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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

VIENNA, AUSTRIA

AND

ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

RABAT, MOROCCO

PROJECT PROFILE

ON

CIRCUIT BREAKERS AND ISOLATORS

FINAL REPORT

DEVELOPMENT CONSULTANTS INTERNATIONAL LIMITED

MANAGEMENT CONSULTANCY DIVISION

24-B PARK STREET, CALCUTTA 700 016, INDIA

PROJECT PROFILE
ON
CIRCUIT BREAKERS AND ISOLATORS

MARCH 1996

DEVELOPMENT CONSULTANTS INTERNATIONAL LIMITED
MANAGEMENT CONSULTANCY DIVISION

DEVELOPMENT CONSULTANTS INTERNATIONAL LIMITED

CONSULTING ENGINEERS

Suite 1205, Hong Kong Arts Centre
2 Harbour Road, Wan Chai, Hong Kong
Tel : (852) 877 0377 • Fax : (852) 802 2100
Telex : 83013 AFNDC HX

DCIL-116/AC-5/1111 March 19, 1996

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

Attn : Mr V. Koloskov

Project Profile on Circuit Breakers and Isolators

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

INDEX

INDEX : TEXT

INDEX : EXHIBITS

LIST OF ABBREVIATIONS

A	Ampeare
AC	Alternating current
ASME	American Society for Mechanical Engineers
ASTM	American Society for Testing and Materials
CB	Circuit Breaker
CIF	Cost Insurance & Freight
CuM	Cubic Metre
DC	Direct Current
DPR	Detailed Project Report
EHV	Extra High Voltage
EOT	Electric Overhead Travelling
FOB	Free on board
GWH	Gegawatt hour
HT	High Tension
IEC	International Electrochemical Committee
IRR	Internal Rate of Return
KV	Kilo volt
KVA	Kilo volt ampeare
Lpm	Litres per minute
LV	Low Voltage
LxH	Length x Height
MCC	Machine Control Centre
MS	Mild Steel
MW	Megawatt
R/M	Raw Materials
SF^6	Sulphur Hexaflouride
Sq.M	Square Metre
TR	Tonnes of refrigeration

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 United Nations Industrial Development Organization (UNIDO), shortlisted 8 products for which it wanted to get project profiles prepared. Among these designated products are Circuit Breakers and Isolators for which this Profile has been prepared. 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 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 specification of plant and machinery, and their indicative prices
- Estimated requirement of raw materials, their sources and prices
- Estimated requirement 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 financial 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 titled '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 titled '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. The last two Sections deal with financial analysis and evaluation and implementation plan of the proposed projects respectively.

SECTION - 2
SUMMARY OF FINDINGS

SUMMARY OF FINDINGS

Our findings show that there is a large requirement of circuit breakers and isolators in the Arab region. However, it is suggested that only a part of this demand be met through local manufacture because of the high technology involved.

It is recommended that two plants be set up, one each in Morocco and the UAE. Each of these plants will have identical manufacturing capacities of 880 numbers of circuit breakers and 1800 isolators per annum.

Summary of basic parameters and significant features of the project are presented in Exhibit-1.

JOB NO. : DCIL-105

EXHIBIT : 1

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

SUMMARY OF FINDINGS

Sl. No.	Particulars		Plants 1		Plants 2	
1.	Plant Location	:	Morocco		UAE	
			HT	MT	HT	MT
2.	Plant Capacity (Nos/year)	:				
	- Circuit Breakers		210	670	210	670
	- Isolators		200	1600	200	1600
3.	Area Requirement (Sq.M)	:	33750		33750	
4.	Manpower Requirement (Nos)	:	708		708	
5.	Implementation Period (Months)	:	24		24	
6.	Project Cost ($ Million)		17.95		18.67	
7.	Break Even Point (%)	:	70.40		84.00	
8.	IRR (%)	:	32.20		17.60	

SECTION - 3
PRODUCT ANALYSIS

PRODUCT ANALYSIS

CIRCUIT BREAKERS

A circuit breaker is a device used for making or breaking an electrical circuit under conditions of varying severity. Fuses are used to protect low and medium voltage circuits, whereas high voltage circuits (3.3 KV and above) use circuit breakers. This device is either of the oil- or air-break type, or one employing the gas blast principle.

Current interruption in vacuum consists of separating a pair of current carrying contacts in high vacuum environment of 10^{-5} torr or lower (1 torr is the pressure required to support a column of mercury 1 mm high, or, in other words $1/760^{th}$ of atmospheric pressure). Like all a.c. interrupting devices, the objective during interrupting process is to remove continuously the arc plasma. This is done so that at the normal current zero, the arc path has a minimum memory of the arcing which has preceded the zero. The arc will then be extinguished if the input power from the circuit is less than that dissipated in the de-ionisation process. It will remain extinguished if the dielectric strength between the contacts recovers sufficiently to withstand the restriking and recovery voltages.

The functions of a circuit breaker are as follows :

- It must be capable of closing on to, and carrying full load currents over long periods of time.
- Under prescribed conditions, the circuit breaker must open automatically to disconnect the load or some small overload.

- It must be able to rapidly interrupt they heavy currents which flow when a short circuit has to be cleared from the system.
- It must be able to withstand the circuit voltage across the gap when the contacts are open.
- It must be capable of closing on to a circuit in which a fault exists, and of immediately re-opening to clear the fault from the system.
- It must be capable of carrying current of short circuit magnitude until, and for such time as, the fault is cleared by another circuit breaker (or fuse) nearer to the point of fault.
- It must be capable of successfully interrupting small currents such as transformer magnetising currents (inductive), or line and cable charging currents (capacitive).
- It must be capable of withstanding the effects of arcing at its contacts and the electromagnetic forces and thermal conditions which arise due to the passage of currents of short circuit magnitude.

Circuit breakers are specified according to voltage, amperage and maximum breaking capacity.

Mechanism of Breaking

Circuit breakers are capable of making, carrying, and breaking currents under normal circuit conditions and also under specified, abnormal conditions such as short circuits.

In the simplest terms, interrupting an a.c. arc means deionising (i.e. making non-conductive) the highly ionised gaseous path between the contacts to ensure that at an early current zero (on a 50 Hz system there are 100 zeros every second), the dielectric strength in the contact gap is able to withstand the increasing voltage across the gap which tends to re-establish the arc after a current zero. Ideally, this condition would be achieved at the first current zero after the arc is first established. But this is rarely achieved, and depending on the design and type of circuit breaker there will be several cycles of arcing prior to final extinction.

When the current to be interrupted is the normal load value, the power factor of the system will also be normal (i.e. 0.8 or better) so that at each current zero, the voltage will be almost zero. This makes for easy interruption. But when a short circuit occurs, the power factor may be very low. When the fault is at locations near to the power source it can fall to almost zero. In such situations, the current and voltage will be out of phase such that at current zero the circuit voltage will near its maximum; and this makes it difficult to cause interruption.

The normal system voltage existing prior to the short circuit falls to zero when the fault occurs and stays at zero during the pre-arcing period, i.e. until the contacts seperate. At this point, an arc is struck with a voltage reappearing which is of low value and fairly constant; this voltage is known as the arc or arc burning voltage.

Just before the current reaches its natural zero, the effects deionisation and cooling of the arc gap

predominate, causing the arc voltage to rise to a small peak above its average, forcing the current to zero. If, at this point the deionisation has not progressed sufficiently, then the restriking voltage which rises rapidly to a slightly higher peak in the opposite direction will restrike the arc. As a result, the fault current will flow again until the next natural zero. This process may be repeated several times. The behaviour of voltage before, during and after a short circuit in a specific case is shown in Exhibit-2.

General design Principle

The medium in which circuit interruption is performed may be either air, gas, oil or vacuum. Regardless of the medium of arc interruption and insulation, each circuit breaker consists of the following essential elements :

- o main contact, open or in an interrupting chamber, at system voltage
- o insulation between the main contact and ground potential (porcelain, oil, gas)
- o control, supervisory, and auxiliary devices out of reach of the system voltage-life zone
- o an insulated link between the control unit and the main contact.

Tripping facilities, as part of the circuit breaker control system, are essential to ensure the highest degree of reliability under the service conditions.

Based on the medium of interruption and insulation, circuit breakers may be classified as -

- oil
- air-break
- air/gas-blast
- vacuum interrupter

These are discussed below.

Oil Circuit Breakers

The oil in the oil circuit breaker serves three purposes :

- It insulates live contacts from the earthed metal tank.
- It provides an insulating barrier between the open contacts after the arc is extinguished.
- It produces hydrogen during the arcing period for extinguishing the arc.

The arc produced between the contacts at the time of breaking is surrounded by a bubble of gas. This is caused by the heat of the arc breaking down the oil in the vicinity of the contacts and liberating a mixture of gases and vapours, mainly hydrogen. It is largely due to the hydrogen that successful interruption is achieved, as it recovers its dielectric strength rapidly at each current zero.

A schematic diagram of a simple plain-break oil circuit breaker is shown in Exhibit-3. The electromagnetic loop forces are in the direction of the arrows F.

Other factors that aid interruption are the turbulence of oil in the neighbourhood of the arc, and the closeness of cool oil to give a high temperature gradient. In the plain-break design, there is no fuse restraining the gas bubble in

its effort to push the oil away from the arc. Therefore, the cooling section is diminished and the arc tends to lengthen. Such lengthening is not desirable although it does increase the turbulence which, in turn, aids the cooling process. Under these conditions, the performance may be erratic.

Minimum Oil Circuit Breaker

The performance of the above type of circuit breaker can be improved by the addition of a special device known as side-blast arc control device, which is shown in Exhibit-4. This device encloses the contacts, arc, gas bubble and a quantity of oil. It has side vents which allow the blast of hydrogen and oil vapour with only one outlet for escaping means of escape. The arc is forced by the blast of gas into the side vents, and the cool oil refills the box-like enclosure. New designs incorporate the use of small quantities of oil and arc; therefore, these are designated as small-oil-volume circuit breakers. These designs are popular for the higher KV ranges upto 400 KV.

The minimum oil circuit breaker is a valuable alternative to other types, particularly for locations where switching operations are not too frequent. At higher voltages, it is an economical alternative to the air-blast type in as much as it obviates the need for installing an air compressor together with associated pipelines, etc. As in case of the air-blast circuit breaker, two or more interrupting chambers can be connected in series per pole to achieve the required overall interrupting capacity. Unlike the air-blast type, it is silent in operation and therefore does not require the use of costly silencers.

Airbreak Circuit Breaker

In the air-break circuit breaker, shown in Exhibit-5, the arc exists in a mixture of air and metallic vapour. Interruption is largely due to elongation of the arc which results in cooling and de-ionisation by diffusion. Owing to the high temperature of the arc relative to the surrounding air, the former is subjected to strong convection currents which, coupled with the electromagnetic effect of the current loop, cause the arc to rise vertically. It is therefore driven into the arc chute where splitter plates assist the cooling and lengthening process so that the effective length of the arc is much greater than that of the distance between the fully open contacts. It appears that the resistance of the long arc plays a part in successful interruption, which, in turn brings the voltage nearly into phase with the currents, i.e., improves the power factor. There are quite a few variations in the design of air-break circuit breakers. These interrupters are particularly suitable for the lower KV ranges.

Air-blast Circuit Breaker

In air-blast circuit breakers, the interrupting process is aided by an axial blast of air at high pressure (usually from a compressed air installation) admitted to the arcing chamber, as illustrated in Exhibit-6. The air passes through a nozzle, the main fixed contact, and then to the atmosphere. On leaving the nozzle, the air expands so that its velocity through the nozzle reaches sonic level, centering the arc and transferring its upper root to a probe contact, as shown. In this position, the arc is subjected to high pressure and considerable heat loss by forced

convection. In the design shown, motion of the moving contact is restricted, so that in the fully open position the contact gap is quite small. In air-blast designs, the main feature is a critical gap length for a given blast condition, at which the interrupting capacity is maximum. When this gap is reached, interruption should take place at the next current zero. If it does not, all subsequent zeros will occur at times of falling air pressure and interruption will be correspondingly more difficult.

It is equally important that the moving contact reaches the critical gap as quickly as possible. In most practical designs, motion of this contact is restricted so that it does not pass beyond the critical gap. As the air in the blast tube returns to atmospheric pressure after arc extinction, its dielectric strength in the small gap will be insufficient to withstand the normal system voltage. Therefore a separate isolating switch is provided to open automatically after current interruption. The moving contact, relieved of high pressure on its actuating piston, returns to its closed position; the circuit being restored by closing the external isolating switch.

Although not simple to achieve and for this reason rarely considered, it is possible to eliminate the separate isolating switch and yet retain the feature of restricted movement at the critical gap. This may be done by arranging for the moving contact to pause for a short time at that gap, and then continue its stroke to a fully isolated position.

In the type of design discussed above, the moving contact arrangements depend on admission of high pressure air to the blast tube for the opening movement; the air acting on a spring-loaded piston. Now-a-days, circuit breakers for high voltages, the blast tube and interrupter chamber are permanently pressurised, and the moving contact is mechanically activated. On receipt of a tapping impulse, the contact opens. Simultaneously, a blast valve also opens to release the high pressure to atmosphere. Thus, air at maximum pressure is immediately available in the arcing area. This eliminates the pressure loss and the time delay that occurs when the air travels the full length of the blast tube before it reaches the arcing area. With air maintained at high pressure across the open gap after the arc extinction, the need for a separate isolator disappears.

Gas-blast Circuit Breaker (SF_6 Type)

Arc extinction in the case of SF_6 (sulphur hexaflouride) circuit breakers is similar to air-blast circuit breakers, except that in the latter case the quenching medium is air instead of sulphur hexaflouride gas.

SF_6 is a heavy, chemically-inert, non-toxic, non-inflamable gas, which is odourless and colourless. It has a higher dielectric strength and superior insulating and arc-quenching properties than either air or oil. Moreover, the gas is highly stable and shows no sign of chemical change, at temperatures well above those at which oil begins to oxidise and decompose.

The electromagnetic gas when forced into the arc, rapidly absorbs the free electrons in the arc path between the contacts to form negatively charged ions which are ineffective as current carriers. This electron-trapping action results in a rapid build up of insulation strength after a current zero.

The fixed and moving contact system of SF_6 circuit breaker is shown in Exhibit-7.

Among the several advantages claimed for SF_6 circuit breakers the following are worth mentioning :

- The low gas velocity and the pressures employed minimise any tendency towards current chopping, and capacitive currents can be interrupted without restriking.
- These are virtually maintenance free, they insulation and interruption system needs practically no maintenance as there is no carbon deposition.
- The arc extinguishing properties of SF_6 result in very short arcing times so that contact erosion is extremely less.
- As the SF_6 circuit breaker is totally enclosed and sealed from the atmosphere, it can also be used in coal mines or in any industry where an explosion hazard exists.
- Electrical clearances can be reduced due to the superior insulating properties of SF_6.

There are design variations between manufacturers which are largely due to individual solutions to meet various constraints, but all are essentially similar in concept to the air-blast system discussed earlier. SF_6 type interrupters are particularly suitable for higher voltages (220 KV and above). These types of circuit breakers have combined in them the superior performance of air-blast and the simplicity of minimum oil.

Vacuum Interrupters

The feature of a typical vacuum interrupter is illustrated in Exhibit-8. Unlike other a.c. circuit breakers, the current carriers in the arc are mainly metal ions from the contacts, since a negligible amount of gas is present in the arc plasma. Rapid condensation of these metal ions and vapours on to the contacts determines the efficiency of the breaking process at current zero.

The unique properties of a vacuum interrupter offer many advantages. However, the relatively high cost of a vacuum interrupter comes in the way of making its use more widespread. The use of vacuum as a quenching medium still appears to be confined to medium and low voltages; even there it is restricted to special applications. Efforts made in recent years to introduce vacuum interrupter units at high voltages, have not achieved any marked success. Research is being done on new and economical designs, and within the next decade or so vacuum circuit breakers may become a viable alternative to the existing oil or air/gas interrupter designs.

Construction Aspects of SF_6 Circuit Breakers

From the point of view of constructing these, there are two types of circuit breakers in the high voltage range. These are based on a dead tank or live tank principle respectively.

In the dead tank design, the interruper units are enclosed in an earthed tank with bushing insulators for current entry and exit. The tank and bushings are filled with SF_6; these constitute the low pressure part of a double pressure closed circuit gas system. The live tank design may be used for any number of interrupter heads. The heads are mounted in pairs, in the 'T' or 'V' formation at the top of a hollow insulating support column. Multiple columns are used to cover the total number of interrupters. In this arrangement, the interrupter heads and hollow support columns are fitted with SF_6; these constitute the low pressure part of a double pressure system.

The more popular live tank design achieves equal voltage distribution across the breaks by way of a number of ceramic capacitor packs which are slung below the interrupting elements, in shunt with each break. Synchronous operation of all three phases is ensured by mechanical pull rods which transmit the movement of the pneumatic closing mechanism simultaneously to the moving contacts at each break.

A sectional view of a typical two break assembly at the top of a support column is shown in Exhibit-9. In this type of design, an SF_6 high pressure intermediate receiver is formed by the dome above the column. This receiver is charged with gas from a main high pressure storage tank at the base of

the breaker through feed pipes, which pass through the hollow support insulator. The low pressure system is formed by the interrupter units, distributor head and hollow support insulators. Pressures of 18 kgf/cm² and 2 kgf/cm² for the high and low pressure sides respectively, may be employed.

A schematic diagram of gas flow in the interrupter unit during arc quenching, and with the arc extinguished, is shown in Exhibit-10. The blast valve is located at the base of the intermediate receiver. This is opened as the breaker is tripped through the mechanical linkage seen in the distributor head. It releases a blast of high pressure gas into the arc in both the interrupter units via the blast tubes.

The differential between low and high pressure systems after each operation is restored by pumping excess gas from the low to high pressure systems via filters and a compressor. A thermostatically controlled heater system in the high pressure storage tank prevents the gas from liquifying at low temperatures. The tank and intermediate receiver are lagged to minimise heat loss.

A schematic diagram of a closed gas system is shown in Exhibit-11.

The most recent design in SF_6 circuit breakers employs a 'puffer' principle in which the interrupter chamber contains SF_6 gas at a single high pressure.

A comparative study of the basic features of interruption technologies discussed above and used in the 3-36 KV range power systems is presented in Exhibit-12.

ISOLATORS

Isolators are disconnecting switches used primarily for isolating equipment from buses or line apparatus or for sectionalising buses or circuits. They provide a safe distance between line and earthed parts, in accordance with specified requirements.

Isolators are normally not intended to break load current and should be operated when the voltage across the contacts is not significant. In the closed position, these must be capable of carrying normal current while being able to withstand the forces of short circuit.

Mechanically, isolators should be robust and capable of functioning under extreme climatic conditions.

Various types of EHV isolators incorporating different design features have been developed over the years. Some of the more popular types are :

- Vertical opening horizontal break
- End-rotating centre break
- Centre-rotating end break
- Vertical reach and vertical break
- Vertical break pantograph type
- Vertical break semi-pantograh type
- Horizontal break semi-pantograph type

The pantograph type is a recent design and is especially suitable where space is a constraint. For the same reason, the vertical reach and vertical break isolators are very popular in the United States and Canada. These lead to design of substation layouts that are economical in area

but somewhat greater in height then those using horizontal isolators, because of the vertical clearance required above the open blade. Three insulators per phase are required. The contacts can be arranged to have excellent ice-breaking properties by giving the blade a rotary movement about its own axis at the end of the closing stroke.

Among the other conventional type of isolators mentioned above, the centre rotating end-break type offers great advantages.

The centre break type of isolator calls for special attention regarding the design of the insulators' bottom support bearings and insulator characteristics. This is because its insulators revolve during operation; hence they are unsuitable for supporting bus bars. Moreover, in the event of the isolator being situated adjacent to a gantry, its live end would come very close to the earthed gantry thus requiring further spacing out of the two structures. A schematic drawing of end-rotating centre-break type of isolator is presented in Exhibit-13.

Isolator Contacts

There has been considerable progress in the development of isolator contacts. Design features like high pressure between the contacts improve reliability. Modern designs use silver-plated or silver inlaid contact surfaces to reduce contact resistance and heating due to oxidation. Self cleaning multi-finger pattern fixed contacts are employed to exclude dirt and other pollutants from the space in between the contact surfaces. Shrouds are used to minimise accumulation of ice and snow on the contact surfaces under

extreme weather conditions. A high pressure contact system incorporating a revolving blade is shown in Exhibit-14.

Current Rating

The current rating of an isolator is based upon a temperature rise of not more than 30°C above the ambient level of 40°C. It may be necessary to install an isolator of larger capacity than required, if it is likely to be subjected to very high short circuit currents. This is because the rms current of the maximum half cycle of short circuit should not exceed the momentary current rating of the isolator.

The following paragraphs give the design and construction details of the two most popular types of isolators in the EHV range :

- Centre-rotating end-break type
- Pantograph type

Centre-Rotating End-Break Type Isolator

The centre-rotating end-break type of isolator consists of three insulating posts per phase. The centre post carries a moving switch blade which makes contact with two fixed contacts on the insulating posts on either side.

The fixed contacts are generally silver plated. These non-ferrous finger contacts are designed for high pressure contact to withstand rated current without overheating. The high pressure contact also ensures a wiping action which keeps the switch blade clean.

Synchronous operation of all the three phases can be achieved by a pipe which couples the operating mechanism to all the three rotating blades.

In the open position of the isolator, the cables connected to the two end posts would be left floating. This is not desirable. The cables are therefore earthed by means of earth switches. An interlock is provided which prevents the isolator from closing when the earth switch is on.

Similarly, the earth switch is prevented from closing when the isolator is closed.

A schematic drawing of the centre-rotating end-break type isolator is shown in Exhibit-15.

The operating mechanism may be normal or motor driven. The manual system normally has a fulcrum and lever mechanism for easy operation of the isolator.

The motor operated mechanism may use either an a.c. or a d.c. motor and provides rotary motion by a spur gear to the torsional shaft of the isolator.

Pantograph Type Isolator

Pantograph isolators have been very popular in the EHV range, particularly for system voltages of 400 KV and above. This is mainly because of their compact design. Layouts using pantograph isolators have resulted in an overall saving of 20% in the cost of land, civil structures and insulators.

Technically, they have the advantage of a visible vertical break, single support insulator, small support structure and

better dielectric gap factor.

Several types of pantograph isolators have been developed varying mainly in the lateral extension of the pantograph in the open position and the number of current transfer points.

A conventional full pantograph is shown in Exhibit-16. A pantograph is mounted at the top of an insulator column. In the closed position, it grasps a contact bar supported from the line conductor by a scissor-like action. In the open position, the pantograph collapses, as shown by dotted lines as shown in the exhibit.

The number of current transfer points in a full pantograph is restricted and this gives it added reliability. Speed of contact separation for this type of isolator is quite fast. Other types of pantograph isolators are the semi-pantograph or jointed arm type, double pantograph and the full pantograph with the nut-cracker principle.

The semi-pantograph has only one arm and requires an elaborate system of linkages for actuating the contact. Its speed of contact separation is also slow.

The double pantograph occupies much less horizontal space than the full pantograph. However, due to the increased number of current transfer points it needs to be well maintained.

Operating Mechanisms

The main housing is supported on top of the support insulator and consists of the actuating linkage, contact pressure springs and the arm weight compensating spring.

The pantograph is operated through a rod insulator which may be a slender solid core of porcelain. Actuation takes place by subjecting the operating rod insulator to torsion, or tension and compression, alternately.

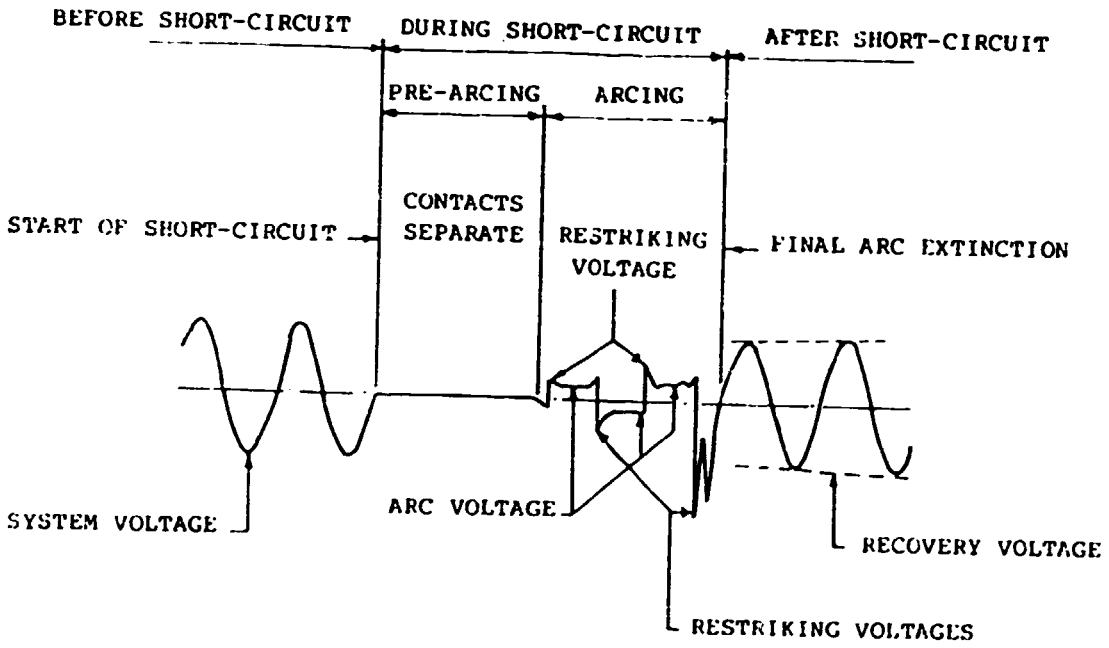
JOB NO. : DCIL-105

EXHIBIT : 2

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

VOLTAGE BEFORE, DURING AND AFTER SHORT-CIRCUIT



JOB NO. : DCIL-105

EXHIBIT : 3

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

PLAIN-BREAK OIL CIRCUIT BREAKER

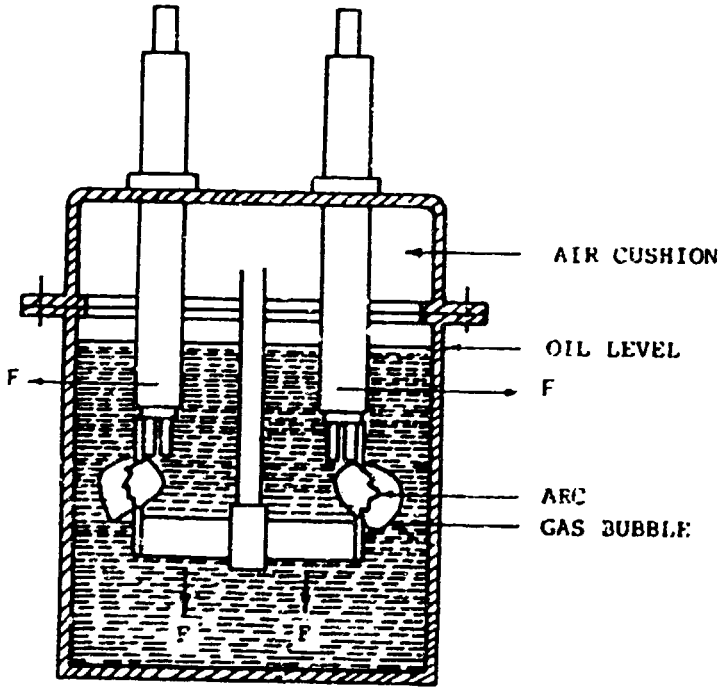

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EXHIBIT : 4

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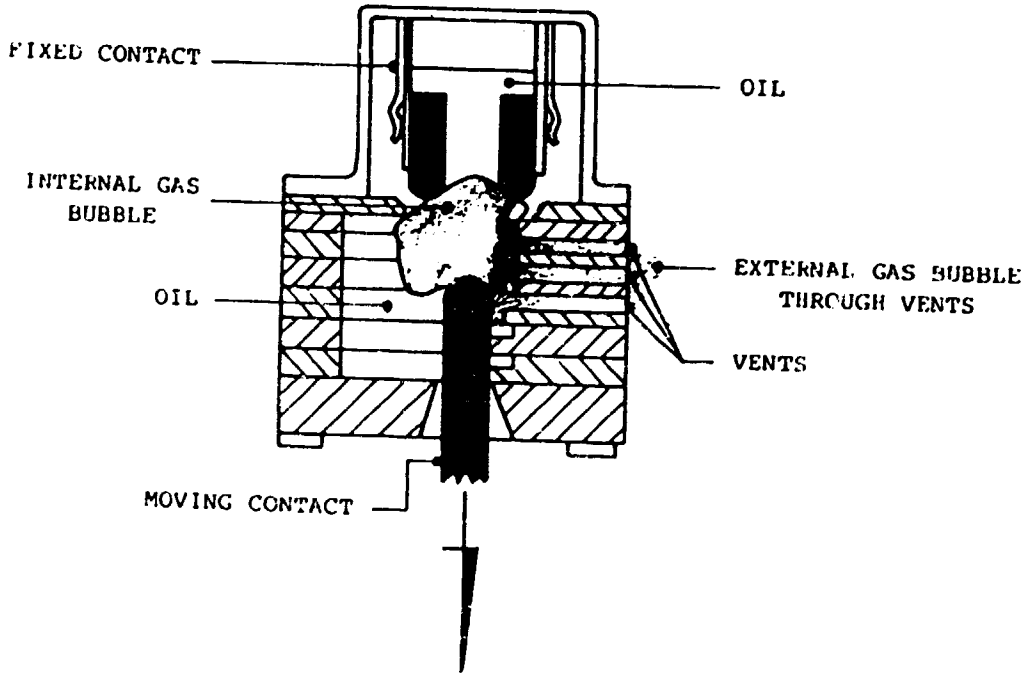
PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

SIDE BLAST ARC CONTROL DEVICE



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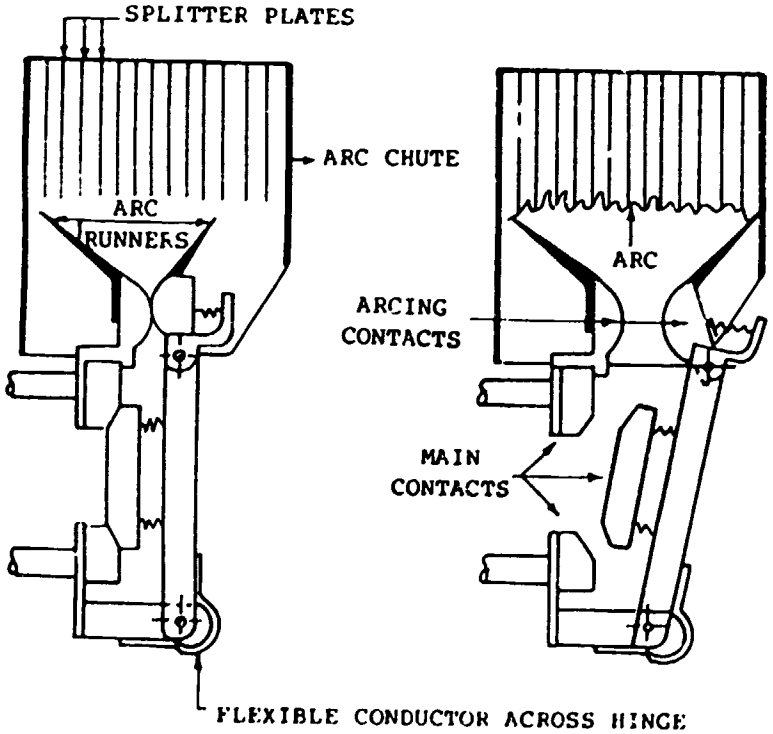
AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

AIR-BREAK CIRCUIT BREAKER



JOB NO. : DCIL-105

EXHIBIT : 6

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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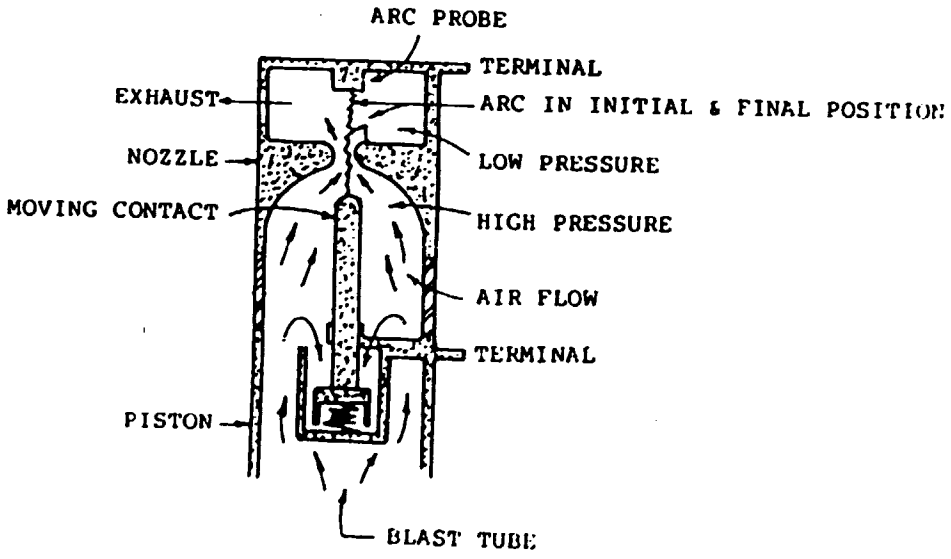
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

AIR-BLAST CIRCUIT BREAKER



JOB NO. : DCIL-105 EXHIBIT : 7

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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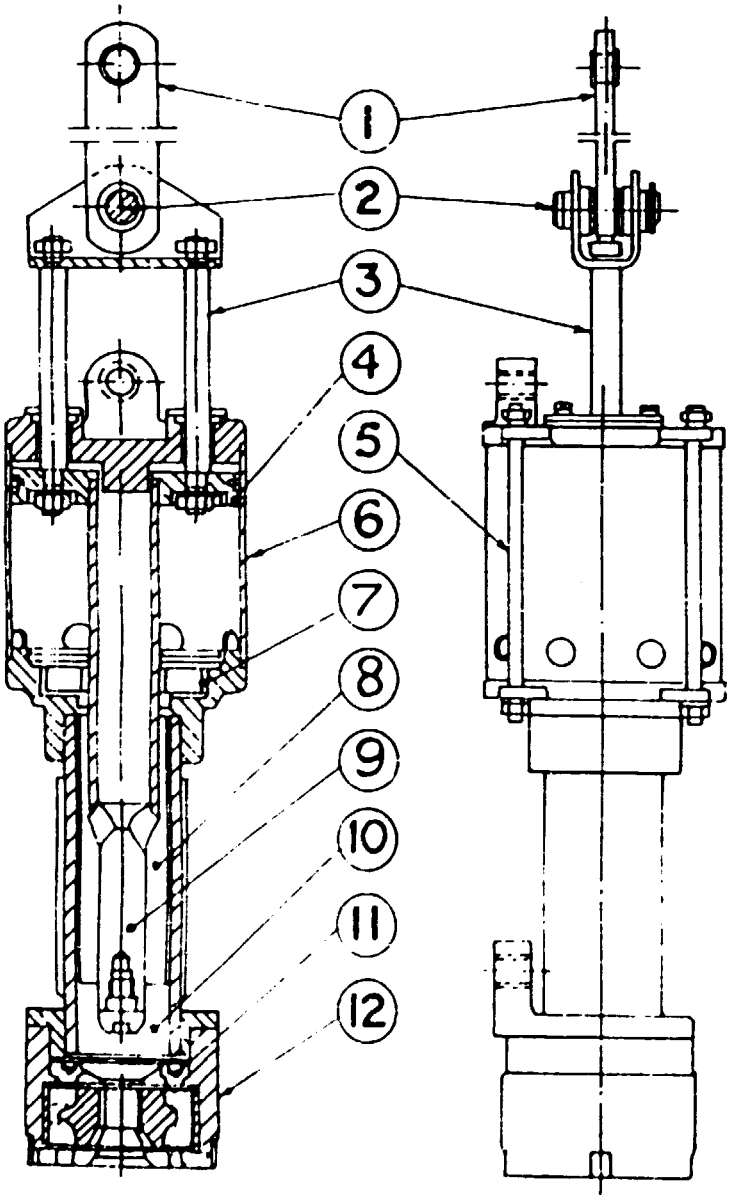
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

