQUIREMENT : PRODUCTION

Sl. No.	Designation	Salary Level	Number
A.	Production Engineer	4	2
B.	Foreman	5	2
C.	Technical Assistant	6	2
D.	Highly Skilled Machine Operator	6	8
E.	Skilled Machine Operator	7	78
F.	Welder	7	4
G.	Crane/Truck Driver	7	8
H.	Material Handler	8	9
I.	Helper	8	87
	TOTAL		200

JOB NO. : DCIL-105 EXHIBIT : 34

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

PROJECT PROFILE ON ELECTRICAL MOTORS

MANPOWER REQUIREMENT : TOOL ROOM AND MAINTENANCE

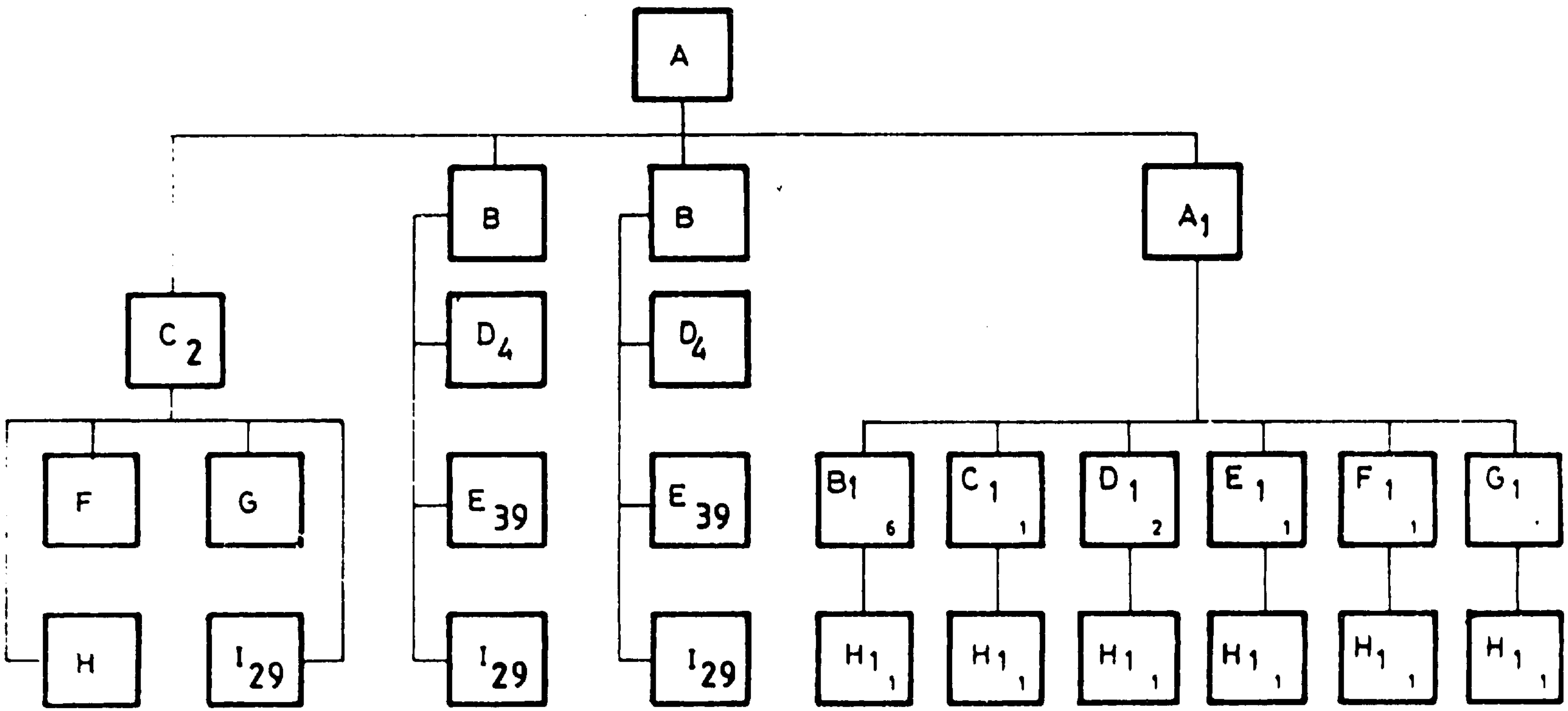
Sl. No.	Designation	Salary Level	Number
A1.	Foreman - Tool Room and Maintenance	5	1
B1.	Machine Operator	7	6
C1.	Furnace Operator	7	1
D1.	Welder	7	2
E1.	Mechanical Fitter	7	1
F1.	Electrician	7	1
G1.	Plumber	7	1
H1.	Helper	8	6
	TOTAL		19

JOB NO. : DCIL-105 EXHIBIT : 35

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

PROJECT PROFILE ON ELECTRICAL MOTORS

OGANISATION CHART : PRODUCTION, TOOL ROOM AND MAINTENANCE



DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 36

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

PROJECT PROFILE ON ELECTRICAL MOTORS

MANPOWER REQUIREMENT : INSPECTION AND QUALITY CONTROL

Sl. No.	Designation	Salary Level	Number
A.	Inspection and Quality Control Engineer	4	1
B.	Inspector - Testing and Quality Control	5	2
C.	Ultrasonic Testing Machine Operator	6	1
D.	CNC Machine Operator	6	1
E.	Machine Operator	7	3
F.	Testing Assistant	7	4
G.	Stenographer	7	2
H.	Helper	8	4
	TOTAL		18

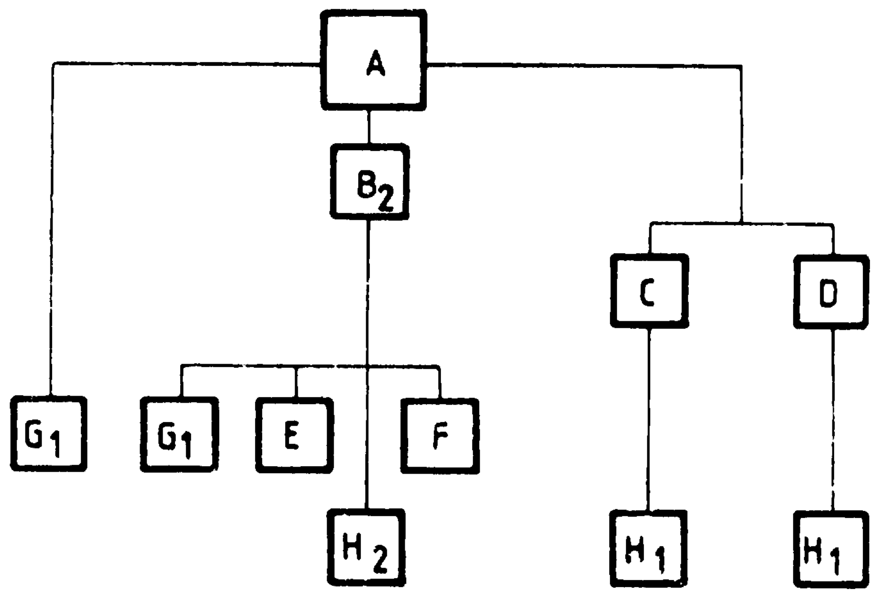
JOB NO. : DCIL-105

EXHIBIT : 37

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

PROJECT PROFILE ON ELECTRICAL MOTORS

ORGANISATION CHART : INSPECTION AND QUALITY CONTROL



DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 38

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

PROJECT PROFILE ON ELECTRICAL MOTORS

MANPOWER REQUIREMENT : ENGINEERING

Sl. No.	Designation	Salary Level	Number
A.	Design Engineer	4	1
B.	Process Planning Engineer	4	1
C.	Draftsman	6	3
D.	Stenographer	7	1
E.	Printing Machine Operator	7	1
	TOTAL		7

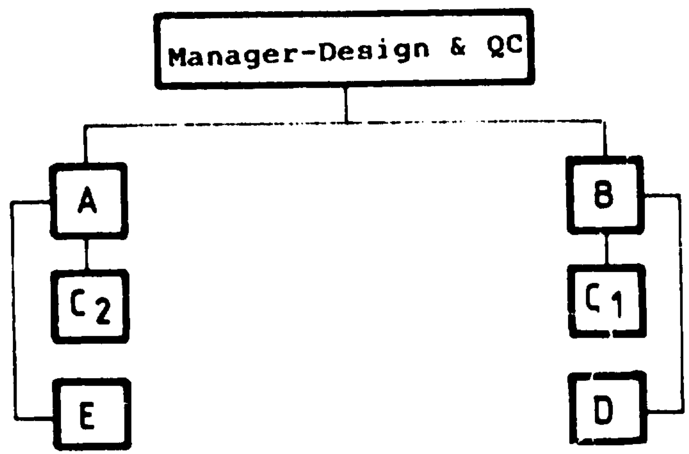
JOB NO. : DCIL-105

EXHIBIT : 39

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

PROJECT PROFILE ON ELECTRICAL MOTORS

ORGANISATION CHART : ENGINEERING



DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 40

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

PROJECT PROFILE ON ELECTRICAL MOTORS

MANPOWER REQUIREMENT : MATERIALS

Sl. No.	Designation	Salary Level	Number
A.	Materials Engineer	4	1
B.	Purchase Officer	4	1
C.	Purchase Assistant	6	1
D.	Stores Assistant	6	1
E.	Tool and Material Issue Clerk	7	2
F.	Goods Despatch Clerk	7	2
G.	Stenographer	7	2
H.	Material Handler	8	2
	TOTAL		12

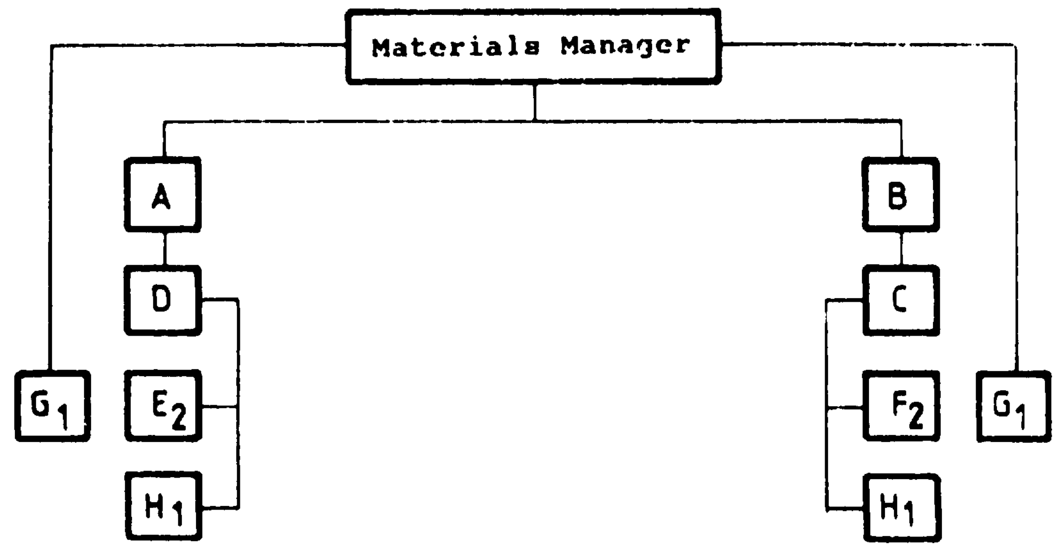
JOB NO. : DCIL-105

EXHIBIT : 41

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

PROJECT PROFILE ON ELECTRICAL MOTORS

ORGANISATION CHART : MATERIALS



DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 42

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

PROJECT PROFILE ON ELECTRICAL MOTORS

MANPOWER REQUIREMENT : MARKETING

Sl. No.	Designation	Salary Level	Number
A.	Area Manager	4	1
B.	Sales Engineer	5	3
C.	Steno-Typist	7	2
	TOTAL		6

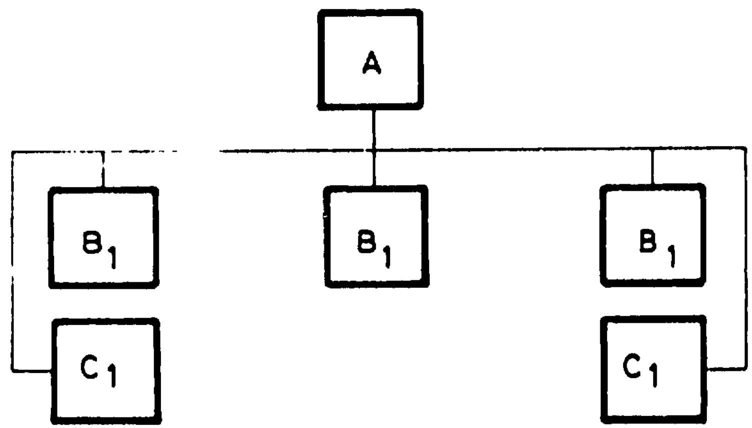
JOB NO. : DCIL-105

EXHIBIT : 43

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

PROJECT PROFILE ON ELECTRICAL MOTORS

ORGANISATION CHART : MARKETING



DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 44

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

PROJECT PROFILE ON ELECTRICAL MOTORS

MANPOWER REQUIREMENT : FINANCE AND ACCOUNTS

Sl. No.	Designation	Salary Level	Number
A.	Senior Cost Accountant	4	1
B.	Accountant	5	2
C.	Accounts Assistant	6	2
D.	Cashier	6	1
E.	Accounts Clerk	7	1
F.	Stenographer	7	2
	TOTAL		9

