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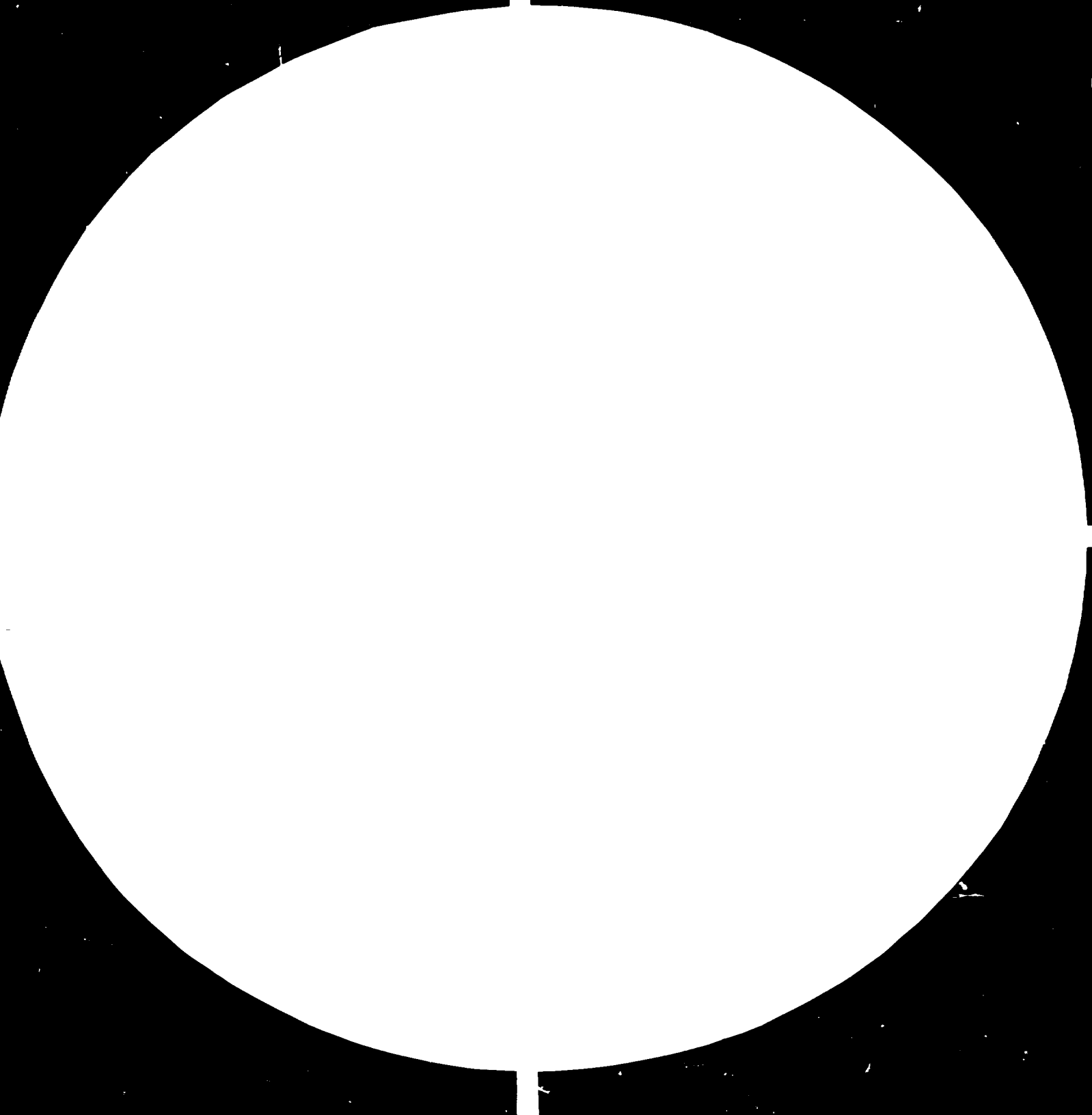

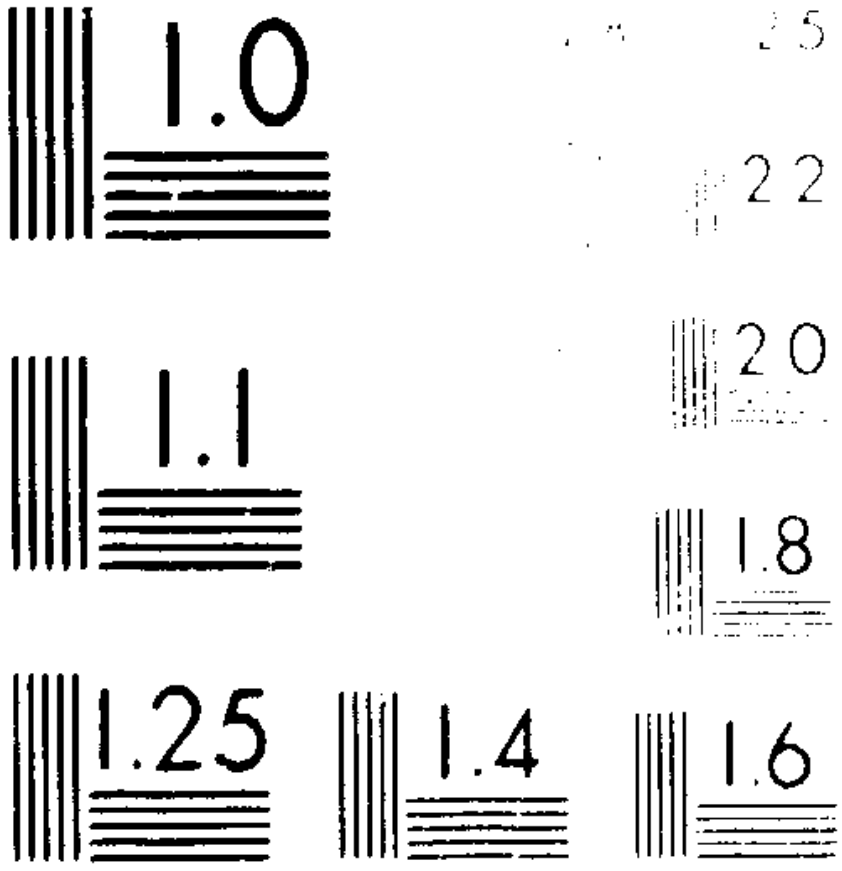
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10 September 1982

ENGLISH

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Angola.

SERVICE CENTRE FOR MAINTENANCE AND REPAIR

US/ANG/78/209

PEOPLE'S REPUBLIC OF ANGOLA

Mission Report*

Prepared for the Govenrment of the People's Republic of Angola
by the United Nations Industrial Development Organization

Based on the work of Mr. P. Savino, Expert
in Repair and Maintenance of Electrical Equipment

* This report has been reproduced without formal editing.

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UNIDO/IO/R.31/Corr.1

12 October 1982

ENGLISH

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

SERVICE CENTRE FOR MAINTENANCE AND REPAIR

US/ANG/78/209

PEOPLE'S REPUBLIC OF ANGOLA

Mission Report

Corrigendum

Document UNIDO/IO/R.27, dated 14 September 1982, should bear the symbol UNIDO/IO/R.31.

INTRODUCTION

In the wake of the Independence war and still suffering from the deep-rooted affects of colonialism, Angola has found itself overwhelmed by economic and social upheavals. In the industrial sector, these problems have been reflected in the total shut-down of factories, loss of machineries and documentation, destruction of existing equipment and the lack of managerial and technical personnel - including skilled workers. This personnel vacuum - more unique than rare - is the result of years of the "Portuguese only" policy which made skilled work within reach only of the Portuguese population in Luanda and other major cities in Angola. Perhaps the skilled personnel problem has been and will be for a long time yet the major problem to be solved in the reconstruction of Angola. While machinery, equipment and even services can easily be got from donors or brought from foreign companies, the training of local personnel who will be managing the country's resources will take more time. In fact this was the first observation made shortly after arrival in Luanda. In light of this existing local phenomenon, the main objectives of the project had to be reviewed and urgency was given to personnel training.

Originally, the main objectives were laid down in this order:

- to help the local Government to establish a section for electrical maintenance and repair within the Service Centre for Repair and Maintenance;
- to help the Centre to provide assistance to factories serviced by this Centre;
- to train personnel.

work was to be started according to the scheme outlined above. Instead, we deemed it more logical, after consultations with the Team Leader and the Counterpart, to screen, recruit and train personnel - since this was definitely the more urgent need of the Centre. It was extremely difficult to find prospective trainees with adequate background (average literacy level: 5th grade elementary). This problem was compounded by the fact that the minimum indispensable didactic material for personnel training was practically inexistent. Inspite of these difficulties, a group of 14 workers was selected and a 48-week course was organised. Taking into consideration observations made at some existing professional schools in Luanda and in 'NGunza, and analyses made together with the Counterpart on the actual needs of the Centre, we decided to base the course almost exclusively on practical training (70% of the time) and the course was launched using materials salvaged here and there, viz. old burnt out motors, contactors, solenoid starters, timers, etc. Two simulation panels and two manual winding machines were made - utilizing whatever was available in the Centre for this purpose, like electrical machines and equipment still in working condition. These simulation panels were to be utilized for breakdown simulations, observation of electrical schemes and winding exercises.

ACTIVITIES AND OUTPUT

Training

The following Training Programme was formulated:

1. Introduction to Maintenance
2. Understanding of Electrical Circuits
3. Electrical Machines Control
4. Methodology in Winding Design
5. Methodology in Localizing Breakdowns
6. Breakdown Simulations
7. Conversion of technical features of motors
8. Conversion of technical features of electrical controls
9. Apparatus Control Testing
10. Electrical Machine Testing

Naturally, a short propaedeutical course in basic subjects like Mathematics, Electrotechnics and Electrical Measurements preceded the above-outlined course.