FIXED AND MOVING CONTACT AND ARC CONTROL CHAMBER IN AN SF_6 CIRCUIT BREAKER



LEGEND

1 INSULATED MOVING CONTACT ACTUATOR

2 STEEL CONNECTING PIN GUIDES

3 GUIDES

4 SF_6 COMPRESSION PISTON TO ASSIST RAPID ARC EXTINCTION

5 SF_6 COMPRESSION CYLINDER SUPPORTS

6 SF_6 COMPRESSION CYLINDER

7 MOVING CONTACT CURRENT-COLLECTOR RING

8 GLASS FIBRE REINFORCED EPOXY-RESIN ARCING CHAMBER

9 MOVING CONTACT ATTACHED TO 4

10 TUNGSTEN-TIPPED MOVING CONTACT

11 FIXED-CONTACT ARCING RING

12 FIXED-CONTACT HOLDER

JOB NO. : DCIL-105

EXHIBIT : 8

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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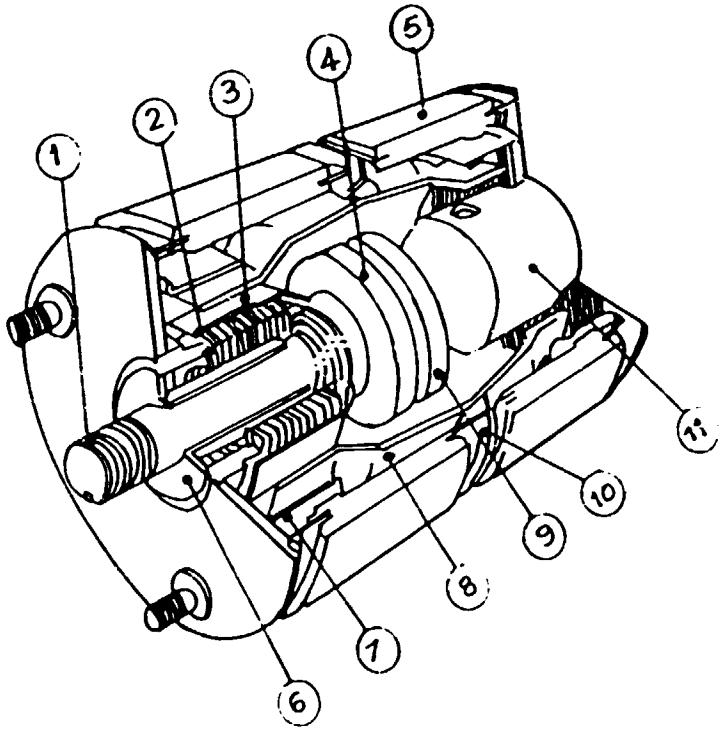
PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

CONSTRUCTION FEATURES OF AN 11-KV VACUUM INTERRUPTER



LEGEND

1 MOVING CONTACT STEM	6 MOVING CONTACT GUIDE
2 BELLOWS	7 GRADING SHIELD
3 SPUTTER SHIELD FOR BELLOWS	8 SPUTTER SHIELD
4 MOVING CONTACT	9 FIXED CONTACT
5 GLASS CERAMIC BODY	10 SPUTTER SHIELD MOUNTING

11 FIXED-CONTACT STEM

JOB NO. : DCIL-105

EXHIBIT : 9

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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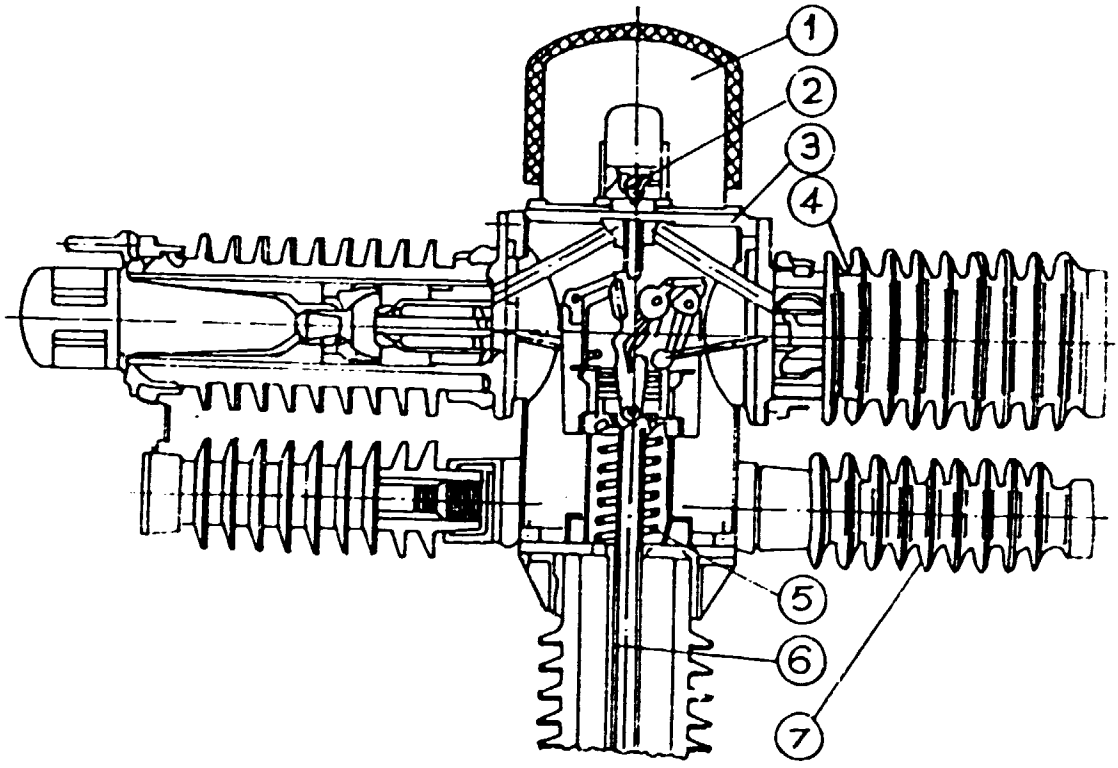
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

SECTIONAL VIEW OF A TYPICAL TWO-BREAK ASSEMBLY IN SF_6 CIRCUIT BREAKER



LEGEND

1. SF_6 HIGH PRESSURE INTERMEDIATE RECEIVER
2. BLAST VALVE
3. DISTRIBUTOR HEAD
4. INTERRUPTER UNIT
5. TRIPPING SPRING
6. INSULATING ROD
7. GRADING CAPACITOR

JOB NO. : DCIL-105

EXHIBIT : 10

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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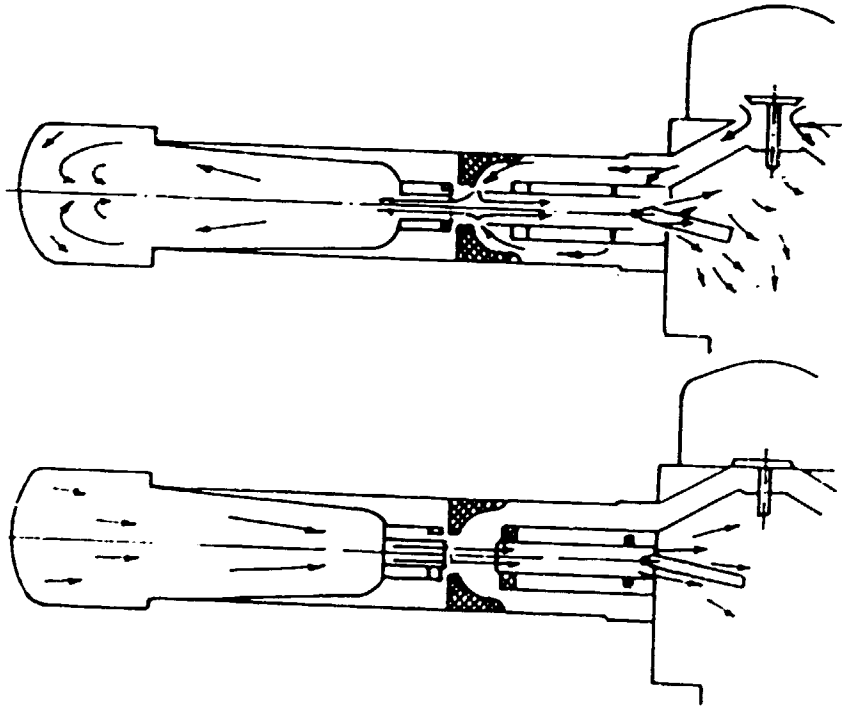
PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

GAS FLOW IN INTERRUPTER UNITS OF AN SF_6 CIRCUIT BREAKER



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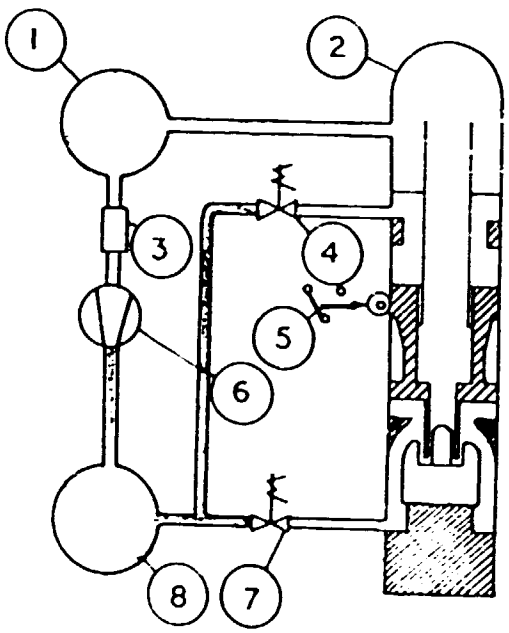
PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

CLOSED GAS SYSTEM FOR SF_6 CIRCUIT BREAKERS



L E G E N D

1. LOW PRESSURE TANK
2. INTERRUPTER HEAD
3. FILTER
4. CLOSING VALVE
5. AUXILIARY SWITCH
6. COMPRESSOR
7. TRIP VALVE
8. HIGH PRESSURE TANK

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JOB NO. : DCIL-105 EXHIBIT : 12

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

COMPARISON OF THE BASIC FEATURES OF THE INTERRUPTION TECHNOLOGIES USED IN 3-36 KV RANGE POWER SYSTEMS

Sl. No.	Basic Feature	Breaker Type			
		Oil	Air	SF_6	Vacuum
1.0	Reliability	G	G	VG	E
2.0	Safety :				
	- Toxic gas-free operation	F	F	VG	E
	- Explosion resistance	F	G	G	E
	- Tolerance to special atmosphere (tropical/ marine/desert/polluted industrial ambient)	F	F	G	E
	- Cleanliness	F	G	G	E
	- Freedom from fire hazard	F	G	VG	E
	- Noise of interruption	G	F	VG	E
3.0	Maintenance for Interrupter :				
	- Insulating Medium	*	@	#	$
	- Contact Wear	F	F	G	$
4.0	Characteristics :				
	- Energy requirement for Operating Mechanism	F	G	F	VG
	- Dynamic Loading	F	F	G	VG

JOB NO. : DCIL-105 EXHIBIT - 12

Sl. No.	Basic Feature	Breaker Type Oil	Air	SF_6	Vacuum
	- Contact Life (Switching Operations) :				
	o Interrupting fault current	F	G	VG	E
	o Rated Current	G	G	G	VG
	o Mechanical	G	G	G	VG
	- Available upto Interrupting Capacity of (Max.) - KA rms	40	40	63	100
	- Breaking time-cycles	3-8	5	3(2)	3(2)
	- Drain on Battery	G	VG	F	E
	- Overall dimensions	G	F	G	VG
	- Weight	G	F	G	VG
	- Performance	F	G	VG	E
5.0	Comparative Cost~				
	- Equipment Cost	VG	VG	F	G
	- Installation Cost	F	F	G	VG
	- Operating Cost	F	G	VG	E
	- Maintenance Cost	F	F	G	VG

Legend :

F = Fair/Exorbitant~; G = Good/Expensive~;
VG = Very Good/Moderate~; E = Excellent/Inexpensive~

JOB NO. : DCIL-105 EXHIBIT - 12

* : Oil has to be filtered and/or changed

@ : Arc chutes have to be replaced

: Consideration needs to be paid from the stand point of maintenance and inspection to decomposed gases after interruptions.

$: Inspection of contact wear and degree of vacuum - every 3 years/3000 operations.

JOB NO. : DCIL-105

EXHIBIT : 13

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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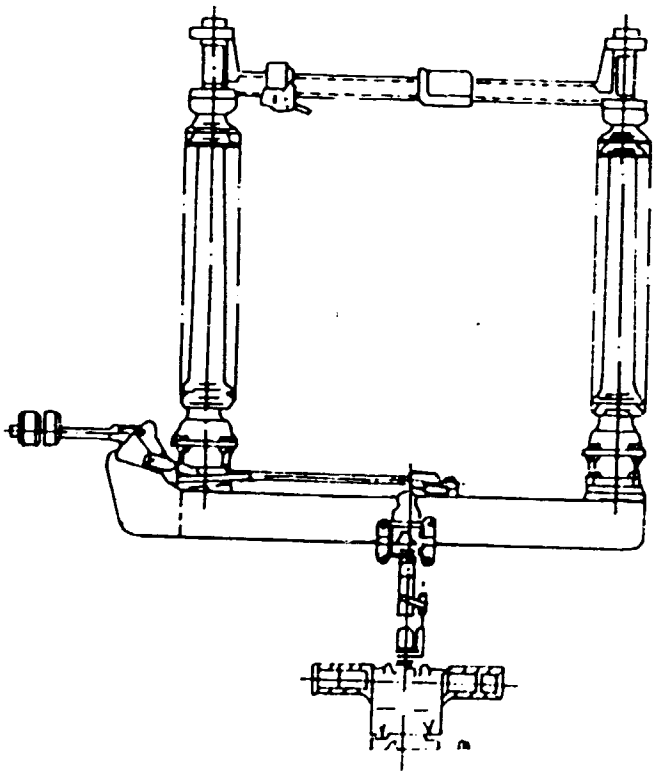
PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

END-ROTATING CENTRE-BREAK TYPE ISOLATOR



JOB NO. : DCIL-105

EXHIBIT : 14

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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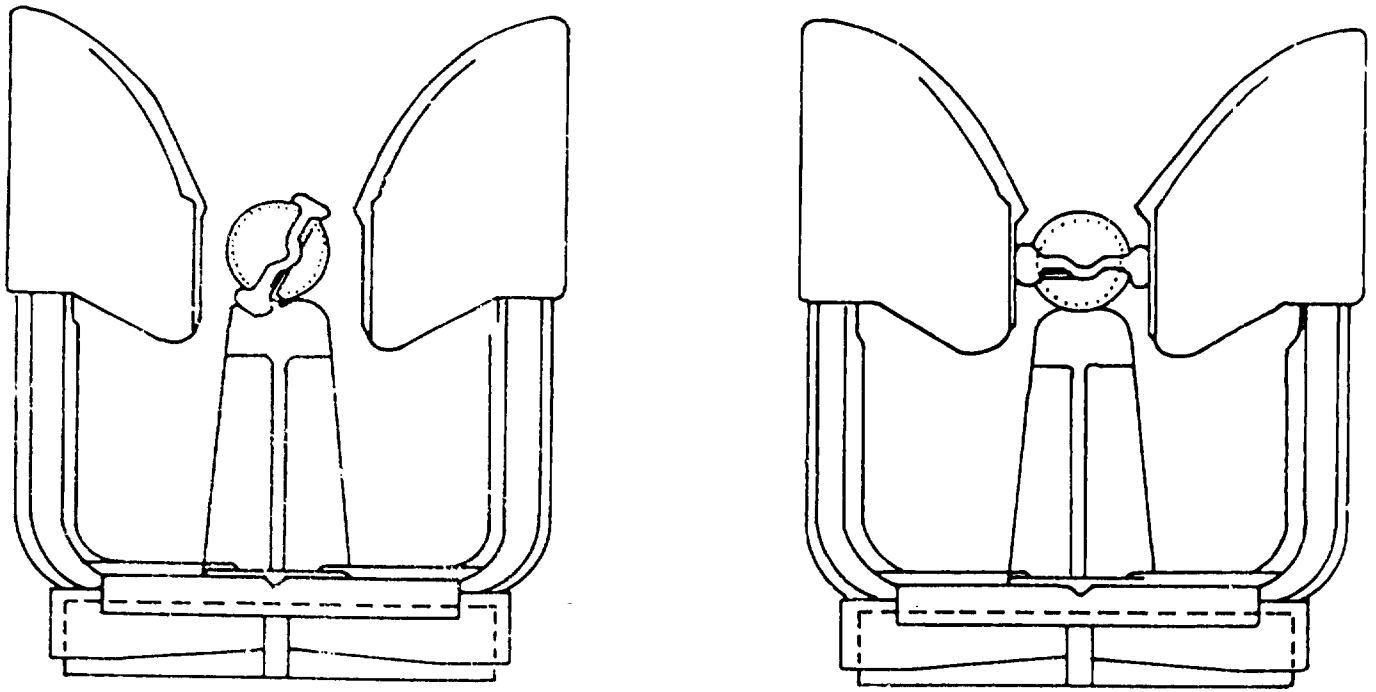
PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

HIGH PRESSURE CONTACT SYSTEM OF AN ISOLATOR



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JOB NO. : DCIL-105

EXHIBIT : 15

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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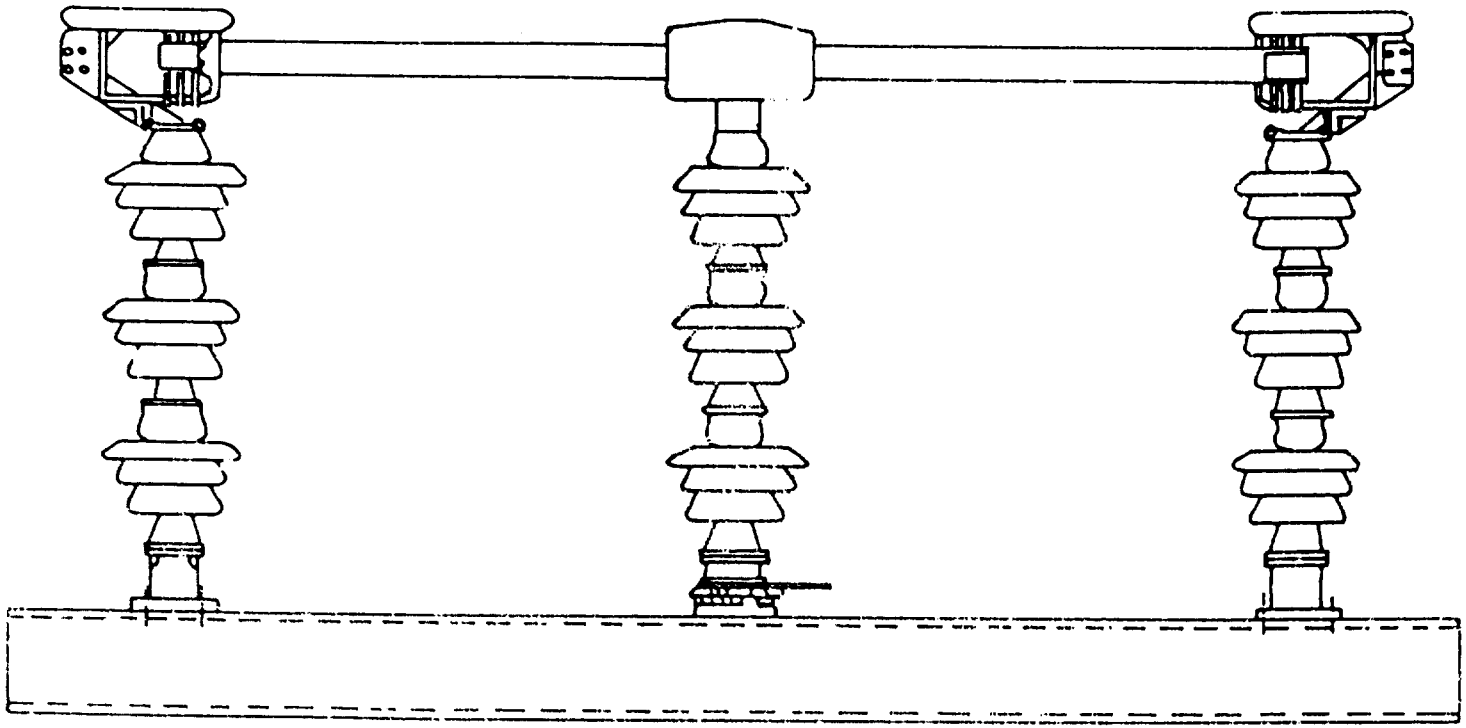
PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

CENTRE-ROTATING END-BREAK TYPE ISOLATOR



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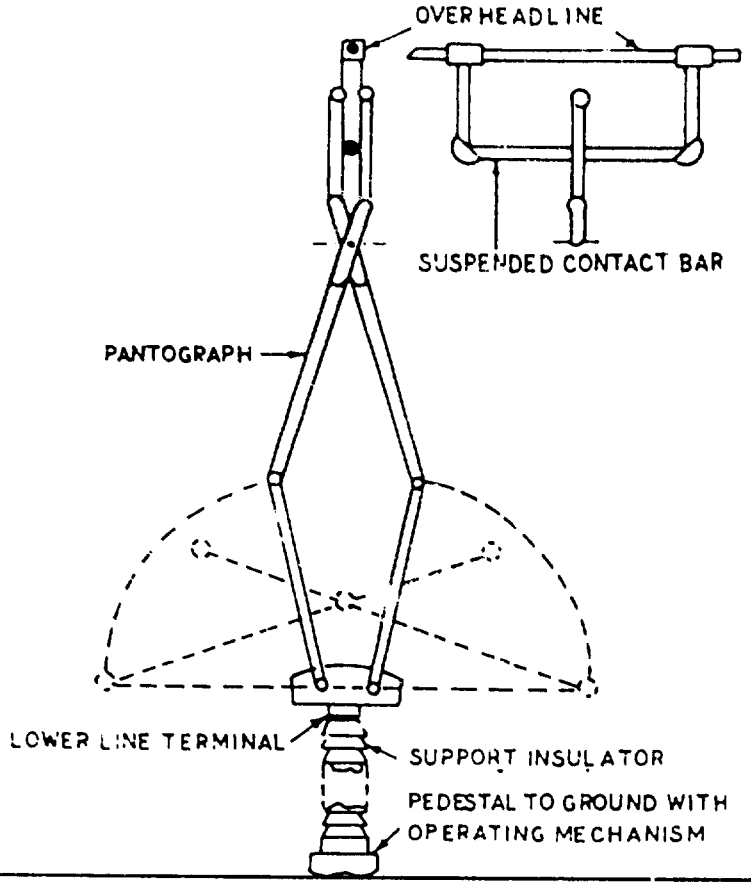
JOB NO. : DCIL-105

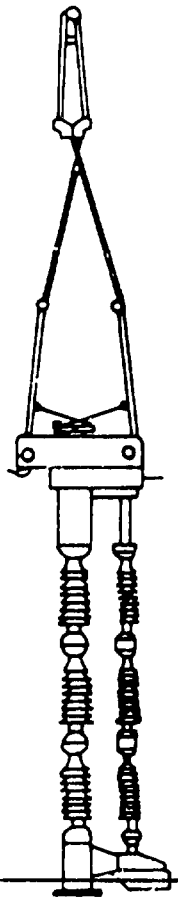
EXHIBIT : 16

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

FULL PANTOGRAPH ISOLATOR





DEVELOPMENT CONSULTANTS

SECTION - 4
MARKET ANALYSIS

MARKET ANALYSIS

Circuit breakers and isolators are important equipment used in power transmission and distribution, including sub-stations. Both these are used to protect electrical circuits. While circuit breakers are used to either make or break a contact, isolators are used to disconnect other equipment from the supply line. Any increase in transmission/distribution network or sub-station capacity will lead to increasing demand for circuit breakers and isolators.

According to a Sectoral Study carried out by AIDMO, the average annual increase in power generating capacity for the Arab region comprising 20 countries ranges from 7000 MW in the early 1990's to nearly 9900 MW by 2010 AD. The increase in the generating capacity in the designated region comprising 13 countries is likely to range from 6,700 MW in the early 1990s to nearly 9,390 MW by 2010 AD. Corresponding increase in the generation is estimated to be about 23,500 giga watt hour (GWH) per year during the period 1991-95 to about 28,560 GWH per year during 2006-2010.

Transmission and distribution of this additional generation will require additional circuit breakers and isolators in the transmission/distribution network, as well as at the generating stations. Estimated average annual additional requirement of circuit breakers and isolators for the period 1991-2010 are presented in Exhibits 17 and 18 respectively.

In these Exhibits, equipment in the voltage range 60 KV to 225 KV are grouped under HT, while those in the range 5.5 KV to 36 KV are grouped under MT. These requirements are based on the following norms :

	HT	MT
Circuit breaker (Nos/GWH)	0.082	0.37
Isolator (Nos/GWH)	0.23	1.66

The above norms relate only to the requirement in the transmission and distribution network. In order to estimate the requirement of these equipment at generating stations, the norms for HT and MT have been revised upwards by 10% and 20%, respectively.

Projected requirement shown in the Exhibits are based on additional generating capacities outlined in the AIDMO report. However, what was actually implemented during the period 1986-90 by many countries was only about 50-80% of the projections made by AIDMO. In view of the foregoing, it is assumed that, on a conservative basis, only about 70% of the additional generating capacity proposed in the AIDMO report may actually be implemented. Therefore, the demand for various electrical equipment is taken to be 70% of the projections made by AIDMO.

Exhibits 19 and 20 present demand estimates for circuit breakers and isolators respectively.

Both Circuit Breakers and Isolators are high technology products. At present, these are not manufactured in the Arab region, but are entirely imported. Manufacture/assembly of

these products requires considerable skill and hence it is recommended that only about 10% of the total demand for isolators in the period 1991-95 and 5% of the demand for circuit breakers during the same period be met through local production. Gradually, imports may be reduced on acquiring skill and experience in manufacturing.

It is suggested that two plants of identical size be set up to manufacture circuit breakers and isolators. Product mix for each of these plants is indicated in Exhibit-21.

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 17

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

ESTIMATED ANNUAL REQUIREMENT OF CIRCUIT BREAKERS

(Figures in nos.)

Country	1991-95		1996-2000		2001-2005		2006-2010	
	HT	MT	HT	MT	HT	MT	HT	MT
Algeria	222	1091	226	1110	226	1110	226	1110
Bahrain	44	214	70	344	70	344	70	344
Egypt	422	2082	532	2620	532	2620	532	2620
Iraq	462	2273	545	2682	545	2682	545	2682
Jordan	32	155	33	392	33	392	33	392
Kuwait	119	586	121	595	121	595	121	595
Libya	108	533	108	533	108	533	108	533
Morocco	67	329	92	452	92	452	92	452
S.Arabia	208	1024	253	1246	343	1690	200	983
Sudan	17	80	25	122	25	122	25	122
Syria	267	1316	388	1913	388	1913	388	1913
Tunisia	42	206	41	199	45	222	45	222
U.A.E.	119	586	175	860	175	860	175	860
Total	2129	10475	2609	13068	2703	13535	2560	12828

JOB NO. : DCIL-105 EXHIBIT : 18

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

ESTIMATED ANNUAL REQUIREMENT OF ISOLATORS

(Figures in nos.)

Country	1991-95		1996-2000		2001-2005		2006-2010	
	HT	MT	HT	MT	HT	MT	HT	MT
Algeria	622	4892	633	4980	633	4980	633	4980
Bahrain	122	960	196	1546	196	1546	196	1546
Egypt	1186	9338	1493	11753	1493	11753	1493	11753
Iraq	1296	10199	1528	12031	1528	12031	1528	12031
Jordan	88	694	94	739	94	739	94	739
Kuwait	334	2629	339	2669	339	2669	339	2669
Libya	304	2390	304	2390	304	2390	304	2390
Morocco	187	1474	259	2032	259	2032	259	2032
S.Arabia	583	4594	710	5587	963	7579	560	4410
Sudan	45	359	69	550	69	550	69	550
Syria	750	5909	1090	8581	1090	8581	1090	8581
Tunisia	118	924	113	893	127	996	127	996
U.A.E.	333	2628	491	3860	491	3860	491	3860
Total	5968	46690	7319	57611	7586	59706	7183	56537

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 19

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

ESTIMATED ANNUAL DEMAND FOR CIRCUIT BREAKERS

(Figures in nos.)

Country	1991-95		1996-2000		2001-2005		2006-2010	
	HT	MT	HT	MT	HT	MT	HT	MT
Algeria	155	764	158	777	158	777	158	777
Bahrain	31	150	49	241	49	241	49	241
Egypt	295	1457	372	1834	372	1834	372	1834
Iraq	323	1591	382	1877	382	1877	382	1877
Jordan	22	109	23	274	23	274	23	274
Kuwait	83	410	85	417	85	417	85	417
Libya	76	373	76	373	76	373	76	373
Morocco	47	230	64	316	64	316	64	316
S.Arabia	146	717	177	872	240	1183	140	688
Sudan	12	56	18	85	18	85	18	85
Syria	187	921	272	1339	272	1339	272	1339
Tunisia	29	144	29	139	32	155	32	155
U.A.E.	83	410	123	602	123	602	123	602
Total	1489	7332	1828	9146	1894	9473	1794	8978

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT - 20

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

ESTIMATED ANNUAL DEMAND FOR ISOLATORS

(Figures in nos.)

Country	1991-95		1996-2000		2001-2005		2006-2010	
	HT	MT	HT	MT	HT	MT	HT	MT
Algeria	435	3424	443	3486	443	3486	443	3486
Bahrain	85	672	137	1082	137	1082	137	1082
Egypt	830	6537	1045	8227	1045	8227	1045	8227
Iraq	907	7139	1070	8422	1070	8422	1070	8422
Jordan	62	486	66	517	66	517	66	517
Kuwait	234	1840	237	1868	237	1868	237	1868
Libya	213	1673	213	1673	213	1673	213	1673
Morocco	131	1032	181	1422	181	1422	181	1422
S.Arabia	408	3216	497	3911	674	5605	392	3087
Sudan	32	251	48	385	48	385	48	385
Syria	525	4136	763	6007	763	6007	763	6007
Tunisia	83	647	79	625	89	697	89	697
U.A.E.	233	1840	344	2702	344	2702	344	2702
Total	4178	32893	5123	40327	5310	41793	5028	39575

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT - 21

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

PRODUCT-MIX

(Figures in nos.)

Description	HT	MT
CIRCUIT BREAKERS	**210**	**670**
400 KV SF_6 type	70	-
220 KV SF_6 type	70	-
132 KV Minimum Oil type	70	-
33 KV Minimum Oil type	-	70
11 KV Minimum Oil type	-	300
11 KV Vacuum type	-	300
ISOLATORS	**200**	**1600**
400 KV Pantograph type	100	-
220 KV Centre rotating end break type	50	-
132 KV Centre rotating end break type	50	-
33 KV Centre rotating end break type	-	800
11 KV Centre rotating end break type	-	800

SECTION - 5
PLANT LOCATION

PLANT LOCATION

The two plants recommended for manufacturing Circuit Breakers and Isolators will cater to only a small part of the demand for these products in the Arabian region. Production capacities of these plants have been kept identical to facilitate interchangeability of men, machines, materials, products, etc. It will also be easier to implement the projects simultaneously as they are identical in nature.

The selection of location for establishing the manufacturing plants was made, based on the following considerations :

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

Taking into account the above factors, it is recommended that the plants be located in Morocco and the U.A.E. Each of these plants will have a capacity to manufacture 200 HT and 670 MT circuit breakers, and 200 HT and 1600 MT isolators. While the plant in Morocco will cater to the requirement of Arab countries in North Africa, the middle east demand will be met through the plant in the UAE.

SECTION - 6
MANUFACTURING PROCESS

MANUFACTURING PROCESS

CIRCUIT BREAKERS

Circuit breakers of the types discussed in Section-3 are manufactured mostly from pre-engineered components. These components are to be procured from external sources either in completely finished form or in the semifinished form.

The completely finished components are large in number. These can be divided into the following three main groups :

- Non metallic components like insulators, bushings, operating rods; generally made from porcelain, plastics, glass reinforced epoxy, etc.
- Standard metallic components like ball and roller bearings, split bushes, compressor plants, valves for gases and hydraulic lines, springs and other hardware
- Electromagnetic components like relays, switches, transformers, etc.

Semifinished components include castings, forgings and sintered items. Interrupter housing, moving and stationary components, etc., are generally procured in the semifinished form. The shop-made items consist of panels, fabricated housings and linkages.

The production processes which require to be carried out in the plant are :

- Metal forming and metal joining process

- o Machining and surface finishing process
- o Application of protective coating
- o Assembly of the components and
- o Testing of circuit breaker

Metal Forming and Joining

The metal forming processes generally consist of cutting to size, bending, pressing, and drawing to shape. The components thus formed are generally joined together by various arc welding processes. Sometimes brazing is also done.

Machining

The machining processes include turning, milling, shaping, boring, drilling, screw cutting etc. The surface finishing processes include grinding, lapping, honing etc. Most of the components procured in the semifinished form are required to undergo necessary machining operations to impart them the desired surface finish and dimensional accuracy. The components for various operating linkages are also machined to finished size and shape in the plant.

Coating

Most of the circuit breaker components need surface coating, which include deposition of metals by electroplating, hot dip galvanizing, metal spraying and painting. Before applying protective coatings, cleanliness of the surface to be coated is of prime importance. Removal of organic substances such as oil and grease is carried out by immersing the components in trichloro ethylene or a similar degreasing agent. The removal of inorganic materials such as

scale, corrosion products and mineral matter is done by shot blasting or by immersing them in a solution of hydrochloric acid or sulphuric acid, followed by rinsing and drying. It is important that the clean metal surfaces should be covered with the protective coating as soon as possible and not later than a period of four hours, to prevent further contamination of the surface.

Cadmium and zinc are commonly used for plating iron and steel components. Tin is also used for the protection of steel components. Hot dip galvanizing is done for cubicles and heavy components. Tin, silver and chrome plating are used for current carrying parts. Silver coating has the advantage that silver oxides form on exposed surfaces, and these act as good conductors. Also included among protective coatings are phosphatic treatment i.e. immersion in manganese - or zinc-phosphates. This form of treatment is normally applied on aluminium components.

Assembly

Some of the important factors which need to be considered during the assembly of a circuit breaker are stated below :

- To ensure that there is a smooth surface between the moving contact and the stationary fingers on engagement, it should be ensured that the radius on the outside tip of the moving contact is smooth.
- A non-uniform clearance betwen the moving contact and the stationary fingers indicates a need for realignment. This can be checked by inserting a contact feeler gauge under the stationary contact

fingers and over the moving contact, keeping the larger end of the gauge in contact with the moving contact.

- The clearance of the arcing horn to the moving contact should be checked for proper alignment.
- The 'kick off' spring behind the blast piston assembly should operate only over a part of the stroke. Depending on the design, it should be free, with no initial compression in one position of the piston.
- A thin film of lubricant should be applied on the slots in the moving contact guide. Lubricants should also be applied on all bearings in the mechanisms, as well as on all joints in the linkages.
- To prevent corrosion, all machined surfaces on the flanges must be coated with grease or anti-rust oil.
- It should be ensured that travel of contacts is proper.
- There should be no sudden increase in the effort require to close the interruptor slowly by hand. In case such an increase occurs, the closing operation should be stopped and the cause determined. All fingers should engage the moving contact simultaneously.
- The grading capacitors and closing resistors should be fitted only after the interruptor has been assembled.

- It should be ensured that wires used in control wiring do not cause excessive drop in voltage as this will slow down the tripping time of the breaker.
- It should be ensured that all control wiring connections are tight.
- The air compressor may be started sometime before the complete breaker is assembled, to allow it to build up pressure to the desired value. It also provides an opportunity to rectify any defects in the compressed air system.
- Pressure switches should be adjusted to the desired operating pressure.
- The operation of auxiliary switches in both the open and closes position of the breaker should be checked to ensure that contacts have a positive 'make' and 'break' in both these positions.
- The contacts of control relays should be inspected. The operation of relays should also be checked to make sure they are picked up positively.

The pneumatic operating mechanism will require assembly of air compressors, air receivers and the necessary attachments and accessories for controlling the air supply. A control pannel will be required to provide the necessary relay interlocks for remote electrical control.

Other accessories to be assembled for the proper functioning of the pneumatic system include a trip magnet assembly, control valve, auxiliary switches, a latch check switch,

and fused knife switches, for establishing protection of electrical circuits and terminal blocks.

Precautions should be taken during storage of the circuit breaker parts to see that there is no condensation on them. These should be stored in a dry place and heaters should be used, if needed.

Testing

The circuit breaker shall be tested in accordance with the International Electrotechnical Commission standards (IEC-56). Both type tests and routine tests shall be carried out.

Type Tests are those which are only carried out on one unit or a few units of the same type to verify the design characteristics.

Routine Tests are those which are carried out on each unit to check certain essential requirements.

Type Tests

The IEC type tests are designed to prove the characteristics of circuit breakers, their operating devices and auxiliary equipment. These tests specially assess the following -

- Mechanical performance
- Mechanical operation
- Temperature rise of any part within specified limits
- Compliance of insulation with specified standards
- Short circuit making and breaking performance
- Short time current performance

- Performance when breaking line charging currents
- Performance when breaking single capacitor bank currents
- Performance when breaking small inductive currents

Individual type tests should be made on the ciruit breaker in a new and clean condition.

Routine Tests

Routine tests of the IEC are required to made for the purpose of detecting faults in material or construction. These are acceptance tests and should be carried out on a number of samples.

Specifically these consist of :

- Power frequency voltage dry tests on the main circuit
- Voltage tests on control and auxiliary circuits
- Measurement of the resistances of the main circuit
- Mechanical operating tests

The circuit breaker should be examined after the tests to determine whether any part has sustained damage during the tests, and whether all parts are in satisfactory operating condition.

Facilities may be provided at the plant for routine tests only, as these tests need to be carried out on all circuit breakers produced.

ISOLATORS

The construction of an isolator is much simpler than that of a circuit breaker. It's components are easier to manufacture and do not require any new process other than process involved in the manufacture of a circuit breaker. However, their testing norms are different from that of circuit breakers.