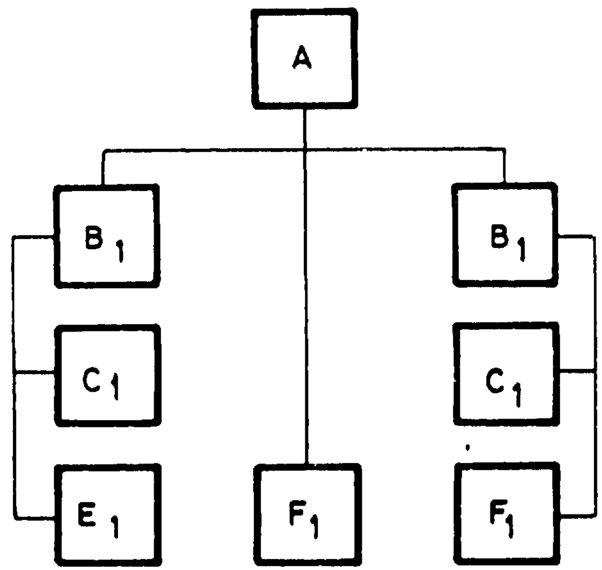
JOB NO. : DCIL-105

EXHIBIT : 45

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

PROJECT PROFILE ON ELECTRICAL MOTORS

ORGANISATION CHART : FINANCE AND ACCOUNTS



JOB NO. : DCIL-105 EXHIBIT : 46

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

PROJECT PROFILE ON ELECTRICAL MOTORS

MANPOWER REQUIREMENT : PERSONNEL AND ADMINISTRATION

Sl. No.	Designation	Salary Level	Number
A.	Personnel & Administrative Officer	4	1
B.	Welfare Officer	5	1
C.	Chief Security Guard	5	1
D.	Incharge-Canteen, Environment and First Aid	6	1
E.	Welfare Assistant	7	1
F.	Security Guard	7	4
G.	Driver	7	2
H.	Stenographer	7	2
I.	Telephone Operator cum Receptionist	7	1
J.	Cook	8	1
K.	Despatch Clerk	8	1
L.	Watchman	8	8
M.	Sweeper and Gardener	8	6
	TOTAL		30

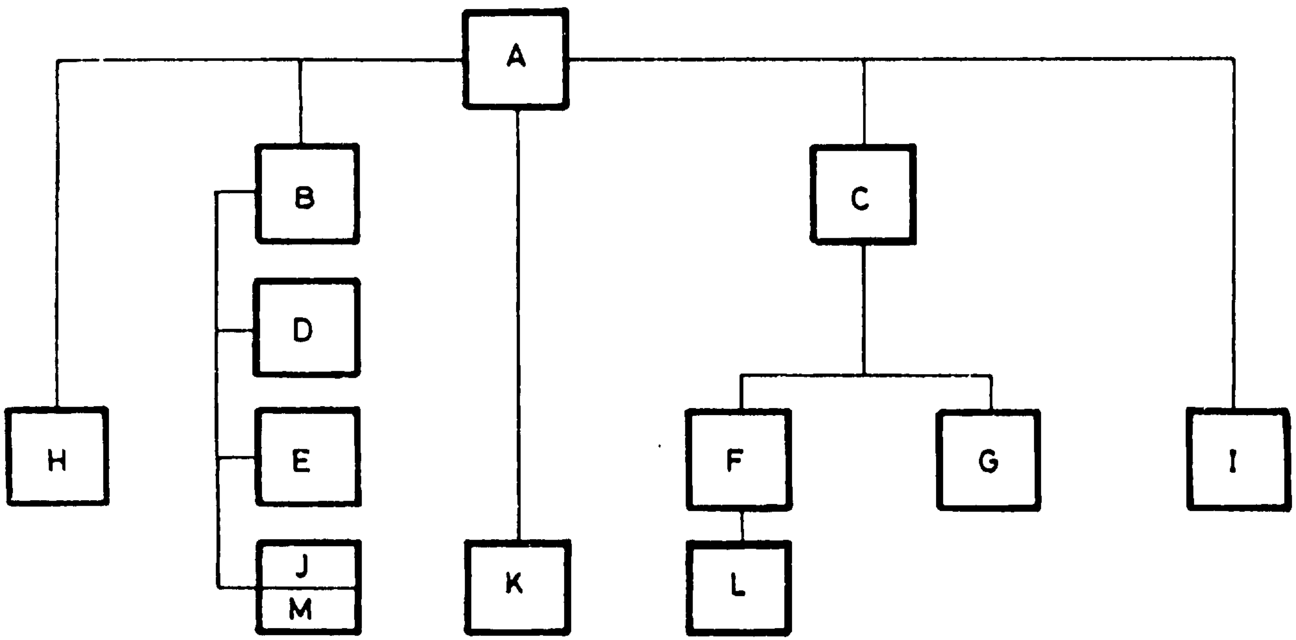
JOB NO. : DCIL-105

EXHIBIT : 47

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

PROJECT PROFILE ON ELECTRICAL MOTORS

ORGANISATION CHART : PERSONNEL AND ADMINISTRATION



DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 48

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

PROJECT PROFILE ON ELECTRICAL MOTORS

SUMMARY OF MANPOWER REQUIREMENT

Sl. No.	Designation/Department	Number
1.	General Manager	1
2.	Works Manager	1
3.	Production Manager	1
4.	Manager- Design and Quality Control	1
5.	Materials Manager	1
6.	Marketing Manager	1
7.	Finance and Accounts Manager	1
8.	Personnel Manager	1
9.	Secretary to General Manager	1
10.	PA to Works Manager	1
11.	Stenographer	2
12.	Production	200
13.	Tool Room and Maintenance	19
14.	Inspection and Quality Control Laboratory	18
15.	Engineering	7
16.	Materials	12
17.	Marketing	6

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 48

Sl. No.	Designation	Number
18.	Finance and Accounts	9
19.	Personnel and Administration	30
	TOTAL	313

DEVELOPMENT
CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 49

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

PROJECT PROFILE ON ELECTRICAL MOTORS

STATEMENT OF MONTHLY SALARIES AND WAGES

Salary Level	Numbers	Monthly Salary ($) Basic	Other Benefits	Total per Month ($)
1	1	9,000		9,000
2	1	6,500		6,500
3	6	3,320		19,920
4	11	1,480		16,280
5	13	1,200		15,600
6	21	1,000		21,000
7	136	900		1,22,400
8	124	580		71,920
TOTAL	313			2,82,620

SECTION - 12
FINANCIAL ANALYSIS AND EVALUATION

FINANCIAL ANALYSIS AND EVALUATION

COUNTRY : SAUDI ARABIA

The financial analysis and evaluation of the proposed project for setting up the Electrical Motors plant in this country are based on the capacity utilisation, price and costs. The plant will be operated in two shifts.

Project Cost

The estimated cost of the project of setting up the plant is around US $ 13.6 million as can be seen from Exhibit-50. 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 51 and 52 respectively.

Margin money for working capital is presented in Exhibit-53. 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 54 and 55 respectively. Capacity utilisation is assumed at the rate of 50% in the first year, 60% in the second year and 70% from the third year onwards.

Costs

The annual costs of production and sales computed over 10 years are presented in Exhibit-56. 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-57. The average profit before tax works out to 16.4% of average revenue.

Statement of fixed assets and depreciation under straight line method is presented in Exhibit-58. Tax computation and depreciation for tax are presented in Exhibits 59 and 60 repspectively.

Working capital requirements are shown in Exhibit-61.

Projected cash flow statement and balance sheet over 10-year period are shown in Exhibits 62 and 63 respectively.

The project breaks even at around 49.4% and shows internal rate of return of 18.2% as can be seen from Exhibits 64 and 65 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 : 50

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
AND
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PROJECT PROFILE ON ELECTRICAL MOTORS

ESTIMATED PROJECT COST

('000 US $)

Sl. No.	Items	Value	Total
1.	Land and Land Development (@ US$ 180 per m² for 10,440 m²)	1879.20	1879.20
2.	Building and Civil Work		
i)	Workshop Building (@ US$ 903 per m² for 3,240 m²)	2925.72	
ii)	Administrative Building (@ US$ 1089 per m² for 576 m²)	627.26	
iii)	Auxiliary Buildings (@ US$ 1089 per m² for 1404 m²)	1528.96	
	Sub-total (2)		5081.94
3.	Plant and Machinery		
i)	Imported		
	- Fabrication shop equipment	327.06	
	- Machine shop equipment	1077.00	
	- Motor manufacturing shop equipment	344.40	
	- Coil winding shop equipment	216.00	
	- Commutator shop equipment	64.60	
	- Material handling equipment	633.02	
	- Tool room and maintenance equipment	145.95	
	- Inspection and testing equipment	114.02	
	Total F.O.B. Value	2922.05	
ii)	Insurance & Freight (@ 10% of FOB Value)	292.21	
iii)	C.I.F. Value	3214.26	
iv)	Import duty @ 6% on CIF value	192.86	
v)	Transportation @ 1% of CIF Value	32.14	
	Landed Cost at Site [Sub-total (3)]		3439.26

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 50

('000 US $)

	Items	Value	Total
4.	Miscellaneous Fixed Assets		
i)	Transformers	47.80	
ii)	Switchgears	4.00	
iii)	Central Airconditioning system	90.30	
iv)	Illumination,Fans and Room Coolers	8.50	
v)	Water Pumps and Tank	5.60	
vi)	Compressors	13.00	
vii)	Fire fighting system	1.80	
viii)	Telecommunication system	20.00	
ix)	Office Furniture and Equipment	18.00	
x)	Vehicles	70.90	
	Sub-total (4)		279.90
5.	Preliminary Expenses	25.00	25.00
6.	Pre-operative Expenses		
i)	Establishment	915.16	
ii)	Travelling Expenses	89.00	
iii)	Miscellaneous	45.00	
			1049.16
7.	Technical Know-how Fees	449.00	449.00
8.	Sub-total (1 thru 7)	-	12203.46
9.	Contingency @ 5% on above	-	610.17
10.	Sub-total (8 & 9)	-	12813.63
11.	Interest during Construction	-	477.38
12.	Margin Money for Working Capital	-	324.93
	TOTAL COST	-	13615.94

JOB NO. : DCIL-185

EXHIBIT : 51

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

PROJECT PROFILE ON ELECTRICAL MOTORS

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	1879.20	0.00	375.84	751.68	751.68	0.00	0.00	0.00	0.00	0.00
2. Building and Civil Work	5081.94									
i) Workshop Building	2925.72	0.00	0.00	0.00	731.43	731.43	731.43	731.43	0.00	0.00
ii) Administrative Building	627.26	0.00	0.00	0.00	0.00	250.91	250.91	125.45	0.00	0.00
iii) Auxiliary Buildings	1528.96	0.00	0.00	0.00	0.00	509.65	509.65	509.65	0.00	0.00
3. Plant and Machinery	3439.26									
i) Ordering	1031.78	0.00	0.00	0.00	0.00	0.00	1031.78	0.00	0.00	0.00
ii) Supply, delivery and installation at site	2407.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2347.30	60.19

DEVELOPMENT CONSULTANTS

('000 US $)

		Total	Construction Period in Quarters								
			1	2	3	4	5	6	7	8	9
4.	Miscellaneous Fixed Assets	279.90									
i)	Transformers	47.80	0.00	0.00	0.00	0.00	0.06	9.56	0.00	38.24	0.00
ii)	Switchgears	4.00	0.00	0.00	0.00	0.00	0.00	0.80	0.00	3.20	0.00
iii)	Central Airconditioning system	90.30	0.00	0.00	0.00	0.00	0.00	18.06	0.00	72.24	0.00
iv)	Illumination,Fans and Room Coolers	8.50	0.85	0.00	1.53	1.53	1.53	1.53	1.53	0.00	0.00
v)	Water Pumps and Tank	5.60	0.00	0.00	0.00	2.80	2.80	0.00	0.00	0.00	0.00
vi)	Compressors	13.00	0.00	0.00	0.00	0.00	0.00	2.60	0.00	10.40	0.00
vii)	Fire fighting system	1.80	0.00	0.00	0.00	0.00	0.00	0.90	0.00	0.90	0.00
viii)	Telecommunication system	20.00	0.00	2.00	0.00	0.00	2.00	4.00	4.00	4.00	4.00
ix)	Office Furniture and Equipment	18.00	0.00	0.90	0.90	1.80	1.80	1.80	1.80	1.80	7.20
x)	Vehicles	70.90	0.00	9.70	9.70	0.00	0.00	0.00	0.00	0.00	51.50
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	1049.16									
i)	Establishment	915.16	0.00	24.80	60.90	84.00	84.00	103.32	103.32	103.32	351.50
ii)	Travelling Expenses	89.00	0.00	2.00	6.00	8.00	8.00	10.00	10.00	10.00	35.00
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	449.00	22.45	89.80	89.80	44.90	44.90	44.90	44.90	44.90	22.45
8.	Sub-total (1 thru' 7)	12203.46	40.80	522.54	925.51	1631.14	1642.02	2726.24	1537.07	2641.30	536.84
9.	Contingency @ 5% on above	610.17	2.04	26.13	46.28	81.56	82.10	136.31	76.85	132.06	26.84
10.	Sub-total (8 & 9)	12813.63	42.84	548.67	971.78	1712.70	1724.12	2862.55	1613.93	2773.36	563.68