The success of nine months of training is spelled out in the achievement of above pre-set objectives:

- the trainees have learned how to design simple electrical schemes of installations and winding schemes of mono-phase and tri-phase electrical motors;
- the trainees have learned how to interpret electrical schemes.
- four trainees have specialised in repairing electrical panels and in the localization of breakdowns;

- four trainees have learned basic apparatus control testing and electrical machine testing;
- two of the above trainees received elementary lessons on conversion of technical features of motors and controls;
- four trainees have specialised in re-winding;
- two trainees attained sufficient general knowledge with difficulty while two trainees who showed an aptitude mechanics were transferred to another section.

All of the above trainees were given cross-training so that they could have basic knowledge of each other's specialization.

One of the most salient features of this "ad hoc" course was the immediate application of notions acquired in lectures/demonstrations as well as in "workshop" simulations in the normal operation of the Centre.

This training experience gave rise to the preparation of a handbook namely, Course for specialised Electricians in Developing Countries(.). The two-track approach adopted (theory and practice) emphasizes the planning of workshop activities of trainees and the absolute necessity for the U.N. Expert to have immediately available - in loco - equipment and consumable material necessary for personnel training.

(.) See ANNEX I

Establishment of the Centre for Maintenance and Repairs

Regarding the installation of the Centre, a well-defined plan has been formulated bearing in mind the actual conditions and needs of the country. The lay-out (.) of this project has been approved by the management of EMIN and this plan gave rise to a detailed list of machines, instruments and consumable materials (about 25,000 dollars worth). The relative purchase order was sent to UNIDO in Vienna during the first decade of December 1981. To-date we have received varnish for motors, namely:

300 litres varnish (oven drying type)
30 " " (air drying type)
100 " thinner
200 " chemical varnish remover from burnt-out motors

In the meantime, we started to gather used materials locally and this way we were able to salvage: 1 megaohmetre, 1 multimetre, a revolution indicator and some workbenches. But to get our plans going, we had to have basic instruments and consumable materials to work with. With the agreement of R/R Mr. G. Asplund, these were purchased and air-shipped directly from Rome (value: U.S.$2,300). The shipment arrived within a month after purchase order was made, and it consisted of:

instruments: 2 Universal Testers (multimetres)
1 Portable Amperometre (clip-on)A.C. 300A
1 Portable Earth Resistance Tester
1 Manual Speed Counter

consumable materials:
16 Electrical outlets III-Phase with base for fuses 20A
16 Plugs for above outlets
50 Fuses for above bases 20A

(.) See ANNEX II

5 Bases II-Phase for fuses, NHO type

41 Fuses for above bases 25A

9 " " " " 20A

All purchase documentation will duly be sent to UNIDO.

In any case, this embryonic electrical section (while waiting for the rest of the material in Vienna) has begun to operate satisfactorily and has been able to give some technical assistance to the Centre itself:

- installment of an earthing system (accident prevention)
- partial revision of machine and equipment controls (whenever possible considering the scarcity of materials)
- rewinding of motors

Consequently, the number of breakdowns at the Centre itself has significantly gone down. It must be emphasized, however, that the complete revision of electrical installations of the Centre will be viable only when the materials ordered will have arrived.

Assistance to Factories Operating in the Industrial Area of Luanda

Technical Service has been given to the following:

1. AVILA - Electric Cable Factory in Viana
2. CORAL - Paint Factory in Luanda
3. IAMPUL - Fluorescent Lamp Frame Factory in Luanda
4. FABAL - Furniture Factory in Luanda
5. EMPAL - Industrial Bakery in Luanda

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6. DECORANG - Paint Factory in Luanda
7. DINAUTO - Secreteria do Estado
8. M. VALENTE - Furniture Factory
9. A.P. do ANGOLA - Ondulated Carton Factory
10. C.E.E.L. - New Milk Processing Plant in Luanda

Technical assistance given to the above-mentioned firms consisted of localization of breakdowns and relevant repair. Moreover, advice was given to these firms on ordinary maintenance leaving behind guidlines and lists of basic spare parts. Assistance given to C.E.E.L.(Milk Factory) was a little different. In addition to the monitoring of the performance tests, (this factory is a F.A.O. project result) a complete preventive maintenance programme has been drawn up. This programme could very well be used as a benchmark for computerized maintenance in the future (the use of a micro-computer in this case).

Assistance given to other firms was resolved in short visits because breakdowns were quite simple and evident (e.g. short circuits and burned fuses) but which could not be localised and taken care of by the factories themselves. But even in these cases, advice was given on the organization of maintenance hopefully to make them understand that some basic "scheduling" could be done by themselves. Many simple breakdowns could be avoided if regular inspection of "strategic" parts were done.

In many of the firms visited, the following situations were observed:

- the majority of the breackdowns are localized in electrical parts of the machinery (60 - 70 %)
- tampering of contactors, relay, fuses etc. in electrical panels of the machines. Consequentely a lot of electrical motors, without protection, burn-out.
- lack of cleaning of contactors and relay causes bad control of the machines with consequence of breackdowns and production stoppages
- electrical installations were insufficient and obsolete
- insufficient earthing system
- miscalculated transformer room with resulting black-outs
- missing documentation on existing equipment, machines, etc.
- no warehousing system for spare parts
- inadequate scholastic preparation of personnel
- inadequate understanding of the role of maintenance
- non-observance of work accident prevention measures

The above spells out the complexity of the problems to be solved. Any attempt to improve the situation should take into consideration the utmost importance of the human element: Both scholastic and technical preparation should be upgraded. The training course given to electricians at the Centre should at least partly be extended to factory personnel by means of elementary guidelines (leave-behinds) to be followed by seminars in the future. This again leads to the conclusion that basic training of personnel comes first and that any and all didactic materials should be ready in situ by the time the trainer arrives.

ACHIEVEMENT OF OBJECTIVES and UTILIZATION OF PROJECT RESULTS

Training

Training Programme as described under ACTIVITIES has been implemented. Trainees can now answer service calls with sufficient autonomy. Experience gained in this area has been reflected in a handbook: Course for Specialised Electricians in Developing Countries . This handbook could very well be utilized as a benchmark for other projects in similar situations.

Establishment of Maintenance and Repair Centre

When the rest of the materials arrive, the Centre will be able to:

- produce daily 3 motors, average power 3~4 Kw
- produce weekly one motor, 10~15 kw
- re-structure daily one control panel with about 6 contactors.

Assistance to Factories in the Luanda Area and Outskirts

When the rest of the materials arrive,

- the mobile team will be able to control and certify the earthing system of one firm on a daily basis;
- the mobile team will be able to re-structure the earthing system of a small/medium factory on a weekly basis;
- technical department will be able to draft elementary programming of maintenance of Electrical Parts of small factories and prepare relative List of Spare Parts needed. This could be done on a monthly basis.

- the mobile team will able to give technical assistance upon request of factories in and around Luanda. This assistance will consist of localization of breakdowns and relevant repairs, briefing on basic norms on preventive maintenance.

FINDINGS

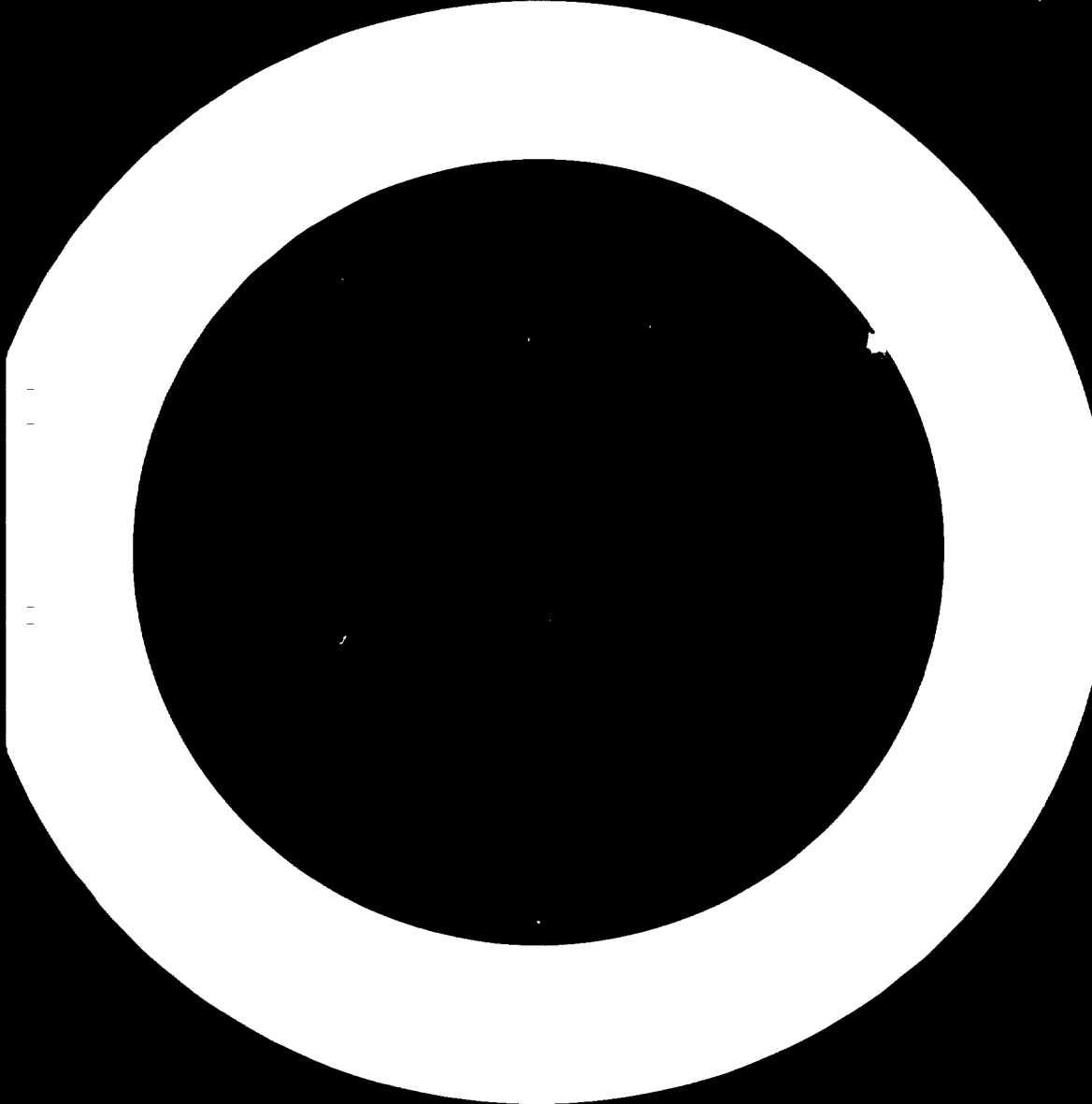
The launching of the project itself was delayed due to the lack of materials. The inadequate scholastic preparation of local personnel had to be compensated with propaedeutical courses. The lack of "a sense of care" for things in general, which was a tremendous obstacle, was surmounted - thanks to the willingness and the ductility of the trainees.