Isolators must be subjected to Type Tests and Routine Tests in accordance with the relevant national/international standards.

Type Tests

These comprise the following tests :

- Impulse voltage dry tests
- Power-frequency voltage dry test on main circuit
- Power-frequency voltage wet tests on main circuit
- Power-frequency voltage tests on auxiliary equipment
- Temperature rise tests of the main circuit
- Temperature rise tests of the auxiliary equipment
- Measurement of the resistance of the main circuits
- Tests to prove the capability of carrying the rated peak short circuit current and the rated short time current
- Tests to prove making capacity of earthing switches
- Operation tests and
- Mechanical endurance tests

Routine Tests

These comprise the following tests :

- Power Frequency Voltage Dry Tests : Isolators and earthing switches shall be subjected to one minute power-frequency voltage dry tests, in accordance with the relevant national/international standards. If flashover or puncture occurs, the isolator or earthing switch shall be considered to have failed the test.

- Power Frequency Voltage Tests on auxiliary circuits: Auxiliary equipment of isolators and earthing switches, including their operating devices, shall be subjected to one - minute power frequency voltage tests as follows :

  - between all live parts of the auxiliary equipment connected together and the frame; and

  - if practicable, between each part of the auxiliary circuit, which in normal use may be insulated from the other parts, and the other parts connected together and to the frame.

  For auxiliary circuits, the r.m.s. value of the test voltage shall be equal to twice the highest rated auxiliary supply voltage plus 1000 V, with a minimum of 1,500 V.

  If puncture or flashover occurs, the isolator or earthing switch shall be considered to have failed the test.

- Measurement of the resistance of the main circuit : The resistance of each main circuit of each isolator shall be measured under conditions similar to those under which the corresponding type test was made.

- Tests to prove satisfactory operation : These tests are made to ensure that the isolators or earthing switches comply with the prescribed operating conditions within the specified voltage and supply pressure limits of their operating devices.

The most commonly used isolators in high voltage and extra high voltage system are of the pantograph type and the centre-rotating, end-break type. Contact assembly of a pantograph isolator and a centre-rotating, end-break type isolator are shown in Exhibits 22 and 23 respectively. The actuating mechanism for a pantograph isolator is shown in Exhibit-24. Schematic eletrical layout of a typical short cirtuit testing station is presented in Exhibit-25.

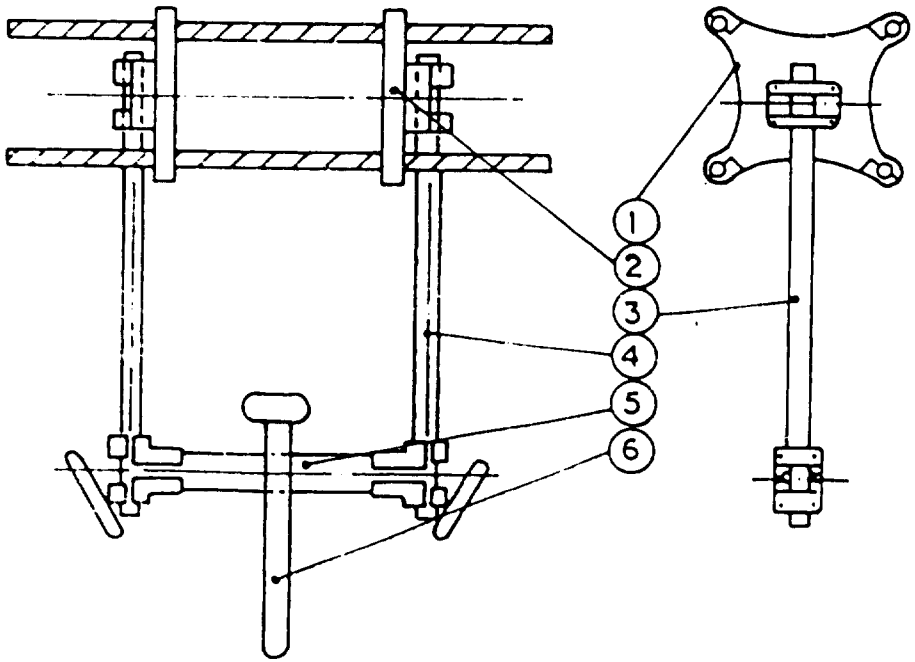
JOB NO. : DCIL-105

EXHIBIT : 22

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

CONTACT ASSEMBLY OF A PANTOGRAPH TYPE ISOLATOR



LEGEND

1. SPACER
2. SPACER
3. DROPPER
4. DROPPER
5. FIXED CONTACT
6. MOVING CONTACT

DEVELOPMENT CONSULTANTS

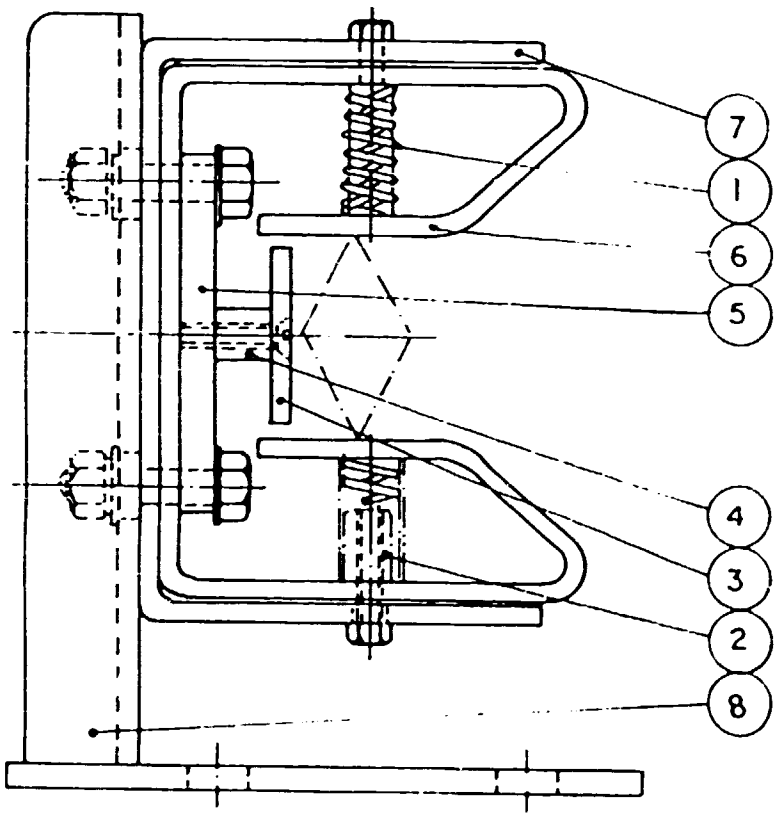
JOB NO. : DCIL-105

EXHIBIT : 23

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

CONTACT ASSEMBLY OF A CENTRE-ROTATING
END-BREAK TYPE ISOLATOR



LEGEND

1. SPRING
2. SPRING BOSS
3. STOPPER PLATE
4. STOPPER BOSS
5. TERMINAL PAD
6. CONTACT
7. CONTACT COVER
8. CONTACT ASSEMBLY HOLDER

JOB NO. : DCIL-105

EXHIBIT : 24

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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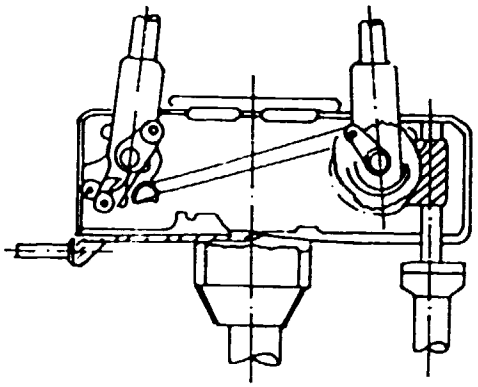
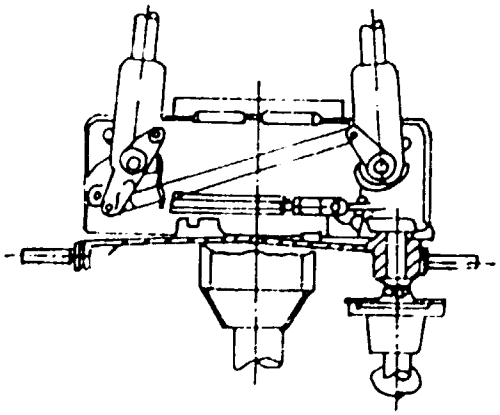
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

ACTUATING MECHANISM IN A PANTOGRAPH ISOLATOR



WARM GEAR ACTUATING MECHANISM



ROTARY ACTUATING MECHANISM

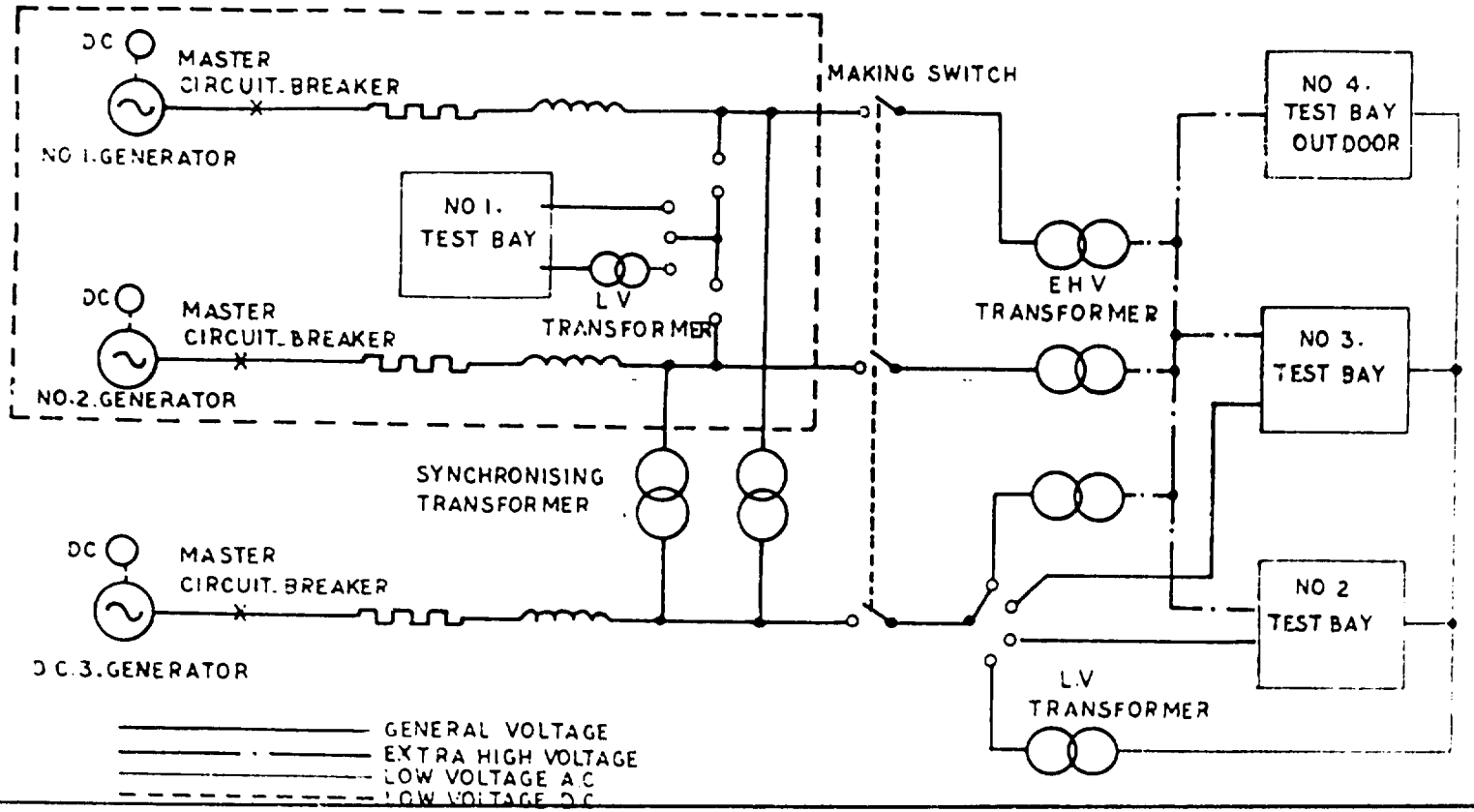
JOB NO. : DCIL-105

EXHIBIT : 25

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

ELECTRICAL LAYOUT OF A TYPICAL SHORT-CIRCUIT TESTING STATION



DEVELOPMENT CONSULTANTS

SECTION - 7
PLANT AND EQUIPMENT

PLANT AND EQUIPMENT

The plant has been designed to manufacture both circuit breakers and isolators. Two identical plants having the same product-mix and capacity have been suggested. Therefore, the requirement of plant and equipment and other facilities will be identical in both the manufacturing plants. Major plant and machinery and other facilities in one manufacturing plant are outlined here.

Both the plants are designed to operate in two shifts a day, each shift lasting for 8 hours. The plants will have a capacity to manufacture 880 circuit breakers and 1800 isolators per year.

Main Plant

The major manufacturing operations in the plant will include machining of barstock, forgings and castings, and fabrication of items such as tanks, linkages and supporting structures. The machines are mostly of general purpose type, and hence can be used for different designs and sizes of components as is required for the suggested product-mix

The calculations, based on which the requirement of machines for circuit breaker and isolator manufacture were arrived at, are shown in Exhibits 26 through 29.

The plant will have galvanising facilities for galvanising small fabricated components. It will also have silver plating facilities for the plating of contacts and other current carrying components.

Items like motors and actuators, and electromechanical components like relays, solenoid valves, etc., will be

procured as bought-out items; they will not be manufactured in the plant. However, the plant will have facilities to assemble the control mechanism and the circuit breaker isolator.

The plant will also have facilities to conduct routine tests on circuit breakers/isolators.

Tool Room and Maintenance

The plant has been provided with equipment and facilities for maintenance and repair of plant and equipment. Major spares will have to be procured from the original equipment suppliers.

Material Handling

Material handling is an important function in the plant. Raw materials, semifinished components, sub-assemblies, bought-out components, and final assembly will have to be handled in the plant. Although the unit weight of many components or sub-assemblies may not be more than a few hundred kilograms, the finally assembled products may weigh upto 8-9 tonnes.

Material handling facilities considered in the plant include EOT cranes, forklift trucks, hand push trolleys and two-wheel barrows. A mobile crane is also provided to handle any large piece of item in the stock yard, or for loading and unloading.

Handtools and Auxiliary Equipment

The plant will have necessary hand tools, testing and measuring instruments, and auxiliary equipment, including storage racks, shelfs, lockers, work tables, ladders, etc.

Exhibit-30 lists down the major plant and equipment.

JOB NO. : DCIL-105 EXHIBIT : 26

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

CALCULATIONS FOR MACHINES IN MACHINE SHOP : CIRCUIT BREAKERS

Machined items per year : 501.75 tonnes
Production Man-hours/tonne : 700
Total production man-hours : 351225

Distribution of Production Man-hours

	Preparation, Cutting (10%)		Turning & other Lathe Work (30%)		Gear Cutting, Milling, Shaping, Slotting (30%)		Grinding (10%)		Drilling (20%)	
	Manual 50%	Machine 50%	Manual 15%	Machine 85%	Manual 15%	Machine 85%	Manual 15%	Machine 85%	Manual 15%	Machine 85%
Production hours	17561.25	17561.25	15805	89562	15805	89562	5268	29854	10536	59708
Number of shifts	2	2	2	2	2	2	2	2	2	2
Available hours/ year	4800	4800	4800	4800	4800	4800	4800	4800	4800	4800
No. of machines required	-	4	-	18	-	18	-	6	-	12

JOB NO. : DCIL-105 EXHIBIT : 27

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

CALCULATIONS FOR MACHINES IN FABRICATION SHOP : CIRCUIT BREAKERS

Fabricated items : 188.20 tonnes
Production man-hours/tonne : 300
Total production man-hours : 56460

Distribution of Production Man-hours

	Preparation, Cutting, Shearing 15%	Marking Lay-out 5%	Forming 10%	Fabrication (Filling & Dressing) 30%	Welding 35%	Drilling 5%
Men per machine	2	-	2	-	1	1
Production machine hours	4234.5	-	2823	-	19761	2823
Available hours/ year	4800	-	4800	-	4800	4800
No. of machines required	1	-	1	-	4	1

JOB NO. : DCIL-105

EXHIBIT : 28

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

CALCULATIONS FOR MACHINES IN MACHINE SHOP : ISOLATORS

Machined items per year : 325.5 tonnes
Production Man-hours/tonne : 700
Total production man-hours : 227850

Distribution of Production Man-hours

	Preparation, Cutting 5%		Turning & other Lathe Work 50%		Gear Cutting, Milling, Shaping, Slotting 25%		Drilling 20%	
	Manual 50%	Machine 50%	Manual 25%	Machine 75%	Manual 25%	Machine 75%	Manual 25%	Machine 75%
Production hours	5696	5696	28480	85444	14241	42722	11393	34178
Number of shifts	2	2	2	2	2	2	2	2
Available hours/ year	4800	4800	4800	4800	4800	4800	4800	4800
No. of machines required	-	2	-	18	-	9	-	7

JOB NO. : DCIL-105

EXHIBIT : 29

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

CALCULATIONS FOR MACHINES IN FABRICATION SHOP : ISOLATORS

Fabricated items : 280 tonnes
Production man-hours/tonne : 300
Total production man-hours : 84000

Distribution of Production Man-hours

	Preparation, Cutting, Shearing 15%	Marking Lay-out 5%	Forming 10%	Fabrication (Filling & Dressing) 30%	Welding 35%	Drilling 5%
Men per machine	2	-	2	-	1	1
Production machine hours	6300	-	4200	-	29400	4200
Available hours/ year	4800	-	4800	-	4800	4800
No. of machines required	2	-	1	-	6	1

JOB NO. : DCIL-105 EXHIBIT : 30

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

LIST OF PLANT AND EQUIPMENT

Description	Brief Specification	Nos	Power (KW)	Unit Price ($)	Total Price ($)
A. MACHINE SHOP - CIRCUIT BREAKERS					
1. Power Hacksaw	Capacity: 300 mm Ø	2	1.5	2,200	4,400
2. Power Hacksaw	Capacity: 150 mm Ø	1	1.5	1,600	1,600
3. Circular Coldsaw	Capacity: 250 mm Ø	1	10.5	48,600	48,600
4. Centre Lathe	Swing over bed: 300 mm Centre Distance: 1000 mm	9	72.0	33,000	2,97,000
5. Centre Lathe	Swing over bed: 450 mm Centre Distance: 1500 mm	3	27.0	45,000	1,35,000
6. Centre Lathe	Swing over bed: 500 mm Centre Distance: 1500 mm	2	24.0	60,000	1,20,000
7. Automatic Turret Lathe	Swing: 640 mm Dia of barstock: 65 mm	2	20.0	70,000	1,40,000
8. Pipe & Bolt Threading M/c	Capacity: 3 mm thru' 50 mm	2	3.0	8,000	16,000
9. Universal Milling M/c	Table Size: 1070x230 mm	5	11.0	19,000	95,000

JOB NO. : DCIL-105 EXHIBIT : 30

	Description	Brief Specification	Nos	Power (KW)	Unit Price ($)	Total Price ($)
10.	Vertical Milling M/c	Table Size: 1070x230 mm	2	4.4	12,000	24,000
11.	Vertical Milling M/c	Table Size: 1350x310 mm	2	12.0	14,000	28,000
12.	Universal Milling M/c	Table Size: 1350x310 mm	1	6.0	22,000	22,000
13.	Shaping M/c	Max. Stroke Length: 630 mm Table Cross Travel: 650 mm	1	3.0	43,000	43,000
14.	Slotting M/c	Length of Stroke: 300 mm	1	4.0	8,000	8,000
15.	Horizontal Boring, Milling & Facing M/c	Type: Table Spindle Size: 50 mm Ø	1	6.0	6,000	6,000
16.	Gear Hobber	Max. dia: 400 mm Max. module: 8 mm	5	18.0	80,000	4,00,000
17.	Cylindrical Grinding M/c	Height of Centre: 180 mm Max. grinding length: 1000 mm	1	11.0	1,80,000	1,80,000
18.	Hydraulic Surface Grinding M/c	Type: Horizontal Spindle Table Size: 1000x250 mm	1	4.2	35,000	35,000
19.	Double ended bench grinder	Wheel Size: 200x25x25 mm	3	3.0	1,400	4,200
20.	Radial Drilling M/c	Drilling Capacity in Steel: 50 mm	2	9.0	20,000	40,000
21.	Column Drilling M/c	Drilling Capacity in Steel: 45 mm	4	16.0	5,000	20,000

JOB NO. : DCIL-105 EXHIBIT : 30

	Description	Brief Specification	Nos	Power (KW)	Unit Price ($)	Total Price ($)
22.	Pillar Drilling M/c	Drilling Capacity in Steel: 20 mm	4	10.0	1,400	5,600
23.	Bench Drilling M/c	Drilling Capacity in Steel: 15 mm	2	3.0	1,600	3,200
	TOTAL					**16,76,600**
B.	**FABRICATION SHOP - CIRCUIT BREAKERS**					
24.	Guillotine shear	Max. Plate Thickness: 6 mm Max. Plate Width: 2440 mm	1	16.0	50,000	50,000
25.	Pipe Bending M/c	Bending Capacity: 1/2" - 4"	1	1.0	5,000	5,000
26.	Bending Roll	Plate Thickness: 6 mm Width of Plate: 1800 mm	1	3.5	5,000	5,000
27.	Universal Edging, Bending, Folding M/c	Capacity in MS: 3 mm Max. Bending Width: 1800 mm	1	-	4,000	4,000
28.	Transformer Arc Welding Set	Max. Current: 300 amps	3	30.0	800	2,400
29.	Rectifier DC Welding Set	Current Range: 40-200 amps	2	50.0	2,000	4,000
30.	Spot Welding M/c	Max. Thickness in MS: 4 mm	1	20.0	2,500	2,500
31.	Oxy-acetylene Gas Welding Set	Welding Thickness: 0-30 mm	2	-	2,000	4,000
32.	Oxy-acetylene Gas Cutting Set	Cutting Thickness: 0-30 mm	2	-	1,000	2,000

JOB NO. : DCIL-105 EXHIBIT : 30

	Description	Brief Specification	Nos	Power (KW)	Unit Price ($)	Total Price ($)
3.	Centre Lathe	Swing over bed: 300 mm Centre Distance: 1000 mm	9	72.0	33,000	2,97,000
4.	Centre Lathe	Swing over bed: 500 mm Centre Distance: 1500 mm	2	24.0	60,000	1,20,000
5.	Automatic Turret Lathe	Swing: 640 mm Dia of barstock: 65 mm	2	10.0	55,000	1,10,000
6.	Pipe & Bolt Threading M/c	Capacity: 3 mm thru 50 mm	2	3.0	8,000	16,000
7.	Radial Drilling M/c	Drilling Capacity: 50 mm Ø Drilling Radius: 1500 mm	1	4.5	20,000	20,000
8.	Column Drilling M/c	Drilling Capacity: 45 mm	2	8.0	5,000	10,000
9.	Pillar Drilling M/c	Drilling Capacity: 20 mm	2	5.0	1,400	2,800
10.	Bench Drilling M/c	Drilling Capacity: 15 mm	2	3.0	1,600	3,200
11.	Ram type Universal Milling M/c	Table Surface: 1040x230 mm	2	5.0	23,000	46,000
12.	Universal Milling M/c	Table Size: 1070x230 mm	1	2.5	22,000	22,000
13.	Gear Hobber	Max. Dia of Gear: 625 mm Max. Module: 9 mm	2	6.0	85,000	1,70,000
14.	Shaping M/c	Max Stroke Length: 630 mm	2	6.0	43,000	86,000

JOB NO. : DCIL-105 EXHIBIT : 30

	Description	Brief Specification	Nos	Power (KW)	Unit Price ($)	Total Price ($)
15.	Bench Grinder	Wheel Size: 200x25x25 mm	2	2.0	1,400	2,800
	TOTAL					9,13,400
E.	FABRICATION SHOP - ISOLATORS					
16.	Metal Cutting Band Saw	Size of Tilting Table: 450x450 mm Dia of Wheels: 450 mm	1	1.5	3,000	3,000
17.	Universal Edging, Bending, Folding M/c	Capacity in MS: 3 mm Max. Bending Width: 1800 mm	1	-	4,000	4,000
18.	Arc Welding Set	Max. Current Capacity: 300 A	3	36.0	650	1,950
19.	Arc Welding Set	Max. Current Capacity: 200 A	3	24.0	600	1,800
20.	Forging Hammer	Pressure: 360 Kg	1	5.0	10,000	10,000
21.	Forging Hearth	Type: Blower Type Size: 800x1200 mm	1	1.0	5,000	5,000
22.	Pipe Bending M/c	Bending Capacity: 10 mm - 100 mm	1	1.0	5,000	5,000
23.	Pedestal Grinding M/c	Type: Double Wheel Wheel Size: 400x50x40 mm	2	5.0	1,300	2,600
	TOTAL					33,350
F.	ASSEMBLY SHOP - ISOLATORS					
24.	Hydraulic Press	Capacity: 10 tons	1	1.5	5,000	5,000
25.	Arbour Press	Pressure: 4 tons	1	1.0	2,000	2,000

JOB NO. : DCIL-105

EXHIBIT : 30

	Description	Brief Specification	Nos	Power (KW)	Unit Price ($)	Total Price ($)
26.	Oil Heating Tank	Chamber Size: 600x640x480 mm Max. Temp.: 300°C	1	20.0	10,000	10,000
	TOTAL					17,000
G.	**GALVANISING & ELECTROPLATING**					
27.	Galvanising Plant	-	1	-	12,000	12,000
28.	Silver Plating Unit	-	2	8.0	7,000	14,000
29.	Electric Polisher	Polishing Pad: 200 mm Ø	2	1.0	500	1,000
	TOTAL					27,000
H.	**TESTING EQUIPMENT**					
1.	Single phase testing transformer	230 V/800 KV with controllable output, 1 miliammeter, 1 ammeter, 1 calibrated voltmeter, and other accessories				5,000
2.	Single phase transformer	230 V/3 KV with controlling device, 1 miliammeter, 1 ammeter, 1 calibrated voltmeter				2,500
3.	Test Battery	Battery with current output of 100 Amps or more shunt reactor, motors, balancers, etc.				500
4.	Other testing eqpt	Equipment and accessories such as benches, fixtures, meggar, etc.				1,000

JOB NO. : DCIL-105

EXHIBIT : 30

	Description	Brief Specification	Nos	Power (KW)	Unit Price ($)	Total Price ($)
I.	TOOL ROOM					
1.	Centre Lathe	Centre Height: 170 mm Centre Distance: 1000 mm	1	7.5	17,900	17,900
2.	Universal Milling M/c	Table Size: 1350x310 mm	1	5.5	21,000	21,000
3.	Boring Machine	Type: Precision, Vertical Table Size: 400x300 mm	1	11.0	9,000	9,000
4.	Column Drilling M/c	Capacity: 45 mm	1	4.0	5,000	5,000
5.	Universal Tool & Cutter Grinder	Max. Swing Dia: 280 mm Centre Length: 760 mm	1	1.0	2,000	2,000
6.	Carbide Tipped Tool Grinding & Lapping M/c	Wheel Size: 175x20x35 mm	1	0.5	1,800	1,800
7.	Bench Grinder	Wheel Size: 250x25x25 mm	2	2.0	1,400	2,800
8.	Drill Point Grinder	Size of Drill: 6-50 mm	1	2.0	1,100	1,100
9.	Heat Treatment Furnace with Quenching Tank	Type: Electrically Heated batch type, bogie hearth Chamber Size: 300x300x150 mm Temperature Range: 700-1250°C	1	7.0	48,000	48,000
10.	Arbour Press	Pressure: 20 tons	1	-	10,000	10,000
	TOTAL					1,18,600

JOB NO. : DCIL-105 EXHIBIT : 30

Description	Brief Specification	Nos	Power (KW)	Unit Price ($)	Total Price ($)
J. MATERIAL HANDLING					
1. E.O.T. Crane	Duty: Class III SWL: 10 T Span: 12 M	1	30.0	56,680	56,680
2. E.O.T. Crane	Duty: Class III SWL: 5 T Span: 12 M	3	45.0	37,800	1,13,400
3. Forklift Truck with Crane lifting attachment	Type: Counter balanced, battery - operated, Rubber tyred, 4-wheeled Capacity: 2 ton Lifting Height: 3 M	1	-	25,000	25,000
4. Forklift Truck with Crane lifting attachment	Type: Counter balanced, battery - operated, Rubber tyred, 4-wheeled Capacity: 1 ton Lifting Height: 3 M	1	-	22,000	22,000
5. Hand Push Trolleys	Capacity: 1000 kgs Capacity: 500 kgs	6 6	- -	100 75	600 450
6. Two-wheel Barrow	Capacity: 250 kgs	6	-	100	600
7. Gas servicing trailer consisting of motor driven gas compressor and motor driven vacuum pump with space for carrying gas cylinder	-	1 set	-	-	500

JOB NO. : DCIL-105 EXHIBIT : 30

Description	Brief Specification	Nos	Power (KW)	Unit Price ($)	Total Price ($)
8. Mobile Crane	Capacity: 5 tons	1	-	50,000	50,000
TOTAL					2,69,230
K. HANDTOOLS AND MEASURING INSTRUMENTS					10,000
L. AUXILIARY EQUIPMENT	Equipment such as work tables, storage rack, workers cabinets, lockers, ladder, etc.				10,000

SECTION - 8
RAW MATERIALS AND OTHER INPUTS

RAW MATERIALS AND OTHER INPUTS

Circuit Breakers

The components of circuit breakers can be broadly classified as machined parts, fabricated parts, and bought-out items like insulators, motors, etc. Major sub-assemblies of a SF_6 or minimum oil circuit breaker are :

- The interrupting unit which is filled with either SF_6 gas or oil, depending on the type of circuit breaker
- Valve housing and associated mechanism
- Supporting insulator with switching rod
- Operating mechanism with auxiliary switch
- Control cabinet

Apart from the above, SF_6 circuit breakers will also have compressed air supply. The main components of an SF_6 circuit breaker are listed in Exhibit-31.

The exact specification of materials and components used, may vary with the manufacturer. Estimated weight of different types of materials for each kind of circuit breaker is presented in Exhibit-32. The annual requirement of machined and fabricated parts are given in Exhibit-33. This is based on the estimated weight of these materials per unit, machining allowances and wastage.

11 KV circuit breakers are normally sold along with other switchgear such as current transformer, potential transformer, bus-bar, etc. as a complete unit. These switchgears shall be procured as bought-out items.

Certain critical materials in the manufacture of SF_6 circuit breakers that need special attention are the SF_6 gas, operating rods, the nozzles, porcelain, absorbants, lubricants, the gas density detector and gas leak detector for SF_6 gas, and the hygrometer. In principle, SF_6 gas is quite simple to manufacture but difficulties arise in its purification.

The operating rods of the circuit breaker must be capable of transmitting mechanical power from the driving mechanism to operate the valve without failing. One of the materials used for the operating rod is epoxy glass made by the pultrusion process which gives it a tensile strength more than that of mild steel.

The nozzle in the interrupting chamber must have high resistance to heat and arc, high mechanical and dielectric strength, low moisture absorption and resistance to decomposed products of SF_6 gas. Teflon has all these qualities.

The porcelain used in the manufacture of the cover for the interrupter unit should be resistant to the decomposed products of SF_6 gas and must also be able to withstand the internal gas pressure. Equally important, the gasket surface of the porcelain should have a perfect finish so as to prevent leakage of gas. A synthetic zeolite which is a crystalline allumine silicate of alkali metals or alkali earth metals has been developed as an absorbant for SF_6 circuit breakers. It is quite consistant under varying conditions and does not react chemically with SF_6 gas.

Estimated cost of raw materials and other inputs for each type of circuit breaker is given in Exhibit-34.

Isolators

Isolators essentially consist of three major sub-assemblies:

- isolating unit and operating mechanism
- insulators, and
- the supporting structure

The main components of a pantograph isolator and centre rotating end break isolator are listed in Exhibits 35 and 36 respectively.

Depending on the design, the material of construction and the specification will vary from manufacturer to manufacturer. In general, the current carrying components of the isolator are made of copper and then silver plated to prevent the formation of copper oxide. The plating also ensures better conductivity at the joints and contacts.

Insualtion from ground is provided by porcelain isolators.

Supporting structures are fabricated from mild steel and then galvanised to prevent these parts from rusting. Alternatively, the structures could be painted but galvanising is considered a better and more lasting solution to this problem.

The actuating mechanism and motor operating mechanism mainly consist of gears of EN-8 steel. Other parts like worm wheel are of brass, couplings and brake drum of cast iron, bushes of bronze and springs of phospher bronze.

The motor of the operating mechanism and the porcelain insulators are the main bought-out items. All castings are procured as bought-out items and machined at the plant to specifications.

Exhibit-37 presents an estimate of annual requirement of machined and fabricated parts for isolators.

Estimated cost of raw materials and other inputs for each type/size of isolator is given in Exhibit-38.

JOB NO. : DCIL-105 EXHIBIT : 31

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

MAIN COMPONENTS OF AN SF_6 CIRCUIT BREAKER

Interruptor Unit

1. Fixed Contact
2. Moving Contact
3. Arcing horn
4. Blast piston
5. Porcelain casing
6. Moisture Absorber
7. Grading capacitor
8. Closing resistor
9. SF_6 gas
10. SF_6 pressure monitor
11. Closing resistor

Valve House & Associated Mechanism

1. Housing
2. Valve
3. Valve seat
4. Exhaust ports
5. Friction & Impact seals
6. Springs
7. Elastomer rings

Insulator for Insulation to Earth

1. Hollow porcelain insulators
2. Flanges
3. Sealing rings/gaskets
4. Switching rods

JOB NO. : DCIL-105 EXHIBIT - 31

Lower Part of Breaker

1. Breaker base
2. Connection housing
3. Solenoid valve
4. Control block
5. Auxiliary switches

Compressor Station

1. Air compressor
2. Air receiver
3. Accessories for controlling air supply
4. Filter, sieve, humidity separator

Miscellaneous

1. Lubricants
2. Hygrometer
3. Gas leak detector
4. Gaskets, adhesives, cables, fittings, operating coils

JOB NO. : DCIL-105 EXHIBIT : 32

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

CIRCUIT BREAKER : ESTIMATED WEIGHT OF DIFFERENT TYPES OF MATERIALS

(Figures in Kgs)

Voltage Class	Machined Parts	Fabrication items	Insulators	Control Mechanism	Compressor Station	Oil	Misc	Total
400 KV SF_6	3000	1000	3500	300	500	-	400	8700
220 KV SF_6	1600	900	2000	300	300	-	100	5200
132 KV MO	800	300	1100	320	-	270	50	2840
33 KV MO	375	60	250	260	-	180	20	1145
11 KV MO	150	50	100	200*	-	70	10	580
11 KV Vac.	175	50	150	200*	-	-	10	585

* This includes bus-bars, current and potential transformers, operating mechanism, instrument pannel, etc.

Legend : MO - Minimum oil circuit breaker Vac. - Vacuum circuit breaker

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JOB NO. : DCIL-105

EXHIBIT : 33

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

ANNUAL REQUIREMENT OF MACHINED AND FABRICATED ITEMS FOR CIRCUIT BREAKERS

Voltage Class (KV)	Type	No. of units	Machined parts per Unit (kg)	Total Weight of machined parts (kg)	Fabricated parts per unit (kg)	Total Weight of fabricated parts (kg)
400	SF_6	70	3000	210000	1000	70000
220	SF_6	70	1600	112000	900	63000
132	MO	70	800	56000	300	21000
33	MO	70	375	26250	60	4200
11	MO	300	150	45000	50	15000
11	Vac.	300	175	52500	50	15000
			Total	501750		188200

Legend : MO - Minimum Oil Circuit Breaker Vac. - Vacuum Circuit Breaker

JOB NO. : DCIL-105

EXHIBIT : 34

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
AND
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PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

CIRCUIT BREAKER : ESTIMATED COST OF RAW MATERIALS AND OTHER INPUTS

(Figures in '000 US $)

Material	400 KV SF_6	220 KV SF_6	132 KV MO	33 KV MO	11 KV MO	11 KV Vac.	TOTAL
Steel, Copper, Aluminium Alloy Material and Components	1800.54	1092.00	354.90	169.00	324.00	726.00	4465.44
Fabrication	28.70	25.90	8.75	2.80	9.00	9.00	84.15
Insulators	711.20	406.00	476.00	203.00	435.00	435.00	2666.20
Compressor and Associated Accessories	813.40	609.00	-	-	-	-	1422.40
SF_6 gas	508.20	244.30	-	-	-	-	752.50
Oil	-	-	23.80	16.45	30.00	-	70.25
Closing Resistors	813.40	-	-	-	-	-	813.40
Grading Capacitors	305.20	-	101.50	-	-	-	406.70
Miscellaneous (instruments, consumables, etc.)	406.70	203.00	203.00	169.40	582.00	639.00	2203.50
Bought out Switchgear	-	-	-	-	2034.00	2034.00	4068.00
TOTAL	5387.34	2580.20	1167.95	559.65	3414.00	3843.00	16952.14

Note : All costs are for 3-phase units

MO - Minimum oil CB

Vac - Vacuum CB

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JOB NO. : DCIL-105 EXHIBIT : 35

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AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

MAIN COMPONENTS OF PANTOGRAPH ISOLATORS

- Fixed contact
- Moving contact
- Scissors
- Spacers, dropper
- Earth blade
- Supporting structure
- Motor operating mechanism
- Actuating mechanism
- Insulators
- Interlock mechanism
- Miscellaneous : Switches, solenoid valves, terminal board, etc.