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 52

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

PROJECT PROFILE ON ELECTRICAL MOTORS

ESTIMATION OF INTEREST DURING CONSTRUCTION

('000 US $)

	Construction Period in Quarters									Total
	1	2	3	4	5	6	7	8	9	
Capital Expenditure	42.84	548.67	971.78	1712.70	1724.12	2862.55	1613.93	2773.36	563.68	12813.63
Margin Money	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	324.93	324.93
Total	42.84	548.67	971.78	1712.70	1724.12	2862.55	1613.93	2773.36	888.61	13138.56
Equity	21.53	275.93	491.32	868.57	883.05	1464.00	851.27	1442.45	509.84	6807.97
Loan	21.53	275.93	491.32	868.58	883.05	1464.00	851.26	1442.45	509.84	6807.97
Total	43.06	551.86	982.64	1737.17	1766.10	2928.00	1702.53	2884.90	1019.68	13615.94

JOB NO. : DCIL-105 EXHIBIT : 52

('000 US $)

	Construction Period in Quarters									Total
	1	2	3	4	5	6	7	8	9	
Interest on loan										
- @ 8% p.a.	0.22	2.76	4.91	8.69	8.83	14.64	8.51	14.42	5.10	68.08
		0.43	5.52	9.83	17.37	17.66	29.28	17.03	28.85	125.97
			0.43	5.52	9.83	17.37	17.66	29.28	17.03	97.12
				0.43	5.52	9.83	17.37	17.66	29.28	80.09
					0.43	5.52	9.83	17.37	17.66	50.81
						0.43	5.52	9.81	17.37	33.15
							0.43	5.52	9.83	15.78
								0.43	5.52	5.95
									0.43	0.43
Total	0.22	3.19	10.86	24.47	41.98	65.45	88.60	111.54	131.07	477.38
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	6807.97
	LOAN	6807.97
	TOTAL	13615.94

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 53

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

PROJECT PROFILE ON ELECTRICAL MOTORS

MARGIN MONEY FOR WORKING CAPITAL

('000 US $)

Item	Period (Days)	1st Year Operation				2nd Year Operation			
		Cost	Bank Finance Available (%)	Bank Finance Available (Amount)	Margin Money	Cost	Bank Finance Available (%)	Bank Finance Available (Amount)	Margin Money
1. Raw materials & Consumables	120	1121.92	100%	1121.92	0.00	1346.30	100%	1346.30	0.00
2. Finished Stock	30	519.62	100%	519.62	0.00	587.68	100%	587.68	0.00
3. Sundry Debtors	30	701.29	100%	701.29	0.00	905.30	100%	905.30	0.00
Sub-total		2342.83		2342.83	0.00	2839.28		2839.28	0.00
4. Expenses	30	324.93	0%	0.00	324.93	340.90	0%	0.00	340.90
Total		2667.76		2342.83	324.93	3180.18		2839.28	340.90

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

PROJECT PROFILE ON ELECTRICAL MOTORS

STATEMENT OF PRODUCTION & SALES

(in MT)

		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
No. of shift		2	2	2	2	2	2	2	2	2	2
Utilisation		50%	60%	70%	70%	70%	70%	70%	70%	70%	70%
2.01-4.0 KW											
Capacity - Single shift	(Nos.)	453	453	453	453	453	453	453	453	453	453
Capacity - Two shifts	(Nos.)	906	906	906	906	906	906	906	906	906	906
Annual Output	(Nos.)	453	544	634	634	634	634	634	634	634	634
Opening Stock		0	38	45	53	53	53	53	53	53	53
Production		453	544	634	634	634	634	634	634	634	634
Total		453	581	680	687	687	687	687	687	687	687
Closing Stock		38	45	53	53	53	53	53	53	53	53
Sales		415	536	627	634	634	634	634	634	634	634

JOB NO. : DCIL-105 EXHIBIT : 54

(in MT)

		OPERATING YEARS									
		1	2	3	4	5	6	7	8	9	10
4.01-5.0 KW											
Capacity - Single shift	(Nos.)	407	407	407	407	407	407	407	407	407	407
Capacity - Two shifts	(Nos.)	814	814	814	814	814	814	814	814	814	814
Annual Output	(Nos.)	407	488	570	570	570	570	570	570	570	570
Opening Stock		0	34	41	47	47	47	47	47	47	47
Production		407	488	570	570	570	570	570	570	570	570
Total		407	522	611	617	617	617	617	617	617	617
Closing Stock		34	41	47	47	47	47	47	47	47	47
Sales		373	482	563	570	570	570	570	570	570	570
5.01-7.0 KW											
Capacity - Single shift	(Nos.)	175	175	175	175	175	175	175	175	175	175
Capacity - Two shifts	(Nos.)	349	349	349	349	349	349	349	349	349	349
Annual Output	(Nos.)	175	209	244	244	244	244	244	244	244	244
Opening Stock		0	15	17	20	20	20	20	20	20	20
Production		175	209	244	244	244	244	244	244	244	244
Total		175	224	262	265	265	265	265	265	265	265
Closing Stock		15	17	20	20	20	20	20	20	20	20
Sales		160	206	241	244	244	244	244	244	244	244

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 54

(in MT)

	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
7.01-10.0 KW										
Capacity - Single shift (Nos.)	256	256	256	256	256	256	256	256	256	256
Capacity - Two shifts (Nos.)	511	511	511	511	511	511	511	511	511	511
Annual Output (Nos.)	256	307	358	358	358	358	358	358	358	358
Opening Stock	0	21	26	30	30	30	30	30	30	30
Production	256	307	358	358	358	358	358	358	358	358
Total	256	328	383	388	388	388	388	388	388	388
Closing Stock	21	26	30	30	30	30	30	30	30	30
Sales	234	302	353	358	358	358	358	358	358	358
10.01-30.0 KW										
Capacity - Single shift (Nos.)	268	268	268	268	268	268	268	268	268	268
Capacity - Two shifts (Nos.)	535	535	535	535	535	535	535	535	535	535
Annual Output (Nos.)	268	321	375	375	375	375	375	375	375	375
Opening Stock	0	22	27	31	31	31	31	31	31	31
Production	268	321	375	375	375	375	375	375	375	375
Total	268	343	401	406	406	406	406	406	406	406
Closing Stock	22	27	31	31	31	31	31	31	31	31
Sales	245	317	370	375	375	375	375	375	375	375

JOB NO. : DCIL-105

EXHIBIT : 54

(in MT)

		OPERATING YEARS									
		1	2	3	4	5	6	7	8	9	10
30.01-100.0 KW											
Capacity - Single shift	(Nos.)	163	163	163	163	163	163	163	163	163	163
Capacity - Two shifts	(Nos.)	326	326	326	326	326	326	326	326	326	326
Annual Output	(Nos.)	163	196	228	228	228	228	228	228	228	228
Opening Stock		0	14	16	19	19	19	19	19	19	19
Production		163	196	228	228	228	228	228	228	228	228
Total		163	209	245	247	247	247	247	247	247	247
Closing Stock		14	16	19	19	19	19	19	19	19	19
Sales		149	193	225	228	228	228	228	228	228	228
100.01-1000.0 KW											
Capacity - Single shift	(Nos.)	268	268	268	268	268	268	268	268	268	268
Capacity - Two shifts	(Nos.)	535	535	535	535	535	535	535	535	535	535
Annual Output	(Nos.)	268	321	375	375	375	375	375	375	375	375
Opening Stock		0	22	27	31	31	31	31	31	31	31
Production		268	321	375	375	375	375	375	375	375	375
Total		268	343	401	406	406	406	406	406	406	406
Closing Stock		22	27	31	31	31	31	31	31	31	31
Sales		245	317	370	375	375	375	375	375	375	375

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 54

(in MT)

	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
1001 KW & above										
Capacity - Single shift (Nos.)	36	36	36	36	36	36	36	36	36	36
Capacity - Two shifts (Nos.)	71	71	71	71	71	71	71	71	71	71
Annual Output (Nos.)	36	43	50	50	50	50	50	50	50	50
Opening Stock	0	3	4	4	4	4	4	4	4	4
Production	36	43	50	50	50	50	50	50	50	50
Total	36	46	53	54	54	54	54	54	54	54
Closing Stock	3	4	4	4	4	4	4	4	4	4
Sales	33	42	49	50	50	50	50	50	50	50

DEVELOPMENT CONSULTANTS

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

PROJECT PROFILE ON ELECTRICAL MOTORS

STATEMENT OF REVENUE

('000 US $)

Product (Motor Rating)	Average Selling Price (US $/Unit)	OPERATING YEARS									
		1	2	3	4	5	6	7	8	9	10
3.01-4.0 KW	350.00	145.34	187.62	219.33	221.97	221.97	221.97	221.97	221.97	221.97	221.97
4.01-5.0 KW	420.00	156.70	202.28	236.47	239.32	239.32	239.32	239.32	239.32	239.32	239.32
5.01-7.0 KW	450.00	71.98	92.92	108.63	109.94	109.94	109.94	109.94	109.94	109.94	109.94
7.01-10.0 KW	990.00	231.87	299.32	349.91	354.12	354.12	354.12	354.12	354.12	354.12	354.12
10.01-30.0 KW	2800.00	686.58	886.32	1036.12	1048.60	1048.60	1048.60	1048.60	1048.60	1048.60	1048.60
30.01-100.0 KW	9200.00	1374.63	1774.53	2074.45	2099.44	2099.44	2099.44	2099.44	2099.44	2099.44	2099.44
100.01-1000.0 KW	21000.00	5149.38	6647.38	7770.88	7864.50	7864.50	7864.50	7864.50	7864.50	7864.50	7864.50
1001 KW & above	22000.00	715.92	924.18	1080.38	1093.40	1093.40	1093.40	1093.40	1093.40	1093.40	1093.40
Total		8532.39	11014.54	12876.15	13031.28	13031.28	13031.28	13031.28	13031.28	13031.28	13031.28

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 56

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

PROJECT PROFILE ON ELECTRICAL MOTORS

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	3250.00	3900.00	4550.00	4550.00	4550.00	4550.00	4550.00	4550.00	4550.00	4550.00
Power	31.56	37.79	44.02	44.02	44.02	44.02	44.02	44.02	44.02	44.02
Water	2.29	2.75	3.21	3.21	3.21	3.21	3.21	3.21	3.21	3.21
Sub-total	3283.85	3940.54	4597.22	4597.22	4597.22	4597.22	4597.22	4597.22	4597.22	4597.22
Contingency (@ 5% on above)	164.19	197.03	229.86	229.86	229.86	229.86	229.86	229.86	229.86	229.86
Total 'A'	3448.04	4137.56	4827.08	4827.08	4827.08	4827.08	4827.08	4827.08	4827.08	4827.08
B. Fixed Cost										
i) Labour & Plant Overhead *										
a) Direct labour	1720.80	1806.84	1892.88	1978.92	2064.96	2151.00	2237.04	2323.08	2409.12	2495.16
b) Indirect labour	863.04	906.19	949.34	992.50	1035.65	1078.80	1121.95	1165.10	1208.26	1251.41
c) Supervision	187.20	196.56	205.92	215.28	224.64	234.00	243.36	252.72	262.08	271.44
Sub-total	2771.04	2909.59	3048.14	3186.70	3325.25	3463.80	3602.35	3740.90	3879.46	4018.01

DEVELOPMENT CONSULTANTS

JOB NO. : DCTL-185

EXHIBIT : 56

('000 US $)

	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
ii) Other Factory Expenses										
a) Maintenance @ 2.5%										
on Plant & Equipment	85.98	85.98	85.98	85.98	85.98	85.98	85.98	85.98	85.98	85.98
b) Maintenance @ 1%										
on Building & Civil Work	50.82	50.82	50.82	50.82	50.82	50.82	50.82	50.82	50.82	50.82
c) Miscellaneous	27.36	27.36	27.36	27.36	27.36	27.36	27.36	27.36	27.36	27.36
Sub-total	164.16	164.16	164.16	164.16	164.16	164.16	164.16	164.16	164.16	164.16
iii) Administrative & Sales Expenses										
a) Salaries *	620.40	651.42	682.44	713.46	744.48	775.50	806.52	837.54	868.56	899.58
b) Overheads	124.08	130.28	136.49	142.69	148.90	155.10	161.30	167.51	173.71	179.92
Sub-total	744.48	781.70	818.93	856.15	893.38	930.60	967.82	1005.05	1042.27	1079.50
Total (i+ii+iii)	3679.68	3855.46	4031.23	4207.01	4382.79	4558.56	4734.34	4910.11	5085.89	5261.67
Contingency (@ 5% on above)	183.98	192.77	201.56	210.35	219.14	227.93	236.72	245.51	254.29	263.08
Total 'B'	3863.67	4048.23	4232.79	4417.36	4601.92	4786.49	4971.06	5155.61	5340.18	5524.75
Total Cost of Production and Sales (A+B)	7311.71	8185.79	9059.88	9244.44	9429.01	9613.57	9798.15	9982.69	10167.27	10351.83