RECOMMENDATIONS

1. Emphasize in existing courses for Electricians in local Professional Schools the following topics:
   - Test and Design of Earthing System
   - Design and Construction of Electrical Control Panels .
2. Organization of a series of seminars on a national level involving decision-makers in the field of maintenance as part of an awareness campaign on the role of preventive maintenance in cost-effective operations.
3. Organization of trainees for the formation of Experts capable of designing electrical installations.

4. Introduction of a Micro-Computer within the Centre for keeping under constant control breakdown and repair situations of factories assisted by the Centre.

5. Restructuring of the existing distribution system of electrical energy in small and medium industries to avoid breakdowns and production stoppages caused by frequent black-outs.



ANNEX I

COURSE FOR SPECIALISED ELECTRICIANS IN DEVELOPING COUNTRIES

INTRODUCTION

This manual which deals with both theory and practice is the logical result of a singular experience, i.e. the installation of a Service Centre for maintenance and repair of electrical material and training of personnel that would for service teams to factories assisted by said Centre.

Didactic and installation material was practically inexistent at the Centre, a condition that significantly delayed the launching of the project. It was therefore necessary to construct two consoles for exercises and simulation, and two manual winders. Also, to better familiarize personnel in the localization of breakdowns in control circuits, a series of breakdowns simulations was inserted in this training programme. Such simulations were done using both assembled circuits on the training consoles and the control circuits of machines installed at the Centre. From the very start, personnel was involved in didactic activities, in installation workshops within the Centre and, last but not least, in education toward an awareness of the philosophy and practice of maintenance ... an attitude that "consolidated" in the actual servicing of factories that needed assistance.

This manual will constantly reflect the two-pronged approach used: theory and practice effectively supported by the possibility of utilizing within the Centre theoretical notions and practical knowledge learned on daily basis. The singularity of this approach is precisely in the application of notions acquired in lectures/demonstrations as well as in "workshop" simulations in the normal operation of the Centre. In this context personnel training is part and parcel of the total activities of the Centre.

One of major problems encountered since the very beginning of this experience was the lack of material to work with. Although a problem common to all developing countries, this problem was compounded in Angola due to recent historical events. It was extremely difficult - if not at times impossible - just to go ahead with the simplest tasks for lack

of material (from testers all the way down to screws!) It is therefore imperative that any programme/project aimed at being developed in similar conditions be started with all the basic materials all ready on hand. This easy availability will not only help the expert and the counterpart to efficiently work together with no time wastage but will also help make the project cost-effective.

Training Programme

The entire course will require 24 weeks articulated in three 8-week stages. The first stage is purely propaedeutical while the second and the third stages are geared for specialization:

- Specialization in electro-mechanical constuction (winders))
- Specialization in electrical installation (machine cont..ls)

Each stage will terminate with a series of " examinations" to ascertain degree of learning of trainees.

Principal Topics:

Propaedeutical:
- Mathematics
- Electro-technics
- Electrical measures

Specialization in winding
- Electro-mechanical construction
- Maintenance
- Work security measures
- Perforation and cutting-out of metal sheets

Specialization in electrical installations
- Electrical installations
- Maintenance
- Work security measures
- Perforation and cutting-out of metal sheets

Each topic will be articulated in three phases:
- Theory
- Graphic and numeral excercises
- Laboratory and workshop

The course will require six hours daily
- 2 hours for theory
- 2 hours for excercises
- 2 hours for workshop

PRINCIPAL TOPICS OF FIRST STAGE - PROPAEDEUTICAL

I. Mathematics

- the four operations
- prime numbers
- rational numbers
- fractions, proper and improper fractions
- minimum common multiple
- maximum common divisor
- decimal system
- square root, exponents
- multiples and sub-multiples of unit
- basic trigonometrical expressions
- theory of Pitagora
- principal geometric figures

Numerical excercises

- addition and subtraction of whole and decimal numbers
- multiplication of whole and decimal numbers
- division of whole and decimal numbers
- calculation of series of prime numbers up to 1,000
- multiplication of a number by a sum
- multiplication and division of fractions
- calculation of the c.m.m. of two or more numbers
- addition and subtraction of fractions
- calculation of copper conductor section from the diameter
- calculation of copper conductor diameter from section

Didactic material (class of 16 trainees)

- 1 blackboard, 64 notebooks, 16 chairdesks, chalk etc.

II. Electro-technics:

- what is electricity?
- electrical circuits
- elements of electrical cicuits
- conductor and insulating materials
- tension and current
- units of tension and current
- conductor resistence
- temperature influence
- Ohm's law
- serial and parallel connections
- energy and power
- thermal effect
- chemical effect
- electro-static effect
- magnetic effect
- electro-dynamic action between currents
- A.C. circuits, reactor, condensator, impedance
- three-phases circuits
- delta-star connections
- A.C. power
- reactive power
- magnetic circuits

Numerical excercises (2 hrs. each)

- a circuit is struck by constant current of 8 A for 4 hrs. Calculate the quantity of electricity flow.
- a completely discharged accumulator has furnished a constant current of 2A by 20h.Calculate its capacity in Ah
- indicate the difference between f.e.m., tension and d.d.p., visualizing such difference by drawing a circuit that includes both generetor and utilizer
- a copper conductor is 350 metre long and has a diametre d =3mm. Calculate the resistence

- a platinum wire having the resistence of 30 Ω at 20 C is heated up to 250 °C.
  Calculate its resistence at this elevated temperature
- a 12V battery having an internal resistence of 0.14 Ω is connected with a resistence of 6.8 Ω.
  Calculate the current and the d.d.p. at the terminals of the resistence.
- calculate the resistence of a series of 3 resistences having the following values: $R_1 = 5\,\Omega$, $R_2 = 6\,\Omega$, $R_3 = 2.5\,\Omega$
- calculate the resistence of 3 resistences the values of which are the same as those of the preceding exc.
- three resistences which values are $R_1 = 3\,\Omega$, $R_2 = 2\,\Omega$ $R_3 = 7\,\Omega$ are connected parallel-wise and serial-wise to other two resistences which values are $R_1 = 6\,\Omega$ $R_2 = 3.6\,\Omega$.
  What is the total resistence?
- calculate the resistence of a water-heater that has to heat 100 litres of water from 25°C to 80°C in 4 hours by a tension of 220V.
- three conderses: 6, 10 and 15uF are connected in serie, What is the total capacity?
- the same conderses mentioned above are placed parallel-wise, what is the total capacity?
- an inductance of 0.032H, with a resistence of 16 Ω connected in serie, is fed with a tension of 110V 50Hz. What is the current and phase displacement?
- calculate the power and the inductive reactance of a coil with an ohmic resistence of 300 Ω which when fed with 220V, 50Hz absorbs 0.5A?
- calculate the current in a condenser of 15uF fed with tension 80V, 50kHz.

Lab. excercises (6 hours each) 4-member groups

1 Assemblage of a complete circuit: generetor, switches, instruments for measurement and utilizers.
Materials:
- three 1.5v batteries
- conductors with $1mm^2$ terminals
- set of terminals

- one key-switch
- 3 "mignon" bulb sockets
- 3 bulbs from 1.5v and 0.5w

Equipment:
- vertical panel
- standard set electrical equipment
- 2 universal electric testers

2. Serial and parallel connection of resistences

Materials:
- set of electronic type of resistors
- set of terminals, about 4m of wire
- tin

Equipment:
- vertical panel
- one pistol-type solderer
- two universal testers

3. Examination of Ohm's law

Materials:
- 3 batteries (1.5 V)
- conductors with 1 mm^2 section
- variable resistor
- one key-switch

Equipment:
- vertical panel
- 2 universal testers

4. Examination of thermal effect of current

Materials:
- 6 batteries (1.5 V)
- 1 "mignon" bulb socket
- 1 bulb 1.5v 2w
- 4 metres conductor 1mm^2
- set of terminals

Equipment:
- vertical panel
- 2 universal testers
- 1 termometre

5. Examination of magnetic effect of electrical current

Materials:
- 2 tubes of presspah (insulation) of different diametres (20mm - 40mm)
- 40 m copper wire 0.25mm
- 6 batteries 1,5 V