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JOB NO. : DCIL-105 EXHIBIT : 36

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AND
ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

MAIN COMPONENTS OF A CENTRE-ROTATING END-BREAK TYPE ISOLATOR

- Fixed finger contacts and termination block
- Moving blade
- Insulators
- Down operating rod
- Phase coupling rod
- Interlock mechanism
- Square tubular base
- Motor operating mechanism
- Aluator assembly
- Bearing assembly
- Miscellaneous : Switches, solenoid valves, terminal board, etc.

JOB NO. : DCIL-105 EXHIBIT - 37

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

ANNUAL REQUIREMENT OF MACHINED AND FABRICATED ITEMS FOR ISOLATORS

Voltage Class (KV)	Type	No. of units	Machined parts per Unit (kg)	Total Weight of machined parts (kg)	Fabricated parts per unit (kg)	Total Weight of fabricated parts (kg)
400	Pantograph	100	840	84000	400	40000
220	CREB	50	390	19500	425	21250
132	CREB	50	360	18000	375	18750
33	CREB	800	150	120000	150	120000
11	CREB	800	105	84000	100	80000
			Total	325500		280000

Legend : CREB - Centre Rotating End Break type

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JOB NO. : DCIL-105 EXHIBIT : 38

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

ISOLATORS : ESTIMATED COST OF RAW MATERIALS AND OTHER INPUTS

(Figures in '000 US $)

Material	400 KV Pantograph	220 KV CREB	132 KV CREB	33 KV CREB	11 KV CREB	Total
o Steel, Copper, Aluminium and other Ferrous/non-Ferrous materials	467.40	270.40	250.35	61.55	11.42	1061.12
o Porcelain Insulators	828.70	916.90	800.05	77.07	38.34	2661.06
o Motors and associated Accessories	116.00	33.35	33.33	21.20	25.30	229.18
o Control Mechanism: Terminal board, solenoid valves, auxiliary and limit switches, indicators and other associated accessories	215.45	66.68	66.67	40.18	35.12	424.10
o Miscellaneous items and consumables	49.70	33.34	25.00	10.00	10.00	128.04
Total	1677.25	1320.67	1175.40	210.00	120.18	4503.50

CREB - Centre-rotating end-break type

SECTION - 9
UTILITIES

UTILITIES

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

Power

Power is required to operate all the equipment in the factory, the airconditioning system in the office, for lighting and air-circulation. As all the equipment will not be operated simultaneously, different load factors have been assumed to estimate the power requirement as shown in the Exhibit-39. It may be observed from this exhibit that the average demand works out to 770 KVA. Considering future expansion needs, the connected load for the plant is estimated to be about 1000 KVA. It is assumed here that power will be made available from an 11 KV overhead transmission line. Two 500 KVA transformers have been provided for stepping down this voltage to 440/220 volts.

Water

There is no requirement of process water in the plant. However, water will be required for washing, gardening, air conditioning and for human needs. Water for human needs is estimated at 100 litres per person per day. Exhibit-40 gives the estimated water requirement.

Compressed Air

None of the major equipment in the plant will require compressed air for operation. However, some hand tools may require compressed air. For this purpose, two mobile compressors, each of 0.15 Cu M capacity, and one stationary compressor of 1.0 CuM capacity have been provided.

Exhibit-41 gives a list of equipment required for utilities.

Other miscellaneous equipment required in the plant are listed in Exhibit-42.

JOB NO. : DCIL-105 EXHIBIT : 39

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

SUMMARY OF POWER REQUIREMENT

Equipment/Department	Max. Power (KW)	Load Factor	Power Reqd. (KW)
Machinery Shop - Circuit Breakers	280	0.6	168
Fabrication shop - Circuit Breakers	127	0.6	76
Assembly Shop - Circuit Breakers	9	0.5	5
Machine Shop - Isolators	156	0.6	94
Fabrication Shop - Isolators	74	0.6	44
Assembly Shop - Isolators	23	0.5	12
Galvanising & Electroplating	9	0.6	5
Inspection and Testing	15	0.4	6
Tool Room	41	0.5	21
Material Handling	75	0.6	45
Sub-total	809		476
Water Pump, Compressor, etc.	40	0.5	20
Airconditioning & Office Lighting	120	0.6	72
Shop Lighting & Air Circulation	60	0.6	36
Lighting in other areas	20	0.5	10
Sub-total	1049		614
Average demand, based on a power factor of 0.8	:	770 KVA	

JOB NO. : DCIL-105 EXHIBIT : 40

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

ESTIMATED REQUIREMENT OF WATER

(Figures in ltrs/day)

Description	Requirement
Human needs	71,000
Cooling water for airconditioning	8,000
Washing, gardening and other miscellaneous requirements	21,000
Total	100,000

JOB NO. : DCIL-105 EXHIBIT : 41

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

REQUIREMENT OF EQUIPMENT FOR UTILITIES

Sl. No.	Description	Numbers Required	Total Cost ($)
1.	Oil cooled transformer 11 KV/440-220 volts, 3 Ph, 50 Hz Capacity: 500 KVA	2	26,000
2.	Switchgears, MCC, distribution boards and cables	-	4,600
3.	Centralised airconditioning system with 2 air-handling units and cooling water Capacity: 70 TR	1	79,100
4.	Lights with fittings, air coolers and fans	-	5,000
5.	Stationery, air-cooled compressor of 1.0 CuM capacity (Delivery pressure 7 kg/sq.cm), piping and valves	1	1,700
6.	Mobile aircompressors of 0.15 CuM capacity	2	1,200
7.	3 nos. borewell pumps of 200 lpm capacity, valves, pipes and fittings, 3 nos. 4" dia tube wells, overhead RCC water tank of 60 CuM capacity	-	3,600 2,900
	TOTAL		1,24,100

JOB NO. : DCIL-105 EXHIBIT : 42

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

REQUIREMENT OF MISCELLANEOUS EQUIPMENT

Sl. No.	Description	Total Cost ($)
1.	Fire fighting system with hydrant, piping, etc.	6,000
2.	Telecommunication systems with EPABX facilities, telephone instruments, cabling, etc.	11,000
3.	Office equipment and furniture	3,000
4.	Weighbridge (Lever type, Road transport, 25 tonnes) - 1 no.	3,700
5.	Goods transport truck - 1 no.	27,000
6.	Passenger transport vehicle - 1 no.	25,800
7.	Ambulance - 1 no.	19,300
8.	Cars - 2 nos.	19,000
	TOTAL	1,14,800

SECTION - 10
SPACE AND LAYOUT

SPACE AND LAYOUT

The manufacturing plant will have areas separately demarcated for the manufacture/assembly of circuit breakers and isolators. Floor space for the machines has been worked out, taking into account the following requirements :

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

The workshop will also include separate stores for raw materials, steel items, bought-out items and finished goods.

Other buildings in the plant include :

- o Administrative Office building
- o Canteen
- o Garage
- o Security & Time Office
- o Transformer Room
- o Compressor Room
- o Pump House

Summary of space requirement is given in Exhibit-43.

Workshop Building

The workshop building has been designed so as to ensure smooth movement of men, materials and handling equipment. Both raw materials and finished goods stores are serviced by overhead cranes. The steel store is located in a manner as to facilitate access to it by the cranes in the circuit

breaker and isolator fabrication shops. The workshop building also houses the shop offices.

Layout of the workshop building is shown in Exhibit-44, enclosed in a pouch at the end of the Report.

The workshop building will be made of reinforced concrete construction. The columns, roof, floor, etc., shall also be of RCC structure. The building will be designed in a manner as to ensure adequate natural lighting and ventilation.

Office Building

This will be a two-storeyed RCC brick building with central airconditioning.

Other Building

All the other buildings will be of masonry brick construction.

Exhibit-45, enclosed in a pouch at the end of this Report presents the block layout of the plant, showing the relative locations of different buildings.

Estimated costs of civil work including land development, fencing, drainage, roads and building construction are shown in Exhibit-46.

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JOB NO. : DCIL-105 EXHIBIT : 43

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

SUMMARY OF SPACE REQUIREMENT

Description	Area (Sq.M)
A. WORKSHOP BUILDING	
- R/M & consumables store	152
- Machine shops	1350
- Fabrication area	642
- Galvanising & Electroplating	67
- Assembly	380
- Bought-out items store	95
- Testing	114
- Finished goods store	285
- Despatch area	76
- Tool room	209
- MCC	64
- Shop offices	136
- Workers' lockers	86
- Toilets	232
Sub-total	3888
- Aisles and gang ways (40% of sub-total of A)	1540
Sub-total	5428
B. OFFICE BUILDING (2-storeyed, 16 x 32m x 2)	
- Office	592
- Conference room	33
- Lecture room	52
- Reception & lobby	52
- Tea room	15

JOB NO. : DCIL-105 EXHIBIT - 43

Description	Area (Sq.M)
- Air conditioning & plant elec. distribution	16
Sub-total	760
Add 30% for staircase & aisles	228
Sub-total	988
Plinth area (2-storeyed)	512
C. OTHER BUILDINGS	
- Canteen	1100
- Garage	150
- Time office & security	80
- First aid room	25
- Transformer room	75
- Pump house	50
- Compressor room	25
Sub-total	1505
D. Open storage yard	750
E. Area for future expansion (50% of workshop built-up area 'A')	2714
F. Area for roads	3000
Total Area	13909
Total land area (250 x 135 M) :	33750

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JOB NO. : DCIL-105

EXHIBIT : 46

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

ESTIMATED COST OF CIVIL WORK

Sl. No.	Description	Area (Sq.M)	Cost ($ Million)	
			Morocco	UAE
1.	Land and land development including fencing, drainage and road construction	33750	2.29	2.49
2.	Workshop building having a height of 9 metres from floor to top of crane rail	5428	4.52	4.86
3.	Administrative building (double storied)	512x2	0.51	0.54
4.	Auxiliary buildings comprising canteen, garage, time office & security, first aid room, transformer room, pump house and compressor room	1505	1.51	1.59
5.	Open Storage Yard	750	0.62	0.67
	TOTAL		9.45	10.15

SECTION - 11
MANPOWER AND ORGANIZATION

MANPOWER AND ORGANISATION

The plant will manufacture fairly high technology products, essentially with overseas technical collaboration. The technical collaborator will give all designs, manufacturing drawings, material specification and also specify the manufacturing methods/processes. The operations in the plant will include machining, fabrication, electroplating, assembly and testing. The entire plant will operate in two shifts except for the tool room, which will be working in the general shift.

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

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

The plant will operate for 300 days in a year, on an average.

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

- Production
- Marketing
- Materials
- Finance & Accounts
- Personnel & Administration

The plant will be under the overall supervision and control of the General Manager, while manufacturing operations will be looked after by a Works Manager, who shall report to the General Manager. Each department shalll be headed by the manager, who will, depending on the nature of activity, report to either the Works Manager or to the General Manager.

Production

All production-related functions shall be looked after by the Production Manager. He will be assisted by four Shift-incharges two for circuit breakers and two for isolators, one for each shift. Maintenance will also be under the control of the Production Manager and this function will be handled by a Maintenance Engineer.

Exhibit-47 presents the total requirement of workmen in the plant, categorised by equipment/facility and the level of skill involved.

Technical

All design drawings and manufacturing drawings for the products will be obtained from the technical collaborator. However, the drawings will be reviewed by the technical department, headed by the Technical Manager. This department, besides handling design changes, will also handle production/process planning and coordinate with marketing and production departments in ensuring timely deliveries.

Quality Control & Testing

Quality Control department shall be headed by the Quality Control Manager. It will ensure that the raw materials and finished products conform to the specifications laid down by the technical collaborator. This department will also be responsible for final testing and preparing necessary test reports and documentation.

Marketing

Products manufactured in the plant are meant for both domestic and export markets. Marketing of the products will be handled by a team of sales engineers and assistants, under the overall supervision of a Marketing Manager.

Materials

Materials is an important function in the plant. Apart from raw materials, several bought-out components and sub-assemblies like insulators, switchgears, etc., will have to be procured from local and foreign sources. This function will be headed by the Materials Manager. He will be assisted by purchase engineers and purchase assistants. The stores in the plant, operating in two shifts, will also be controlled by the materials department. Despatch of finished goods will be supervised by Despatch Supervisor.

Finance & Accounts

The Accounts department will be headed by a Chief Accountant-cum-Company Secretary, who shall be assisted by Accountants and Accounts Assistants.

Personnel & Administration

This Department will deploy staff to handle personnel, labour and welfare, security and other administrative functions. The department will be headed by the Personnel Manager.

Exhibit-48 gives a comprehensive list of managerial, supervisory and other staff required for the plant.

Summary of manpower requirement and the statement of salaries and wages are presented in Exhibits 49 and 50 respectively.

Organisational Structure of the entire plant is given in Exhibit-51.

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JOB NO. : DCIL-105 EXHIBIT : 47

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

REQUIREMENT OF WORKMEN IN THE PLANT

Equipment/Section	No. of Machines	Skilled	Unskilled
Machine Shop - Circuit Breakers			
- Cutting	4	8	4
- Lathe	16	32	-
- Threading	2	4	-
- Milling	10	20	-
- Shaping, Slotting	2	4	-
- Boring, Hobbing	3	6	-
- Grinding	2	4	-
- Drilling	12	24	-
		100	4
Fabricating Shop - Circuit Breakers			
- Cutting	1	2	2
- Bending & Folding	3	4	2
- Welding & Gas Cutting	10	12	-
- Drilling	1	2	-
		20	4
Assembly Shop - Circuit Breakers		20	20
Machine Shop - Isolators			
- Cutting	3	6	-
- Lathe	12	24	-
- Threading	2	4	-
- Drilling	7	12	-
- Milling, Hobbing	4	8	-
- Shaping	2	4	-
		58	-

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT - 47

Equipment/Section	No. of Machines	Skilled	Unskilled
Fabrication Shop - Isolators			
- Cutting, Bending	3	6	2
- Welding	6	8	-
- Forging	1	2	4
		16	6
Assembly Shop - Isolators	-	40	40
Galvanising & Electroplating	-	2	4
Tool Room & Maintenance			
- Lathe	1	1	-
- Milling, Boring	2	2	-
- Drilling	1	1	-
- Grinding	3	2	-
- Heat Treatment	1	1	1
- Electrician	-	4	4
- Transformer House	-	2	-
- Pump House	-	2	-
- Plumbing	-	2	2
- Mechanical Maintenance and Lubrication	-	8	8
- Building Maintenance	-	2	2
- Plant upkeep	-	-	12
		27	29
Material Handling			
- EOT Crane	4	8	8
- Forklift Truck	2	4	4
- Trolleys	18	-	24
- Gas Trailer	1	2	2
- Mobile Crane	1	1	2
		15	40

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT - 47

Equipment/Section	No. of Machines	Skilled	Unskilled
Testing Equipment	-	6	12
Sub-total		302	159
Add 10% for absenteeism		30	16
Total		334	175

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 48

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

REQUIREMENT OF MANAGERIAL, SUPERVISORY AND OTHER STAFF

Description	Salary Level	Nos.
A. PRODUCTION		
1. Production Manager	3	1
2. Shift Incharge (CB)	4	2
3. Shift Incharge (Isolator)	4	2
4. Maintenance Engineer	4	1
5. Supervisor - M/c shop (CB)	5	4
6. Supervisor - Fabrication (CB)	5	2
7. Supervisor - Assembly (CB)	5	4
8. Supervisor - M/c shop (Isolator)	5	4
9. Supervisor - Fabrication (Isolator)	5	2
10. Supervisor - Assembly (Isolator)	5	4
11. Supervisor - Tool Room	5	1
12. Supervisor - Maintenance	5	2
13. Supervisor - Material Handling	5	2
		31
B. TECHNICAL		
1. Technical Manager	3	1
2. Design Engineer	4	2
3. Planning Engineer	4	2
4. Tech. Assistant (Planning)	5	4
5. Draftsman	5	4
6. Steno-typist	6	2
7. Reproduction Operator	6	1
		16
C. QUALITY CONTROL AND TESTING		
1. Quality Control Manager	3	1
2. Quality Control Engineer	4	3

JOB NO. : DCIL-105 EXHIBIT - 48

Description	Salary Level	Nos.
3. Quality Control Inspector	5	8
4. Steno-typist	6	2
5. Inspection Helper	7	4
		18
D. MARKETING		
1. Marketing Manager	3	1
2. Sales Engineer	4	4
3. Sales Assistant	5	4
4. Steno-typist	6	2
		11
E. MATERIALS		
1. Materials Manager	3	1
2. Purchase Officer	4	2
3. Stores Officer	4	1
4. Store Keeper	5	6
5. Despatch Supervisor	5	1
6. Stores Assistant	6	9
7. Purchase Assistants	6	5
8. Steno typist	6	2
9. Stores Helper	7	10
		37
F. FINANCE & ACCOUNTS		
1. Chief Accountant-cum-Company Secretary	3	1
2. Accountant (Costing & Budget)	4	1
3. Accountant (Taxes, Insurance & Imports)	4	1
4. Accountant (Wage & Salary Administration)	4	1
5. Accountant (Receipts & Payments)	4	1
6. Accounts Assistant	5	8
7. Cashier	5	1
8. Accounts Clerk	6	5
9. Steno-typist	6	2
		21

JOB NO. : DCIL-105 EXHIBIT - 48

Description	Salary Level	Nos.
G. **PERSONNEL & ADMINISTRATION**		
1. Personnel Manager	3	1
2. Personnel Officer	4	1
3. Incharge - General Administration	4	1
4. Labour and Welfare Officer	4	1
5. Security Officer	4	1
6. First-aid Incharge	5	1
7. Canteen Incharge	5	1
8. Personal Assistant	5	2
9. Training Assistant	5	1
10. First-aid Assistant	6	2
11. Telephone Operator	6	2
12. Steno-typists	6	2
13. Clerks	6	3
14. Security Guard	6	12
15. Drivers	6	6
16. Office Boy	7	4
17. Tea Boy	7	16
18. Sweeper & Gardener	7	6
		63
General Manager	1	1
Works Manager	2	1
Secretary to General Manager	5	1
Steno to Works Manager	6	1
		4

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 49

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

SUMMARY OF MANPOWER REQUIREMENT

	Designation/Department	Numbers
1.	General Manager	1
2.	Works Manager	1
3.	Production	538*
4.	Technical	16
5.	Quality Control & Testing	18
6.	Marketing	11
7.	Materials	37
8.	Finance & Accounts	21
9.	Personnel & Administration	63
10.	Secretary to General Manager	1
11.	Steno-typist to Works Manager	1
	Total	708

* Including workmen

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 50

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

STATEMENT OF SALARIES AND WAGES

Level	Nos.	Monthly Salary per Person (US $)		Total per Month	
		Morocco	UAE	Morocco	UAE
1	1	9,000	9,000	9,000	9,000
2	1	6,000	6,000	6,000	6,000
3	7	3,803	4,357	26,621	30,499
4	27	2,576	2,853	69,552	77,031
5	67	920	1,440	61,640	96,480
6*	390	800	900	3,12,000	3,51,000
7@	215	245	597	52,675	1,28,355
TOTAL	708			5,37,488	6,98,365

* includes skilled workers

@ includes unskilled workers

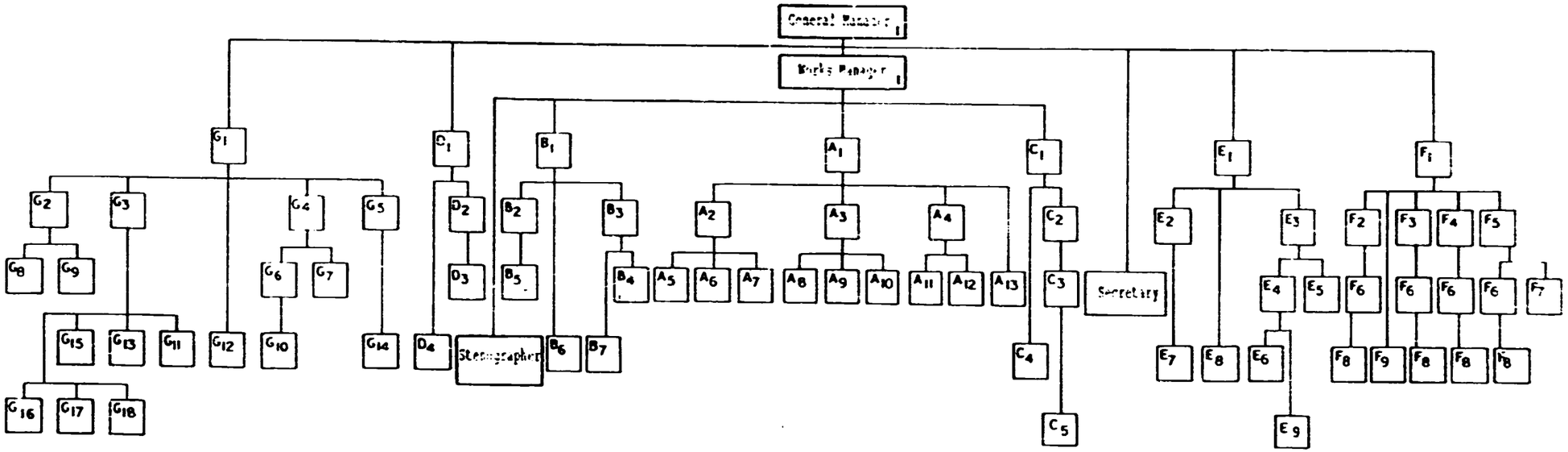
JOB NO. : DCIL 105

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

EXHIBIT 51

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

ORGANISATION CHART



LEGEND

PRODUCTION

A_1 Production Manager
A_2 Shift Incharge (CB)
A_3 Shift Incharge (Isolator)
A_4 Maintenance Engineer
A_5 Supervisor - M/c shop (CB)
A_6 Supervisor - Fabrication (CB)
A_7 Supervisor - Assembly (CB)
A_8 Supervisor - M/c shop (Isolator)
A_9 Supervisor - Fabrication (Isolator)
A_{10} Supervisor - Assembly (Isolator)
A_{11} Supervisor - Tool Room
A_{12} Supervisor - Maintenance
A_{13} Supervisor - Material Handling

TECHNICAL

B_1 Technical Manager
B_2 Design Engineer
B_3 Planning Engineer
B_4 Tech. Assistant (Planning)
B_5 Draftsman
B_6 Steno-typist
B_7 Reproduction Operator

QUALITY CONTROL AND TESTING

C_1 Quality Control Manager
C_2 Quality Control Engineer
C_3 Quality Control Inspector
C_4 Steno-typist
C_5 Inspection Helper

MARKETING

D_1 Marketing Manager
D_2 Sales Engineer
D_3 Sales Assistant
D_4 Steno-typist

MATERIALS

E_1 Materials Manager
E_2 Purchase Officer
E_3 Stores Officer
E_4 Store Keeper
E_5 Despatch Supervisor
E_6 Stores Assistant
E_7 Purchase Assistants
E_8 Steno typist

FINANCE & ACCOUNTS

F_1 Chief Accountant-cum-Company Secretary
F_2 Accountant (Costing & Budget)
F_3 Accountant (Taxes, Insurance & Imports)
F_4 Accountant (Wage & Salary Administration)
F_5 Accountant (Receipts & Payments)
F_6 Accounts Assistant
F_7 Cashier
F_8 Accounts Clerk
F_9 Steno-typist

PERSONNEL & ADMINISTRATION

G_1 Personnel Manager
G_2 Personnel Officer
G_3 Incharge - General Administration
G_4 Labour and Welfare Officer
G_5 Security Officer
G_6 First-aid Incharge
G_7 Canteen Incharge
G_8 Personal Assistant
G_9 Training Assistant
G_{10} First-aid Assistant
G_{11} Telephone Operator
G_{12} Steno-typists
G_{13} Clerks
G_{14} Security Guard
G_{15} Drivers
G_{16} Office Boy
G_{17} Tea Boy
G_{18} Sweeper & Gardener

SECTION - 12
FINANCIAL ANALYSIS AND EVALUATION

PLANT LOCATION : MOROCCO

FINANCIAL ANALYSIS AND EVALUATION

The financial implications of the proposed projects are presented in this Section.

It may be mentioned here, that for the sake of uniformity, the prices of plant and equipment and raw materials have been considered identical for both the countries, where the plants will be set up. Since most of the plant and equipment and raw materials are to be imported, the prevailing international prices of these items have been taken as the basis of calculation. For other cost parameters, which vary from country to country, the figures, as provided by the client has been considered.

COUNTRY : MOROCCO

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

Project Cost

The estimated cost of the project of setting up the plant is around US $ 17.95 million as can be seen from Exhibit-52. 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 53 and 54 respectively.

Margin money for working capital is presented in Exhibit-55. 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

56 and 57 respectively. Capacity utilisation is assumed at the rate of 80% in the first year, 90% in the second year and 100% from the third year onwards.

Costs

The annual costs of production and sales computed over 10 years are presented in Exhibit-58. 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-59. The average profit before tax works out to 11% of average revenue.

Statement of fixed assets and depreciation under straight line method is presented in Exhibit-60. Tax computation and depreciation for tax are presented in Exhibits 61 and 62 repspectively.

Working capital requirements are shown in Exhibit-63.

Projected cash flow statement and balance sheet over 10-year period are shown in Exhibits 64 and 65 respectively. The term loan will be repaid in 15 years including a 2-year moratorium.

The project breaks even at around 70.4% and shows internal rate of return of 32.2% as can be seen from Exhibits 66 and 67 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 : 52

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

ESTIMATED PROJECT COST

('000 US $)

Items	Value	Total
1. Land and Land Development (@ US$ 165 per m² for 13909 m²)	2294.99	2294.99
2. Building and Civil Work		
i) Workshop Building (@ US$ 834 per m² for 5428 m²)	4526.95	
ii) Administrative Building (@ US$ 1006 per m² for 512 m²)	515.07	
iii) Auxiliary Buildings (@ US$ 1006 per m² for 1505 m²)	1514.03	
iv) Open storage yard (@ US$ 834 per m² for 750 m²)	625.50	
Sub-total (2)		7181.55
3. Plant and Machinery		
i) Imported		
o Circuit Breakers		
- Machine shop equipment	1676.60	
- Fabrication shop equipment	83.15	
- Assembly shop equipment	11.54	
o Isolators		
- Machine shop equipment	913.40	
- Fabrication shop equipment	33.35	
- Assembly shop equipment	17.00	
o Galvanising & Electroplating equipment	27.00	
o Testing equipment	9.00	
o Tool room equipment	118.60	
o Material handling equipment	269.23	
o Handtools & measuring instruments	10.00	
o Auxiliary equipment	10.00	
Total F.O.B. Value		3178.87

JOB NO. : DCIL-105

EXHIBIT : 52

('000 US $)

Items		Value	Total
ii)	Insurance & Freight (@ 10% of FOB Value)	317.89	
iii)	C.I.F. Value	3496.76	
iv)	Import duty @ 6% on CIF value	209.81	
v)	Transportation @ 1% of CIF Value	34.97	
	Landed Cost at Site [Sub-total (3)]		3741.53
4.	Miscellaneous Fixed Assets		
i)	Transformers	26.00	
ii)	Switchgears	4.60	
iii)	Central Airconditioning system	79.10	
iv)	Illumination,Fans and Room Coolers	5.00	
v)	Water Pumps and Tank	6.50	
vi)	Compressors	2.90	
vii)	Fire fighting system	6.00	
viii)	Telecommunication system	11.00	
ix)	Office Furniture and Equipment	3.00	
x)	Vehicles and Weighbridge	94.80	
	Sub-total (4)		238.90
5.	Preliminary Expenses	25.00	25.00
6.	Pre-operative Expenses		
i)	Establishment	1362.52	
ii)	Travelling Expenses	135.00	
iii)	Miscellaneous	40.00	
			1537.52
7.	Technical Know-how Fees	573.00	573.00
8.	Sub-total (1 thru 7)	-	15592.49
9.	Contingency @ 5% on above	-	779.62
10.	Sub-total (8 & 9)	-	16372.11
11.	Interest during Construction	-	951.74
12.	Margin Money for Working Capital	-	624.84
	TOTAL COST	-	17948.69

JOB NO. : DCIL-105 EXHIBIT : 53

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

PHASING OF CAPITAL EXPENDITURE

('000 US $)

	Total	Construction Period in Quarters							
		1	2	3	4	5	6	7	8
1. Land and Land Development	2294.99	0.00	459.00	917.99	918.00	0.00	0.00	0.00	0.00
2. Building and Civil Work	7181.55								
i) Workshop Building	4526.95	0.00	0.00	1131.74	1131.74	1131.74	1131.73	0.00	0.00
ii) Administrative Building	515.07	0.00	0.00	206.03	206.03	103.01	0.00	0.00	0.00
iii) Auxiliary Buildings	1514.03	0.00	0.00	504.68	504.68	504.67	0.00	0.00	0.00
iv) Open Storage Yard	625.50	0.00	0.00	208.50	208.50	208.50	0.00	0.00	0.00
3. Plant and Machinery	3741.53								
i) Ordering	1122.46	0.00	0.00	1122.46	0.00	0.00	0.00	0.00	0.00
ii) Supply, delivery and installation at site	2619.07	0.00	0.00	0.00	0.00	0.00	0.00	2553.59	65.48

JOB NO. : DCIL-105

EXHIBIT : 53

('000 US $)

	Total	Construction Period in Quarters							
		1	2	3	4	5	6	7	8
4. Miscellaneous Fixed Assets	238.90								
i) Transformers	26.00	0.00	0.00	0.00	5.20	0.00	20.80	0.00	0.00
ii) Switchgears	4.60	0.00	0.00	0.00	0.92	0.00	3.68	0.00	0.00
iii) Central Airconditioning system	79.10	0.00	0.00	0.00	15.82	0.00	63.28	0.00	0.00
iv) Illumination,Fans and Room Coolers	5.00	0.50	0.00	0.90	0.90	0.90	0.90	0.90	0.00
v) Water Pumps and Tank	6.50	0.00	0.00	0.00	3.25	3.25	0.00	0.00	0.00
vi) Compressors	2.90	0.00	0.00	0.00	0.58	0.00	2.32	0.00	0.00
vii) Fire fighting system	6.00	0.00	0.00	0.00	0.00	0.00	3.00	0.00	3.00
viii) Telecommunication system	11.00	0.00	1.10	0.00	1.10	2.20	2.20	2.20	2.20
ix) Office Furniture and Equipment	3.00	0.00	0.15	0.30	0.30	0.30	0.30	0.30	1.35
x) Vehicles	94.80	0.00	18.96	18.96	0.00	0.00	0.00	0.00	56.88
5. Preliminary Expenses	25.00	12.50	12.50	0.00	0.00	0.00	0.00	0.00	0.00
6. Pre-operative Expenses	1537.52								
i) Establishment	1362.52	0.00	23.62	57.36	83.09	83.09	122.12	122.12	871.12
ii) Travelling Expenses	135.00	0.00	2.00	6.00	8.00	8.00	12.00	12.00	87.00
iii) Miscellaneous	40.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
7. Technical Know-how Fees	571.00	28.65	114.60	114.60	85.95	57.30	57.30	57.30	57.30
8. Sub-total (1 thru 7)	15592.49	46.65	636.93	4294.52	3179.06	2107.96	1424.63	2753.41	1149.33
9. Contingency @ 5% on above	779.62	2.33	31.85	214.73	158.95	105.40	71.23	137.67	57.46
10. Sub-total (8 & 9)	16372.10	48.98	668.78	4509.25	3338.01	2213.35	1495.85	2891.08	1206.78

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 54

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

ESTIMATION OF INTEREST DURING CONSTRUCTION

('000 US $)

	Construction Period in Quarters								Total
	1	2	3	4	5	6	7	8	
Capital Expenditure	48.98	668.78	4509.25	3338.01	2213.35	1495.85	2891.08	1206.78	16372.11
Margin Money	0.00	0.00	0.00	0.00	0.00	0.00	0.00	624.84	624.84
Total	48.98	668.78	4509.25	3338.01	2213.35	1495.85	2891.08	1831.63	16996.94
Equity	24.69	337.29	2277.13	1721.50	1180.94	837.33	1552.87	1042.61	8974.35
Loan	24.68	337.29	2277.14	1721.50	1180.94	837.33	1552.86	1042.61	8974.34
Total	49.35	674.58	4554.27	3443.00	2361.88	1674.66	3105.73	2085.22	17948.68

JOB NO. : DCIL-105

EXHIBIT : 54

('000 US $)

	Construction Period in Quarters								Total
	1	2	3	4	5	6	7	8	
Interest on loan									
- @ 12% p.a.	0.37	5.06	34.16	25.82	17.71	12.56	23.29	15.64	134.61
		0.74	10.12	68.31	51.64	35.43	25.12	46.59	237.95
			0.74	10.12	68.31	51.64	35.43	25.12	191.36
				0.74	10.12	68.31	51.64	35.43	166.24
					0.74	10.12	68.31	51.64	130.81
						0.74	10.12	68.31	79.17
							0.74	10.12	10.86
								0.74	0.74
Total	0.37	5.80	45.02	104.99	148.52	178.80	214.65	253.59	951.74
Debt/Equity	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

MEANS OF FINANCING : EQUITY 8974.35
LOAN 8974.34
TOTAL 17948.68

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 55

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

MARGIN MONEY FOR WORKING CAPITAL

('000 US $)

Sl. No.	Item	Period (Days)	Cost	Bank Finance Available (%)	Bank Finance Available (Amount)	Margin Money
1.	Raw materials & Consumables	90	4443.96	100%	4443.96	0.00
2.	Finished Stock	30	1922.82	100%	1922.82	0.00
3.	Sundry Debtors	30	2315.67	100%	2315.67	0.00
Sub-total			8682.45		8682.45	0.00
4.	Expenses	30	624.84	0%	0.00	624.84
	Total		9307.29		8682.45	624.84

JOB NO. : DCIL-105

EXHIBIT : 56

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

STATEMENT OF PRODUCTION AND SALES

(In Nos.)

	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
Working Days/Year	300	300	300	300	300	300	300	300	300	300
Utilisation	80%	90%	100%	100%	100%	100%	100%	100%	100%	100%
CIRCUIT BREAKERS										
- 400 KV SF6										
Capacity (Nos.)	70	70	70	70	70	70	70	70	70	70
Annual Output (Nos.)	56	63	70	70	70	70	70	70	70	70
Opening Stock	0	5	5	6	6	6	6	6	6	6
Production	56	63	70	70	70	70	70	70	70	70
Total	56	68	75	76	76	76	76	76	76	76
Closing Stock	5	5	6	6	6	6	6	6	6	6
Sales	51	62	69	70	70	70	70	70	70	70
- 220 KV SF6										
Capacity (Nos.)	70	70	70	70	70	70	70	70	70	70
Annual Output (Nos.)	56	63	70	70	70	70	70	70	70	70

JOB NO. : DCIL-105

EXHIBIT : 56

(in Nos.)

	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
Opening Stock	0	5	5	6	6	6	6	6	6	6
Production	56	63	70	70	70	70	70	70	70	70
Total	56	68	75	76	76	76	76	76	76	76
Closing Stock	5	5	6	6	6	6	6	6	6	6
Sales	51	62	69	70	70	70	70	70	70	70
- 132 KV MOCB										
Capacity (Nos.)	70	70	70	70	70	70	70	70	70	70
Annual Output (Nos.)	56	63	70	70	70	70	70	70	70	70
Opening Stock	0	5	5	6	6	6	6	6	6	6
Production	56	63	70	70	70	70	70	70	70	70
Total	56	68	75	76	76	76	76	76	76	76
Closing Stock	5	5	6	6	6	6	6	6	6	6
Sales	51	62	69	70	70	70	70	70	70	70
- 33 KV MOCB										
Capacity (Nos.)	70	70	70	70	70	70	70	70	70	70
Annual Output (Nos.)	56	63	70	70	70	70	70	70	70	70
Opening Stock	0	5	5	6	6	6	6	6	6	6
Production	56	63	70	70	70	70	70	70	70	70
Total	56	68	75	76	76	76	76	76	76	76
Closing Stock	5	5	6	6	6	6	6	6	6	6
Sales	51	62	69	70	70	70	70	70	70	70

JOB NO. : DCIL-105

EXHIBIT : 56

(in Nos.)

	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
- 11 KV MOCB										
Capacity (Nos.)	300	300	300	300	300	300	300	300	300	300
Annual Output (Nos.)	240	270	300	300	300	300	300	300	300	300
Opening Stock	0	20	23	25	25	25	25	25	25	25
Production	240	270	300	300	300	300	300	300	300	300
Total	240	290	323	325	325	325	325	325	325	325
Closing Stock	20	23	25	25	25	25	25	25	25	25
Sales	220	268	298	300	300	300	300	300	300	300
- 11 KV Vacuum										
Capacity (Nos.)	300	300	300	300	300	300	300	300	300	300
Annual Output (Nos.)	240	270	300	300	300	300	300	300	300	300
Opening Stock	0	20	23	25	25	25	25	25	25	25
Production	240	270	300	300	300	300	300	300	300	300
Total	240	290	323	325	325	325	325	325	325	325
Closing Stock	20	23	25	25	25	25	25	25	25	25
Sales	220	268	298	300	300	300	300	300	300	300
ISOLATORS										
- 400 KV Pantograph										
Capacity (Nos.)	100	100	100	100	100	100	100	100	100	100
Annual Output (Nos.)	80	90	100	100	100	100	100	100	100	100

JOB NO. : DCIL-105

EXHIBIT : 56

(in Nos.)