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

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 57

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

PROJECT PROFILE ON ELECTRICAL MOTORS

PROJECTED PROFITABILITY STATEMENT

('000 US $)

Elements	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
Raw Materials and Consumables	3250.00	3900.00	4550.00	4550.00	4550.00	4550.00	4550.00	4550.00	4550.00	4550.00
Power	31.56	37.79	44.02	44.02	44.02	44.02	44.02	44.02	44.02	44.02
Water	2.29	2.75	3.21	3.21	3.21	3.21	3.21	3.21	3.21	3.21
Labour & Plant Overhead	2771.04	2909.59	3048.14	3186.70	3325.25	3463.80	3602.35	3740.90	3879.46	4018.01
Other Factory Expenses	164.16	164.16	164.16	164.16	164.16	164.16	164.16	164.16	164.16	164.16
Administrative & Sales Expenses	744.48	781.70	818.93	856.15	893.38	930.60	967.82	1005.05	1042.27	1079.50
Sub-total	6963.53	7795.99	8628.46	8804.22	8980.02	9155.79	9331.56	9507.34	9683.12	9858.90
Contingency	348.17	389.80	431.42	440.21	449.00	457.79	466.58	475.37	484.16	492.94
Total	7311.70	8185.79	9059.88	9244.43	9429.02	9613.58	9798.14	9982.71	10167.28	10351.84
Stock Variation	-519.62	-68.06	-68.05	-11.96	-11.95	-11.96	-11.96	-11.96	-11.95	-11.96
Cost of Production and Sales	6792.08	8117.73	8991.83	9232.47	9417.07	9601.62	9786.18	9970.75	10155.33	10339.88
PROJECTED REVENUE	8532.39	11014.54	12876.15	13031.28	13031.28	13031.28	13031.28	13031.28	13031.28	13031.28
Profit before Interest and Depreciation	1740.31	2896.81	3884.32	3798.81	3614.21	3429.66	3245.10	3060.53	2875.95	2691.40

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 57

('000 US $)

Elements	1	2	3	4	5	6	7	8	9	10
					OPERATING YEARS					
Interest										
On Term Loan										
- @ 8% p.a.	544.64	544.64	544.64	466.83	389.03	311.22	233.42	155.61	77.80	0.00
On Working Capital Loan										
- @ 10% p.a.	234.28	234.28	175.71	117.14	58.57	0.00	0.00	0.00	0.00	0.00
Sub-total	778.92	778.92	720.35	583.97	447.60	311.22	233.42	155.61	77.80	0.00
Profit before Depreciation	961.39	2117.89	3163.97	3214.84	3166.61	3118.44	3011.68	2904.92	2798.15	2691.40
Depreciation and Amortisation	686.85	686.85	686.85	686.85	686.85	686.85	686.85	686.85	686.85	686.85
Profit before Tax	274.54	1431.04	2477.12	2527.99	2479.76	2431.59	2324.83	2218.07	2111.30	2004.55
Tax	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Distributable Profit	274.54	1431.04	2477.12	2527.99	2479.76	2431.59	2324.83	2218.07	2111.30	2004.55
Dividend	0.00	680.80	680.80	680.80	851.00	851.00	1021.19	1021.19	1021.19	1361.59
Retained Earnings	274.54	750.24	1796.32	1847.19	1628.76	1580.59	1303.64	1196.88	1090.11	642.96
Add Back : Depreciation & Amortisation	686.85	686.85	686.85	686.85	686.85	686.85	686.85	686.85	686.85	686.85
NET CASH ACCRUAL	961.39	1437.09	2483.17	2534.04	2315.61	2267.44	1990.49	1883.73	1776.96	1329.81

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EXHIBIT : 58

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

PROJECT PROFILE ON ELECTRICAL MOTORS

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	1879.20	0.00	1879.20	0.00	1879.20	0.00	1879.20	0.00	1879.20	0%	0.00
2. Building & Civil Work	5081.94	259.26	5341.20	352.33	5693.53	275.65	5969.18	303.24	6272.42	4%	250.90
3. Plant & Mahinery	3439.26	175.46	3614.72	238.44	3853.16	186.55	4039.71	205.22	4244.93	8%	339.59
4. Miscellaneous Fixed Assets	279.90	14.28	294.18	19.40	313.58	15.18	328.76	16.70	345.46	12%	41.46
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	1049.16	0.00	1049.16	0.00	1049.16	0.00	1049.16	-525.16	524.00	10%	52.40
7. Technical Know-how Fees	449.00	-449.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0%	0.00
Sub-total	12203.46		12203.46		12813.63		13291.01		13291.01		686.85
8. Contingency	610.17	0.00	610.17	-610.17	0.00	0.00	0.00	0.00	0.00		------
Sub-total	12813.63		12813.63		12813.63		13291.01		13291.01		
9. Interest during Construction	477.38	0.00	477.38	0.00	477.38	-477.38	0.00	0.00	0.00		
Total	13291.01		13291.01		13291.01		13291.01		13291.01		

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 59

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON ELECTRICAL MOTORS

TAX COMPUTATION

('000 US $)

	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
Profit before Depreciation	961.39	2117.89	3163.97	3214.84	3166.61	3118.44	3011.68	2904.92	2798.15	2691.40
Less : Current Depreciation	686.85	644.67	605.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Balance	274.55	1473.22	2558.30	3214.84	3166.62	3118.44	3011.68	2904.92	2798.16	2691.40
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	274.55	1473.22	2558.30	3214.84	3166.62	3118.44	3011.68	2904.92	2798.16	2691.40
Tax @ 0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 60

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

PROJECT PROFILE ON ELECTRICAL MOTORS

DEPRECIATION FOR TAX

('000 US $)

WDV Rate	Building & Civil Work 4%	Plant and Machinery 8%	Misc. Fixed Assets 12%	Amortisation 10%	Total
Value	6272.42	4244.93	345.46	549.00	
Depreciation Year 1	250.90	339.59	41.46	54.90	686.85
Balance	6021.52	3905.34	304.00	494.10	
Depreciation Year 2	240.86	312.43	36.48	54.90	644.67
Balance	5780.66	3592.91	267.52	439.20	
Depreciation Year 3	231.23	287.43	32.10	54.90	605.66
Balance	5549.43	3305.48	235.42	384.30	
Depreciation Year 4	221.98	264.44	28.25	54.90	569.57
Balance	5327.46	3041.04	207.17	329.40	
Depreciation Year 5	213.10	243.28	24.86	54.90	536.14
Balance	5114.36	2797.76	182.31	274.50	
Depreciation Year 6	204.57	223.82	21.88	54.90	505.17
Balance	4909.78	2573.94	160.43	219.60	
Depreciation Year 7	196.39	205.91	19.25	54.90	476.46
Balance	4713.39	2368.02	141.18	164.70	
Depreciation Year 8	188.54	189.44	16.94	54.90	449.82
Balance	4524.86	2178.58	124.24	109.80	
Depreciation Year 9	180.99	174.29	14.91	54.90	425.09
Balance	4343.86	2004.29	109.33	54.90	
Depreciation Year 10	173.75	160.34	13.12	54.90	402.12
Balance	4170.11	1843.95	96.21	0.00	

WDV : Written Down Value

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 61

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

PROJECT PROFILE ON ELECTRICAL MOTORS

WORKING CAPITAL REQUIREMENTS
(Excluding Cash & Bank Balances)

('000 US $)

Items	OPERATING YEAR									
	1	2	3	4	5	6	7	8	9	10
1. Raw materials & Consumables	1121.92	1346.30	1570.68	1570.68	1570.68	1570.68	1570.68	1570.68	1570.68	1570.68
2. Finished Stock	519.62	587.68	655.73	667.69	679.64	691.60	703.56	715.52	727.47	739.43
3. Sundry Debtors	701.29	905.30	1058.31	1071.06	1071.06	1071.06	1071.06	1071.06	1071.06	1071.06
TOTAL	2342.83	2839.28	3284.72	3309.43	3321.38	3333.34	3345.30	3357.26	3369.21	3381.17
Increase/(decrease)	2342.83	496.45	445.44	24.71	11.95	11.96	11.96	11.96	11.95	11.96
Stock Variation	519.62	68.06	68.05	11.96	11.95	11.96	11.96	11.96	11.95	11.96

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-185

EXHIBIT : 62

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

PROJECT PROFILE ON ELECTRICAL MOTORS

PROJECTED CASH FLOW STATEMENT

('000 US $)

	Construction Period	YEAR 1	2	3	4	5	6	7	8	9	10
A. SOURCES											
Increase in Share Capital	6807.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Increase in Term Loan	6807.97	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	2342.83	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	1053.46	2209.96	3197.47	3111.96	2927.36	2742.81	2558.25	2373.68	2189.10	2004.55
Depreciation	0.00	686.85	686.85	686.85	686.85	686.85	686.85	686.85	686.85	686.85	686.85
TOTAL 'A'	13615.94	4083.14	2896.81	3884.32	3798.81	3614.21	3429.66	3245.10	3060.53	2875.95	2691.40
B. APPLICATIONS											
Increase in Capital Expenditure	12813.63	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	2342.83	496.45	445.44	24.71	11.95	11.96	11.96	11.96	11.95	11.96

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 62

('000 US $)

	Construction Period	YEAR									
		1	2	3	4	5	6	7	8	9	10
Interest											
On Term Loan - @ 8% p.a.	477.38	544.64	544.64	544.64	466.83	389.03	311.22	233.42	155.61	77.80	0.00
On Working Capital Loan - @ 10% p.a.	0.00	234.28	234.28	175.71	117.14	58.57	0.00	0.00	0.00	0.00	0.00
Total Interest	477.38	778.92	778.92	720.35	583.97	447.60	311.22	233.42	155.61	77.80	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	0.00	680.80	680.80	680.80	851.00	851.00	1021.19	1021.19	1021.19	1361.59
Repayment of Term Loan	0.00	0.00	0.00	972.57	972.57	972.57	972.57	972.57	972.57	972.55	0.00
Repayment of Working Capital Loan	0.00	0.00	585.71	585.71	585.71	585.70	0.00	0.00	0.00	0.00	0.00
TOTAL 'B'	13291.01	3121.75	2541.88	3404.87	2847.76	2868.82	2146.75	2239.14	2161.33	2083.49	1373.55
Opening Balance	0.00	324.93	1286.32	1641.25	2120.70	3071.75	3817.14	5100.05	6106.01	7005.21	7797.67
Surplus /(Deficit) during the Year (A - B)	324.93	961.39	354.93	479.45	951.05	745.39	1282.91	1005.96	899.20	792.46	1317.85
Closing Balance	324.93	1286.32	1641.25	2120.70	3071.75	3817.14	5100.05	6106.01	7005.21	7797.67	9115.52

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 63

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

PROJECT PROFILE ON ELECTRICAL MOTORS

PROJECTED BALANCE SHEET

('000 US $)

		Y			E		A		R		
		1	2	3	4	5	6	7	8	9	10
	Share Capital	6807.97	6807.97	6807.97	6807.97	6807.97	6807.97	680[illegible].97	6807.97	6807.97	6807.97
Add:	Reserves & Surplus	274.54	1024.78	2821.10	4668.29	6297.05	7877.64	918[illegible].28	10378.16	11468.27	12111.23
	SHAREHOLDERS' FUND	7082.51	7832.75	9629.07	11476.26	13105.02	14685.61	15989.25	17186.13	18276.24	18919.20
Less:	Intangible Assets	494.10	439.20	384.30	329.40	274.50	219.60	164.70	109.80	54.90	0.00
	TANGIBLE NET WORTH	6588.41	7393.55	9244.77	11146.86	12830.52	14466.01	15824.55	17076.33	18221.34	18919.20
Add:	Term Loan	6807.97	6807.97	5835.40	4862.83	3890.26	2917.69	1945.12	972.55	0.00	0.00
	CAPITAL FUND	13396.38	14201.52	15080.17	16009.69	16720.78	17383.70	17769.67	18048.88	18221.34	18919.20
Less:	Net Fixed Assets	12110.06	11478.11	10846.16	10214.21	9582.26	8950.31	8318.36	7686.41	7054.46	6422.51
	NET CURRENT ASSETS	1286.32	2723.41	4234.01	5795.48	7138.52	8433.39	9451.31	10362.47	11166.88	12496.69
A.	CURRENT ASSETS										
	Working Capital	2342.83	2839.28	3284.72	3309.43	3321.38	3333.34	3345.30	3357.26	3369.21	3381.17
	Cash & Bank Balance as per Cash Flow Sttatement	1286.32	1641.25	2120.70	3071.75	3817.14	5100.05	6106.01	7005.21	7797.67	9115.52
	TOTAL 'A'	3629.15	4480.53	5405.42	6381.18	7138.52	8433.39	9451.31	10362.47	11166.88	12496.69