SCHEDULE

First stage - Propaedeutical

Time	Mon	Tue	Wed	Thur	Fri	Sat
8 - 9	Mat	Mat	Mat	Mat	Mat	Mat
9 - 10	El.Tech.	Meas	El.Tech.	Meas	El.Tech.	Meas
10 - 12	Num.Ex. Mat	Num.Ex. El.Tech.	Num.Ex. Meas	Num.Ex. Mat	Num.Ex. El.Tech.	Num.Ex. Meas
14 - 16	wrk.shp. El.Tech.	wrk.shp. Meas	wrk.shp. El.Tech.	wrk.shp. Meas	wrk.shp. El.Tech.	wrk.shp. Meas

Mathematics:

- 6 x 8 = 48 hrs of Theory
- 4 x 8 = 32 hrs of Numerical excercises

Electro-technics:

- 3 x 8 = 24 hrs of Theory
- 4 x 8 = 32 hrs of Numerical excercises
- 6 x 8 = 48 hrs of Laboratory

Electrical measures:

- 3 x 8 = 24 hrs of Theory
- 4 x 8 = 32 hrs of Numerical excercises
- 6 x 8 = 48 hrs of Laboratory

Personnel:

- 1 Instructor
- 2 Assistents

Equipment: - vertical panel
- standard equipment for electricians
- 2 testers

6. Examination of electro-mechanical action between currents

The same materials and equipment of above experiment

7. Examination of an A.C. circuit

Materials: - 2 condensers (150uF)
- variable rheostate (0 - 1000 Ω)
- 2 inductances (0.15H)
- conductors ($1mm^2$)
- set of terminals

Equipment: - vertical panel
- monophase VARIAC (0 - 120 V)
- 2 ampermetres
- 2 voltmetres
- 2 monophase switches

8. Examination of Delta-Star connections

Materials: - 3 bulb sockets
- 3 bulbs 125 V 60 w
- conductors $1.5mm^2$
- set of terminals
- varius materials of insulation

Equipment: - vertical panel
- three-phase VARIAC (0 - 124 V)
- 3 ampermetres
- 3 voltmetres

III. Electrical measures:

- units of measurement - multiples and submultiples
- errors in measurement, precision classes measurement of voltage and current
- description and insertion in a circuit of votmetres and ampermetres
- measurement of resistence, ohmmetre
- Wheatstone bridge
- measurement of insulation resistence
- description of megaOhmmetre
- measurement of earth rsistence
- description of earth-resistence-metre
- measurement of power in D.C.
- measurement of impedence
- measurement of power in A.C. monophase
- measurement of power in A.C. threephase
- measurement of electrical energy

Numerical excercises:

Numerical excercises will be drawn from data processing yielded from laboratory activities. For every 6 hours measurement excercises, 4 hours will be set aside for data processing.

Laborarory excercises: 3-member groups

1. Rating of a voltmetre with a stardard instrument

Equipment and materials:

- vertical panel
- monophase variac
- voltmetre A.C. 150 v class 0.2
- voltmetre A.C 150 V class 1.5
- conductors with terminals
- design materials (graph-paper, pencils, erasers, i.e. basic set for drawing)
- poket electronic calculator

2. Measurement of current and voltage with a tester

Equipment and materials:

- vertical panel
- 6 batteries (1.5 V)
- 2 variable rheostates (0 - 100 Ω)
- some resisters electronic type
- 2 testers
- 1 monophase VARIAC
- conductors with terminals

3. Measurement of resistence and power in D.C.

Equipment and materials:

- vertical panel
- ampermetre D.C. 10 A
- voltmetre D.C. 30 V
- resistence 5 , 20 w
- 8 batteries (1.5 V)
- conductors with terminals
- basic set for design

4. Measurement of resistence with Wheatstone bridge

Equipment and materials:

- vertical panel
- 3 cases of resistors (dec. type)
- 1 resistence
- 1 accumulator 12 V
- 1 key switch
- 1 galvanometre
- conductors and terminals

5. Measurement of insulation resistence of an electrical machine

Equipment and materials:

- stardard equipment for electricians
- mega-ohmetre
- set of screw bolts and nuts

6. Measurement of earth resistence

Equipment and materials:

- standard equipment for electricians
- complete equipment for earth measurement (with all the accessories commercially available)
- metric band (20 m)

7. Measurement of power active, reactive and apparent

Equipment and materials:

- vertical panel
- wattmetre 300/5
- ampermetre 10 A
- voltmetre 300 V
- monphase VARIAC
- Impedance
- conductors, terminals, design mat.

8. Measurement of active power in threephase system

Equipment and materials:

- vertical panel
- 2 wattmetres 300/5
- 3 ampermetres 10 A
- 2 voltmetres 300 V
- threephase VARIAC
- threephase impedance
- conductors, terminals, design mat.

SCHEDULE

Second stage - Special. in electrical installations

Time	Mon	Tue	Wed	Thur	Fri	Sat
8 - 10	Electr. Install.	Electr. Install.	Electr. Maint.	Electr. Maint.	Work Accid Prev	Perfor. Cut-up Sheet
10 - 12	Graphic Exercises Install.	Graphic Exercises Install.	Graphic Exercises Install.	Workshop Electr. Maint	Workshop W.A.P. Exerc.	"
14 - 16	Work Shop Install.	Work Shop Install.	Work Shop Install.	Workshop Electr. Maint.	Workshop W. A. P. Exerc.	"

Elctrical installations

- 4 x 8 = 32 hrs of
- 6 x 8 = 48 hrs of Work Shop
- 6 x 8 = 48 hrs of Graphic exc.

Electrical Maintenance

- 4 x 8 = 32 hrs of Theory
- 6 x 8 = 48 hrs of W.Shop and Graph. exc.

Work accident Prevencion

- 2 x 8 = 16 hrs of Theory
- 4 x 8 = 32 hrs of work shop

Perforation/Cutting-sheets

- 6 x 8 = 48 hrs of Graphic exc. and W.shop

Personnel:

- 1 Instructor
- 2 Assistents

PRINCIPAL TOPICS OF SECOND STAGE SPECIALIZATION IN ELECTRICAL INSTALLATIONS

I. Electrical installation

- graphic symbols
- property of materials
- metallic alloys
- conducting materials
- handling and preparation of materials
- identification of conductors
- capacity of conductors
- terminals
- soldering
- basic installations in L.V.
- standard on L.V. installations
- incandescent bulbs
- fluorescent bulbs
- mercury dscharge lamps
- L.V. switches, commutators etc.
- installation of signal devices

Graphic and numerical excercices:
will be drawn from data processing and on the design of electrical schemes. For every 8 hours electrical installations work shop excercice, 8 hours will be set aside for drawing and data processing.

Work shop excercises: 2-member groups

1. Single control light installation

   Equipment and materials:

   - vertical panel
   - standard equipment for electricians
   - bulbs (60 w 125 V)
   - lamp sockets
   - bipolar switch
   - metric band
   - rigid wire conductor (1.5 mm^2)
   - insulating tape
   - clip-on ampermetre

2. Installation of a single control electric light of two parallel bulbs

Equipment and materials:

- vertical panel
- standard equipment for electricians
- bulbs (60 w 125 V)
- lamp sockets
- bipolar switches
- metric band
- rigid wire conductor (1.5 mm^2)
- insulating tape
- clip-on ampermetre

3. Installation of double control electrical light

Equipment and materials:

- vertical panel
- standard equipment for electricians
- bulbs (60 w 125 V)
- lamp sockets
- 2 switches commutator
- metric band
- rigid wire conductor (1.5 mm^2)
- insulating tape
- tester and clip-on ampermetre

4. Installation of single warning alarm

Equipment and materials:

- vertical
- equipment for electricians
- trasformer 15 VA 125/24 V
- various types of signal alarm
- rigid wire conductor 1.5 mm^2
- insulating tape
- push botton
- tester

5. Installation of electrical light with relay commutator

Equipment and materials:

- vertical panel
- solderer
- bulbs (60 w 125 V)
- sockets
- relay commutator
- push buttons
- rigid wire 1.5 mm^2
- tin, soldering paste, sundry consumable materials
- tester

6. Installation of electrical light with relay commutator from three remote controls

Equipment and materials:

same of above experiment

II. Electrical maintenance (applicable to all specialz.)

- general concepts of maintenance
- ideal operating conditions of electr. installations
- organized maintenance
- personnel organization and preparation
- periodic inspection of electr. installations
- considerations on maintenance planning
- accident prevention norms
- preventive maintenance of electrical motors
- preventive maintenance of electrical equipment
- norms of localization of electrical breakdowns
- localization of breakdowns in machines
- localization of breakdowns in distribution systems
- defective electrical panels
- test of electrical materials
- norms for hand-over of new spare partes

4-member groups

Practice on work shop and graphic excercices (16 hrs each)

1. Design of preventive maintenance plan of tri-phase electrical motor

   Equipment and materials:

   - basic set for designers, graphs paper etc.