	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
Opening Stock	0	7	8	8	8	8	8	8	8	8
Production	80	90	100	100	100	100	100	100	100	100
Total	80	97	108	108	108	108	108	108	108	108
Closing Stock	7	8	8	8	8	8	8	8	8	8
Sales	73	89	99	100	100	100	100	100	100	100
- 220 KV CREB										
Capacity (Nos.)	50	50	50	50	50	50	50	50	50	50
Annual Output (Nos.)	40	45	50	50	50	50	50	50	50	50
Opening Stock	0	3	4	4	4	4	4	4	4	4
Production	40	45	50	50	50	50	50	50	50	50
Total	40	48	54	54	54	54	54	54	54	54
Closing Stock	3	4	4	4	4	4	4	4	4	4
Sales	37	45	50	50	50	50	50	50	50	50
- 132 KV CREB										
Capacity (Nos.)	50	50	50	50	50	50	50	50	50	50
Annual Output (Nos.)	40	45	50	50	50	50	50	50	50	50
Opening Stock	0	3	4	4	4	4	4	4	4	4
Production	40	45	50	50	50	50	50	50	50	50
Total	40	48	54	54	54	54	54	54	54	54
Closing Stock	3	4	4	4	4	4	4	4	4	4
Sales	37	45	50	50	50	50	50	50	50	50

JOB NO. : DCIL-105

EXHIBIT : 56

(in Nos.)

	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
- 33 KV CREB										
Capacity (Nos.)	800	800	800	800	800	800	800	800	800	800
Annual Output (Nos.)	640	720	800	800	800	800	800	800	800	800
Opening Stock	0	53	60	67	67	67	67	67	67	67
Production	640	720	800	800	800	800	800	800	800	800
Total	640	773	860	867	867	867	867	867	867	867
Closing Stock	53	60	67	67	67	67	67	67	67	67
Sales	587	713	793	800	800	800	800	800	800	800
- 11 KV CREB										
Capacity (Nos.)	800	800	800	800	800	800	800	800	800	800
Annual Output (Nos.)	640	720	800	800	800	800	800	800	800	800
Opening Stock	0	53	60	67	67	67	67	67	67	67
Production	640	720	800	800	800	800	800	800	800	800
Total	640	773	860	867	867	867	867	867	867	867
Closing Stock	53	60	67	67	67	67	67	67	67	67
Sales	587	713	793	800	800	800	800	800	800	800

JOB NO. : DCTL-105

EXHIBIT : 57

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

STATEMENT OF REVENUE

('000 US $)

Product Voltage Range	Average Selling Price (US $/Unit)	OPERATING YEARS 1	2	3	4	5	6	7	8	9	10
CIRCUIT BREAKER											
- 400 KV SF6	92000.00	4722.67	5742.33	6386.33	6440.00	6440.00	6440.00	6440.00	6440.00	6440.00	6440.00
- 220 KV SF6	92000.00	4722.67	5742.33	6386.33	6440.00	6440.00	6440.00	6440.00	6440.00	6440.00	6440.00
- 132 KV MOCB	92000.00	4722.67	5742.33	6386.33	6440.00	6440.00	6440.00	6440.00	6440.00	6440.00	6440.00
- 33 KV MOCB	15700.00	805.93	979.94	1089.84	1099.00	1099.00	1099.00	1099.00	1099.00	1099.00	1099.00
- 11 KV MOCB	15700.00	3454.00	4199.75	4670.75	4710.00	4710.00	4710.00	4710.00	4710.00	4710.00	4710.00
- 11 KV Vacuum	15700.00	3454.00	4199.75	4670.75	4710.00	4710.00	4710.00	4710.00	4710.00	4710.00	4710.00
Sub-total		21881.93	26606.44	29590.34	29839.00	29839.00	29839.00	29839.00	29839.00	29839.00	29839.00
ISOLATOR											
- 400 KV Pantograph	15700.00	1151.33	1399.92	1556.92	1570.00	1570.00	1570.00	1570.00	1570.00	1570.00	1570.00
- 220 KV CRBB	15700.00	575.67	699.96	778.46	785.00	785.00	785.00	785.00	785.00	785.00	785.00
- 132 KV CRBB	15700.00	575.67	699.96	778.46	785.00	785.00	785.00	785.00	785.00	785.00	785.00
- 33 KV CRBB	3400.00	1994.67	2425.33	2697.33	2720.00	2720.00	2720.00	2720.00	2720.00	2720.00	2720.00
- 11 KV Vacuum	3400.00	1994.67	2425.33	2697.33	2720.00	2720.00	2720.00	2720.00	2720.00	2720.00	2720.00
Sub-total		6292.00	7650.50	8508.50	8580.00	8580.00	8580.00	8580.00	8580.00	8580.00	8580.00
Total		28173.93	34256.94	38098.84	38419.00	38419.00	38419.00	38419.00	38419.00	38419.00	38419.00

JOB NO. : DCIL-105

EXHIBIT : 58

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

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	17164.51	19310.08	21455.64	21455.64	21455.64	21455.64	21455.64	21455.64	21455.64	21455.64
Power	207.70	233.63	259.57	259.57	259.57	259.57	259.57	259.57	259.57	259.57
Water	18.24	20.52	22.80	22.80	22.80	22.80	22.80	22.80	22.80	22.80
Sub-total	17390.45	19564.23	21738.01	21738.01	21738.01	21738.01	21738.01	21738.01	21738.01	21738.01
Contingency (@ 5% on above)	869.52	978.21	1086.90	1086.90	1086.90	1086.90	1086.90	1086.90	1086.90	1086.90
Total 'A'	18259.97	20542.44	22824.91	22824.91	22824.91	22824.91	22824.91	22824.91	22824.91	22824.91
B. Fixed Cost										
1) Labour & Plant Overhead										
a) Direct labour	3744.00	3931.20	4118.40	4305.60	4492.80	4680.00	4867.20	5054.40	5241.60	5428.80
b) Indirect labour	632.10	663.71	695.31	726.92	758.52	790.13	821.73	853.14	884.94	916.55
c) Supervision	739.68	776.66	813.65	850.63	887.62	924.60	961.58	998.57	1035.55	1072.54
Sub-total	5115.78	5371.57	5627.36	5883.15	6138.94	6394.73	6650.51	6906.30	7162.09	7417.88

JOB NO. : DCTL-105

EXHIBIT : 58

('000 RS $)

	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
(C) Other Factory Expenses										
a) Maintenance @ 2.5% on Plant & Equipment	93.54	93.54	93.54	93.54	93.54	93.54	93.54	93.54	93.54	93.54
b) Maintenance @ 1% on Building & Civil Work	71.82	71.82	71.82	71.82	71.82	71.82	71.82	71.82	71.82	71.82
c) Miscellaneous	33.07	33.07	33.07	33.07	33.07	33.07	33.07	33.07	33.07	33.07
Sub-total	198.43	198.43	198.43	198.43	198.43	198.43	198.43	198.43	198.43	198.43
(D) Administrative & Sales Expenses										
a) Salaries *	1334.08	1400.78	1467.48	1534.19	1600.89	1667.60	1734.30	1801.00	1867.71	1934.41
b) Overheads	266.82	280.16	293.50	306.84	320.18	333.52	346.86	360.20	373.54	386.88
Sub-total	1600.90	1680.94	1760.98	1841.02	1921.07	2001.11	2081.16	2161.20	2241.25	2121.29
Total (C+D+E)	6915.11	7250.94	7586.77	7922.61	8258.44	8594.27	8930.11	9265.94	9601.77	9937.61
Contingency (@ 5% on above)	345.76	362.55	379.34	396.13	412.92	429.71	446.51	463.30	480.09	496.88
Total 'B'	7260.87	7613.49	7966.11	8318.74	8671.36	9023.99	9376.62	9729.23	10081.86	10434.49
Total Cost of Production and Sales (A+B)	25520.84	28155.93	30791.02	31143.65	31496.27	31848.90	32201.53	32554.14	32906.77	33259.40

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

JOB NO. : DCIL-105

EXHIBIT : 59

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

PROJECTED PROFITABILITY STATEMENT

('000 US $)

Elements	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
Raw Materials and Consumables	17164.51	19310.08	21455.64	21455.64	21455.64	21455.64	21455.64	21455.64	21455.64	21455.64
Power	207.70	233.63	259.57	259.57	259.57	259.57	259.57	259.57	259.57	259.57
Water	18.24	20.52	22.80	22.80	22.80	22.80	22.80	22.80	22.80	22.80
Labour & Plant Overhead	5115.78	5371.57	5627.36	5883.15	6138.94	6394.73	6650.51	6906.30	7162.09	7417.88
Other Factory Expenses	198.43	198.43	198.43	198.43	198.43	198.43	198.43	198.43	198.43	198.43
Administrative & Sales Expenses	1600.90	1680.94	1760.98	1841.02	1921.07	2001.11	2081.16	2161.20	2241.25	2321.29
Sub-Total	24305.56	26815.17	29324.78	29660.61	29996.45	30332.28	30668.11	31003.94	31339.78	31675.61
Contingency	1215.27	1340.76	1466.24	1483.03	1499.82	1516.61	1533.41	1550.20	1566.99	1583.78
Total	25520.83	28155.93	30791.02	31143.64	31496.27	31848.89	32201.52	32554.14	32906.77	33259.39
Stock Variation	-1922.82	-207.24	-207.24	-22.07	-22.08	-22.07	-22.08	-22.07	-22.08	-22.07
Cost of Production and Sales	23598.01	27948.69	30583.78	31121.57	31474.19	31826.82	32179.44	32532.07	32884.69	33237.32
PROJECTED REVENUE	28173.93	34256.94	38098.84	38419.00	38419.00	38419.00	38419.00	38419.00	38419.00	38419.00
Profit before Interest and Depreciation	4575.92	6308.25	7515.06	7297.43	6944.81	6592.18	6239.56	5886.93	5534.31	5181.68

JOB NO. : DCIL-105

EXHIBIT : 59

('000 US $)

Elements	OPERATING YEARS 1	2	3	4	5	6	7	8	9	10
Interest										
On Term Loan										
- @ 12% p.a.	1076.92	1076.92	1076.92	994.08	911.24	828.40	745.56	662.72	579.88	497.04
On Working Capital Loan										
- @ 14% p.a.	1215.54	1215.54	911.66	607.77	303.89	0.00	0.00	0.00	0.00	0.00
Sub-total	2292.46	2292.46	1988.58	1601.85	1215.13	828.40	745.56	662.72	579.88	497.04
Profit before Depreciation	2283.46	4015.79	5526.48	5695.58	5729.68	5763.78	5494.00	5224.21	4954.43	4684.64
Depreciation and Amortisation	867.08	867.08	867.08	867.08	867.08	867.08	867.08	867.08	867.08	867.08
Profit before Tax	1416.38	3148.71	4659.40	4828.50	4862.60	4896.70	4626.92	4357.13	4087.35	3817.56
Tax	354.09	799.76	1189.10	1262.03	1280.59	1298.44	1239.65	1180.26	1120.31	1059.85
Distributable Profit	1062.29	2348.95	3470.30	3566.47	3582.01	3598.26	3387.26	3176.87	2967.04	2757.71
Dividend	0.00	0.00	897.43	897.43	897.43	1121.79	1121.79	1346.15	1346.15	1794.87
Retained Earnings	1062.29	2348.95	2572.87	2669.04	2684.58	2476.47	2265.48	1830.72	1620.89	962.84
Add Back : Depreciation & Amortisation	867.08	867.08	867.08	867.08	867.08	867.08	867.08	867.08	867.08	867.08
NET CASH ACCRUAL	1929.37	3216.03	3439.95	3536.12	3551.66	3343.55	3132.56	2697.81	2487.97	1829.93

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 60

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

STATEMENT OF FIXED ASSETS AND DEPRECIATION UNDER STRAIGHT LINE METHOD

('000 US $)

Description	Value	Technical Know-how Fees	Sub-Total	Contingency	Sub-Total	Interest during Construct	Sub-Total	50% of Pre-op Expenses	Total	Rate (%)	Amount
1. Land & Land Development	2294.99	0.00	2294.99	0.00	2294.99	0.00	2294.99	0.00	2294.99	0%	0.00
2. Building & Civil Work	7181.55	368.66	7550.22	501.61	8051.82	612.34	8664.17	494.46	9158.63	4%	366.35
3. Plant & Mahinery	3741.53	192.07	3933.60	261.33	4194.92	319.03	4513.96	257.61	4771.57	8%	381.73
4. Miscellaneous Fixed Assets	238.90	12.26	251.16	16.68	267.84	20.37	288.21	16.45	304.66	13%	39.61
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	1537.52	0.00	1537.52	0.00	1537.52	0.00	1537.52	-768.52	769.00	10%	76.90
7. Technical Know-how Fees	573.00	-573.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0%	0.00
Sub-total	15592.49		15592.49		16372.10		17323.84		17323.84		867.08
8. Contingency	779.62	0.00	779.62	-779.62	0.00	0.00	0.00	0.00	0.00		
Sub-total	16372.10		16372.10		16372.10		17323.84		17323.84		
9. Interest during Construction	951.74	0.00	951.74	0.00	951.74	-951.74	0.00	0.00	0.00		
Total	17323.84		17323.84		17323.84		17323.84		17323.84		

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 61

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

TAX COMPUTATION

('000 US $)

	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
Profit before Depreciation	2283.46	4015.79	5526.48	5695.58	5729.68	5763.78	5494.00	5224.21	4954.43	4684.64
Less : Current Depreciation	867.08	816.74	770.09	647.44	607.31	570.04	535.39	503.17	473.19	445.25
Balance	1416.38	3199.06	4756.39	5048.13	5122.37	5193.74	4958.61	4721.03	4481.24	4239.39
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	1416.38	3199.06	4756.39	5048.13	5122.37	5193.74	4958.61	4721.03	4481.24	4239.39
Tax @ 25%	354.09	799.76	1189.10	1262.03	1280.59	1298.44	1239.65	1180.26	1120.31	1059.85

JOB NO. : DCIL-105

EXHIBIT : 62

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

DEPRECIATION FOR TAX

('000 US $)

	WDV Rate	Building & Civil Work 4%	Plant and Machinery 8%	Misc. Fixed Assets 10%	Amortisation 10%	Total
Value		9158.63	4771.57	304.66	794.00	
Depreciation Year 1		366.35	381.73	39.61	79.40	867.08
Balance		8792.28	4389.84	265.05	714.60	
Depreciation Year 2		351.69	351.19	34.46	79.40	816.74
Balance		8440.59	4038.66	230.60	635.20	
Depreciation Year 3		337.62	323.09	29.98	79.40	770.09
Balance		8102.97	3715.56	200.62	555.80	
Depreciation Year 4		324.12	297.25	26.08	79.40	726.84
Balance		7778.85	3418.32	174.54	476.40	
Depreciation Year 5		311.15	273.47	22.69	79.40	686.71
Balance		7467.70	3144.85	151.85	397.00	
Depreciation Year 6		298.71	251.59	19.74	79.40	649.44
Balance		7168.99	2893.27	132.11	317.60	
Depreciation Year 7		286.76	231.46	17.17	79.40	614.79
Balance		6882.23	2661.80	114.93	238.20	
Depreciation Year 8		275.29	212.94	14.94	79.40	582.57
Balance		6606.94	2448.86	99.99	158.80	
Depreciation Year 9		264.28	195.91	13.00	79.40	552.59
Balance		6342.66	2252.95	86.99	79.40	
Depreciation Year 10		253.71	180.24	11.31	79.40	524.65
Balance		6088.96	2072.71	75.68	0.00	

WDV : Written Down Value

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 63

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

WORKING CAPITAL REQUIREMENTS
(Excluding Cash and Bank Balances)

('000 US $)

Items	OPERATING YEAR									
	1	2	3	4	5	6	7	8	9	10
1. Raw materials & Consumables	4443.96	4999.46	5554.95	5554.95	5554.95	5554.95	5554.95	5554.95	5554.95	5554.95
2. Finished Stock	1922.82	2130.06	2337.30	2359.37	2381.45	2403.52	2425.60	2447.67	2469.75	2491.82
3. Sundry Debtors	2315.67	2815.64	3131.41	3157.73	3157.73	3157.73	3157.73	3157.73	3157.73	3157.73
TOTAL	8682.45	9945.16	11023.66	11072.05	11094.13	11116.20	11138.28	11160.35	11182.43	11204.50
Increase /(decrease)	8682.45	1262.71	1078.50	48.39	22.08	22.07	22.08	22.07	22.08	22.07
Stock Variation	1922.82	207.24	207.24	22.07	22.08	22.07	22.08	22.07	22.08	22.07

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 64

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

PROJECTED CASH FLOW STATEMENT

('000 US $)

	Construction Period	Y 1	R 2	3	R 4	5	A 6	7	R 8	9	10
A. SOURCES											
Increase in Share Capital	8974.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Increase in Term Loan	8974.34	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	8682.45	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	3708.84	5441.17	6647.98	6430.35	6077.73	5725.10	5372.48	5019.85	4667.23	4314.60
Depreciation	0.00	867.08	867.08	867.08	867.08	867.08	867.08	867.08	867.08	867.08	867.08
TOTAL 'A'	17948.69	13258.37	6308.25	7515.06	7297.43	6944.81	6592.18	6239.56	5886.91	5534.31	5181.68
B. APPLICATIONS											
Increase in Capital Expenditure	16372.11	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	8682.45	1262.71	1078.50	48.39	22.08	22.07	22.08	22.07	22.08	22.07

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 64

('000 Rs $)

	Construction Period	Y 1	2	R 3	4	A 5	6	R 7	8	9	10
Interest											
On Term Loan - @ 12% p.a.	951.74	1076.92	1076.92	1076.92	994.08	911.24	828.40	745.56	662.72	579.88	497.04
On Working Capital Loan - @ 14% p.a.	0.00	1215.54	1215.54	911.66	607.77	303.89	0.00	0.00	0.00	0.00	0.00
Total Interest	951.74	2292.46	2292.46	1988.58	1601.85	1215.13	828.40	745.56	662.72	579.88	497.04
Tax	0.00	154.09	799.76	1189.10	1262.03	1280.59	1298.44	1239.65	1180.26	1120.31	1059.85
Dividend	0.00	0.00	0.00	897.43	897.43	897.43	1121.79	1121.79	1346.15	1346.15	1794.87
Repayment of Term Loan	0.00	0.00	0.00	690.33	690.33	690.33	690.33	690.33	690.33	690.33	690.33
Repayment of Working Capital Loan	0.00	0.00	2170.61	2170.61	2170.61	2170.62	0.00	0.00	0.00	0.00	0.00
TOTAL 'B'	17323.85	11329.00	6525.54	8014.55	6670.64	6276.18	3961.03	3819.41	3901.53	3758.75	4064.16
Opening Balance	0.00	624.84	2554.21	2336.92	1837.43	2464.22	3132.85	5764.00	8184.15	10169.55	11945.11
Surplus /(Deficit) during the Year (A - B)	624.84	1929.37	-217.29	-499.49	626.79	668.63	2631.15	2420.15	1985.40	1775.56	1117.52
Closing Balance	624.84	2554.21	2336.92	1837.43	2464.22	3132.85	5764.00	8184.15	10169.55	11945.11	13062.63

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 65

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

PROJECTED BALANCE SHEET

('000 US $)

		Y R A R									
		1	2	3	4	5	6	7	8	9	10
	Share Capital	8974.35	8974.35	8974.35	8974.35	8974.35	8974.35	8974.35	8974.35	8974.35	8974.35
Add:	Reserves & Surplus	1062.29	3411.24	5984.11	8653.15	11337.73	13814.20	16079.68	17910.40	19531.29	20494.13
	SHAREHOLRERS' FUND	10036.64	12385.59	14958.46	17627.50	20312.08	22788.55	25054.03	26884.75	28505.64	29468.48
Less:	Intangible Assets	714.60	635.20	555.80	476.40	397.00	317.60	238.20	158.80	79.40	0.00
	TANGIBLE NET WORTH	9322.04	11750.39	14402.66	17151.10	19915.08	22470.95	24815.83	26725.95	28426.24	29468.48
Add:	Term Loan	8974.14	8974.14	8284.01	7593.68	6903.35	6213.02	5522.69	4832.36	4142.03	3451.70
	CAPITAL FUND	18296.38	20724.73	22686.67	24744.78	26818.43	28683.97	30338.52	31558.31	32568.27	32920.18
Less:	Net Fixed Assets	15742.17	14954.49	14166.81	13379.13	12591.45	11803.77	11016.09	10228.41	9440.71	8653.05
	NET CURRENT ASSETS	2554.21	5770.24	8519.86	11365.65	14226.98	16880.20	19322.43	21329.90	23127.54	24267.13
A.	CURRENT ASSETS										
	Working Capital	8682.45	9945.16	11023.66	11072.05	11094.13	11116.20	11138.28	11160.35	11182.43	11204.50
	Cash & Bank Balance as per Cash Flow Statemtatement	2554.21	2336.92	1837.43	2464.22	3132.85	5764.00	8184.15	10169.55	11945.11	13062.63
	TOTAL 'A'	11236.66	12282.08	12861.09	13536.27	14226.98	16880.20	19322.43	21329.90	23127.54	24267.13
B.	CURRENT LIABILITIES										
	Bank Loan	8682.45	6511.84	4341.23	2170.62	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL 'B'	8682.45	6511.84	4341.23	2170.62	0.00	0.00	0.00	0.00	0.00	0.00
	NET CURRENT ASSETS (A-B)	2554.21	5770.24	8519.86	11365.65	14226.98	16880.20	19322.43	21329.90	23127.54	24267.13

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 66

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

BREAK-EVEN ANALYSIS

('000 US $)

Sl. No.	Particulars		Amount
1.	Raw Materials and Consumables		21455.64
2.	Power		259.57
3.	Water		22.80
4.	Sub-total (1 thru 3)		21738.01
5.	Contingency		1086.90
6.	VARIABLE COSTS		22824.91
7.	REVENUE		38419.00
8.	CONTRIBUTION (7 - 6)		15594.09
9.	Labour & Plant Overhead*		6266.83
10.	Other Factory Expenses		198.43
11.	Administrative & Sales Expenses*		1961.09
12.	Sub-Total (9 thru 11)		8426.36
13.	Contingency		421.32
14.	Sub-Total (12+13)		8847.68
15.	Interest*		1270.41
16.	Depreciation		867.08
17.	FIXED COSTS (14+15+16)		10985.16
	BREAK-EVEN SALES	17*7/8	27064.03
	BREAK-EVEN POINT		70.4%
	CASH BREAK-EVEN SALES		24927.82
	CASH BREAK-EVEN POINT		64.9%

* Average over 10 years

JOB NO. : DCIL-105 EXHIBIT : 67

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

INTERNAL RATE OF RETURN

('000 US $)

Year	Outflow	Inflow	Net Inflow
0	-17948.69	0.00	-17948.69
1	0.00	4575.92	4575.92
2	0.00	6308.25	6308.25
3	0.00	7515.06	7515.06
4	0.00	7297.43	7297.43
5	0.00	6944.81	6944.81
6	0.00	6592.18	6592.18
7	0.00	6239.56	6239.56
8	0.00	5886.93	5886.93
9	0.00	5534.31	5534.31
10	0.00	5181.68	5181.68
		IRR 32.2%	

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

PLANT LOCATION : U A E

COUNTRY : UAE

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

Project Cost

The estimated cost of the project of setting up the plant is around US $ 18.70 million as can be seen from Exhibit-68. 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 69 and 70 respectively.

Margin money for working capital is presented in Exhibit-71. 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 72 and 73 respectively. Capacity utilisation is assumed at the rate of 80% in the first year, 90% in the second year and 100% from the third year onwards.

Costs

The annual costs of production and sales computed over 10 years are presented in Exhibit-74. 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-75. The average profit before tax works out to about 5.4% of the average revenue.

Statement of fixed assets and depreciation under straight line method is presented in Exhibit-76. Tax computation and depreciation for tax are presented in Exhibits 77 and 78 repspectively.

Working capital requirements are shown in Exhibit-79.

Projected cash flow statement and balance sheet over 10-year period are shown in Exhibits 80 and 81 respectively. The term loan will be repaid in 15 years including a 2-year moratorium.

The project breaks even at around 84% and shows internal rate of return of 17.6% as can be seen from Exhibits 82 and 83 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 : 68

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

ESTIMATED PROJECT COST

('000 US $)

Items	Value	Total
1. Land and Land Development (@ US$ 179 per m² for 13909 m²)	2489.71	2489.71
2. Building and Civil Work		
i) Workshop Building (@ US$ 896 per m² for 5428 m²)	4863.49	
ii) Administrative Building (@ US$ 1059 per m² for 512 m²)	542.21	
iii) Auxiliary Buildings (@ US$ 1059 per m² for 1505 m²)	1593.80	
iv) Open storage yard (@ US$ 896 per m² for 750 m²)	672.00	
Sub-total (2)		7671.50
3. Plant and Machinery		
i) Imported		
o Circuit Breakers		
- Machine shop equipment	1676.60	
- Fabrication shop equipment	83.15	
- Assembly shop equipment	11.54	
o Isolators		
- Machine shop equipment	913.40	
- Fabrication shop equipment	33.35	
- Assembly shop equipment	17.00	
o Galvanising & Electroplating equipment	27.00	
o Testing equipment	9.00	
o Tool room equipment	118.60	
o Material handling equipment	269.23	
o Handtools & measuring instruments	10.00	
o Auxiliary equipment	10.00	
Total F.O.B. Value	4178.87	

JOB NO. : DCIL-105 EXHIBIT : 68

('000 US $)

Items		Value	Total
ii)	Insurance & Freight (@ 10% of FOB Value)	317.89	
iii)	C.I.F. Value	3496.76	
iv)	Import duty @ 6% on CIF value	209.81	
v)	Transportation @ 1% of CIF Value	34.97	
	Landed Cost at Site [Sub-total (3)]		3741.54
4.	Miscellaneous Fixed Assets		
i)	Transformers	26.00	
ii)	Switchgears	4.60	
iii)	Central Airconditioning system	79.10	
iv)	Illumination,Fans and Room Coolers	5.00	
v)	Water Pumps and Tank	6.50	
vi)	Compressors	2.90	
vii)	Fire fighting system	6.00	
viii)	Telecommunication system	11.00	
ix)	Office Furniture and Equipment	3.00	
x)	Vehicles and Weighbridge	94.80	
	Sub-total (4)		238.90
5.	Preliminary Expenses	25.00	25.00
6.	Pre-operative Expenses		
i)	Establishment	1306.51	
ii)	Travelling Expenses	130.00	
iii)	Miscellaneous	40.00	
			1476.51
7.	Technical Know-how Fees	597.00	597.00
8.	Sub-total (1 thru 7)	-	16240.16
9.	Contingency @ 5% on above	-	812.01
10.	Sub-total (8 & 9)	-	17052.17
11.	Interest during Construction	-	833.15
12.	Margin Money for Working Capital	-	781.75
	TOTAL COST	-	18667.07

JOB NO. : DCIL-105

EXHIBIT : 69

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

PHASING OF CAPITAL EXPENDITURE

('000 US $)

	Total	Construction Period in Quarters							
		1	2	3	4	5	6	7	8
1. Land and Land Development	2489.71	0.00	497.95	995.88	995.88	0.00	0.00	0.00	0.00
2. Building and Civil Work	7671.50								
(i) Workshop Building	4863.49	0.00	0.00	1215.87	1215.87	1215.87	1215.88	0.00	0.00
(ii) Administrative Building	542.21	0.00	0.00	216.88	216.88	108.45	0.00	0.00	0.00
(iii) Auxiliary Buildings	1593.80	0.00	0.00	531.27	531.27	531.26	0.00	0.00	0.00
(iv) Open Storage Yard	672.00	0.00	0.00	224.00	224.00	224.00	0.00	0.00	0.00
3. Plant and Machinery	3741.54								
(i) Ordering	1122.46	0.00	0.00	1122.46	0.00	0.00	0.00	0.00	0.00
(ii) Supply, delivery and installation at site	2619.08	0.00	0.00	0.00	0.00	0.00	0.00	2553.60	65.48

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 69

('000 US $)

	Total	Construction Period in Quarters							
		1	2	3	4	5	6	7	8
4. Miscellaneous Fixed Assets	238.90								
i) Transformers	25.00	0.00	0.00	0.00	5.20	0.00	20.80	0.00	0.00
ii) Switchgears	4.60	0.00	0.00	0.00	0.92	0.00	3.68	0.00	0.00
iii) Central Airconditioning system	79.10	0.00	0.00	0.00	15.82	0.00	63.28	0.00	0.00
iv) Illumination,Fans and Room Coolers	5.00	0.50	0.00	0.90	0.90	0.90	0.90	0.90	0.00
v) Water Pumps and Tank	6.50	0.00	0.00	0.00	3.25	3.25	0.00	0.00	0.00
vi) Compressors	2.90	0.00	0.00	0.00	0.58	0.00	2.32	0.00	0.00
vii) Fire fighting system	6.00	0.00	0.00	0.00	0.00	0.00	3.00	0.00	3.00
viii) Telecommunication system	11.00	0.00	1.10	0.00	1.10	2.20	2.20	2.20	2.20
ix) Office Furniture and Equipment	3.00	0.00	0.15	0.30	0.30	0.30	0.30	0.30	1.35
x) Vehicles	94.80	0.00	18.96	18.96	0.00	0.00	0.00	0.00	56.88
5. Preliminary Expenses	25.00	12.50	12.50	0.00	0.00	0.00	0.00	0.00	0.00
6. Pre-operative Expenses	1476.51								
i) Establishment	1306.51	0.00	24.54	60.12	86.68	86.68	131.29	131.29	785.89
ii) Travelling Expenses	130.00	0.00	2.00	6.00	9.00	9.00	13.00	13.00	78.00
iii) Miscellaneous	40.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
7. Technical Know-how Fees	597.00	29.85	119.40	119.40	89.55	59.70	59.70	59.70	59.70
8. Sub-total (1 thru 7)	16240.16	47.85	681.60	4517.05	3402.21	2246.61	1521.35	2765.99	1057.50
9. Contingency @ 5% on above	812.01	2.39	34.08	225.85	170.11	112.33	76.07	138.30	52.88
10. Total (8 & 9)	17052.17	50.24	715.68	4742.90	3572.32	2358.94	1597.42	2904.29	1110.38

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 70

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

ESTIMATION OF INTEREST DURING CONSTRUCTION

('000 US $)

	Construction Period in Quarters								Total
	1	2	3	4	5	6	7	8	
Capital Expenditure	50.24	715.68	4742.90	3572.32	2358.94	1597.42	2904.29	1110.38	17052.17
Margin Money	0.00	0.00	0.00	0.00	0.00	0.00	0.00	781.75	781.75
Total	50.24	715.68	4742.90	3572.32	2358.94	1597.42	2904.29	1892.13	17833.92
Equity	25.28	360.41	2391.22	1832.32	1244.86	877.37	1545.95	1056.13	9333.54
Loan	25.28	360.41	2391.21	1832.32	1244.87	877.37	1545.94	1056.13	9333.53
Total	50.56	720.82	4782.43	3664.64	2489.73	1754.74	3091.89	2112.26	18667.07

JOB NO. : DCII.-105

EXHIBIT : 70

('000 US $)

	Construction Period in Quarters								Total
	1	2	3	4	5	6	7	8	
Interest on loan									
- @ 10% p.a.	0.32	4.51	29.89	22.90	15.56	10.97	19.32	13.20	116.67
		0.63	9.01	59.78	45.81	31.12	21.93	38.65	206.93
			0.63	9.01	59.78	45.81	31.12	21.93	168.28
				0.63	9.01	59.78	45.81	31.12	146.35
					0.63	9.01	59.78	45.81	115.23
						0.63	9.01	59.78	69.42
							0.63	9.01	9.64
								0.63	0.63
Total	0.32	5.14	39.53	92.32	130.79	157.32	187.60	220.13	833.15
Debt/Equity	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

MEANS OF FINANCING : EQUITY 9333.54
LOAN 9333.53
TOTAL 18667.07

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 71

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

MARGIN MONEY FOR WORKING CAPITAL

('000 US $)

Sl. No.	Item	Period (Days)	Cost	Bank Finance Available (%)	(Amount)	Margin Money
1.	Raw materials & Consumables	60	2962.64	100%	2962.64	0.00
2.	Finished Stock	30	2077.64	100%	2077.64	0.00
3.	Sundry Debtors	30	2315.67	100%	2315.67	0.00
Sub-total			7355.94		7355.94	0.00
4.	Expenses	30	781.75	0%	0.00	781.75
	Total		8137.69		7355.94	781.75

JOB NO. : DCIL-105

EXHIBIT : 72

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

STATEMENT OF PRODUCTION AND SALES

(in Nos.)

	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
Working Days/Year	300	300	300	300	300	300	300	300	300	300
Utilisation	80%	90%	100%	100%	100%	100%	100%	100%	100%	100%
CIRCUIT BREAKERS										
- 400 KV SF6										
Capacity (Nos.)	70	70	70	70	70	70	70	70	70	70
Annual Output (Nos.)	56	63	70	70	70	70	70	70	70	70
Opening Stock	0	5	5	6	6	6	6	6	6	6
Production	56	63	70	70	70	70	70	70	70	70
Total	56	68	75	76	76	76	76	76	76	76
Closing Stock	5	5	6	6	6	6	6	6	6	6
Sales	51	62	69	70	70	70	70	70	70	70
- 220 KV SF6										
Capacity (Nos.)	70	70	70	70	70	70	70	70	70	70
Annual Output (Nos.)	56	63	70	70	70	70	70	70	70	70

JOB NO. : DCIL-105

EXHIBIT : 72

(in Nos.)

	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
Opening Stock	0	5	5	6	6	6	6	6	6	6
Production	56	63	70	70	70	70	70	70	70	70
Total	56	68	75	76	76	76	76	76	76	76
Closing Stock	5	5	6	6	6	6	6	6	6	6
Sales	51	62	69	70	70	70	70	70	70	70
- 132 KV MOCB										
Capacity (Nos.)	70	70	70	70	70	70	70	70	70	70
Annual Output (Nos.)	56	63	70	70	70	70	70	70	70	70
Opening Stock	0	5	5	6	6	6	6	6	6	6
Production	56	63	70	70	70	70	70	70	70	70
Total	56	68	75	76	76	76	76	76	76	76
Closing Stock	5	5	6	6	6	6	6	6	6	6
Sales	51	62	69	70	70	70	70	70	70	70
- 33 KV MOCB										
Capacity (Nos.)	70	70	70	70	70	70	70	70	70	70
Annual Output (Nos.)	56	63	70	70	70	70	70	70	70	70
Opening Stock	0	5	5	6	6	6	6	6	6	6
Production	56	63	70	70	70	70	70	70	70	70
Total	56	68	75	76	76	76	76	76	76	76
Closing Stock	5	5	6	6	6	6	6	6	6	6
Sales	51	62	69	70	70	70	70	70	70	70

JOB NO. : DCIL-105

EXHIBIT : 72

(in Nos.)

	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
- 11 KV MOCB										
Capacity (Nos.)	300	300	300	300	300	300	300	300	300	300
Annual Output (Nos.)	240	270	300	300	300	300	300	300	300	300
Opening Stock	0	20	23	25	25	25	25	25	25	25
Production	240	270	300	300	300	300	300	300	300	300
Total	240	290	323	325	325	325	325	325	325	325
Closing Stock	20	23	25	25	25	25	25	25	25	25
Sales	220	268	298	300	300	300	300	300	300	300
- 11 KV Vacuum										
Capacity (Nos.)	300	300	300	300	300	300	300	300	300	300
Annual Output (Nos.)	240	270	300	300	300	300	300	300	300	300
Opening Stock	0	20	23	25	25	25	25	25	25	25
Production	240	270	300	300	300	300	300	300	300	300
Total	240	290	323	325	325	325	325	325	325	325
Closing Stock	20	23	25	25	25	25	25	25	25	25
Sales	220	268	298	300	300	300	300	300	300	300
ISOLATORS										
- 400 KV Pantograph										
Capacity (Nos.)	100	100	100	100	100	100	100	100	100	100
Annual Output (Nos.)	80	90	100	100	100	100	100	100	100	100

JOB NO. : DCIL-105

EXHIBIT : 72

(in Nos.)

	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
Opening Stock	0	7	8	8	8	8	8	8	8	8
Production	80	90	100	100	100	100	100	100	100	100
Total	80	97	108	108	108	108	108	108	108	108
Closing Stock	7	8	8	8	8	8	8	8	8	8
Sales	73	89	99	100	100	100	100	100	100	100
- 220 KV CRFB										
Capacity (Nos.)	50	50	50	50	50	50	50	50	50	50
Annual Output (Nos.)	40	45	50	50	50	50	50	50	50	50
Opening Stock	0	3	4	4	4	4	4	4	4	4
Production	40	45	50	50	50	50	50	50	50	50
Total	40	48	54	54	54	54	54	54	54	54
Closing Stock	3	4	4	4	4	4	4	4	4	4
Sales	37	45	50	50	50	50	50	50	50	50
- 132 KV CRFB										
Capacity (Nos.)	50	50	50	50	50	50	50	50	50	50
Annual Output (Nos.)	40	45	50	50	50	50	50	50	50	50
Opening Stock	0	3	4	4	4	4	4	4	4	4
Production	40	45	50	50	50	50	50	50	50	50
Total	40	48	54	54	54	54	54	54	54	54
Closing Stock	3	4	4	4	4	4	4	4	4	4
Sales	37	45	50	50	50	50	50	50	50	50

JOB NO. : DCIL-105

EXHIBIT : 72

(in Nos.)