JOB NO. : DCIL-105

EXHIBIT : 63

('000 US $)

	Y			E			A		R	
	1	2	3	4	5	6	7	8	9	10
B. CURRENT LIABILITIESS										
Bank Loan	2342.83	1757.12	1171.41	585.70	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL 'B'	2342.83	1757.12	1171.41	585.70	0.00	0.00	0.00	0.00	0.00	0.00
NET CURRENT ASSETS (A-B)	1286.32	2723.41	4234.01	5795.48	7138.52	8433.39	9451.31	10362.47	11166.88	12496.69

DEVELOPMENT CONSULTANTS

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 64

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

PROJECT PROFILE ON ELECTRICAL MOTORS

BREAK-EVEN ANALYSIS

('000 US $)

Sl. No.	Particulars		Amount
1.	Raw Materials and Consumables		6500.00
2.	Power		62.88
3.	Water		4.58
4.	Sub-total (1 thru' 3)		6567.46
5.	Contingency		328.37
6.	VARIABLE COSTS		6895.83
7.	REVENUE		18616.12
8.	CONTRIBUTION (7 - 6)		11720.29
9.	Labour & Plant Overhead*		3394.52
10.	Other Factory Expenses		164.16
11.	Administrative & Sales Expenses*		911.99
12.	Sub-Total (9 thru 11)		4470.67
13.	Contingency		223.53
14.	Sub-Total (12+13)		4694.21
15.	Interest*		408.78
16.	Depreciation		686.85
17.	FIXED COSTS (14+15+16)		5789.83
	BREAK-EVEN SALES	17*7/8	9196.38
	BREAK-EVEN POINT		49.4%
	CASH BREAK-EVEN SALES		8105.42
	CASH BREAK-EVEN POINT		43.5%

* Average over 10 years

JOB NO. : DCIL-105 EXHIBIT : 65

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

PROJECT PROFILE ON ELECTRICAL MOTORS

INTERNAL RATE OF RETURN

('000 US $)

Year	Outflow	Inflow	Net Inflow
0	-13615.94	0.00	-13615.94
1	0.00	1740.31	1740.31
2	0.00	2896.81	2896.81
3	0.00	3884.32	3884.32
4	0.00	3798.81	3798.81
5	0.00	3614.21	3614.21
6	0.00	3429.66	3429.66
7	0.00	3245.10	3245.10
8	0.00	3060.53	3060.53
9	0.00	2875.95	2875.95
10	0.00	2691.40	2691.40

IRR 18.2%

Outflow = Project Cost
Inflow - Profit before Interest,Depreciation & Tax

SECTION - 13
PROJECT IMPLEMENTATION PLAN

PROJECT IMPLEMENTATION PLAN

The Electrical Motor manufacturing plant will be set up in Saudi Arabia. The implementation schedule of the key activities involved in setting up the plant is presented in Exhibit-66.

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

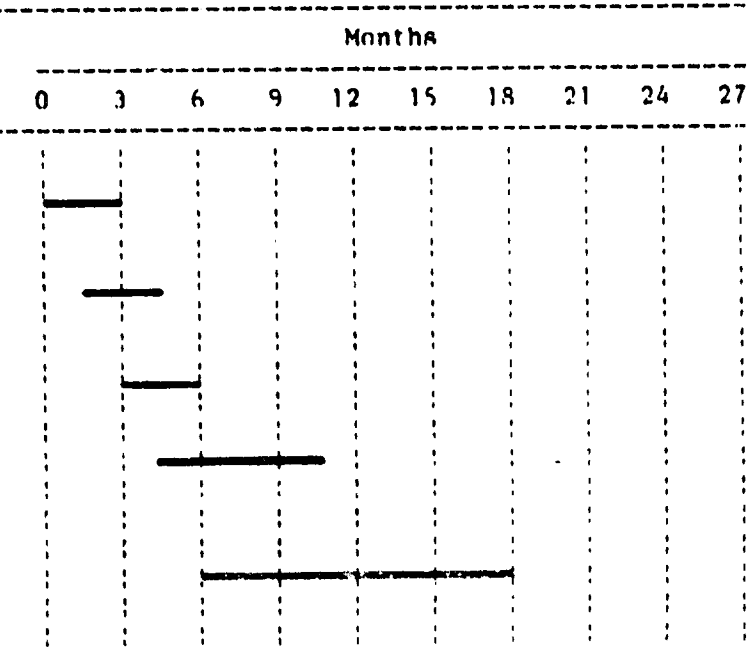
EXHIBIT : 66

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

PROJECT PROFILE ON ELECTRICAL MOTORS

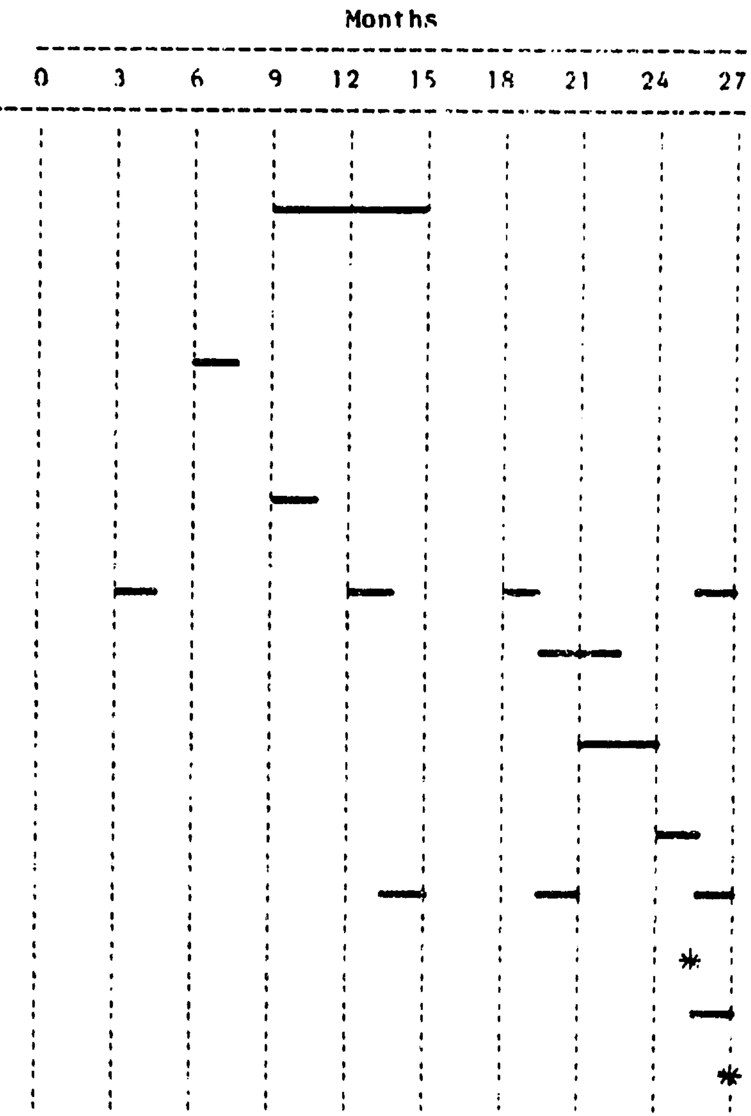
PROJECT IMPLEMENTATION SCHEDULE

Sl. No.	Activity
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

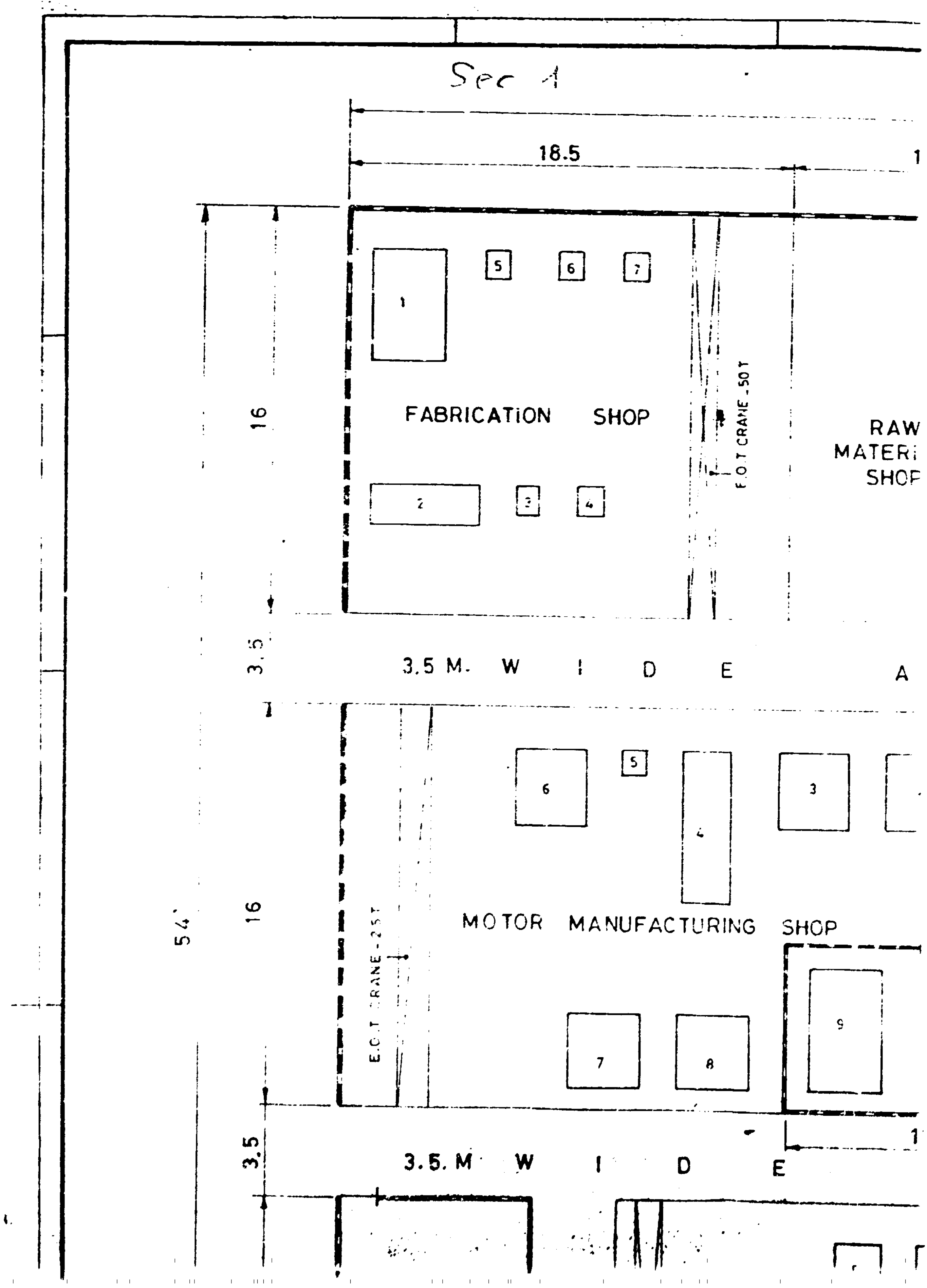


JOB NO. : DCIL-105 | EXHIBIT : 66

Sl. No.	Activity
6.	Civil design and construction of administrative building, including design of ventilation and lighting system
7.	Preparation and floating of tender documents for procurement of equipment inclusive of main plant and machinery, utilities, EOT cranes, etc.
8.	Bid evaluation and finalisation of contracts with various equipment suppliers
9.	Recruitment of personnel
10.	Delivery of equipment at site
11.	Erection of equipment including main plant, EOT cranes and other distribution systems
12.	Equipment and Process Testing
13.	Training of personnel
14.	Commissioning of plant
15.	Trial run
16.	Commencement of commercial production