2. Design of preventive maintenance plan of tri-phase electrical transformer

   Equipment and materials:

   - the same of above excercise

3. Design of preventive maintenance plan of motor control (tri-phase L.V.)

   Equipment and materials:

   - see above

III. Work accident prevention (applicable to all specialz.)

- incorrect use of utensils
- use of difective utensils
- use of electrical utensils without adequate protection
- correct use of electrical utensils
- norms of accident prevention
- norms of electrical accident prevention
- first aid - first aid kit
- artificial respiration

Work shop excercises (practice) 8 hours each

1. Inspection of workers outfits (coveralls, shoes, etc)
2. Inspection placement/attitude of utensils
3. Excercises on first aid basic like: medical tampons on simulated wounds, tourniquet, etc.
4. Excercises on reviving patient soffering electric shock, handling of patient until professional hospital aid arrives etc. (simulated)

IV. Perforation and cutting-out of metal sheets 16 hrs each
(applicable to all specializations) 1-member groups

1. Filing excercises and design of piece to filed
Equipment and materials:
- piece of steel (100 x 100 x 20 mm)
- bench with vice
- set of files
- list (carpenter's)
- mitre square (90°)
- calibre
- tecnical compass (for thickness, diametre, etc.)
- basic set for drawing

2. Threading and drawing of piece to be threaded
Equipment and materials:
- piece of steel (50 x 50 x 12 mm)
- fitting bench
- vertical drill
- set of twist drills
- set of bolts for threading
- calibre
- basic set for drawing

3. Sheet perforation and drawing of a panel
Equipment and materials:
- fitting bench
- vertical drill
- set of twist drills
- set of bolts for threading
- calibre
- list
- basic set for drawing

SCHEDULE

Second stage - Special. in winding motors

Time	Mon	Tue	Wed	Thur	Fri	Sat
8 - 10	Constr. El. Mech.	Constr. El. Mech.	Electr. Maint.	Electr. Maint	Work Accid. Prev.	Perfor. Cutting
10 - 12	Graphic Exercise El. Mech. Constr.	Graphic Exercise El. Mech. Constr.	Graphic Exercise El. Mech. Constr.	Exercise Electr. Maint	W.A.P. Exercise "	" "
14 - 16	Work Shop El. Mech Constr.	Work Shop El. Mech. Constr.	Work Shop El. Mech. Constr.	Work Shop Elec. Maint.	W.A.P. Exercise "	"

Electro-mechanical constructions

- 4 x 8 = 32 hrs of theory
- 6 x 8 = 48 hrs of work shop
- 6 x 8 = 48 hrs of graphic excercises

Electrical maintenance

- 4 x 8 = 32 hrs of theory
- 6 x 8 = 48 hrs of W. shop and graph. exc.

Work accident prevention

- 2 x 8 = 16 hrs of theory
- 4 x 8 = 32 hrs of work shop

Perforation/cutting-sheets

- 6 x 8 = 48 hrs of graphic exc. and W.shop

Personnel:

- 1 Instructor
- 2 Assistents

PRINCIPAL TOPICS OF SECOND STAGE SPECIALIZATION IN WINDING AND REWINDING MOTORS

I. Electro-mechanical constructions

- electrical units of measure
- conducting and insulating materials
- magnetic circuits of electrical machines
- elementary calculation for winding of transformer
- " " " " " monophase motor
- " " " " " triphase motor
- fundamentals of winding of D.C. motors
- relationship between velocity and frequency
- measuring and testing equipment used by winders
- overview of mechanical parts of an electrical motor
- winding of a monophase transformer (scheme)
- winding of a triphase transformer (scheme)
- winding of a monophase motor (scheme)
- winding of a triphase motor (scheme)
- winding of a D.C. motor (scheme)
- insulating varnishes and other insulating materials

Graphic and numerical excercises

The 48 hours set aside for this course will be dedicated to the graphic elaboration of winding schemes to be carried out in the work shop.

Work shop excercises: 12 hours each 2-member groups

1. Winding of an electro-magnet coil

Equipment and materials:

- vertical panel
- manual winder
- enameled copper wire
- various insulating materials (paper, pressphan, sterling tube, insulating tape)
- glue, thinner, varnish, sand paper
- tester and calibre

II. Electrical maintenance (applicable to all specialz.)

- general concepts of maintenance
- ideal operating conditions of electr. installations
- organized maintenance
- personnel organization and preparation
- periodic inspection of electr. installations
- considerations on maintenance planning
- accident prevencion norms
- preventive maintenance of electrical motors
- preventive maintenance of electrical equipment
- norms of localization of electrical breakdowns
- localization of breakdowns in machines
- localization of breakdowns in distribution systems
- defective electrical panels
- test of electrical materials
- norms for hand-over of new spare partes

4-member groups

Practice on work shop and graphic excercices (16 hrs each)

1. Design of preventive maintenance plan of tri-phase electrical motor

   Equipment and materials:

   - basic set for designers, graphs paper etc.

2. Design of preventive maintenance plan of tri-phase electrical transformer

   Equipment and materials:

   - the same of above excercise

3. Design of preventive maintenance plan of motor control (tri-phase L.V.)

   Equipment and materials:

   - see above

2. Winding of a monophase transformer

Equipment and materials:

- winding bench
- manual winder
- enameled copper wire
- various insulating materials
- pistol type solderer
- soldering tin
- drying oven
- laminated magnetic core (200 - 500 VA)
- tester, clip-on ampermetre

3. Winding of a threephase transformer

Equipment and materials:

- the same of above excercise and
- a laminated triphase magnetic core (600 - 1200 VA)

4. Unloaded test of a monophase transformer

Equipment and materials:

- vertical panel
- monophase VARIAC
- ampermetre
- voltmetre
- wattmetre
- monophase transformer (200 - 500 VA)

III. Work accident prevention (applicable to all specialz.)

- incorrect use of utensils
- use of difective utensils
- use of electrical utensils without adequate protection
- correct use of electrical utensils
- norms of accident prevention
- norms of electrical accident prevention
- first aid - first aid kit
- artificial respiration

Work shop excercises (practice) 8 hours each

1. Inspection of workers outfits (coveralls, shoes, etc)
2. Inspection placement/attitude of utensils
3. Excercises on first aid basic like: medical tampons on simulated wounds, tourniquet, etc.
4. Excercises on reviving patient soffering electric shock, handling of patient until professional hospital aid arrives etc. (simulated)

IV. Perforation and cutting-out of metal sheets 16 hrs each
(applicable to all specializations) 1-member groups

1. Filing exercises and design of piece to filed
Equipment and materials:
- piece of steel (100 x 100 x 20 mm)
- bench with vice
- set of files
- list (carpenter's)
- mitre square (90°)
- calibre
- tecnical compass (for thickness, diametre, etc.)
- basic set for drawing

2. Threading and drawing of piece to be threaded
Equipment and materials:
- piece of steel (50 x 50 x 12 mm)
- fitting bench
- vertical drill
- set of twist drills
- set of bolts for threading
- calibre
- basic set for drawing

3. Sheet perforation and drawing of a panel
Equipment and materials:
- fitting bench
- vertical drill
- set of twist drills
- set of bolts for threading
- calibre
- list
- basic set for drawing

SCHEDULE

Third stage - Specialization in electrical installations

Tme	Mon	Tue	Wed	Thur	Fri	Sat
8 - 9	Electr. Install.	Electr. Install	Electr. Install	Electr. Install	Electr. Install	Electr. Install
9 - 10	Schemes	Schemes	Schemes	Schemes	Schemes	Schemes
10 - 12	Workshop	Workshop	Workshop	Workshop	Workshop	Workshop
14 - 16	Work Shop	Work Shop	Work Shop	Work Shop	Work Shop	Work Shop

Electrical installations

- 6 x 8 = 48 hrs of theory
- 6 x 8 = 48 hrs of design of schemes
- 24 x 8 = 192 hrs of work shop

Personnel:

- 1 Instructor
- 2 Assistents

PRINCIPAL TOPIC OF THIRD STAGE
SPECIALIZATION IN ELECTRICAL INSTALLATIONS

I. Electrical installations

- contactors
- contactors with relay protection
- push-buttons
- guidelines for a control installation project
- power scheme
- control scheme
- performance scheme
- thermal protection of motors
- magnetic-thermal protection of motors
- motor controls
- different types of controls: delta-star starter, reversible, with two three velocities, etc. - as per list of practical excercises
- motor control D.C.

Design of schemes and numerical excercises

The 48 hours set aside for this course will be dedicate to design of electrical schemes following the technical norms of the installations to be carried out in the 192 hours of work shop

Work shop excercises: 21 hours each 2-member groups

1. Istallation of 3-point warning system with acustic and light signals

   Equipment and materials:

   - vertical panel
   - set of tools for electricians
   - panel with 3 push-buttons and 3-light signals
   - 3 acustic signals
   - 3 double push-buttons
   - 1 50 VA 220/24 V transformer
   - tester
   - rigid copper wire $1mm^2$, (red, green,yelow)

2. Installation of warning system with luminous numbers on indicator panel

Equipment and materials:

- vertical panel
- set of utensils for electricians
- panel with 3 luminous numbers with respective resetting push-buttons
- 3 push-buttons
- 1 50 VA 220/24 V transformer
- tester
- rigid copper wire 1 mm^2 in various colours
- sundry consumable materials

3. Installation of power supply system

Equipment and materials:

- vertical panel
- set of tools
- solderer
- 3 metallic shunt boxes
- 3 four-holed (with neutral) industrial outlet (16A)
- 1 switch tri-polar (50 A)
- tri-phase cable (with neutral) 6mm^2, 2,5 mm^2
- sundry consumable material

4. Installation of control of a tri-phase motor

Equipment and materials:

- vertical panel
- set of tools
- fuse base (tri-phase)
- thermal relay
- double push-buttons set
- warning lights (green and red)
- box for terminals
- tri-phase flexible cable 2.5 mm^2
- rigid cable 1 mm^2 of different
- tri-phase motor and sundry material

5. Teleinverter with push-button controlled inversion and signal light

Equipment and materials:

- vertical panel
- tools
- terminal box, base for triphase fuses
- 2 contactors 15 A
- 1 termal relay
- 2 signal lamps
- set of 3 push-buttons
- flexible cable 4 mm^2, rigid cable 1 mm^2
- terminals
- sundry material
- 1 motor tri-phase
- tester and clip-on ampermetre

6. Teleinverter with thermal relay with indirect reversing gear and automatic limit stop

Equipment and materials:

- vertical panel
- set of tools, solderer
- 1 relay inverter, 2 contactors 15 A
- 1 thermal relay, 2 limit switches
- 1 triphase fusebase with fuses 25 A
- 2 signal light (green, red)
- 3 push-buttons
- 1 fusebase with fuse 2 A
- 1 tri-phase motor
- tester and clip-on ampermetre