	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
- 33 KV CREB										
Capacity (Nos.)	800	800	800	800	800	800	800	800	800	800
Annual Output (Nos.)	640	720	800	800	800	800	800	800	800	800
Opening Stock	0	53	60	67	67	67	67	67	67	67
Production	640	720	800	800	800	800	800	800	800	800
Total	640	773	860	867	867	867	867	867	867	867
Closing Stock	53	60	67	67	67	67	67	67	67	67
Sales	587	713	793	800	800	800	800	800	800	800
- 11 KV CREB										
Capacity (Nos.)	800	800	800	800	800	800	800	800	800	800
Annual Output (Nos.)	640	720	800	800	800	800	800	800	800	800
Opening Stock	0	53	60	67	67	67	67	67	67	67
Production	640	720	800	800	800	800	800	800	800	800
Total	640	773	860	867	867	867	867	867	867	867
Closing Stock	53	60	67	67	67	67	67	67	67	67
Sales	587	713	793	800	800	800	800	800	800	800

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

STATEMENT OF REVENUE

('000 US $)

Product Voltage Range	Average Selling Price (US $/Unit)	OPERATING YEARS 1	2	3	4	5	6	7	8	9	10
CIRCUIT BREAKER											
- 400 KV SF6	92000.00	4722.67	5742.33	6386.33	6440.00	6440.00	6440.00	6440.00	6440.00	6440.00	6440.00
- 220 KV SF6	92000.00	4722.67	5742.33	6386.33	6440.00	6440.00	6440.00	6440.00	6440.00	6440.00	6440.00
- 132 KV MOCB	92000.00	4722.67	5742.33	6386.33	6440.00	6440.00	6440.00	6440.00	6440.00	6440.00	6440.00
- 33 KV MOCB	15700.00	805.93	979.94	1089.84	1099.00	1099.00	1099.00	1099.00	1099.00	1099.00	1099.00
- 11 KV MOCB	15700.00	3454.00	4199.75	4670.75	4710.00	4710.00	4710.00	4710.00	4710.00	4710.00	4710.00
- 11 KV Vacuum	15700.00	3454.00	4199.75	4670.75	4710.00	4710.00	4710.00	4710.00	4710.00	4710.00	4710.00
Sub-total		21881.93	26606.44	29590.34	29839.00	29839.00	29839.00	29839.00	29839.00	29839.00	29839.00
ISOLATOR											
- 400 KV Pantograph	15700.00	1151.33	1399.92	1556.92	1570.00	1570.00	1570.00	1570.00	1570.00	1570.00	1570.00
- 220 KV CRBB	15700.00	575.67	699.96	778.46	785.00	785.00	785.00	785.00	785.00	785.00	785.00
- 132 KV CRBB	15700.00	575.67	699.96	778.46	785.00	785.00	785.00	785.00	785.00	785.00	785.00
- 33 KV CRBB	3400.00	1994.67	2425.33	2697.33	2720.00	2720.00	2720.00	2720.00	2720.00	2720.00	2720.00
- 11 KV Vacuum	3400.00	1994.67	2425.33	2697.33	2720.00	2720.00	2720.00	2720.00	2720.00	2720.00	2720.00
Sub-total		6292.00	7650.50	8508.50	8580.00	8580.00	8580.00	8580.00	8580.00	8580.00	8580.00
Total		28173.93	34256.94	38098.84	38419.00	38419.00	38419.00	38419.00	38419.00	38419.00	38419.00

JOB NO. : DCIL-105 EXHIBIT : 74

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

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	17164.51	19265.18	21410.75	21455.64	21455.64	21455.64	21455.64	21455.64	21455.64	21455.64
Power	46.65	52.25	57.85	57.85	57.85	57.85	57.85	57.85	57.85	57.85
Water	9.12	10.26	11.40	11.40	11.40	11.40	11.40	11.40	11.40	11.40
Sub-total	17220.28	19327.69	21479.99	21524.89	21524.89	21524.89	21524.89	21524.89	21524.89	21524.89
Contingency (@ 5% on above)	861.01	966.38	1074.00	1076.24	1076.24	1076.24	1076.24	1076.24	1076.24	1076.24
Total 'A'	18081.29	20294.07	22553.99	22601.13	22601.13	22601.13	22601.13	22601.13	22601.13	22601.13
B. Fixed Cost										
i) Labour & Plant Overhead *										
a) Direct labour	4212.00	4422.60	4633.20	4843.80	5054.40	5265.00	5475.60	5686.20	5896.80	6107.40
b) Indirect labour	1540.00	1617.00	1694.00	1771.00	1848.00	1925.00	2002.00	2079.00	2156.00	2233.00
c) Supervision	1157.76	1215.65	1273.54	1331.42	1389.31	1447.20	1505.09	1562.98	1620.86	1678.75
Sub-total	6909.76	7255.25	7600.74	7946.22	8291.71	8637.20	8982.69	9328.18	9673.66	10019.15

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 74

('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	93.54	93.54	93.54	93.54	93.54	93.54	93.54	93.54	93.54	93.54
b) Maintenance @ 1% on Building & Civil Work	76.72	76.72	76.72	76.72	76.72	76.72	76.72	76.72	76.72	76.72
c) Miscellaneous	34.05	34.05	34.05	34.05	34.05	34.05	34.05	34.05	34.05	34.05
Sub-total	204.30	204.30	204.30	204.30	204.30	204.30	204.30	204.30	204.30	204.30
(iii) Administrative & Sales Expenses										
a) Salaries *	1470.40	1543.92	1617.44	1690.96	1764.48	1838.00	1911.52	1985.04	2058.56	2132.08
b) Overheads	294.08	308.78	323.49	338.19	352.90	367.60	382.30	397.01	411.71	426.42
Sub-total	1764.48	1852.70	1940.93	2029.15	2117.38	2205.60	2293.82	2382.05	2470.27	2558.50
Total (i+ii+iii)	8878.54	9312.26	9745.97	10179.68	10613.39	11047.10	11480.82	11914.53	12348.24	12781.95
Contingency (@ 5% on above)	443.93	465.61	487.30	508.98	530.67	552.36	574.04	595.73	617.41	639.10
Total 'B'	9322.47	9777.87	10233.27	10688.66	11144.06	11599.46	12054.87	12510.24	12965.65	13421.05
Total Cost of Production and Sales (A+B)	27403.77	30071.94	32787.26	33289.79	33745.19	34200.59	34656.00	35111.37	35566.78	36022.18

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

JOB NO. : DCIL-105

EXHIBIT : 75

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

PROJECTED PROFITABILITY STATEMENT

('000 US $)

Elements	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
Raw Materials and Consumables	17164.51	19265.18	21410.75	21455.64	21455.64	21455.64	21455.64	21455.64	21455.64	21455.64
Power	46.65	52.25	57.85	57.85	57.85	57.85	57.85	57.85	57.85	57.85
Water	9.12	10.26	11.40	11.40	11.40	11.40	11.40	11.40	11.40	11.40
Labour & Plant Overhead	6909.76	7255.25	7600.74	7946.22	8291.71	8637.20	8982.69	9328.18	9673.66	10019.15
Other Factory Expenses	204.30	204.30	204.30	204.30	204.30	204.30	204.30	204.30	204.30	204.30
Administrative & Sales Expenses	1764.48	1852.70	1940.93	2029.15	2117.38	2205.60	2293.82	2382.05	2470.27	2558.50
Sub-total	26098.82	28639.94	31225.97	31704.56	32138.28	32571.99	33005.70	33439.42	33873.12	34306.84
Contingency	1304.93	1432.00	1561.30	1585.23	1606.91	1628.60	1650.29	1671.97	1693.66	1715.34
Total	27403.75	30071.94	32787.27	33289.79	33745.19	34200.59	34655.99	35111.40	35566.78	36022.18
Stock Variation	-2077.64	-211.11	-214.98	-33.69	-29.82	-29.81	-29.82	-29.82	-29.81	-29.82
Cost of Production and Sales	25326.11	29860.83	32572.29	33256.10	33715.37	34170.78	34626.16	35081.57	35536.97	35992.36
PROJECTED REVENUE	28173.93	34256.94	38098.84	38419.00	38419.00	38419.00	38419.00	38419.00	38419.00	38419.00
Profit before Interest and Depreciation	2847.82	4396.11	5526.55	5162.90	4703.63	4248.22	3792.84	3337.43	2882.03	2426.64

JOB NO. : DCIL-105

EXHIBIT : 75

('000 US $)

Elements	OPERATING YEARS 1	2	3	4	5	6	7	8	9	10
Interest										
On Term Loan - @ 10% p.a.	933.35	933.35	933.35	861.56	789.76	717.96	646.17	574.37	502.58	430.78
On Working Capital Loan - @ 12% p.a.	882.71	882.71	662.04	441.36	220.68	0.00	0.00	0.00	0.00	0.00
Sub-total	1816.06	1816.06	1595.39	1302.92	1010.44	717.96	646.17	574.37	502.58	430.78
Profit before Depreciation	1031.76	2580.05	3931.17	3859.97	3693.18	3530.25	3146.67	2763.06	2379.45	1995.86
Depreciation and Amortisation	876.55	876.55	876.55	876.55	876.55	876.55	876.55	876.55	876.55	876.55
Profit before Tax	155.21	1703.50	3054.61	2983.42	2816.63	2653.71	2270.12	1886.51	1502.90	1119.31
Tax	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Distributable Profit	155.21	1703.50	3054.61	2983.42	2816.63	2653.71	2270.12	1886.51	1502.90	1119.31
Dividend	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Retained Earnings	155.21	1703.50	3054.61	2983.42	2816.63	2653.71	2270.12	1886.51	1502.90	1119.31
Add Back : Depreciation & Amortisation	876.55	876.55	876.55	876.55	876.55	876.55	876.55	876.55	876.55	876.55
NET CASH ACCRUAL	1031.76	2580.05	3931.17	3859.97	3693.18	3530.26	3146.67	2763.06	2379.45	1995.86

JOB NO. : DCIL-185 EXHIBIT : 76

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

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	2489.71	0.00	2489.71	0.00	2489.71	0.00	2489.71	0.00	2489.71	0%	0.00
2. Building & Civil Work	7671.50	393.06	8064.56	534.62	8599.18	548.54	9147.72	486.23	9633.95	4%	385.36
3. Plant & Mahinery	3741.54	191.70	3933.24	260.74	4193.98	267.53	4461.51	237.14	4698.65	8%	375.89
4. Miscellaneous Fixed Assets	238.90	12.24	251.14	16.65	267.79	17.08	284.87	15.14	300.01	13%	39.00
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	1476.51	0.00	1476.51	0.00	1476.51	0.00	1476.51	-738.51	738.00	10%	73.80
7. Technical Know-how Fees	597.00	-597.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0%	0.00
Sub-total	16240.16		16240.16		17052.17		17885.32		17885.32		876.55
8. Contingency	812.01	0.00	812.01	-812.01	0.00	0.00	0.00	0.00	0.00		
Sub-total	17052.17		17052.17		17052.17		17885.32		17885.32		
9. Interest during Construction	833.15	0.00	833.15	0.00	833.15	-833.15	0.00	0.00	0.00		
Total	17885.32		17885.32		17885.32		17885.32		17885.32		

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 77

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

TAX COMPUTATION

('000 US $)

	OPERATING YEARS									
	1	2	3	4	5	6	7	8	9	10
Profit before Depreciation	1031.76	2580.05	3931.17	3859.97	3693.18	3530.25	3146.67	2763.06	2379.45	1995.86
Less : Current Depreciation	1031.76	826.00	779.12	659.33	618.93	581.39	546.48	513.98	483.71	455.49
Balance	0.00	1754.05	3152.04	3200.65	3074.25	2948.86	2600.19	2249.08	1895.74	1540.37
Less : Unabsorbed Depreciation	0.00	-155.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Taxable Income	0.00	1909.26	3152.04	3200.65	3074.25	2948.86	2600.19	2249.08	1895.74	1540.37
Tax @ 0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

JOB NO. : DCIL-105

EXHIBIT : 78

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

DEPRECIATION FOR TAX

('000 US $)

	WDV Rate	Building & Civil Work 4%	Plant and Machinery 8%	Misc. Fixed Assets 10%	Amortisation 10%	Total
Value		9633.95	4698.65	300.01	763.00	
Depreciation Year 1		385.36	375.89	39.00	76.30	876.55
Balance		9248.60	4322.76	261.01	686.70	
Depreciation Year 2		369.94	345.82	33.93	76.30	826.00
Balance		8878.65	3976.94	227.08	610.40	
Depreciation Year 3		355.15	318.15	29.52	76.30	779.12
Balance		8523.51	3658.78	197.56	534.10	
Depreciation Year 4		340.94	292.70	25.68	76.30	735.63
Balance		8182.57	3366.08	171.88	457.80	
Depreciation Year 5		327.30	269.29	22.34	76.30	695.23
Balance		7855.26	3096.79	149.53	381.50	
Depreciation Year 6		314.21	247.74	19.44	76.30	657.69
Balance		7541.05	2849.05	130.09	305.20	
Depreciation Year 7		301.64	227.92	16.91	76.30	622.78
Balance		7239.41	2621.12	113.18	228.90	
Depreciation Year 8		289.58	209.69	14.71	76.30	590.28
Balance		6949.83	2411.43	98.47	152.60	
Depreciation Year 9		277.99	192.91	12.80	76.30	560.01
Balance		6671.84	2218.52	85.67	76.30	
Depreciation Year 10		266.87	177.48	11.14	76.30	531.79
Balance		6404.97	2041.04	74.53	0.00	

WDV : Written Down Value

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 79

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

WORKING CAPITAL REQUIREMENTS
(Excluding Cash and Bank Balances)

('000 US $)

Items	OPERATING YEAR									
	1	2	3	4	5	6	7	8	9	10
1. Raw materials & Consumables	2962.64	3325.22	3695.55	3703.30	3703.30	3703.30	3703.30	3703.30	3703.30	3703.30
2. Finished Stock	2077.64	2288.75	2503.73	2537.42	2567.24	2597.05	2626.87	2656.69	2686.50	2716.32
3. Sundry Debtors	2315.67	2815.64	3131.41	3157.73	3157.73	3157.73	3157.73	3157.73	3157.73	3157.73
TOTAL	7355.95	8429.61	9330.69	9398.45	9428.27	9458.08	9487.90	9517.72	9547.53	9577.35
Increase/(decrease)	7355.95	1073.66	901.08	67.76	29.82	29.81	29.82	29.82	29.81	29.82
Stock Variation	2077.64	211.11	214.98	33.69	29.82	29.81	29.82	29.82	29.81	29.82

JOB NO. : DCIL-105

EXHIBIT : 80

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

PROJECTED CASH FLOW STATEMENT

('000 US $)

	Construction Period	Y 1	2	3	R 4	5	A 6	7	R 8	9	10
A. SOURCES											
Increase in Share Capital	9333.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Increase in Term Loan	9333.53	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	7355.95	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	1971.27	3519.56	4650.00	4286.35	3827.08	3371.67	2916.29	2460.88	2005.48	1550.08
Depreciation	0.00	876.55	876.55	876.55	876.55	876.55	876.55	876.55	876.55	876.55	876.55
TOTAL 'A'	18667.07	10203.77	4396.12	5526.55	5162.90	4703.63	4248.22	3792.84	3337.43	2882.03	2426.64
B. APPLICATIONS											
Increase in Capital Expenditure	17052.17	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	7355.95	1073.66	901.08	67.76	29.82	29.81	29.42	29.82	29.81	29.82

JOB NO. DCIL-105

EXHIBIT : 80

('000 US $)

	Construction Period	Y 1	2	3	E 4	5	A 6	7	R 8	9	10
Interest											
On Term Loan - @ 10% p.a.	833.15	933.35	933.35	933.35	861.56	789.76	717.96	646.17	574.37	502.58	430.78
On Working Capital Loan - @ 12% p.a.	0.00	882.71	882.71	662.04	441.36	220.68	0.00	0.00	0.00	0.00	0.00
Total Interest	833.15	1816.06	1816.06	1595.39	1302.92	1010.44	717.96	646.17	574.37	502.58	430.78
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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Repayment of Term Loan	0.00	0.00	0.00	717.96	717.96	717.96	717.96	717.96	717.96	717.96	717.96
Repayment of Working Capital Loan	0.00	0.00	1838.99	1838.99	1838.99	1838.98	0.00	0.00	0.00	0.00	0.00
TOTAL 'B'	17885.32	9172.01	4728.71	5053.41	3927.63	3597.20	1465.73	1393.95	1322.15	1250.35	1178.56
Opening Balance	0.00	781.75	1813.51	1480.91	1954.04	3189.31	4295.74	7078.23	9477.12	11492.39	13124.07
Surplus /(Deficit) during the Year (A - B)	781.75	1031.76	-332.60	473.13	1235.27	1106.44	2782.49	2398.89	2015.28	1631.68	1248.08
Closing Balance	781.75	1813.51	1480.91	1954.04	3189.31	4295.74	7078.23	9477.12	11492.39	13124.07	14372.16

JOB NO. : DCIL-105 EXHIBIT : 81

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

PROJECTED BALANCE SHEET

('000 US $)

		Y			R		A			R	
		1	2	3	4	5	6	7	8	9	10
	Share Capital	9333.54	9333.54	9333.54	9333.54	9333.54	9333.54	9333.54	9333.54	9333.54	9333.54
Add:	Reserves & Surplus	155.21	1858.71	4913.33	7896.75	10713.39	13367.10	15637.22	17523.72	19026.62	20145.92
	SHAREHOLDERS' FUND	9488.75	11192.25	14246.87	17230.29	20046.93	22700.64	24970.76	26857.26	28360.16	29479.46
Less:	Intangible Assets	686.70	610.40	534.10	457.80	381.50	305.20	228.90	152.60	76.30	0.00
	TANGIBLE NET WORTH	8802.05	10581.85	13712.76	16772.49	19665.43	22395.44	24741.86	26704.66	28283.86	29479.46
Add:	Term Loan	9333.53	9333.53	8615.57	7897.61	7179.65	6461.69	5743.73	5025.77	4307.81	3589.85
	CAPITAL FUND	18135.58	19915.38	22328.33	24670.10	26845.08	28857.13	30485.59	31730.43	32591.67	33069.31
Less:	Net Fixed Assets	16322.07	15521.82	14721.57	13921.32	13121.07	12320.82	11520.57	10720.32	9920.07	9119.82
	NET CORRENT ASSETS	1813.51	4393.56	7606.76	10748.78	13724.01	16536.31	18965.02	21010.11	22671.60	23949.49
A.	CURRENT ASSETS										
	Working Capital	7355.95	8429.61	9330.69	9398.45	9428.27	9458.08	9487.90	9517.72	9547.53	9577.35
	Cash & Bank Balance as per Cash Flow Sttatement	1813.51	1480.91	1954.04	3189.31	4295.74	7078.23	9477.12	11492.39	13124.07	14372.16
	TOTAL 'A'	9169.46	9910.52	11284.73	12587.76	13724.01	16536.31	18965.02	21010.11	22671.60	23949.49
B.	CURRENT LIABILITIES										
	Bank Loan	7355.95	5516.96	3677.97	1838.98	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL 'B'	7355.95	5516.96	3677.97	1838.98	0.00	0.00	0.00	0.00	0.00	0.00
	NET CORRENT ASSETS (A-B)	1813.51	4393.56	7606.76	10748.78	13724.01	16536.31	18965.02	21010.11	22671.60	23949.49

DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105 EXHIBIT : 82

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

BREAK-EVEN ANALYSIS

('000 US $)

Sl. No.	Particulars		Amount
1.	Raw Materials and Consumables		21455.64
2.	Power		57.85
3.	Water		11.40
4.	Sub-total (1 thru 3)		21524.89
5.	Contingency		1076.24
6.	VARIABLE COSTS		22601.13
7.	REVENUE		38419.00
8.	CONTRIBUTION (7 - 6)		15817.87
9.	Labour & Plant Overhead*		8464.46
10.	Other Factory Expenses		204.30
11.	Administrative & Sales Expenses*		2161.49
12.	Sub-Total (7 thru 9)		10830.25
13.	Contingency		541.51
14.	Sub-Total (10+11)		11371.76
15.	Interest*		1041.27
16.	Depreciation		876.55
17.	FIXED COSTS (14+15+16)		13289.59
	BREAK-EVEN SALES	17*7/8	32278.21
	BREAK-EVEN POINT		84.0%
	CASH BREAK-EVEN SALES		30149.21
	CASH BREAK-EVEN POINT		78.5%

* Average over 10 years

JOB NO. : DCIL-105 EXHIBIT : 83

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

PROJECT PROFILE ON CIRCUIT BREAKERS AND ISOLATORS

INTERNAL RATE OF RETURN

('000 US $)

Year	Outflow	Inflow	Net Inflow
0	-18667.07	0.00	-18667.07
1	0.00	2847.82	2847.82
2	0.00	4396.11	4396.11
3	0.00	5526.55	5526.55
4	0.00	5162.90	5162.90
5	0.00	4703.63	4703.63
6	0.00	4248.22	4248.22
7	0.00	3792.84	3792.84
8	0.00	3337.43	3337.43
9	0.00	2882.03	2882.03
10	0.00	2426.64	2426.64

IRR 17.6%

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

SECTION - 13
PROJECT IMPLEMENTATION PLAN

PROJECT IMPLEMENTATION PLAN

Two Circuit Breakers and Isolators manufacturing plants will be set up in Morocco and UAE. The implementation schedule of the key activities involved in setting up these plants is presented in Exhibit-84.

The programme covers a time span of 24 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 7 to 10 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 four 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.

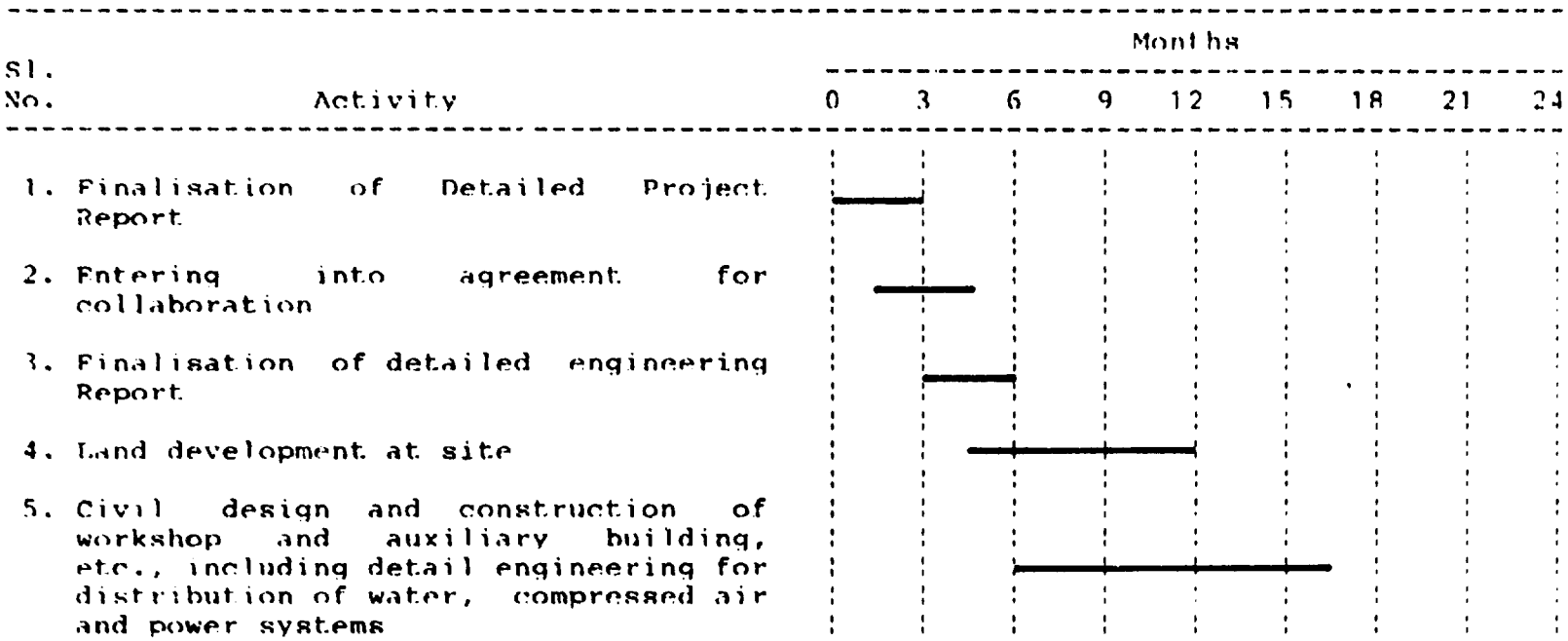
JOB NO. : DCIL-105

EXHIBIT : 84

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

PROJECT PROFILE ON CIRCUIT BREAKERS & ISOLATORS

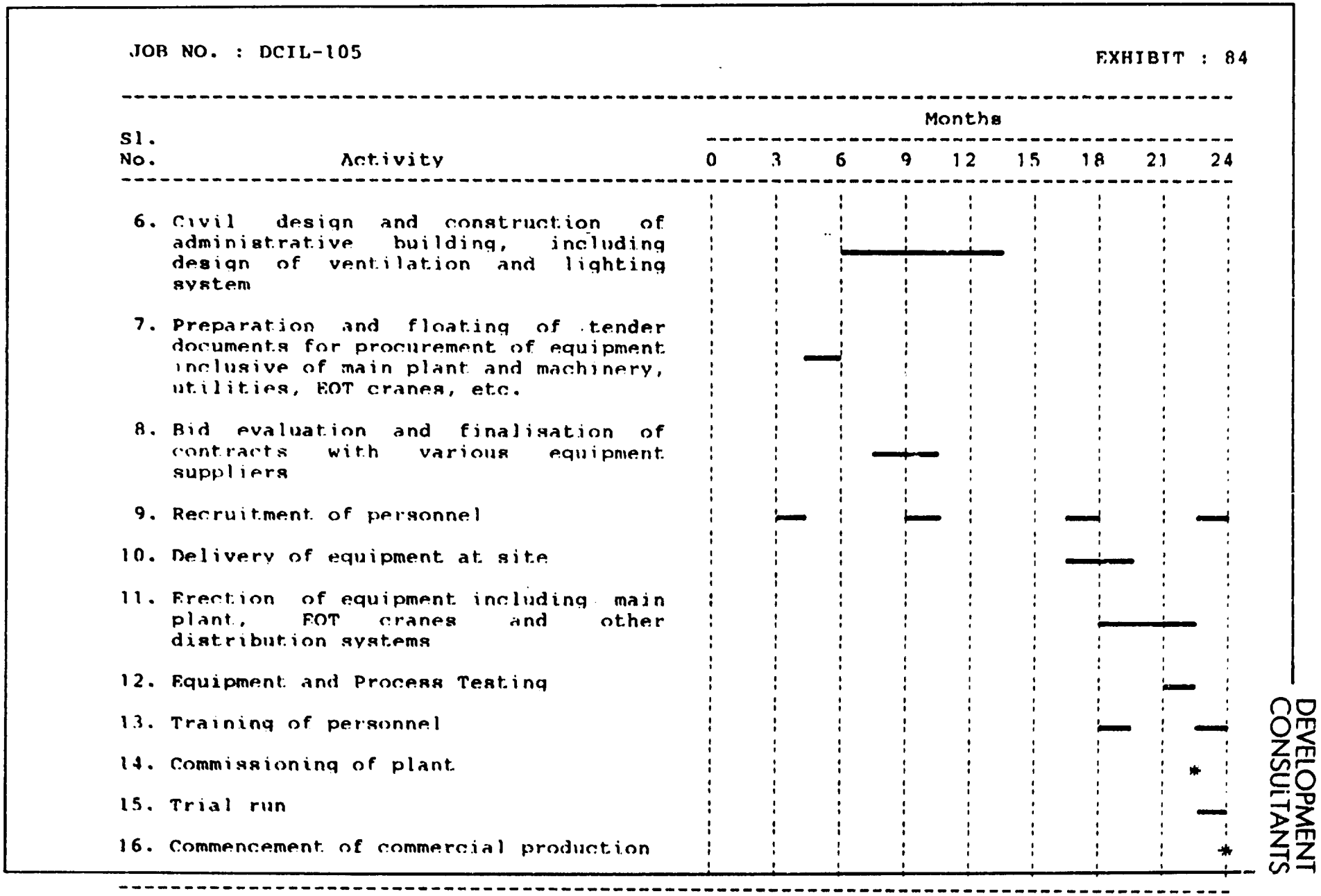
PROJECT IMPLEMENTATION SCHEDULE : CIRCUIT BREAKERS & ISOLATORS



DEVELOPMENT CONSULTANTS

JOB NO. : DCIL-105

EXHIBIT : 84



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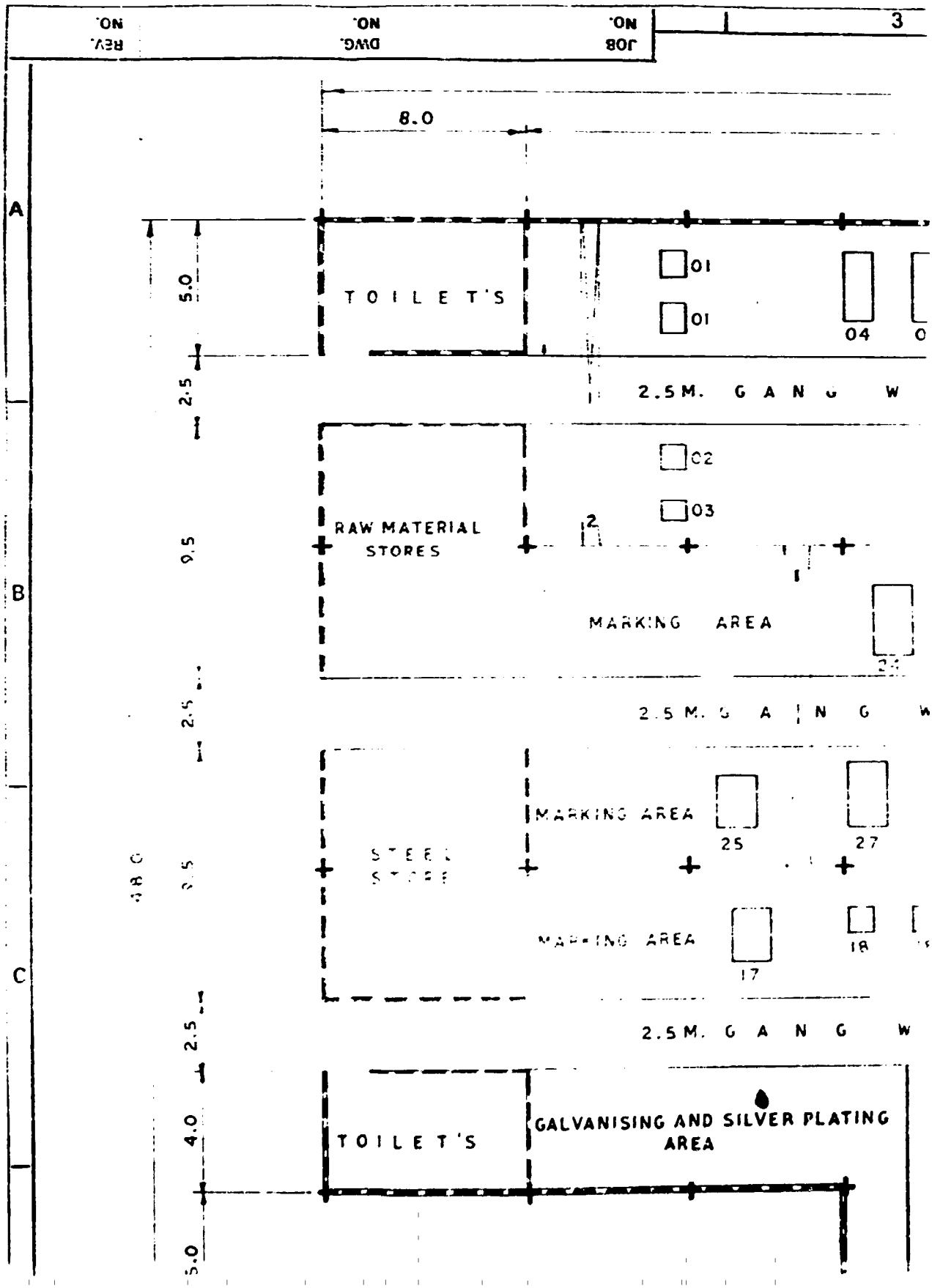
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GALVANISING AND SILVER PLATING AREA