DEVELOPMENT CONSULTANTS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16
FABRICATION SHOP
E.O.T CRANE _50T
RAW
MATERI
SHOP
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3.5 M. W I D E A
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MOTOR MANUFACTURING SHOP
E.O.T CRANE - 25T
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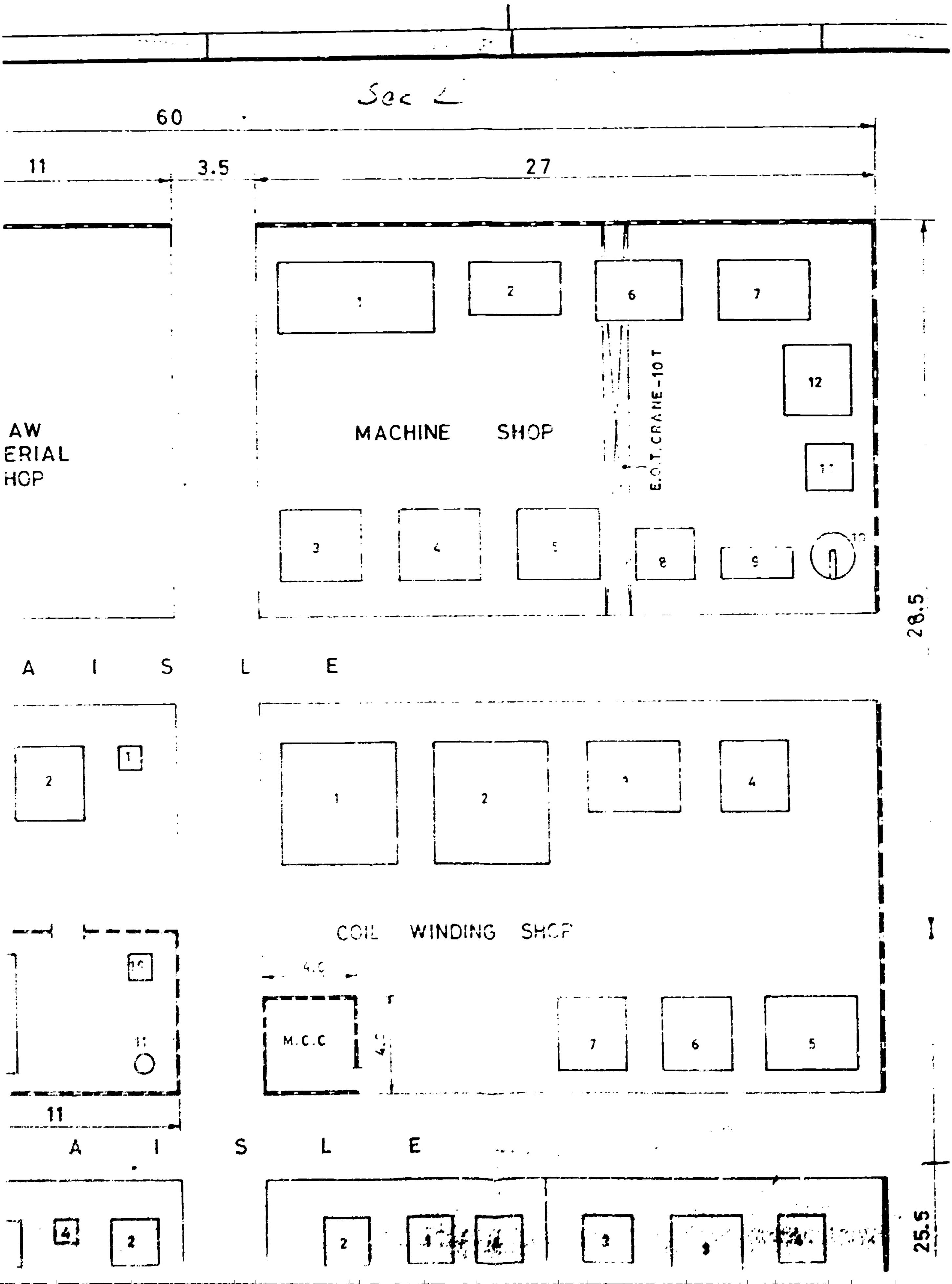

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MACHINE SHOP
E.O.T. CRANE-10T
AW
ERIAL
HOP
28.5
A I S L E
COIL WINDING SHOP
M.C.C
11
A I S L E
25.5

Sec 3

L E G E N D

FABRICATION SHOP

1 PLATE SHEARING MACHINE
2 3 ROLL PLATE BENDING MACHINE
3 CROSS CARRIAGE PROFILE CUTTING MACHINE
4 RECTIFIER DC WELDING SET
5 MIG-WELDING SET
6 HEAT TREATMENT FURNACE
7 STRESS RELIEVING FURNACE

MACHINE SHOP

1 CENTRE LATHE
2 VERTICAL TURRET LATHE
3 C.N.C. VERTICAL MACHINING CENTRE
4 CNC HORIZONTAL MACHINING CENTRE
5 CNC HORIZONTAL MACHINING CENTRE
6 HORIZONTAL MILLING MACHINE
7 KEYWAY MILLING MACHINE
8 CYLINDRICAL GRINDING MACHINE
9 SURFACE GRINDING MACHINE
10 RADIAL DRILLING MACHINE
11 DEEP HOLE DRILLING MACHINE
12 CNC KEY SETTING MACHINE

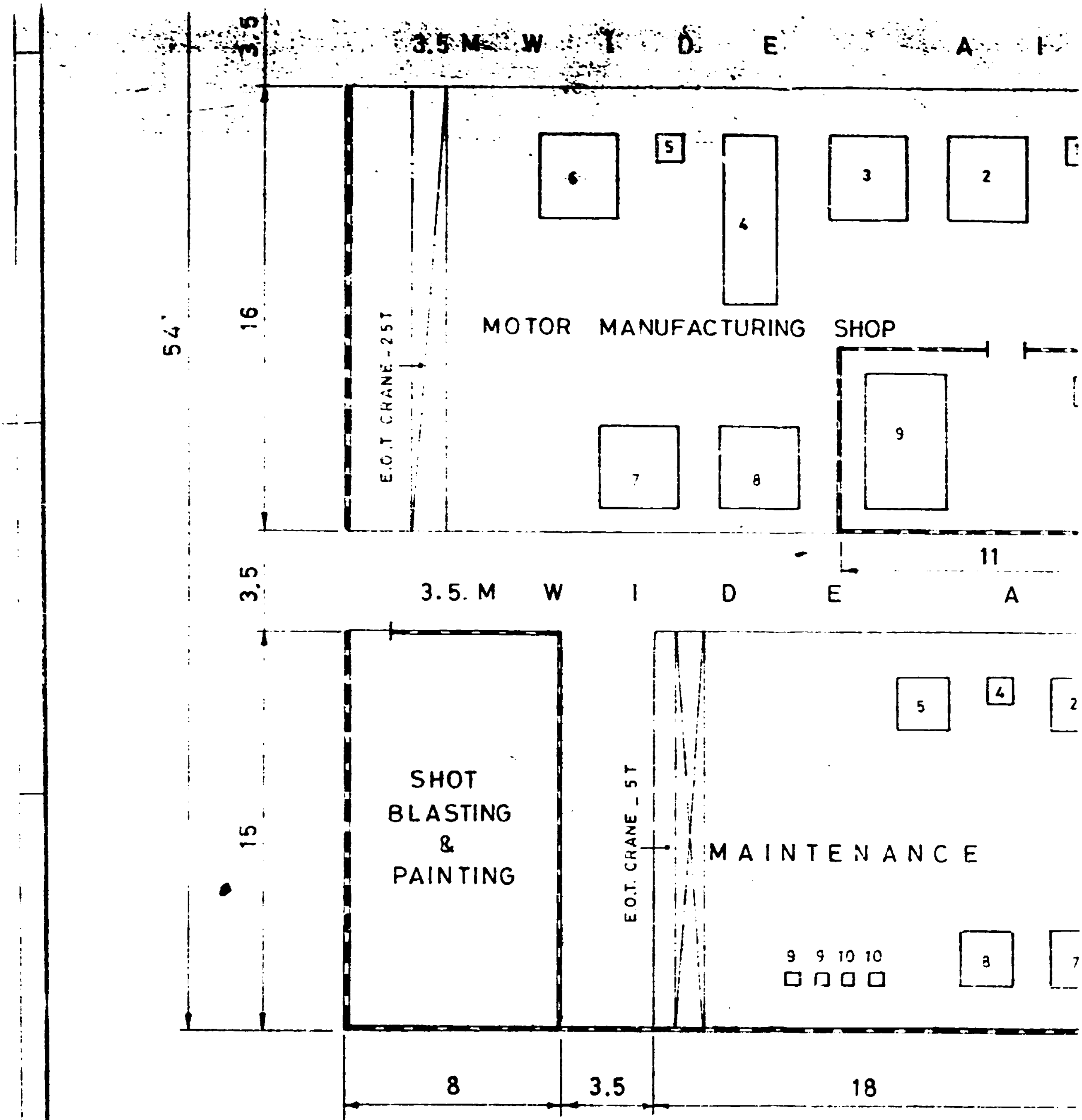
COIL WINDING SHOP

1 COIL TAPPING MACHINE
2 COIL LOOPING & STRETCHING MACHINE
3 LAYER WINDING MACHINE
4 CONTINUOUS CONDUCTOR TAPPING MACHINE
5 STRIP ON EDGE COIL WINDING MACHINE
6 HOT COIL PRESSING MACHINE
7 ARMATURE BANDING MACHINE

COMMUTATOR SHOP

1 HYDRAULIC PRESS
2 L CUT SHEARING PRESS
3 DRAW BENCH
4 OIL FIRED ANNEALING FURNACE
5 PICKLING TANK
6 COMMUTATOR SEASONING OVENS

MOTOR MANUFACTURING SHOP

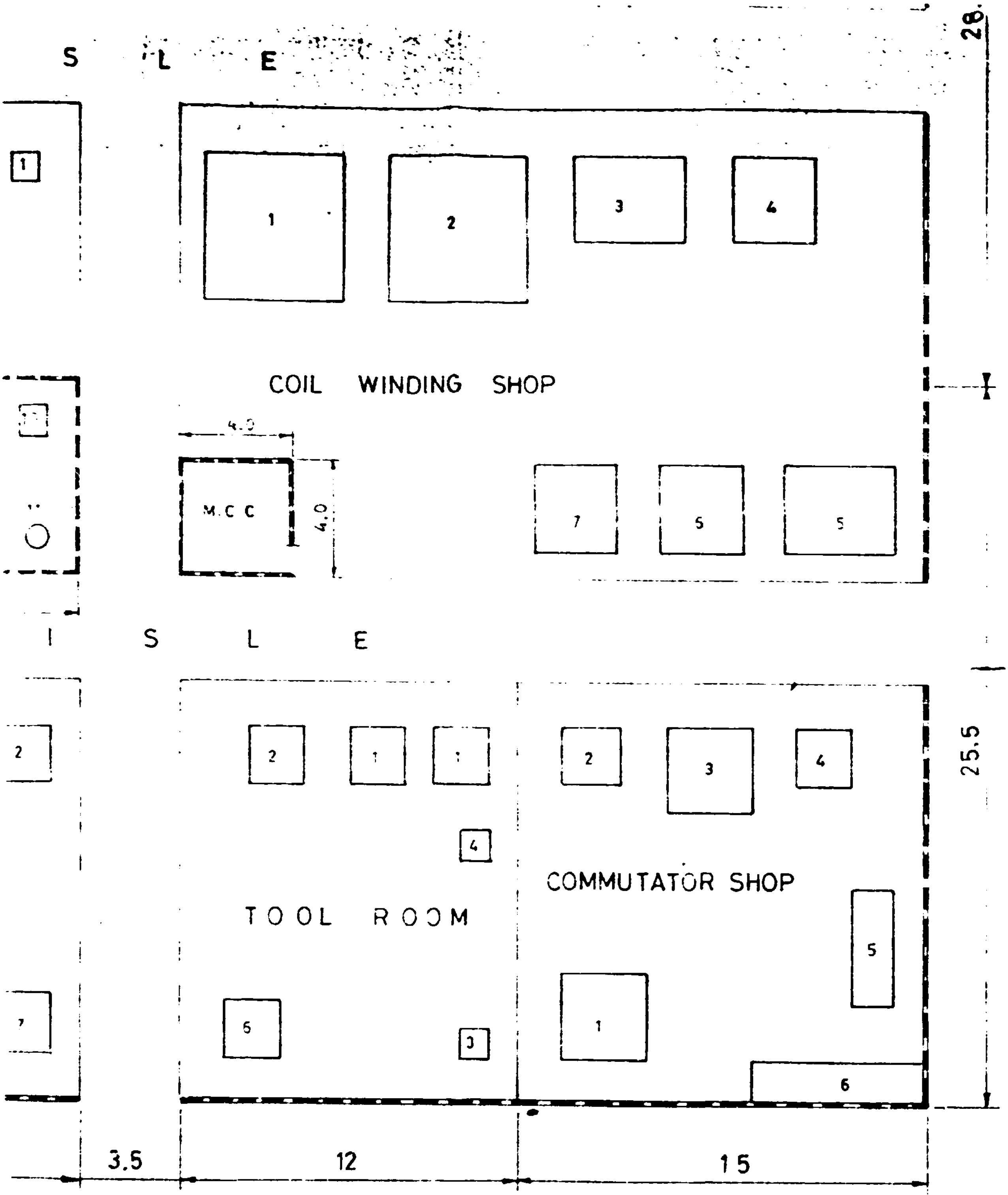


Sec 4

TOOL ROOM AND MAINTENANCE

1 PROFILE GRINDING MACHINE
2 PRECISION LATHE
3 ELECTRIC HEAT TREATMENT FURNACE
4 BENCH GRINDER
5 WIRE CUT EDM MACHINE
6 FINE BORING MACHINE
7 UNIVERSAL MILLING MACHINE
8 COLUMN DRILLING MACHINE
9 ARC WELDING SET
10 RECTIFIER DC WELDING SET

ELEC. MECH.



Sec. 5

STRL	ARCH	NATURE OF REVISION & DESCRIPTION	RELEASE STATUS	DATE	REV.NO.