7. Teleinverter with thermal relay for maximum current direct reversing gear and relay timer

Equipment and materials:

- vertical panel, set of tools
- 2 contactors 25 A or alternatively a contactor with reversing gear and mechanical stop
- thermal relay, timer relay

- triphase fuse-base with fuses 25 A
- fuse-base with fuse 2 A
- green and red lamps
- set of three push-buttons
- flexibl cable 4 mm^2, rigid cable 1 mm^2
- testing motor, tester, clip-on amp.
- sundry material

8. Automatic delta-star starter

Equipment and materials:

- Vertical panel, set of tools
- 3 contactors 25 A
- 1 thermal relay, 1 timer relay
- triphase fuse-base with fuses 25 A
- 2 lamps (green and red)
- flexible wire 4 mm^2, rigid wire 1 mm^2
- 2 push-buttons, fuse-base with fuse 2 A
- testing motor, tester, clip-on amp.
- sundry material

9. Automatic delta-star starter with reversing device

Equipment and materials:

- vertical panel, set of tools
- 4 contactors 25 A
- 1 thermal relay, 1 timer relay
- 1 triphase fuse-base with fuses 25 A
- 2 lights, 3 push-buttons, 1 fuse-base 2A
- flexible cable 4 mm^2, rigid cable 1 mm^2
- testing motor
- tester
- clip-on ampermetre
- set of terminals
- various consumable materials

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SCHEDULE

Third stage - Specialization in winding motors

Time	Mon	Tue	Wed	Thur	Fri	Sat
8 - 9	El. Mech. Construct	"	"	"	"	"
9 - 10	Schemes	"	"	"	"	"
10 - 12	Workshop	"	"	"	"	"
14 - 16	Workshop	"	"	"	"	"

Electro-mechanical constructions

- 6 x 8 = 48 hrs of theory
- 6 x 8 = 48 hrs of design of schemes
- 24 x 8 = 192 hrs of work shop

Personnel:

- 1 Instructor
- 2 Assistents

PRINCIPAL TOPIC OF THIRD STAGE
SPECIALIZATION IN WINDING AND REWINDING MOTORS

I. Electro-mechanical constructions
- two speed winding
- phase connections
- delta-star connections
- conversion of technical features of a triphase transformer
- conversion of technical features of a three-phase motor
- two strata winding
- reverse winding
- universal motor (some aspects)
- useful charts
- transformer tests
- D.C. motor tests
- A.C. motor tests

Design of schemes and numerical excercises
The 48 hours set aside for this topic will be distributed as follows:
- calculations of cable sections and of the number of turns of electric coils.
- design of electrical winding schemes for motors to be winded or rewinded according to excercises difined below.

Work shop excercises: 24 hours each 2-member groups

1. Regular maintenance and disassembly of an electrical motor

Equipement and materials:
- work-bench with vice
- grease, oil detergent
- set of electrical and mechanical tools
- packing/jointing material
- various consumable materials
- bench for tests and measurements with voltmetres, ampermetres, variac etc.

2. Statoric winding of an induction motor with the following characteristics:

Number of slots K =12
Number of poles 2p = 2 (Imbricated type)
Number of phases q = 3
Number of coils B = K
Equipment and materials:

- workbench
- mnual or electric winder
- enameled copper wire
- various insulating material
- air-drying varnish
- solderer
- motor stator with 12 slots 1 HP
- various consumable material

3. Statoric winding of an inductionmotor with the following characteristics:

Number of slots K =12
Number of poles 2p = 2 (Imbricated type)
number of phases q = 3
number of coils B = $\frac{K}{2}$
Equipment and materials:

- same as in number 2

4. Statoric winding of an inductin motor with the following characteristics:

Number of slots K = 24
Number of poles 2p = 4 (Concentric type)
Number of phases q = 3
Equipment and materials:

- same as in number 2 with 24-slots motor 1.5 HP

5. Statoric winding of a monophase motor with the following characteristics:

Winding starter with condenser
Number of slots K = 24
Number of poles 2p = 4

Number of phases q = 1

Equipment and materials:

- the same as in number 2 with a 24 slots motor, a condenser, a centrifugal or thermic switch

6. Inductor winding of a D.C. motor with 4 principal and 4 auxiliaries poles

Equipment and materials:

- the same as in number 2 with test bench equipped with instruments D.C. and D.C. motor stator 2 HP

7. Inducted winding of a D.C. motor, having as inductor the one described in number 6 above

Equipment and materials:

- the same as in number 2 with test bench equipped with instruments D.C. and motor rotary 2 HP

8. No-load test of a three-phase motor as in number 2

Equipment and materials:

- test bench with tri-phase variac,
- 3 ampermetre 10 A
- 2 voltmetre 300 V
- 2 wattmetre 10 A 300 V c 0.3
- 1 stroboscope
- cables with terminals 4 mm^2
- set for drawing

LIST OF MATERIALS, EQUIPMENT AND MEASURING INSTRUMENTS FOR A SIX-MONTH COURSE FOR 16 ELECTRICIANS (8 electro-mechanics - 8 electrical installers)

PREMISES AND EQUIPMENT

2 classrooms - approx. 5m x 7m
2 teacher's desks -
2 2 blackboards - approx 1x3m
16 student desks with incorporated chairs
2 laboratory premises - approx 6x6 m

Didactic material (graph paper, pens, notebooks, pencils, colored chalk, rulers, squares, etc.)

1 principal electric panel
4 section electric panels
2 closets for hardware and instruments
2 closets for electrical material and motors
2 vertical panels for 4 groups of trainnes
1 portable voltage supply
1 coil winding machine (electric)
2 coil winding machine (manual)
8 soldering guns
3 solder bath, electric
1 oven for drying motors 100x100m
2 micrometres
16 sets for electricians including:
16 combination pliers with pipe grip, side cutters, and 2 joint cutters; polished head and PVC insulated handle 160mm long;
16 diagonal cutting pliers - suitable for cutting hard wire, PVC insulated 160mm long;
16 flat-nosed pliers with serrated jaw, PVC insulated 160mm long
16 round-nosed pliers - non-cutting type, PVC insulated 160mm long

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List of Materials, equipment, etc. page 2

16 wire-stripping pliers, standard model with adjustable screw for different size 150mm length for diff. sizes 150mm length

10 long chain-nosed pliers with serrated jaws, bent 45 degrees of approx 75mm length

16 crimping set complete with pliers and assortment of "cimping-on" terminals of various shapes

2 eyelet closing pliers, set comprising of hand-type pliers with eyelet formers for brass eyelet of 2,3,4,5, 6,7,8 mm dia. complete with 1500 brass eyelet

2 pipe cutter with one fast cutting wheel and two rollers to cut from 10 to 50mm dia.

16 adjustable spanners - standard model with 15 degree angle, span up to _____

8 open-ended spanners, metri double-ended type chromo vanadium set, 12 spanners from 6-32mm

16 Tinman's mallet , box wood with wooden handle, approx dia. 75mm

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4 Gun-type Fitters
6 Multimetres
8 amperometres (clip-on type A.C.)
9 Portable Voltmetres
6 Current Transformers 5/30/100/200
2 Phase indicators
4 Portable Power Metres
2 Portable Power Metres with low tanks
4 Portable Wheatstone Bridge
4 Temperature Testers
2 Portable Earth Resistance Testers
2 " Insulation Testers
1 Interton short circuit tester
2 portable electric drills

CONSUMABLE MATERIAL

16	Motor Control Switch (3x15A)
32	Contactors three-phase (coil 24V) 15A
32	" " " " " 25A
16	Thermal relays 0-30A
100	Terminal strips
300m	Flexibla cable 4x4 mm^2
300m	" " 1x4 mm^2
500m	Cable Terminals from 1.0 mm^2 to 10 mm^2
50	three-phase fuse bases (20A-30A)
450	fuses for above bases (10-20-30 A)
2	rolls of enameled wire for winding d = 0.15
"	" " " " " " " " " 0.20
"	" " " " " " " " " 0.25
"	" " " " " " " " " 0.30
"	" " " " " " " " " 0.40
"	" " " " " " " " " 0.50
"	" " " " " " " " " 0.60
"	" " " " " " " " " 0.80
"	" " " " " " " " " 1.00
"	" " " " " " " " " 1.20

5 m^2 laminated paper (3x1000x1000mm)

2 m^2 copper sheet (1x1000x1000mm)

Slot insulation material

2 Kg. Resin Core Solder

1 kg. Soldering pot

100 pieces cotton tape

50 pcs. cotton tape

Assortment of insulation sleeving set

50 litres of varnish oven-drying type for electric motor

50 litres of varnish air-drying type for electric motor

60 Plugs Banana type

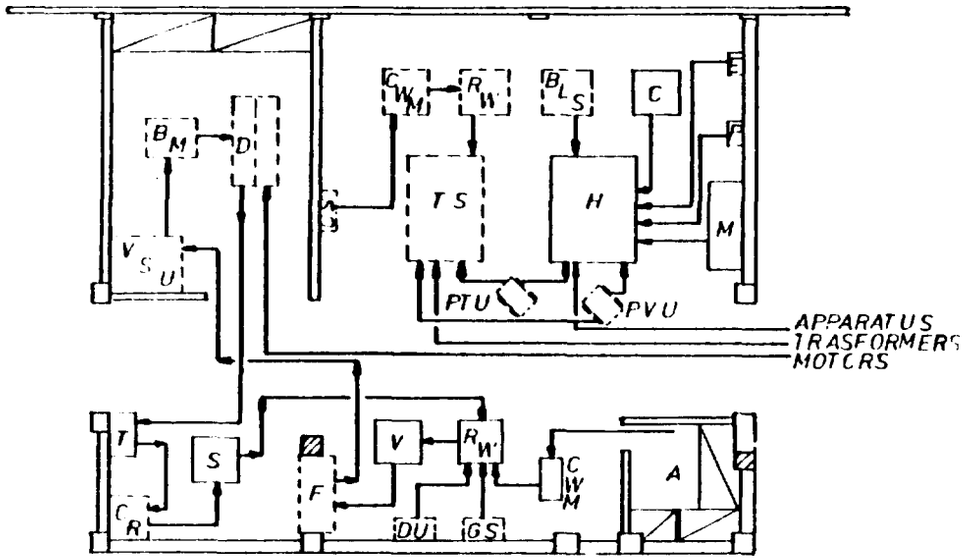
60 Crocodile Clips

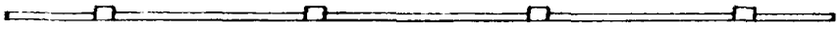
60 Connectors Shoe Type

8 transformers 50 VA 125/24 V

24 push-buttons (set of two buttons)