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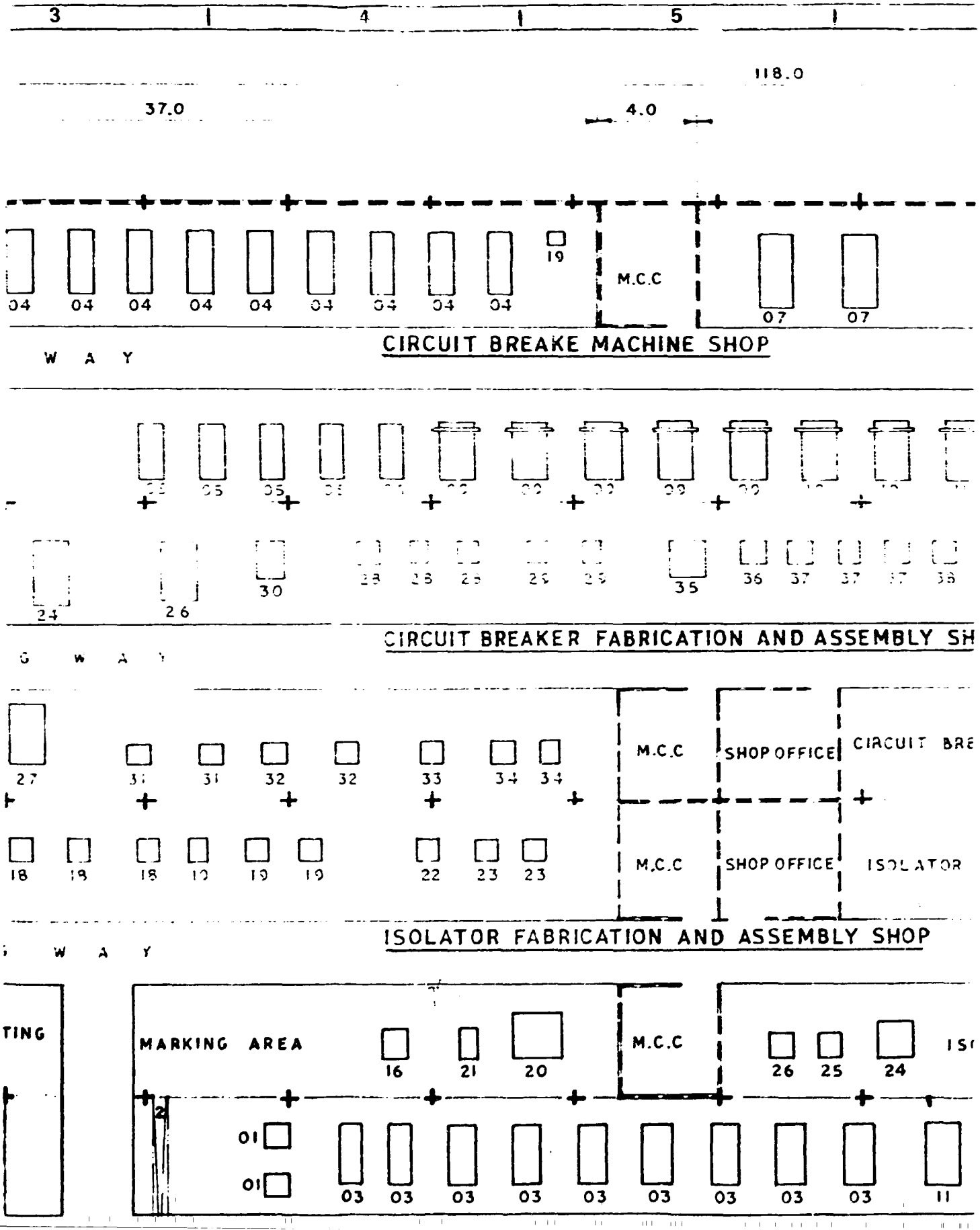
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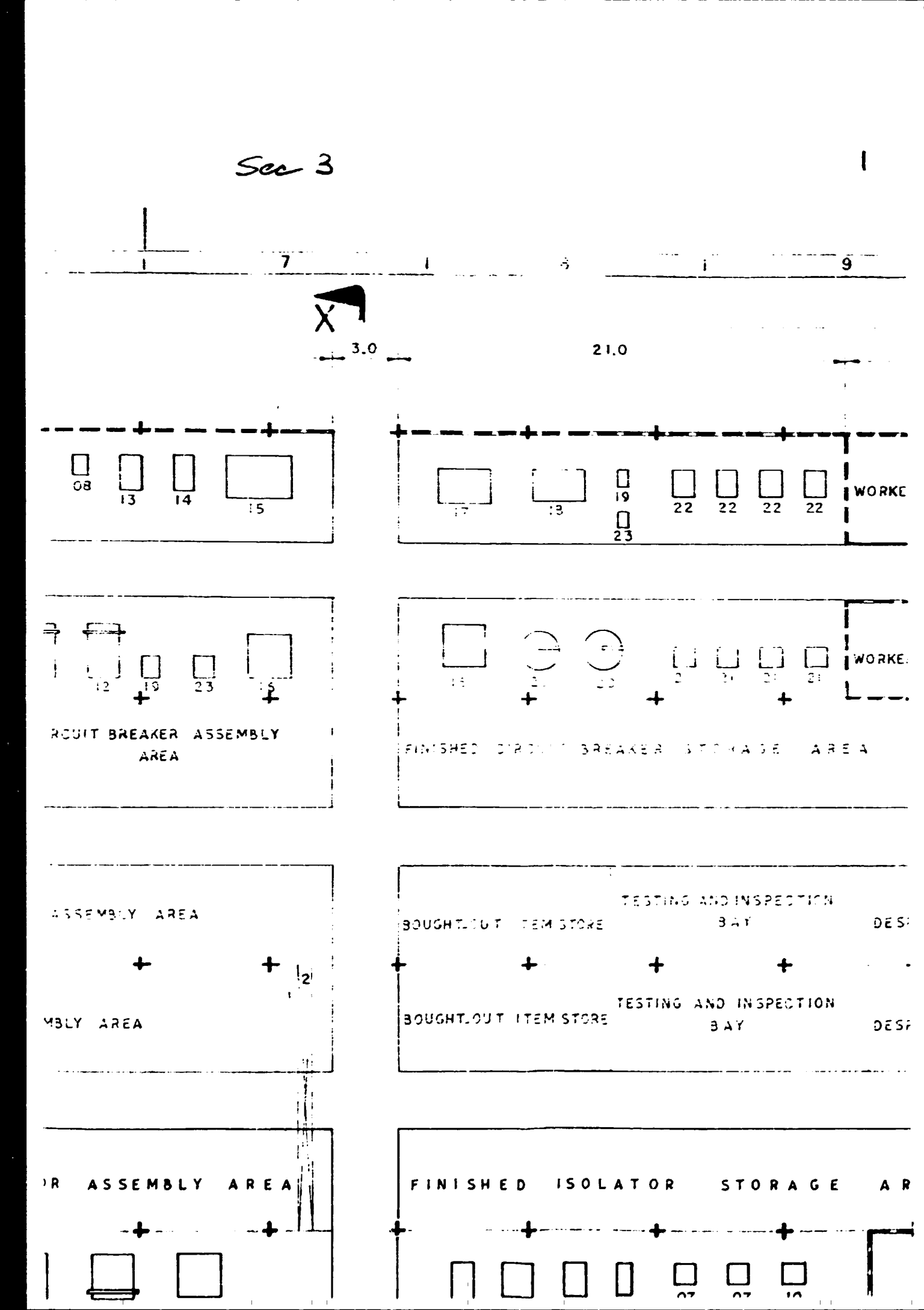
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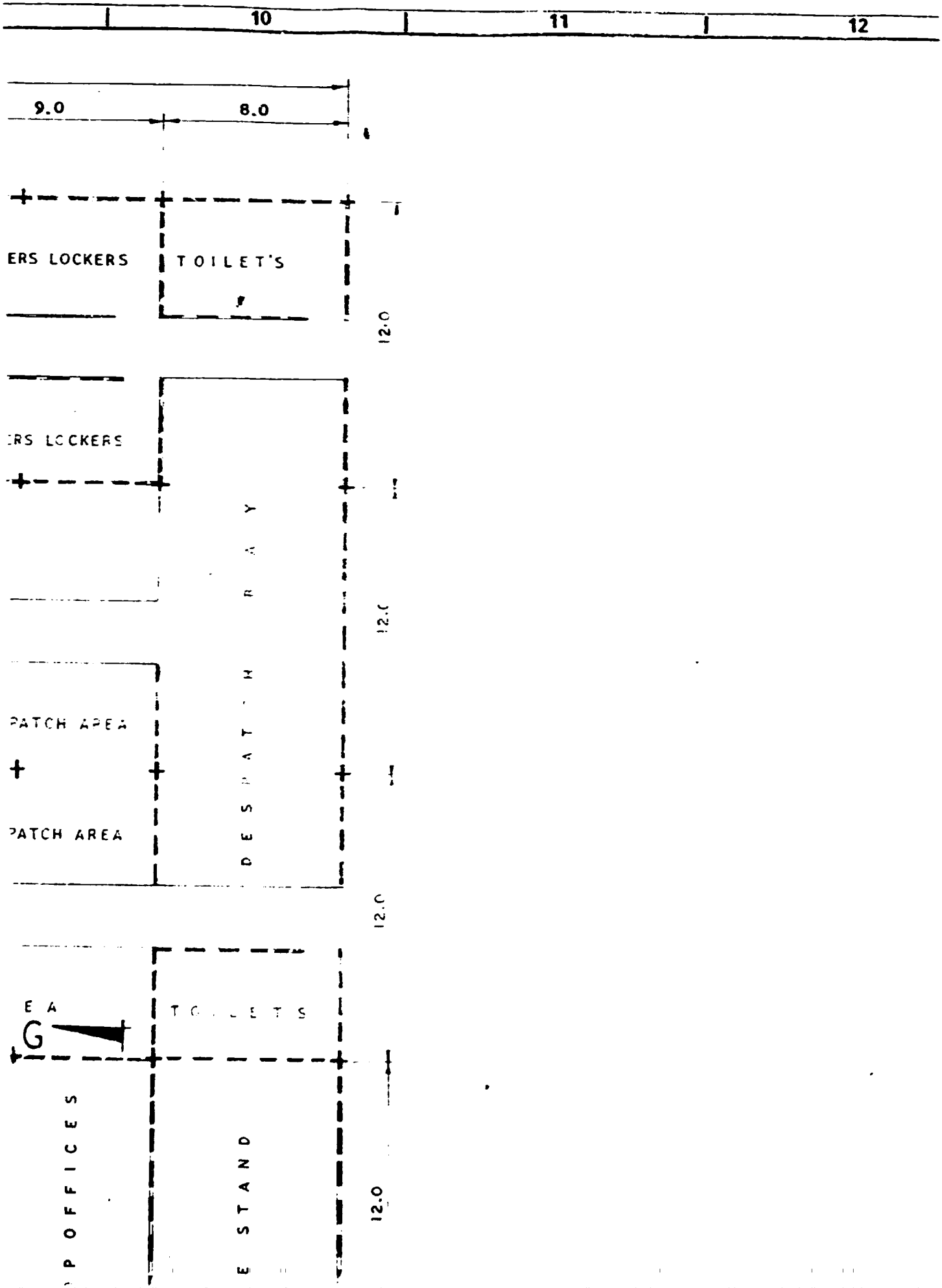
Sec 4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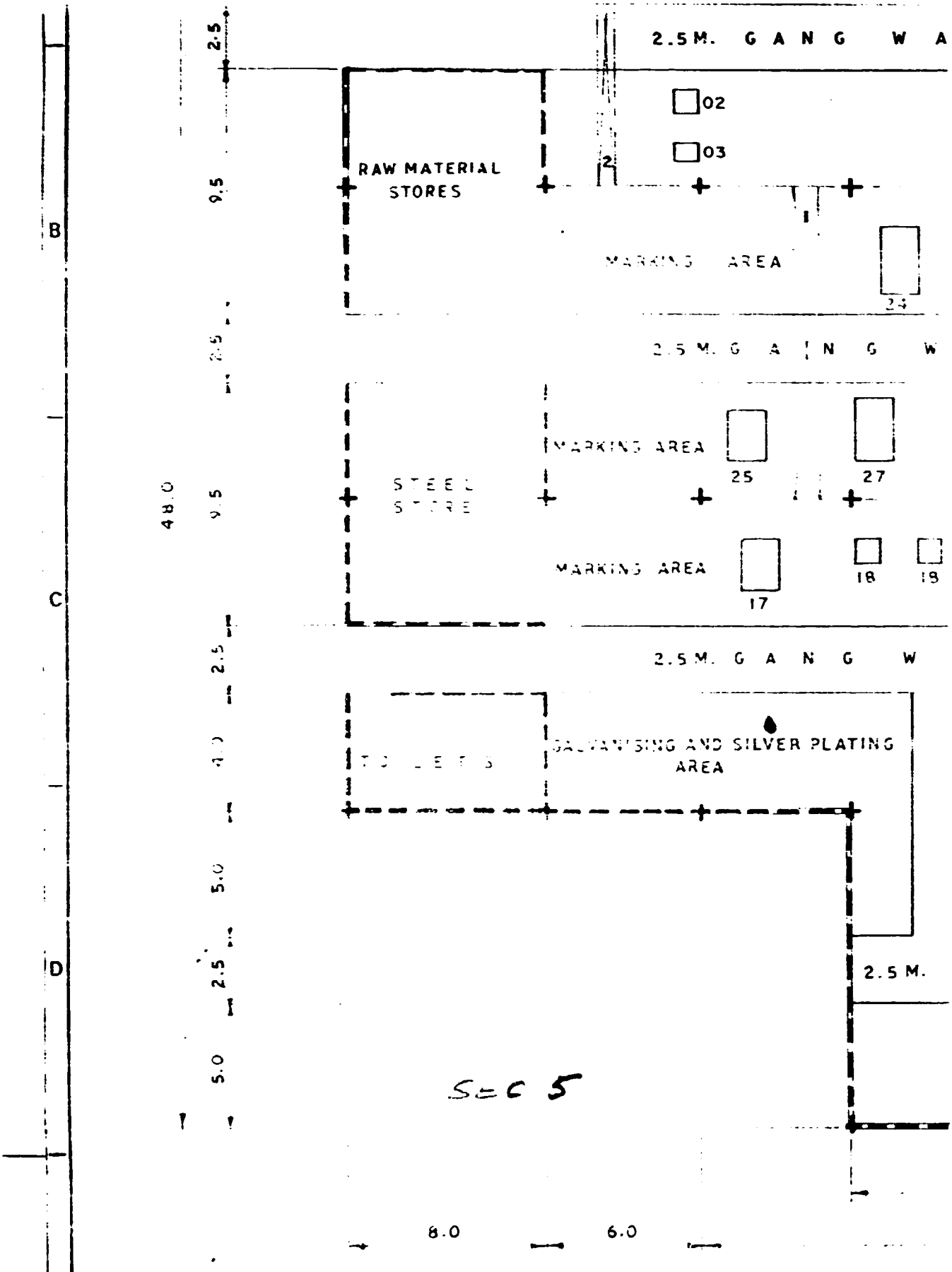
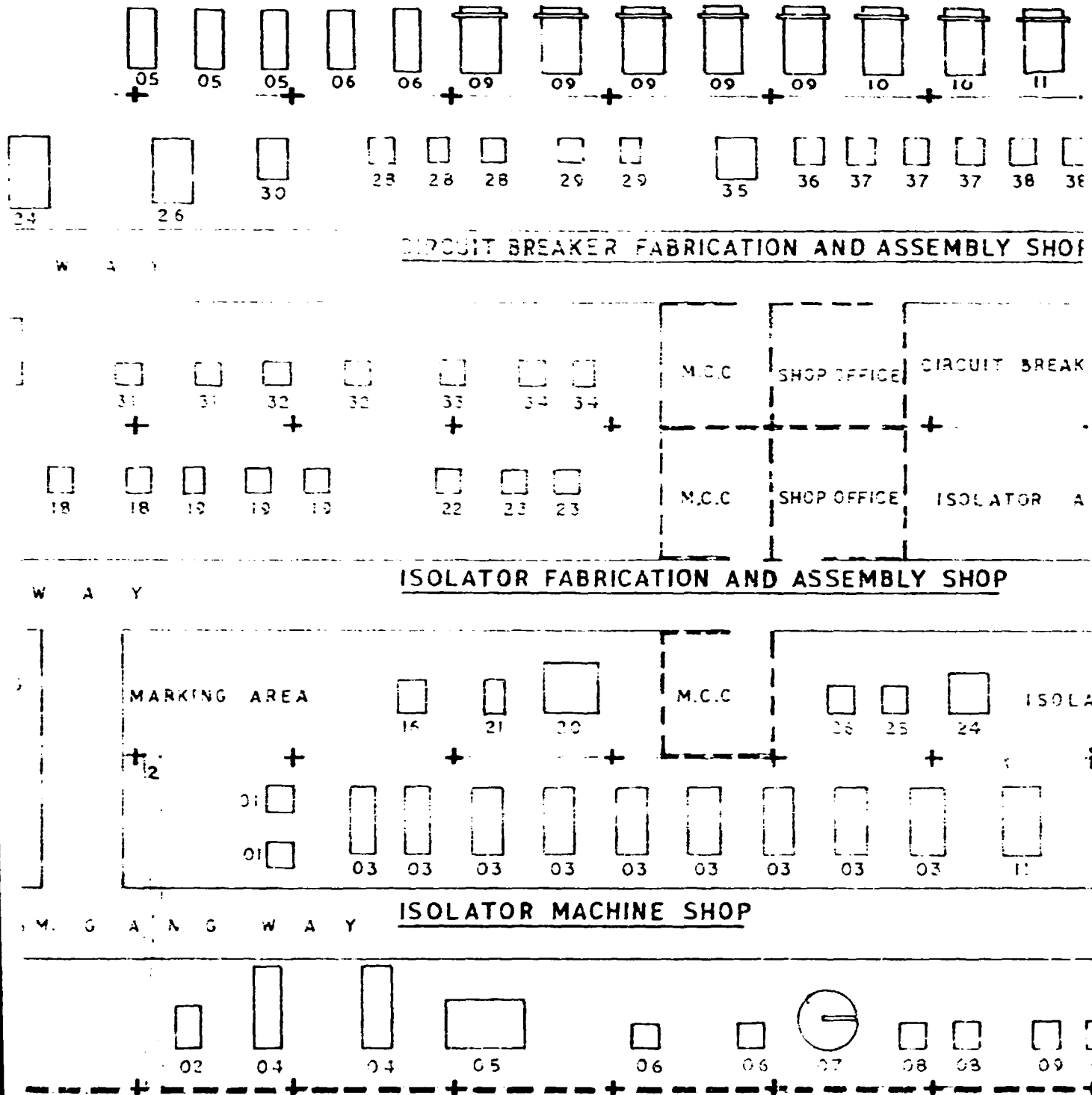


LEGEND

MACHINE SHOP: CIRCUIT BREAKER

SL.NO	EQUIPMENT	QTY
01	POWER HACKSAW_300MM	2
02	POWER HACKSAW_150 MM	1
03	CIRCULAR COLDSAW	1



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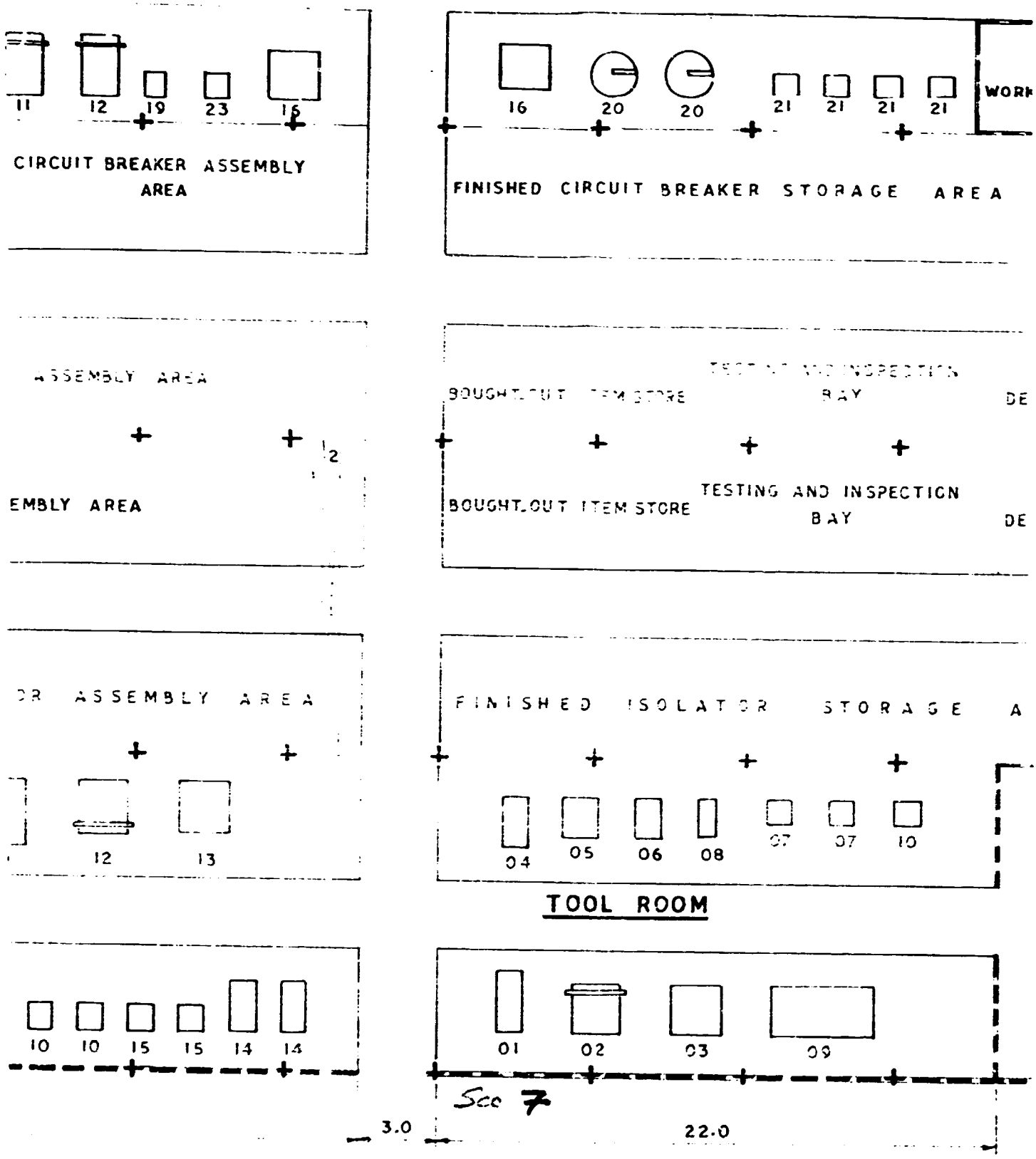
MACHINE SHOP: ISOLATOR

SL.NO.	EQUIPMENT	QTY
01	POWER HACKSAW_150MM	2
02	POWER HACKSAW_300MM	1
03	CENTRE LATHE_300MM	9
04	CENTRE LATHE_500MM	2
05	AUTOMATIC TURRET LATHE	1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CIRCUIT BREAKER ASSEMBLY AREA
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FINISHED CIRCUIT BREAKER STORAGE AREA
ASSEMBLY AREA
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BOUGHT-OUT ITEM STORE
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BOUGHT-OUT ITEM STORE
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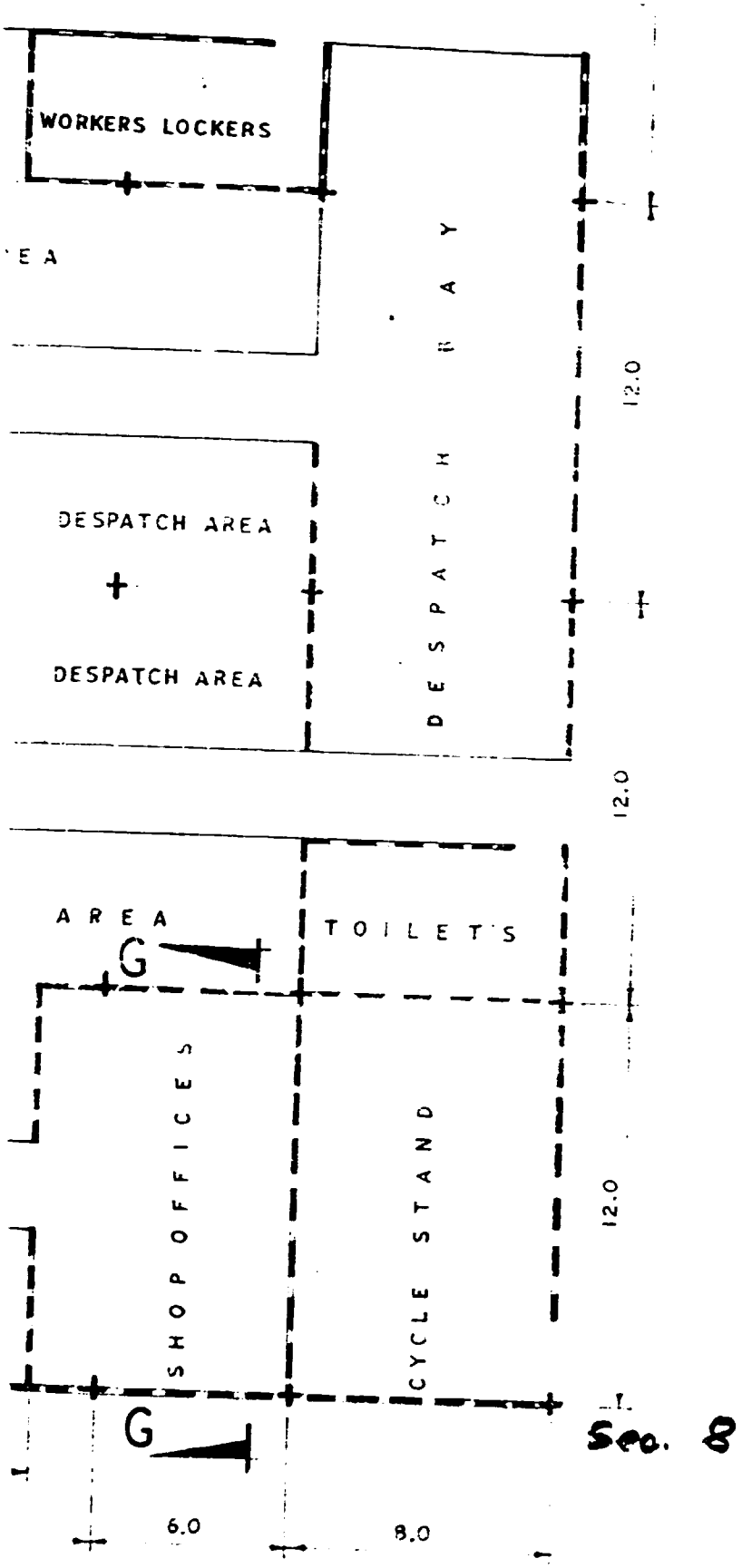
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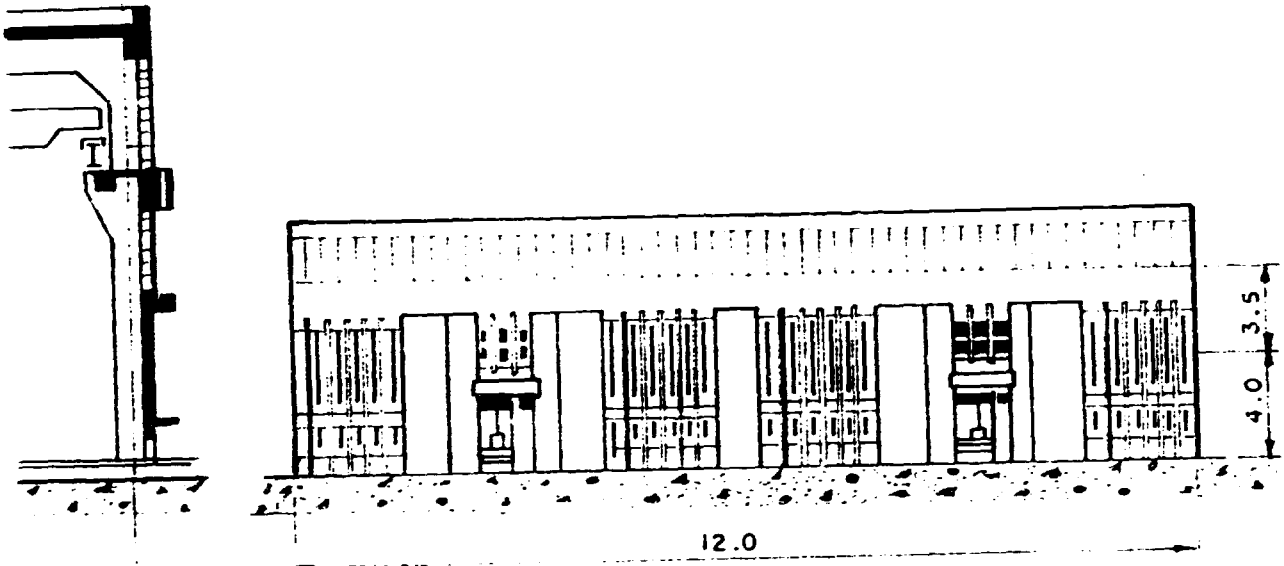

GF_ WORKERS LOCKERS
IST. FLOOR_ SHOP OFFICE

SECTION_GG

shop office & workers lockers
SCALE_N.T.S

LAYOUT OF WORKSHOP BUILDING
CIRCUIT BREAKER AND ISOLATOR 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 MC/SR	SCALE 1:200
PROJ. ENGR.	ENG. MGR.	DATE 7.8.93
DEPT. HEAD		JOB NO. DCIL 45010
DWG. NO. EXHIBIT_44		REV. NO.

DATE | REV. NO.

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L E G E N D

MACHINE SHOP: CIRCUIT BREAKER

SL.NO	EQUIPMENT	QTY
0 1	POWER HACKSAW_300MM	2
0 2	POWER HACKSAW_150 MM	1
0 3	CIRCULAR COLDSAW	1
0 4	CENTRE LATHE_300 MM	9
0 5	CENTRE LATHE_450 MM	3
0 6	CENTRE LATHE 500MM	2
0 7	AUTOMATIC TURRET LATHE	2
0 8	PIPE & BOLT THREADING MACHINE	2
0 9	UNIVERSAL MILLING MACHINE	5
1 0	VERTICAL MILLING MACHINE	2
1 1	VERTICAL MILLING MACHINE	2
1 2	UNIVERSAL MILLING MACHINE	1
1 3	SHAPING MACHINE	1
1 4	SLOTTING MACHINE	1
1 5	HORIZONTAL BORING, MILLING & SHAPING MACHINE	1
1 6	GEAR HOBBER	2
1 7	CYLINDRICAL GRINDING MACHINE	1
1 8	HYDRAULIC SURFACE GRINDING MACHINE	1
1 9	DOUBLE ENDED BENCH GRINDER	3
2 0	RADIAL DRILLING MACHINE	2
2 1	COLUMN DRILLING MACHINE	4
2 2	PILLAR DRILLING MACHINE	4
2 3	BENCH DRILLING MACHINE	2

FABRICATION SHOP: CIRCUIT BREAKER

2 4	GUILLOTINE SHEAR	1
2 5	PIPE BENDING MACHINE	1
2 6	BENDING ROLL	1
2 7	UNIVERSAL EDGING, BENDING & FOLDING MACHINE	1
2 8	TRANSFORMER ARC WELDING SET	3
2 9	RECTIFIER DC WELDING SET	2
3 0	SPOT WELDING MACHINE	1
3 1	OXY-ACETYLENE GAS WELDING SET	2
3 2	OXY ACETYLENE GAS CUTTING SET	2
3 3	PILLAR DRILLING MACHINE	1
3 4	DOUBLE WHEEL GRINDER	2

ASSEMBLY SHOP: CIRCUIT BREAKER

3 5	HYDRAULIC PRESS	1
3 6	ARBOUR PRESS	1
3 7	GASKET CUTTER	3
3 8	DRYING OVEN	2

E F G H

1 | 2 | 3

Sec 10

MACHINE SHOP: ISOLATOR

SL NO.	EQUIPMENT	QTY
01	POWER HACKSAW_150MM	2
02	POWER HACKSAW_300MM	1
03	CENTRE LATHE _ 300MM	5
04	CENTRE LATHE _ 500MM	2
05	AUTOMATIC TURRET LATHE	1
06	PIPE & BOLT THREADING MACHINE	2
07	RADIAL DRILLING MACHINE	1
08	COLUMN DRILLING MACHINE	2
09	PILLAR DRILLING MACHINE	2
10	BENCH DRILLING MACHINE	2
11	RAM TYPE UNIVERSAL MILLING MACHINE	2
12	UNIVERSAL MILLING MACHINE	1
13	GEAR HOBBER	1
14	SHAPING MACHINE	2
15	BENCH GRINDER	2

FABRICATION SHOP: ISOLATOR

16	METAL CUTTING BAND SAW	1
17	UNIVERSAL EDGING BENDING & FOLDING MACHINE	1
18	ARC WELDING SET_ 300 AMPS	3
19	ARC WELDING SET _ 200 AMPS	3
20	FORGING HAMMER	1
21	FORGING HEARTH	1
22	PIPE BENDING MACHINE	1
23	PEDESTAL GRINDING MACHINE	2

ASSEMBLY SHOP: ISOLATOR

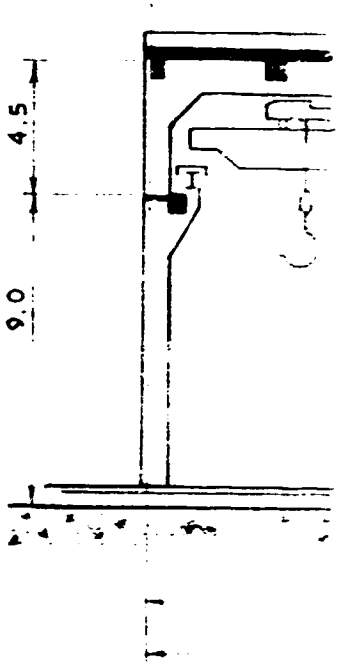
24	HYDRAULIC PRESS	1
25	ARBOUR PRESS	1
26	OIL HEATING TANK	1

TOOL ROOM

01	CENTRE LATHE	1
02	UNIVERSAL MILLING MACHINE	1
03	BORING MACHINE	1
04	COLUMN DRILLING MACHINE	1
05	UNIVERSAL TOOL & CUTTER GRINDER	1
06	CARBIDE TIPPED TOOL GRINDING & LAPPING MACHINE	2
07	BENCH GRINDER	1
08	DRILL POINT GRINDER	1
09	HEAT TREATMENT FURNACE & QUENCHING TANK	1

MATERIAL HANDLING

1	E.O.T CRANE _ 10MT.	1
2	E.O.T CRANE _ 5MT.	3



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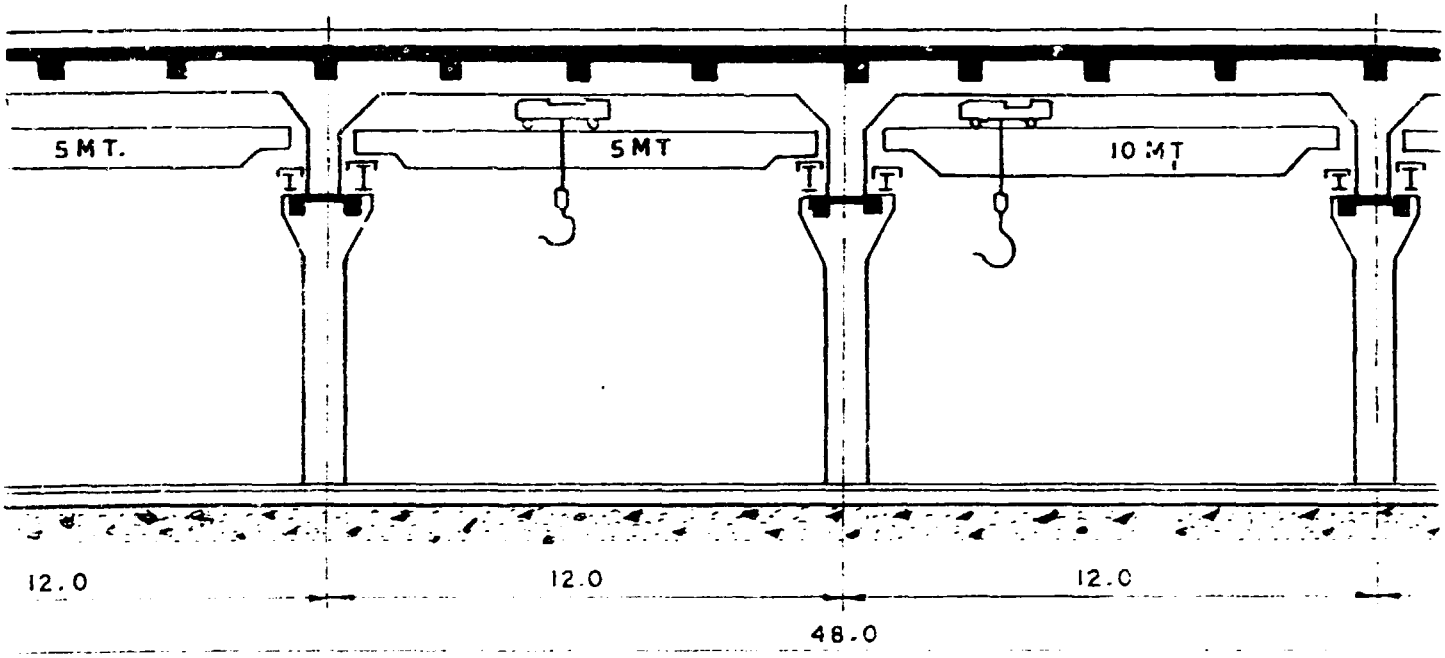

VIEW FROM _ XX

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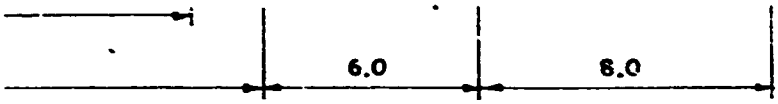

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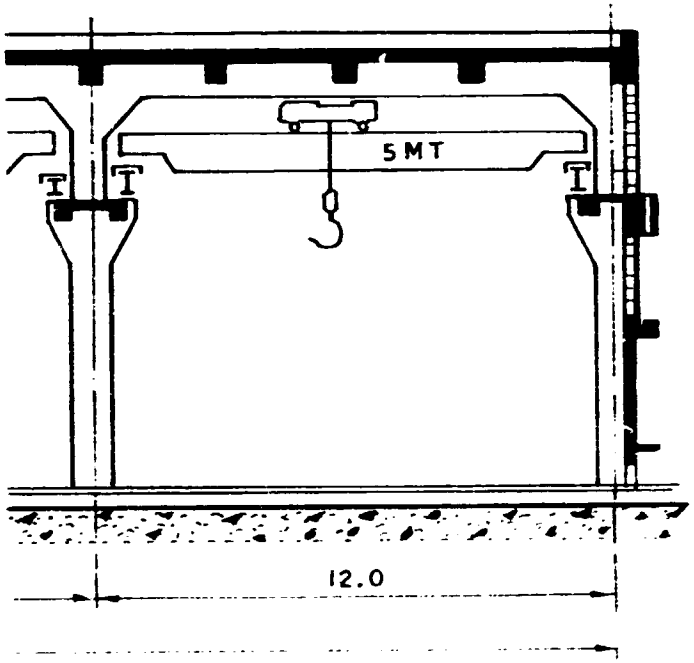

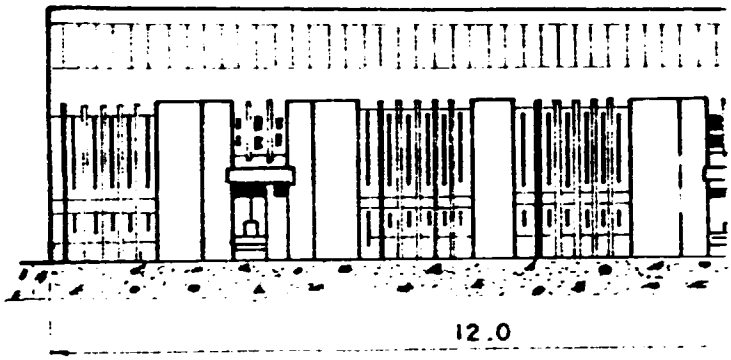

GF_ WORKERS LOCKERS
IST.FLOCR_ SHOP OFFICE

SECTION_G G

shop office & workers lockers

SCALE_N.T.S

LAYOUT OF WORKSHOP BU
CIRCUIT BREAKER AND ISOLA

UNITED NATIONS INDUSTRIAL DEVELOPMEN
ARAB INDUSTRIAL DEVELOPMENT & MININ

DEVELOPMENT CONSUI

CONSULTING ENGINEERS

BOMBAY • CALCUTTA • MADRAS • NEW DE

DRAWN MUKUL	DESIGNED MC/SR
PROJ. ENGR.	ENG. MGR.
DEPT. HEAD	

DWG. NO. EXHIBIT_44

PTION	RELEASE STATUS	DATE	REV. NO.