8 9 10

7 KEYWAY MILLING MACHINE
8 CYLINDRICAL GRINDING MACHINE
9 SURFACE GRINDING MACHINE
10 RADIAL DRILLING MACHINE
11 DEEP HOLE DRILLING MACHINE
12 CNC KEY SETTING MACHINE

COIL WINDING SHOP

1 COIL TAPPING MACHINE
2 COIL LOOPING & STRETCHING MACHINE
3 LAYER WINDING MACHINE
4 CONTINUOUS CONDUCTOR TAPPING MACHINE
5 STRIP_ON_EDGE COIL WINDING MACHINE
6 HOT COIL PRESSING MACHINE
7 ARMATURE BANDING MACHINE

COMMUTATOR SHOP

1 HYDRAULIC PRESS
2 L CUT SHEARING PRESS
3 DRAW BENCH
4 OIL FIRED ANNEALING FURNACE
5 PICKLING TANK
6 COMMUTATOR SEASONING OVENS

MOTOR MANUFACTURING SHOP

1 VERTICAL METAL CUTTING CIRCULAR BAND SAW
2 3_COLUMN DISHING & FLANGING PRESS
3 4_COLUMN DISHING & FLANGING PRESS
4 DYNAMIC ROTOR BALANCING MACHINE
5 TIG WELDING SET
6 ROTOR BANDING MACHINE
7 HYDRAULIC PRESS
8 BLANKING PRESS
9 VARNISH TANK
10 VACUUM PRESSURE IMPREGNATION OVEN
11 VACUUM PRESSURE IMPREGNATION CHAMBER

SEC 6

LAYOUT OF THE MOTOR MANUFACTURING PLANT

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

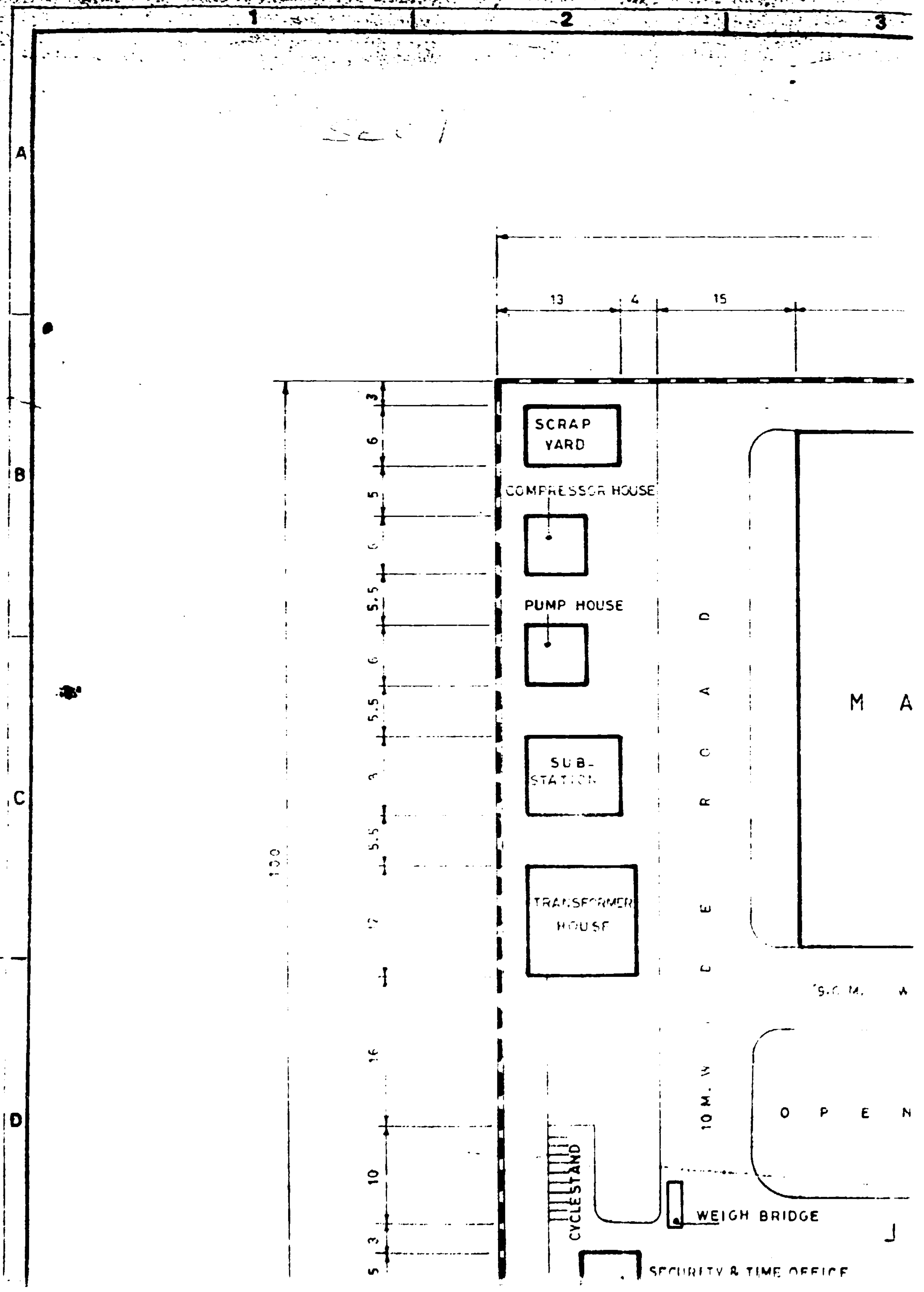
DEVELOPMENT CONSULTANTS LTD
CONSULTING ENGINEERS
BOMBAY • CALCUTTA • MADRAS • NEW DELHI

DRAWN MUKUL	DESIGNED SR / MC	SCALE _ 1:200
PROJ. ENGR.	ENG. MGR.	DATE 28.8.94
DEPT. HEAD		JOB NO. DCIL_45010

DWG. NO. EXHIBIT_ 29 REV. NO.

DATE REV. NO.

10 11 12



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D
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SCRAP YARD
COMPRESSOR HOUSE
PUMP HOUSE
SUB-STATION
TRANSFORMER HOUSE
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O P E N
10 M. W
CYCLE STAND
WEIGH BRIDGE
SECURITY & TIME OFFICE
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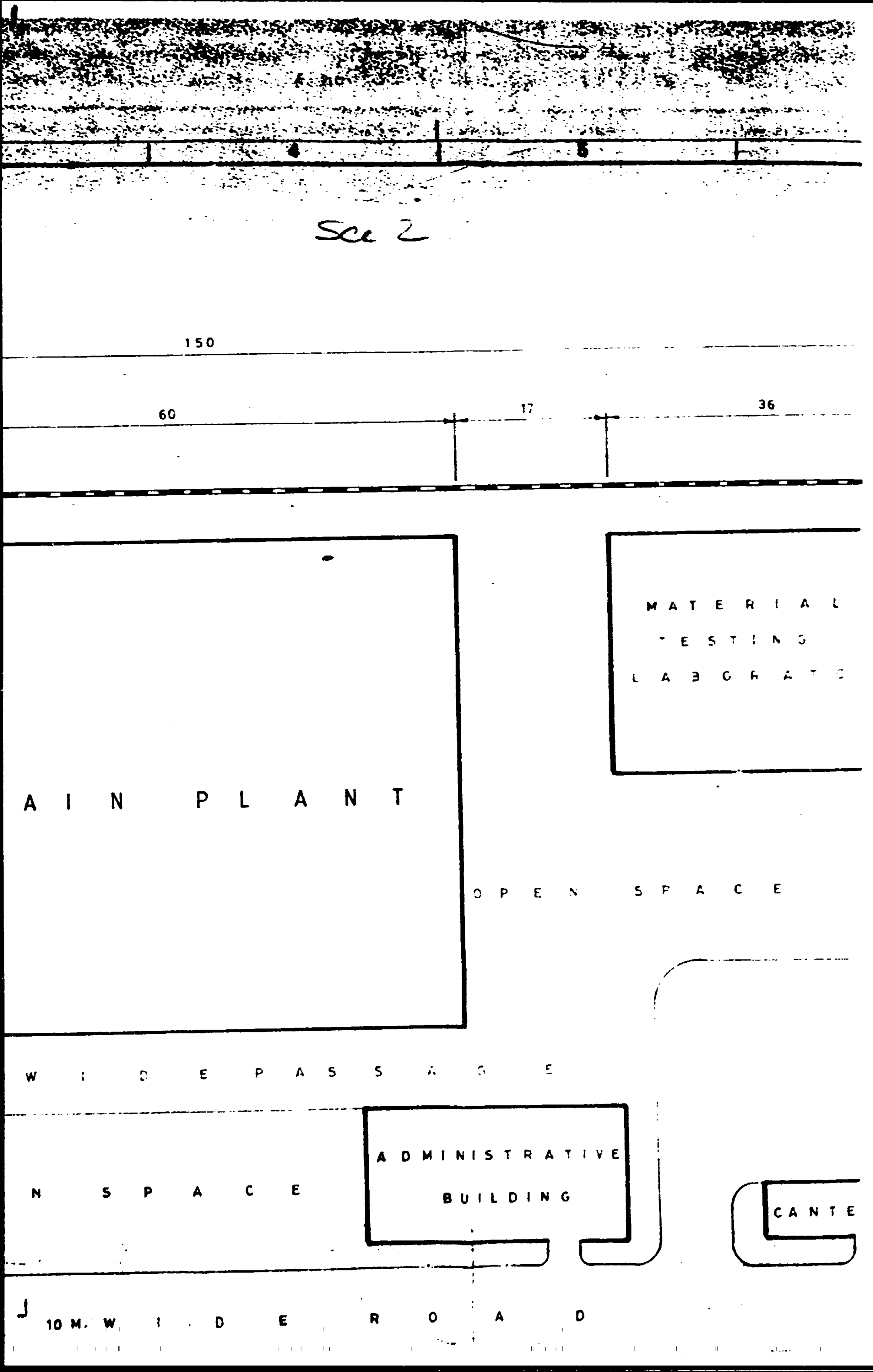
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BUILDING
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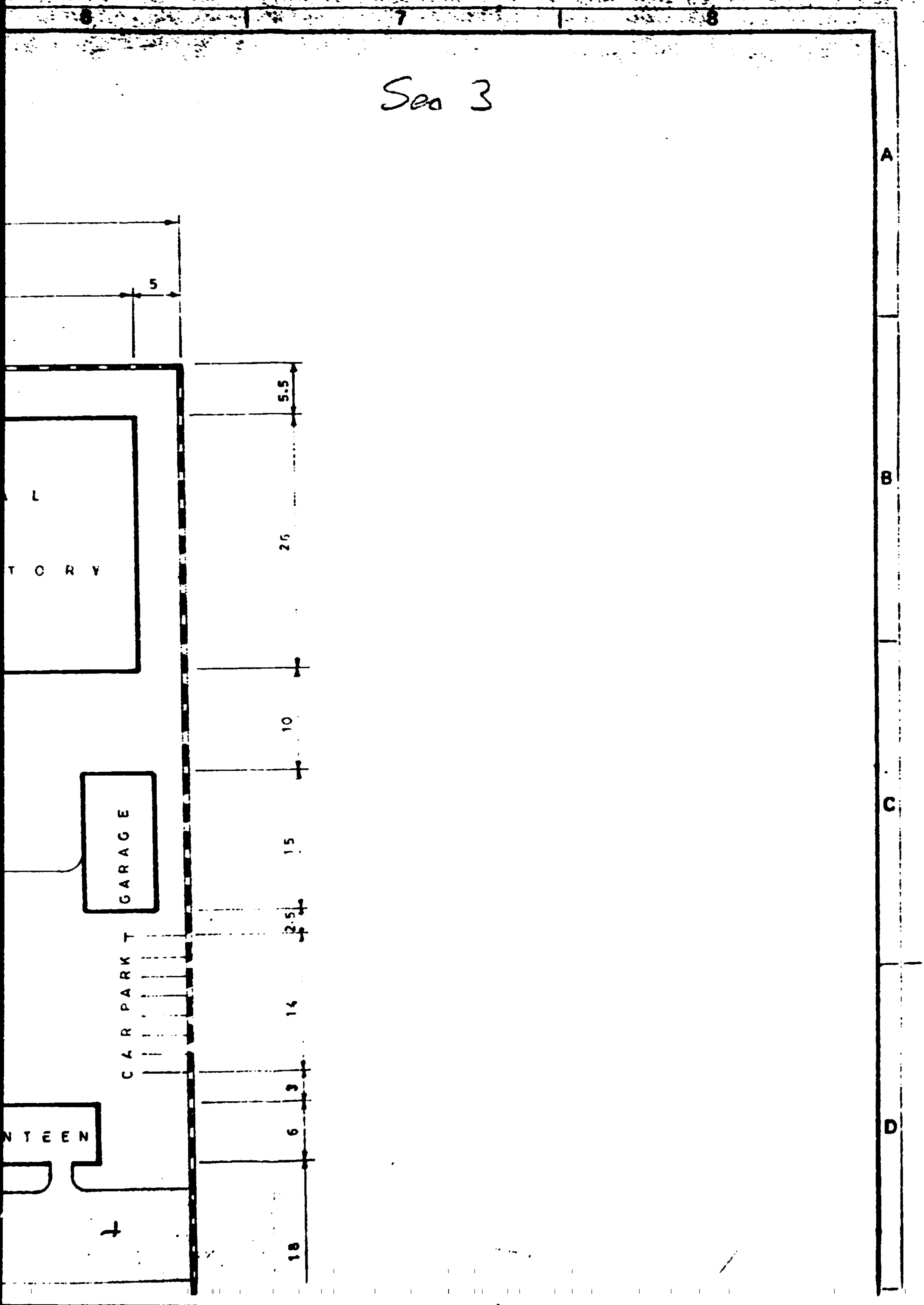