24 push-buttons (set of three buttons)





I PHASE

II PHASE

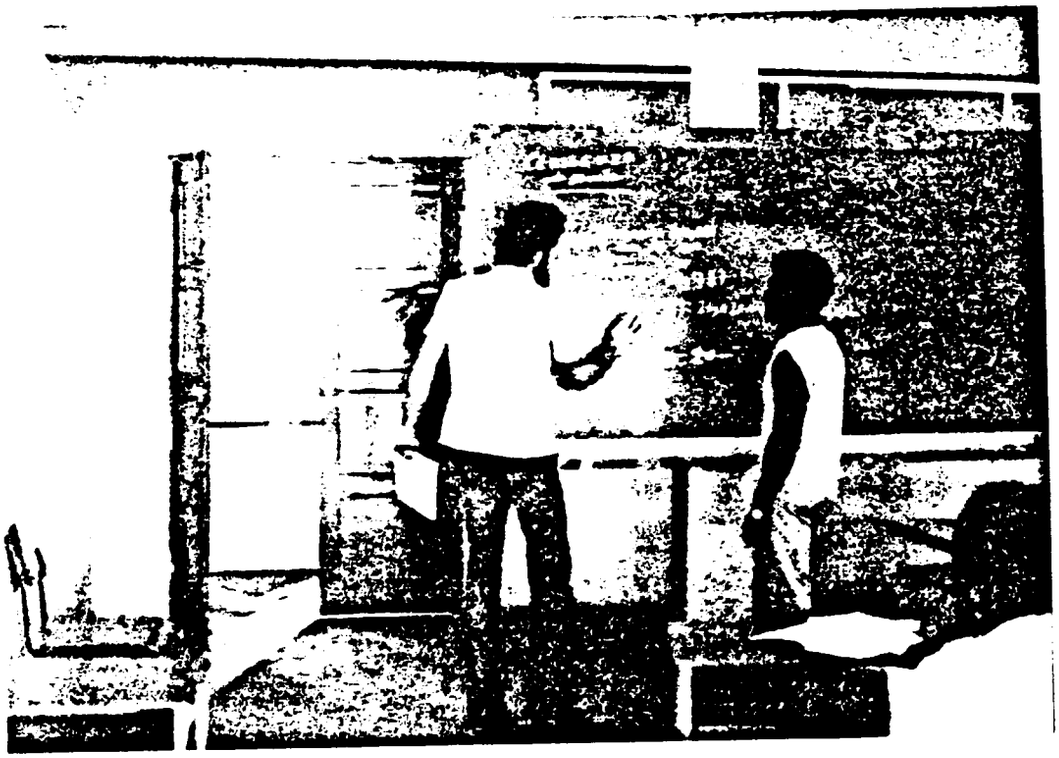
A: Store
CWM: Coil Winding Machine
RW: Rewinding Bench
V: Varnishing
GS: Guillotine Shear
DU: Double Wrouting Machine
CS: Cutting Shear
F: Oven
S: Dismounting Bench
CR: Coil Remouving Apparatus
T: Tank For Remouving Burnt
M: Bench
C: Central Bench
BLS: Bench Lever Shear
D: Measuring Bench
VSU: Voltage Supply Unit.
PTU: Portable Test Unit.
PVU: Portable Voltage Unit.
BM: Balancing Machine
H: Plataform For Apparatus
TS: Plataform For Trasformers
P: Pillar Drilling Machine
E: Double Ended Grinding Machine

•: with tools to execute curves, bending bars, to bore holes etc.....

Desenhou / Tirou	Data: 1-8-82	Nome: FELIPE	Assinatura: [illegible]	Visto	E.M.I.N. LUANDA ANGOLA
Escala: 1:100	Aprovado	ELECTRICAL-SECTION		Substitui o	Substituido por
	Designação	LAY OUT		Des. nº	EMP 01-07