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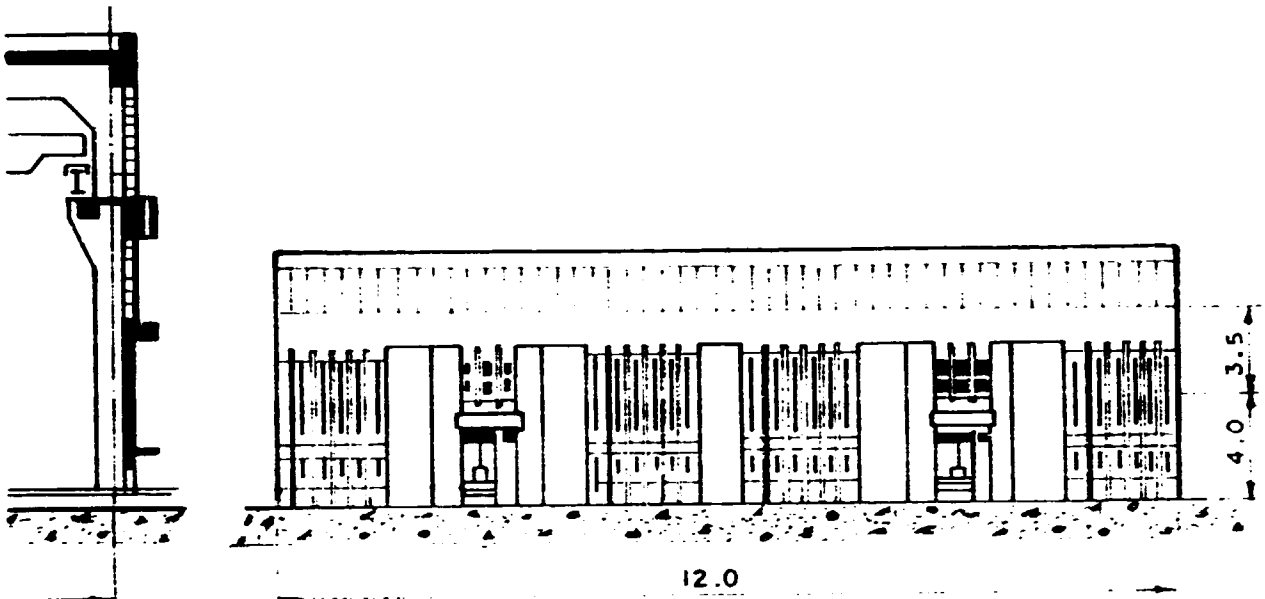

GF_ WORKERS LOCKERS
IST.FLOOR_ SHOP OFFICE

SECTION_G G

shop office & workers lockers

SCALE_N.T.S

LAYOUT OF WORKSHOP BUILDING
CIRCUIT BREAKER AND ISOLATOR PLANT

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
ARAB INDUSTRIAL DEVELOPMENT & MINING ORGANIZATION

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

DRAWN MUKUL	DESIGNED MC/SR	SCALE 1:200
PROJ. ENGR.	ENG MGR.	DATE 7.8.93
DEPT. HEAD		JOB NO. DCIL 45010
DWG. NO. EXHIBIT_44		REV. NO

DATE	REV. NO.

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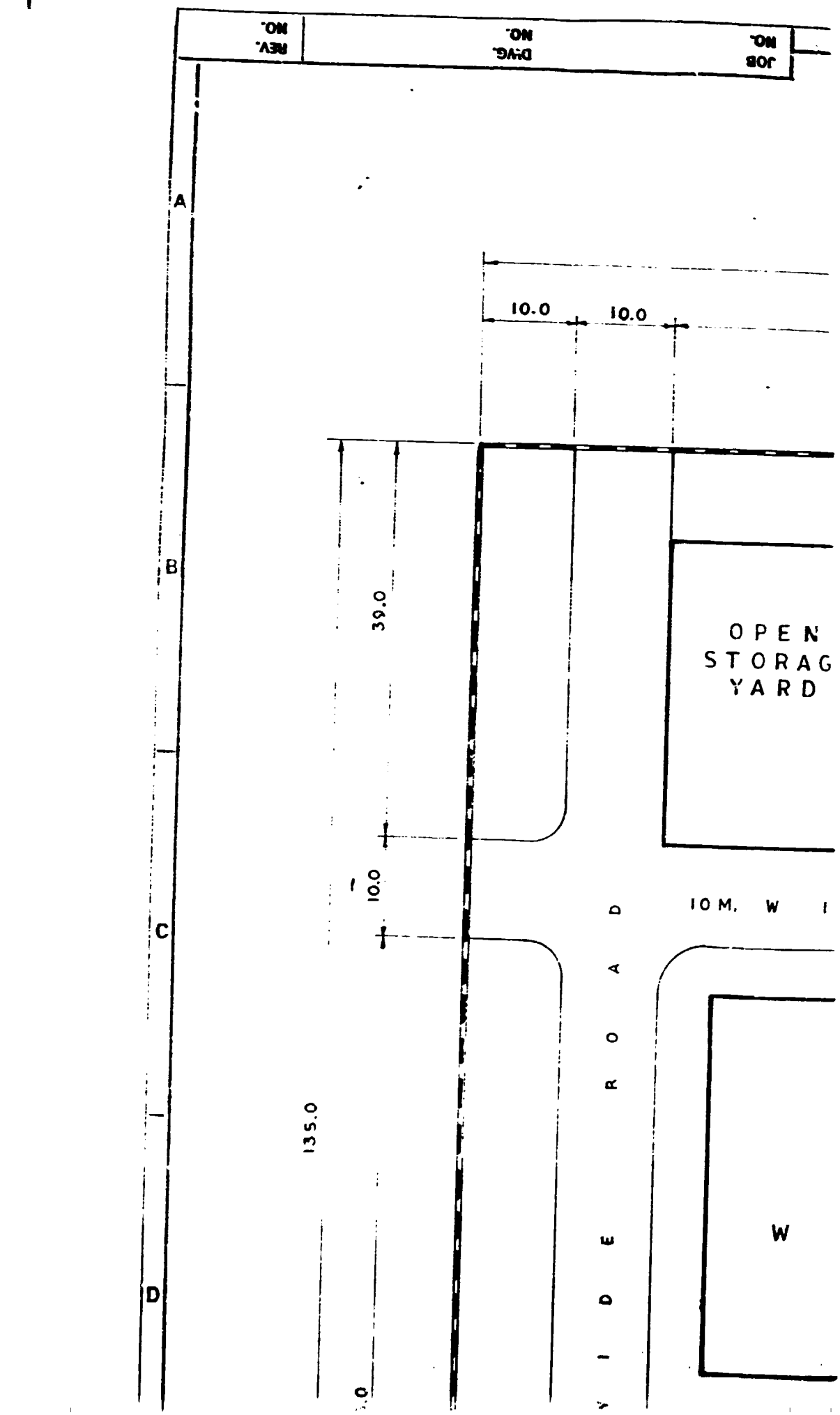
SEC 13

SEC 14

SEC. 1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COMPRESSOR ROOM

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TRANSFORMER ROOM

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CANTEEN

D E R O A D

ADMINISTRATIVE BUILDING

Sag 4

9 | 10 | 11

5.0 10.0

FORMER ROOM

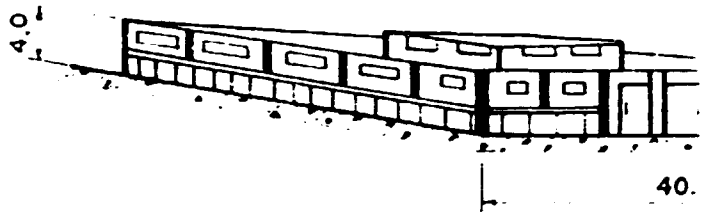
PUMP HOUSE. WATER TANK

13.0

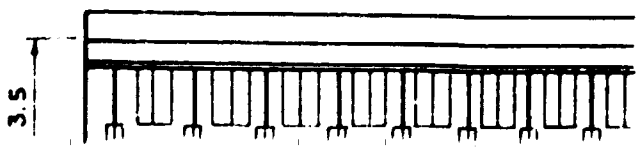
10.0

87.0

ROAD



CANTEEN



Sec. 5

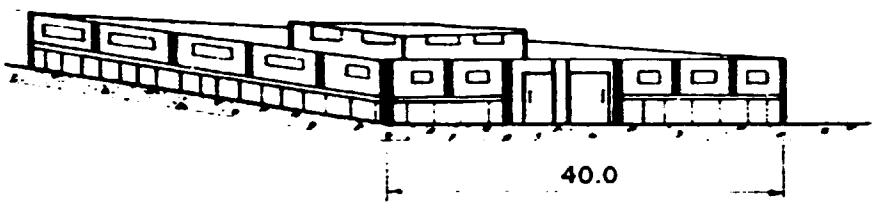
10 | 11 | 12

A

B

C

D



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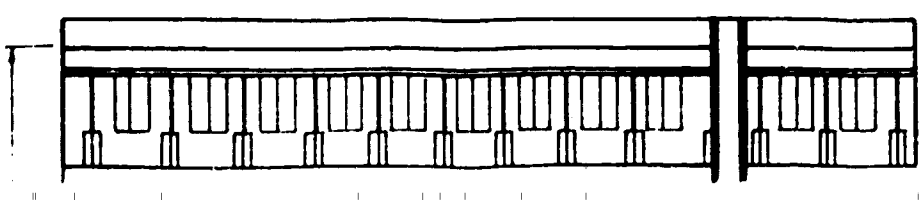
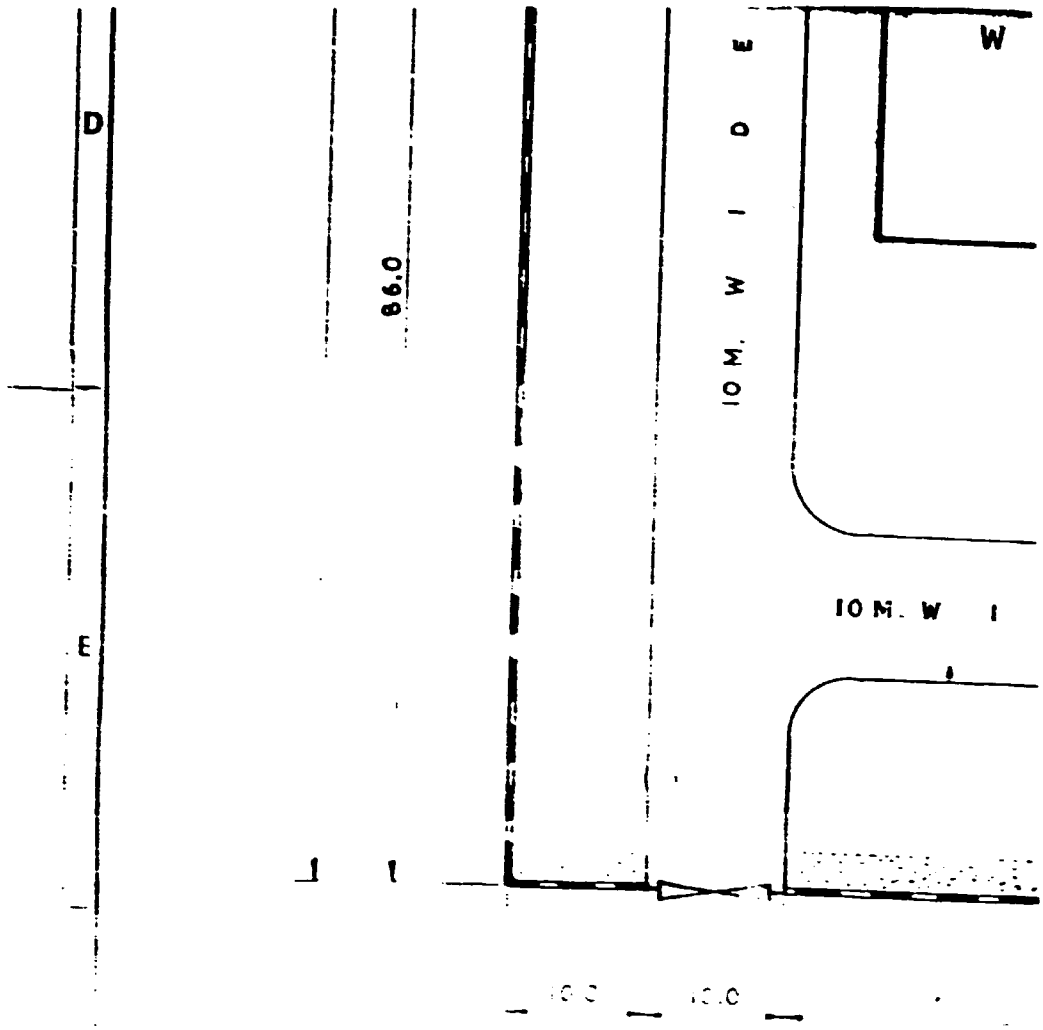



D
E
G
86.0
10 M. WIDE
W
10 M. W I
See 6

W O R K S H O P B U I L D I N G

FIRST AID ROOI

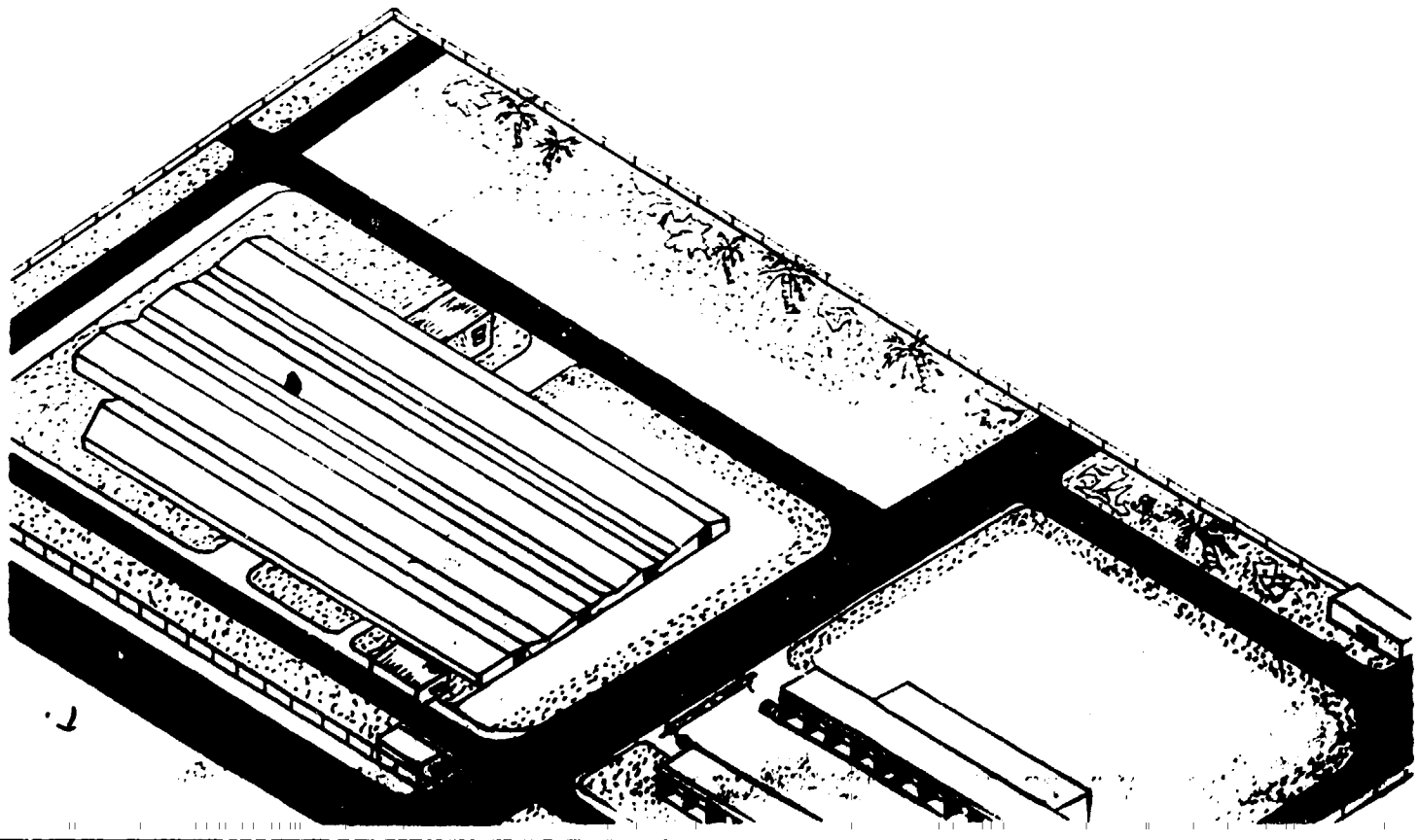
W I D E R C A D

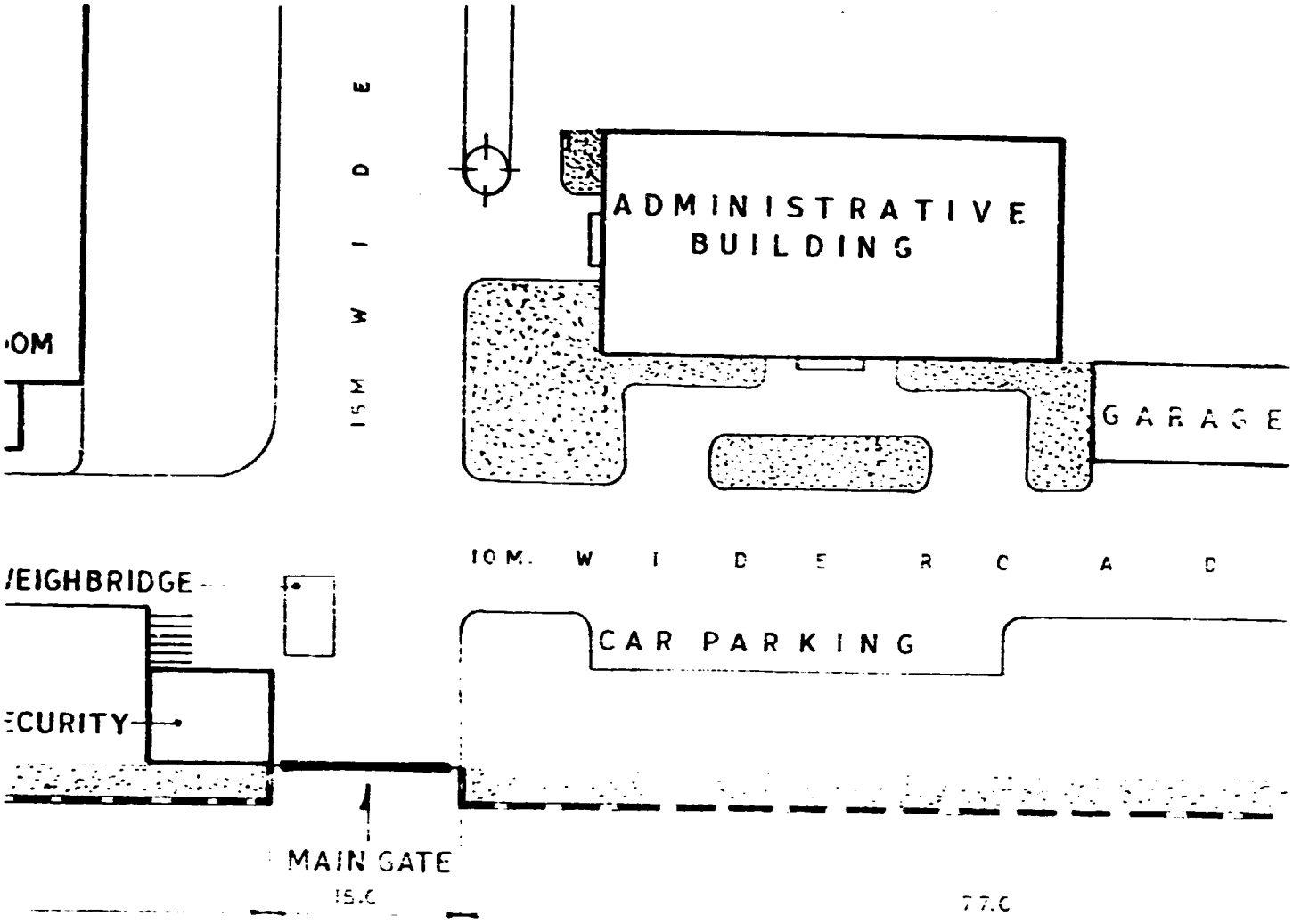
WEI

SECL

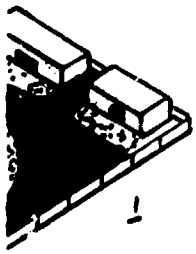
126.0

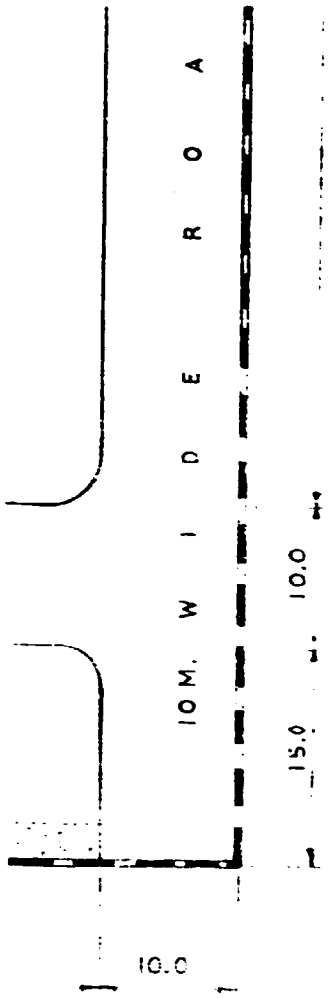
Sec 7

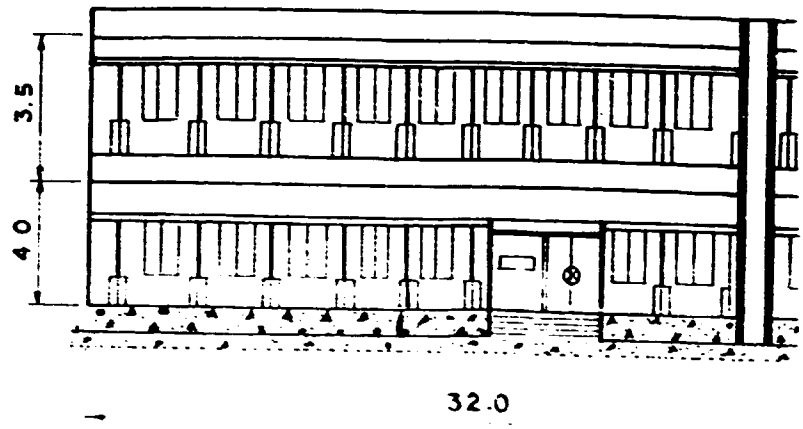



ADMINISTRATIVE BUILDING
GARAGE
15M WIDE
10M. WIDE ROAD
CAR PARKING
MAIN GATE
15.0
77.0

Sec 8







ADMINISTRATIVE OFFICE BUILDIN

SCALE — N.T.S

Sec. 4

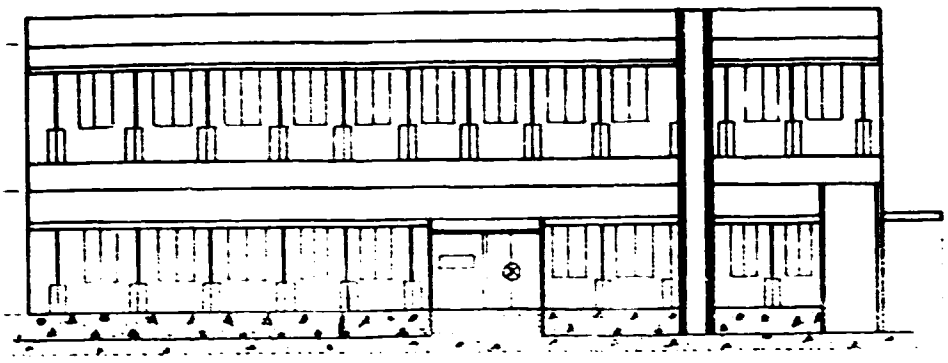
BLOCK LAYOUT: CIRCUIT BREAKER &

UNITED NATIONS INDUSTRIAL DEVEL

&

ARAB INDUSTRIAL DEVELOPMENT AN

DEVELOPMENT CO



32.0 2.0

ADMINISTRATIVE OFFICE BUILDING

SCALE — N.T.S

Sec. 10

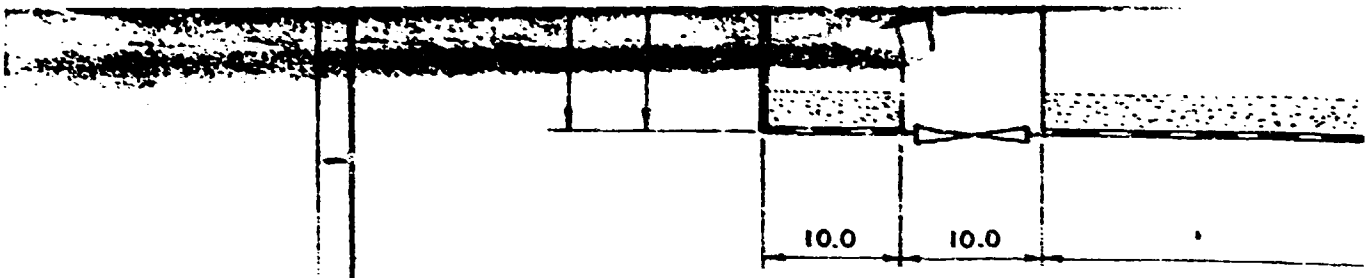
BLOCK LAYOUT: CIRCUIT BREAKER & ISOLATOR PLANT.

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

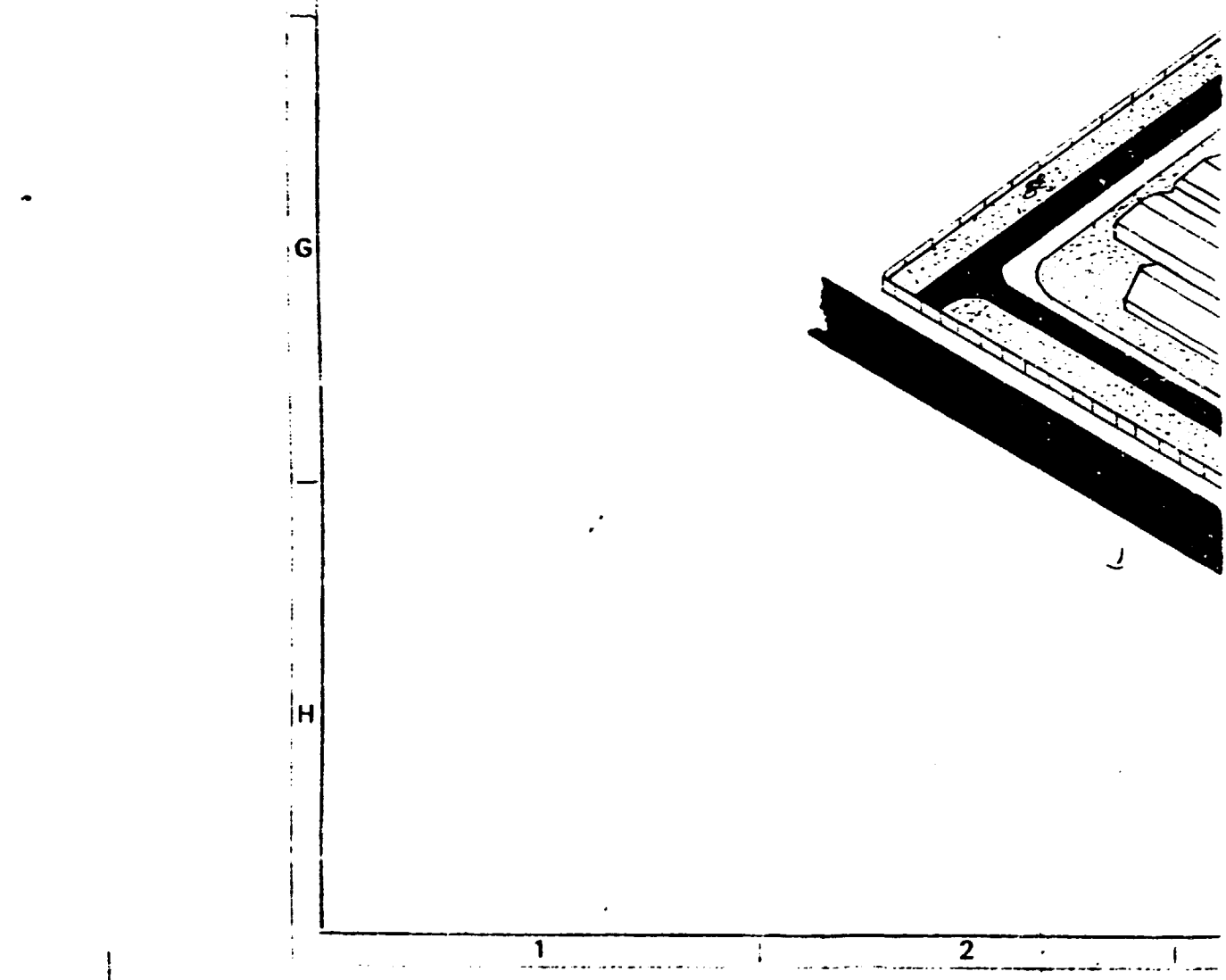
&

ARAB INDUSTRIAL DEVELOPMENT AND MINING ORGANIZATION

DEVELOPMENT CONSULTANTS LTD



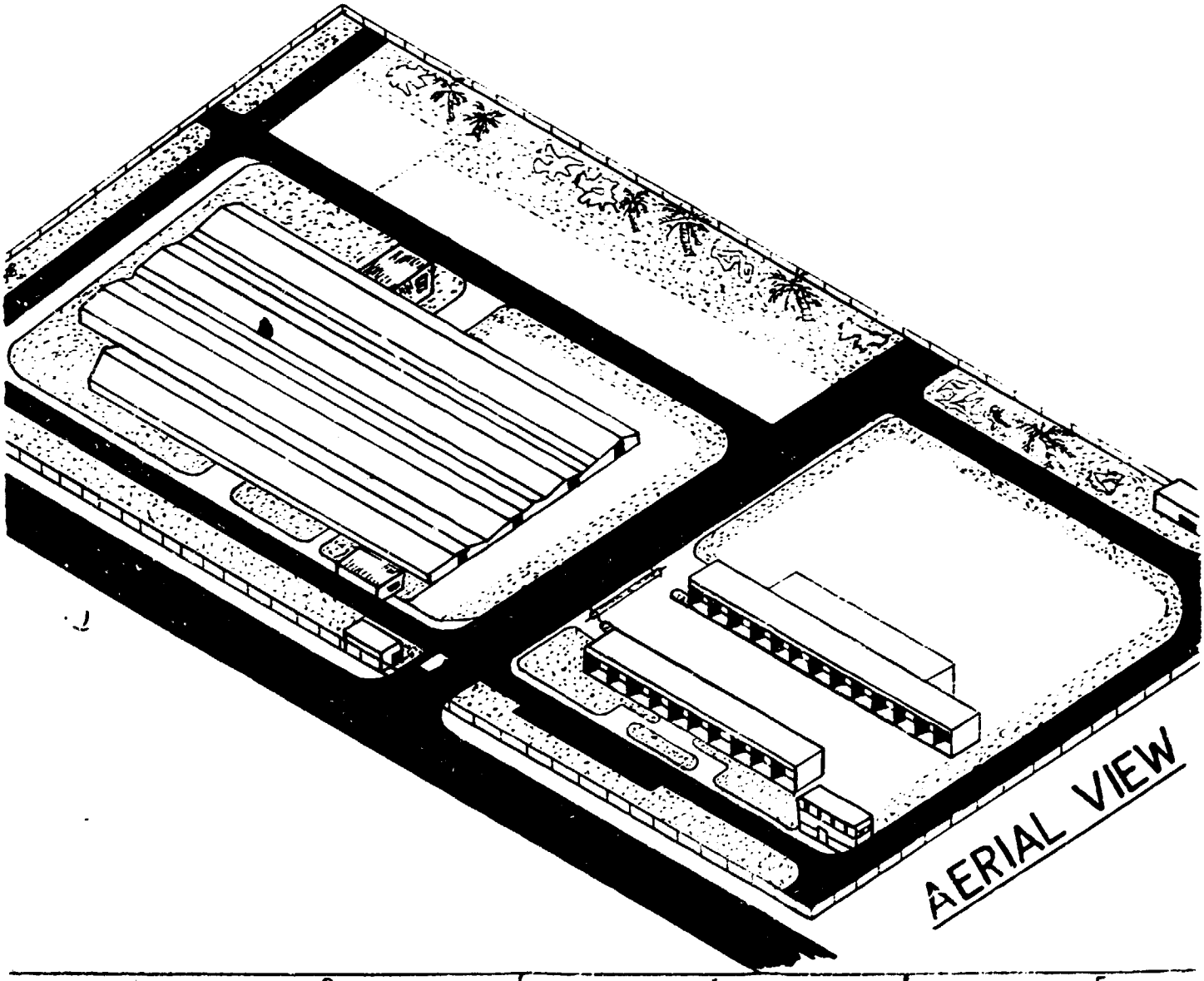
See. 6



Sec. 11

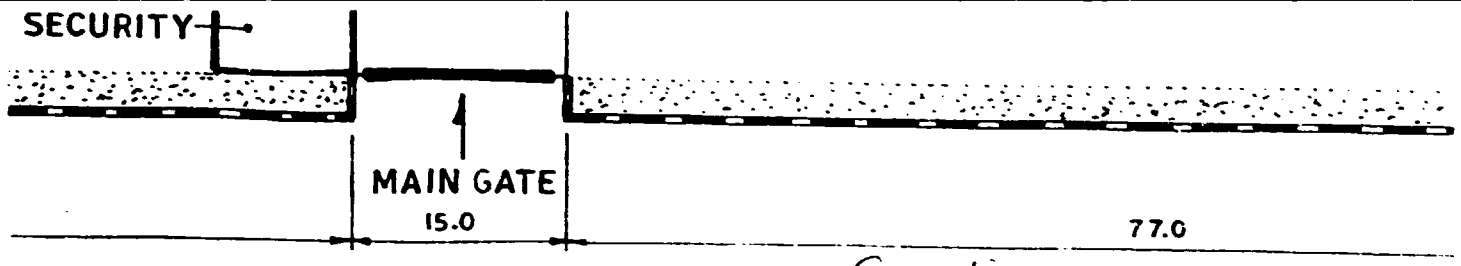
128.0

Sec 7



3 4 5

Sec 12



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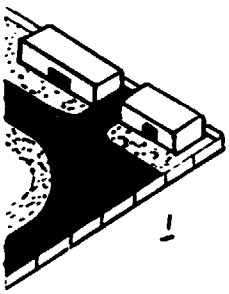
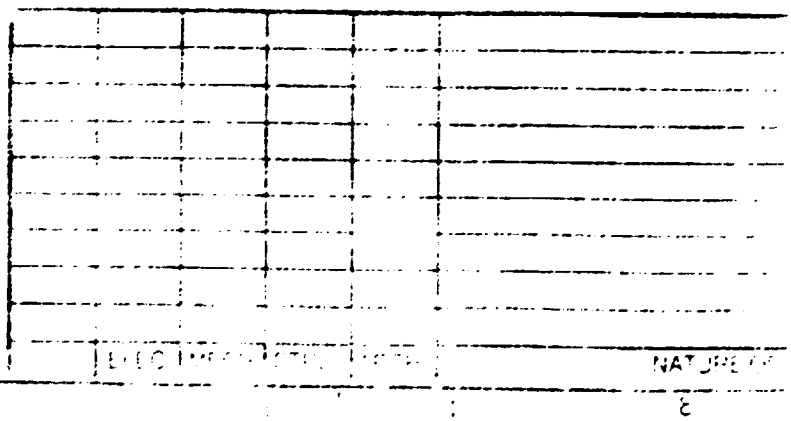
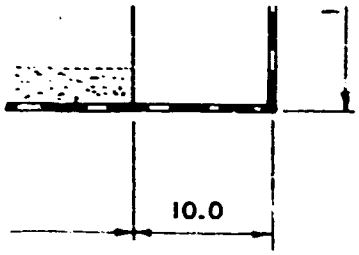




See 13



BLOCK LAYOUT: CIRCUIT BREAKER

UNITED NATIONS INDUSTRIAL DEVE
&
ARAB INDUSTRIAL DEVELOPMENT A

DEVELOPMENT C

CONSULTING ENGINEERS

BOMBAY • CALCUTTA • MADRA

DRAWN MUKUL	DESIGNED MUKU
PROJ ENGR	ENG MGR
DEPT HEAD	

NO	DESCRIPTION	RELEASE STATUS	DATE	REV NO

DWG NO EXHIBIT_45

11

Sec 14

1

Sec 10

F

G

BLOCK LAYOUT: CIRCUIT BREAKER & ISOLATOR PLANT

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

H

DEVELOPMENT CONSULTANTS LTD

CONSULTING ENGINEERS

BOMBAY • CALCUTTA • MADRAS • NEW DELHI

DRAWN MUKUL	DESIGNED MUKUL/SR	SCALE 1:500
PROJ ENGR	ENG. MR	DATE 3.8.93
DEPT HEAD		JOB NO DCIL-45010
REV NO	DWG NO EXHIBIT_45	REV NO

10 11 12

Sec 15