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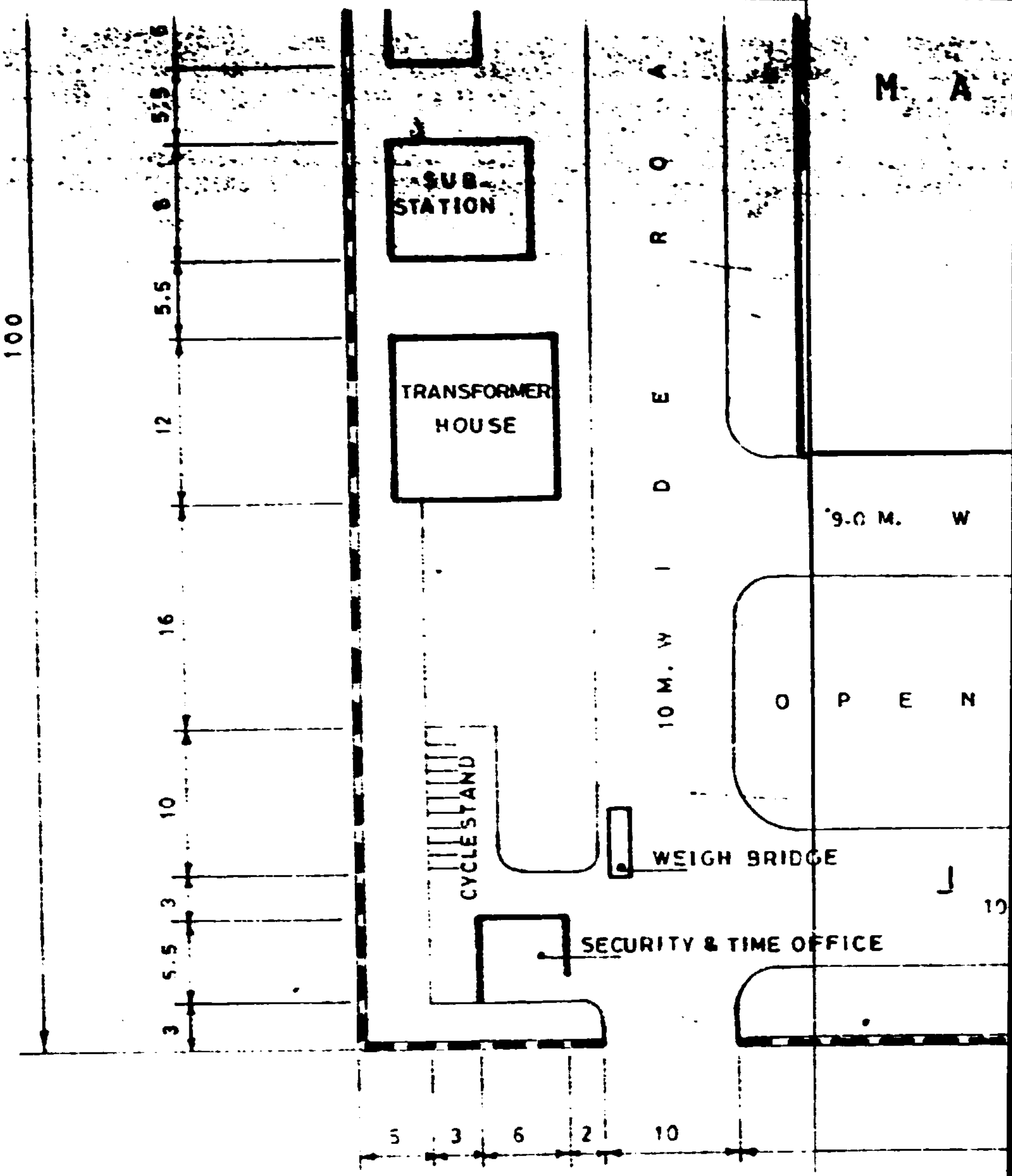
GARAGE
CAR PARK
NTEEN
TORY



M A
SUB-STATION
TRANSFORMER HOUSE
10 M. WIDE ROAD
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CYCLE STAND
WEIGH BRIDGE
SECURITY & TIME OFFICE
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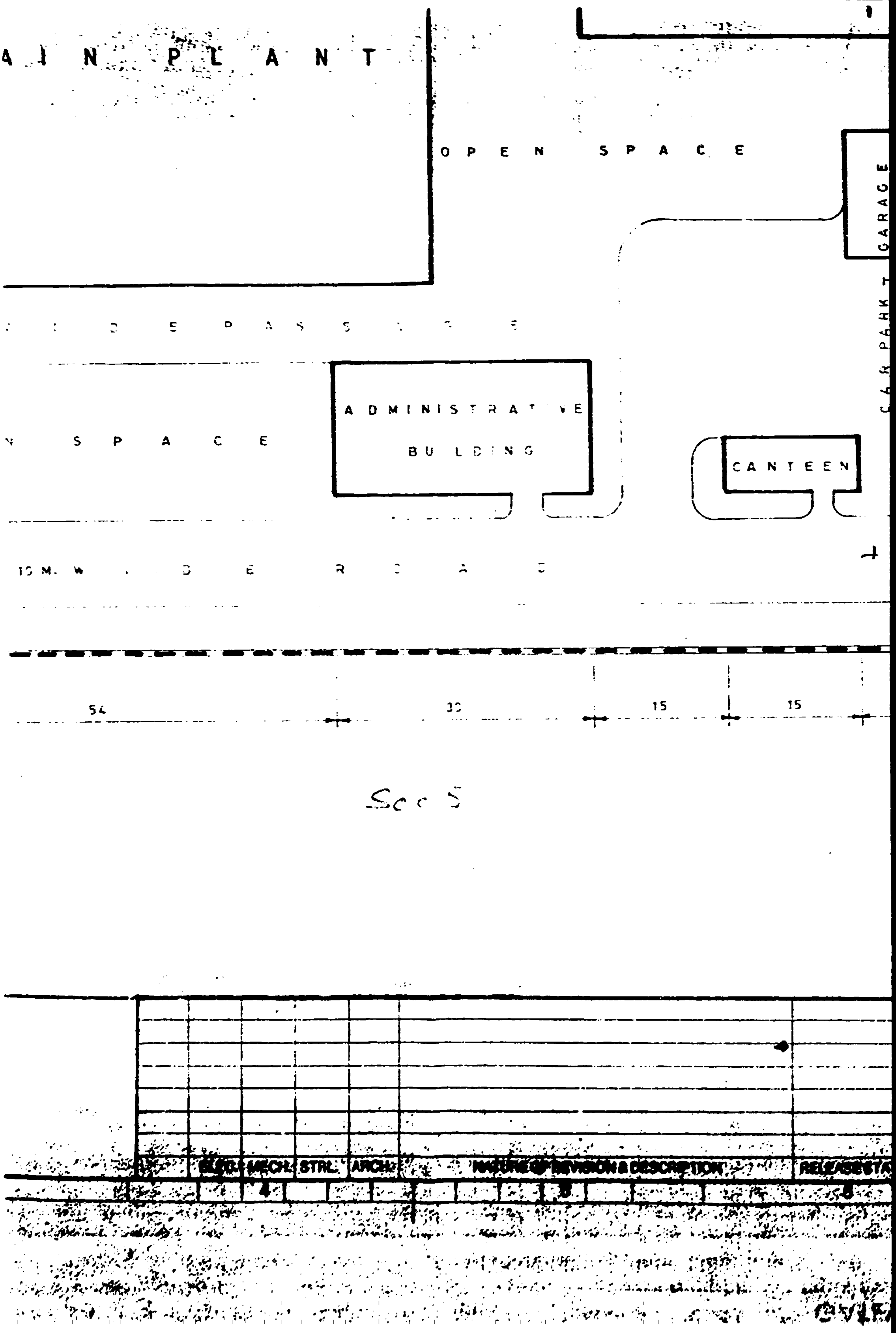
Sec 4



AIN PLANT
OPEN SPACE
GARAGE
CAR PARK
ADMINISTRATIVE BUILDING
SPACE
CANTEEN
10 M. WIDE ROAD
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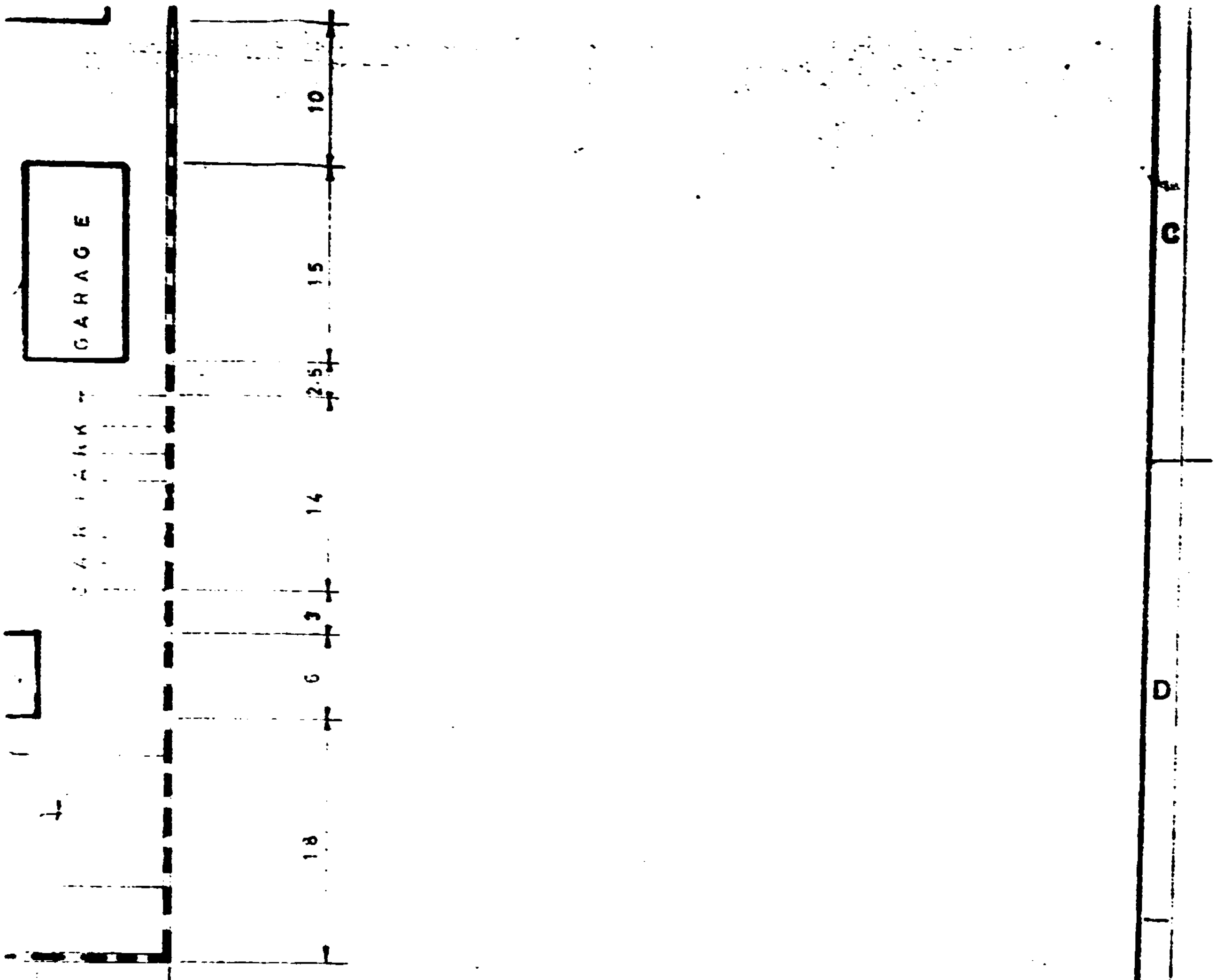
15
See 5
ELEC. MECH. STRL. ARCH.
NATURE OF REVISION & DESCRIPTION
RELEASE STA



Soc 6

BLOCK LAYOUT
MOTOR MANUFACTURING PLANT

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

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

DRAWN MUKUL	DESIGNED S.R / M.C.	DATE 28.8.94
PROJ. ENGR. S.R	ENG. MGR.	SCALE 1:500
DEPT. HEAD		JOB NO. DCIL-45010
DWG. NO. EXHIBIT _30		REV. NO.

STATUS	DATE	REV. NO.

DEVELOPMENT
CONSULTANTS