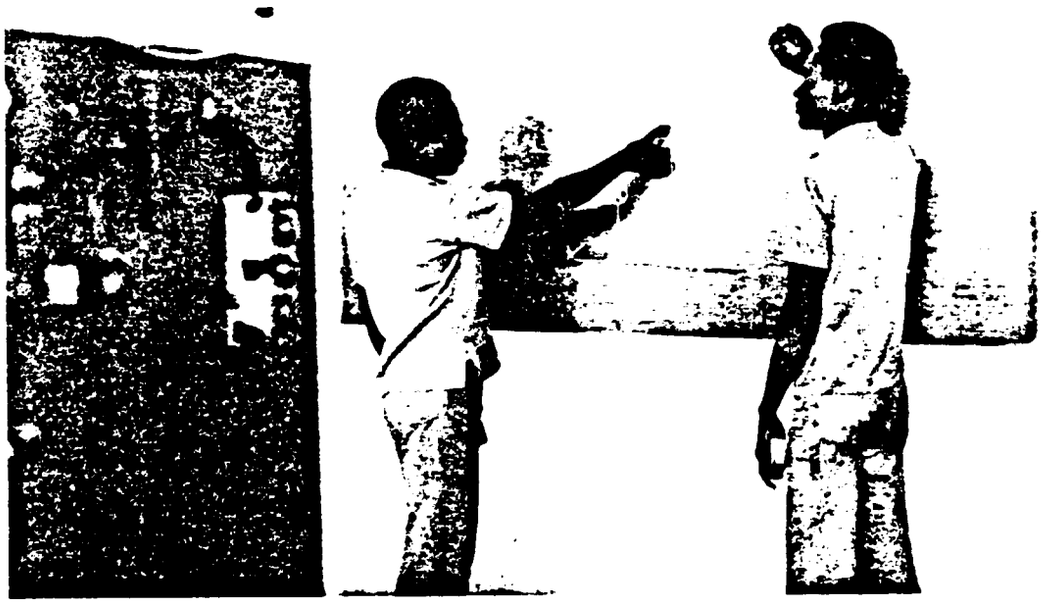
TRAINING ACTIVITIES

a) Theory and numerical excercises



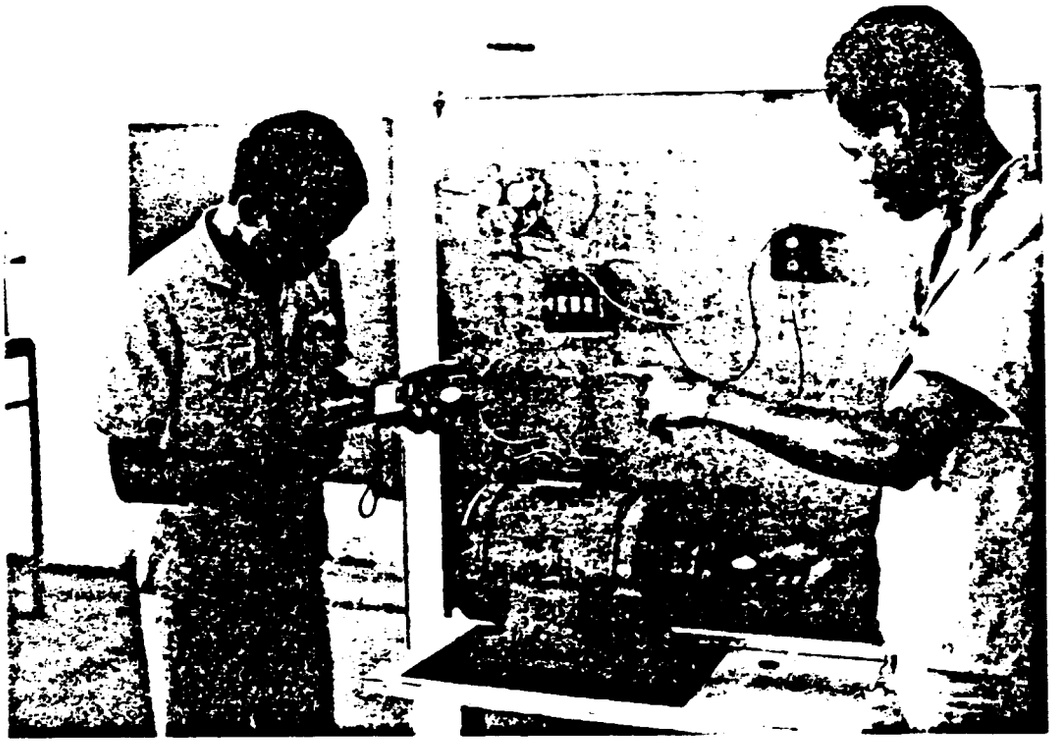
TRAINING ACTIVITIES

b) Work shop excercises



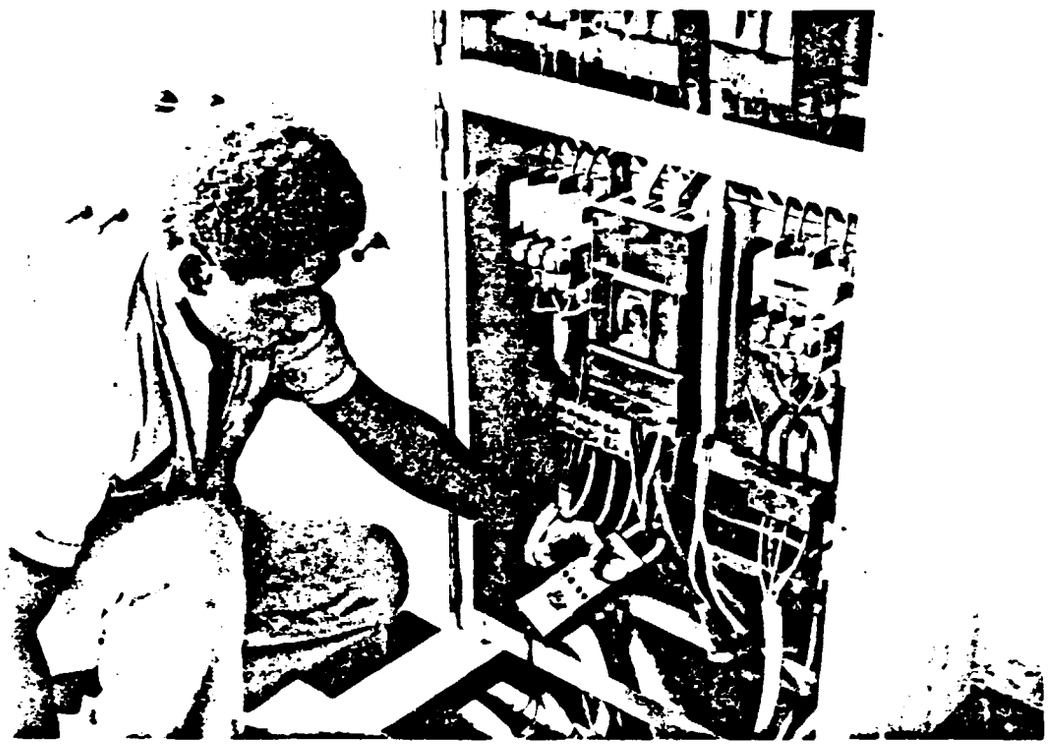
WORKING ACTIVITIES

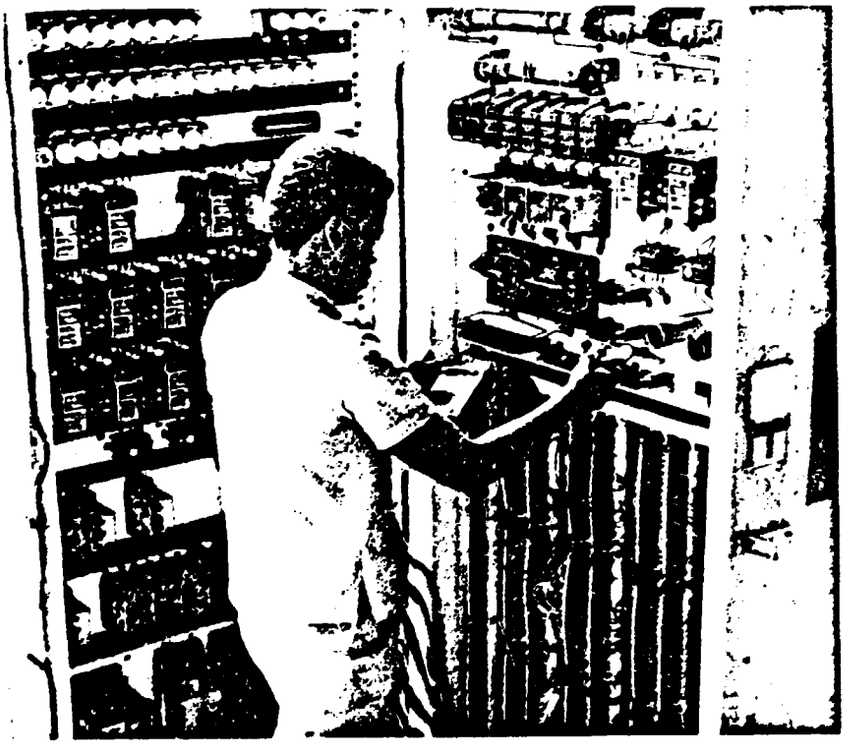
a) Control and measurement of electrical machinery



WORKING ACTIVITIES

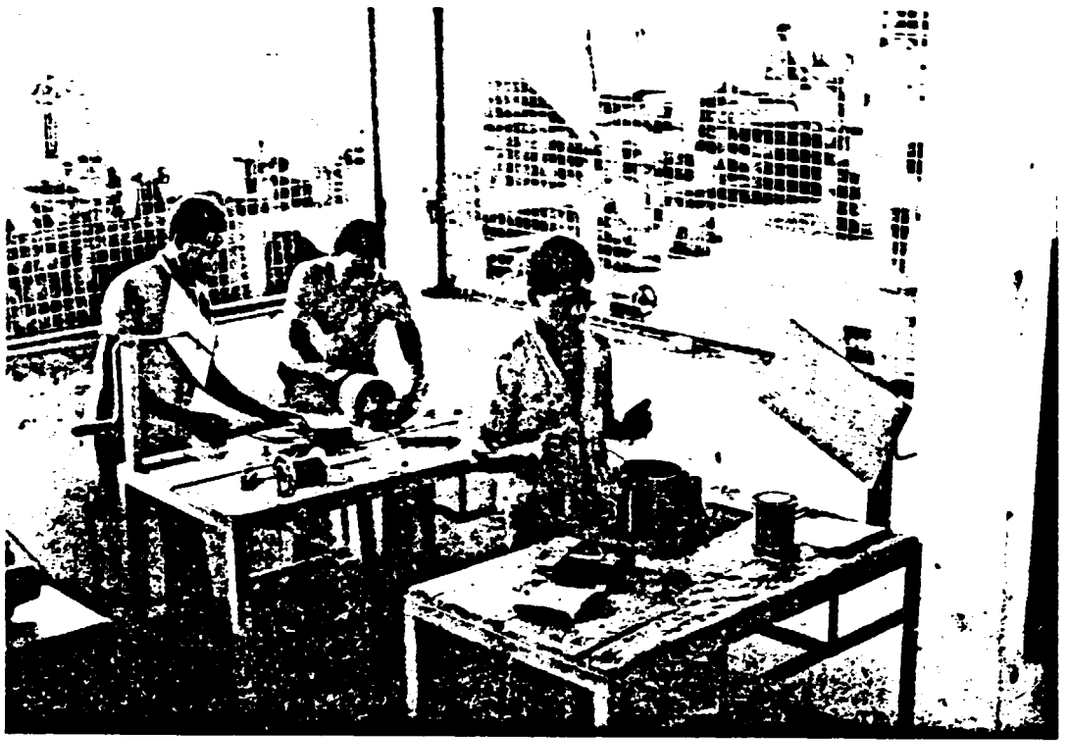
b)Control and measurement of electrical panels





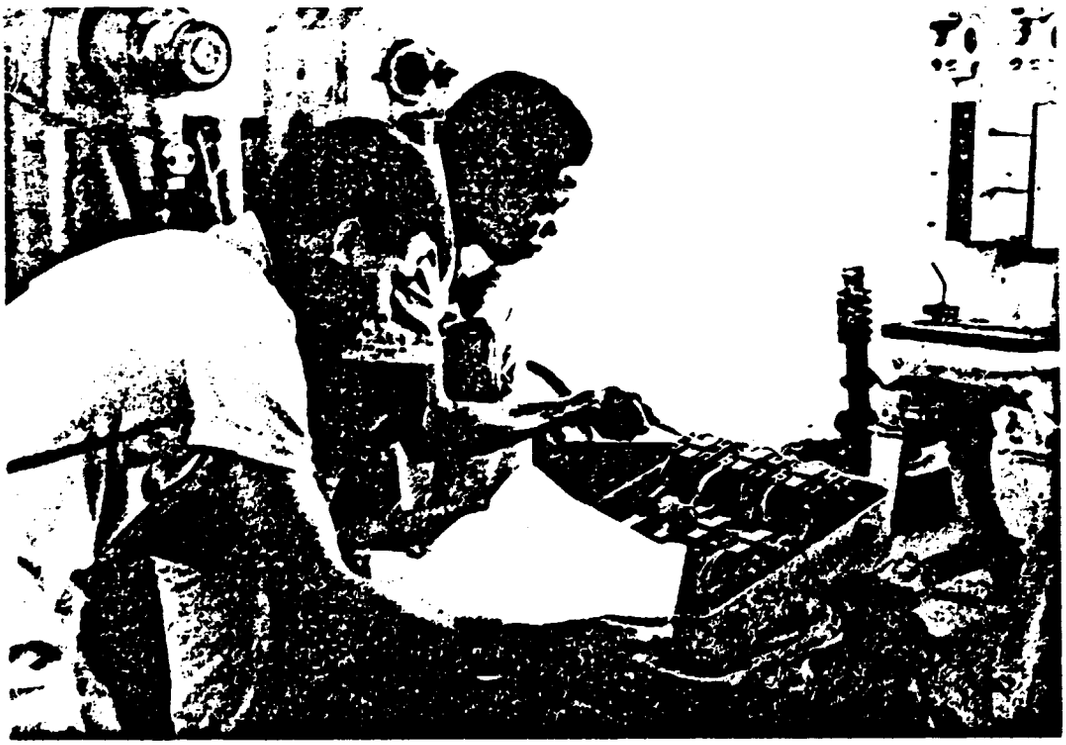
WORKING ACTIVITIES

c) Repair of electrical machinery



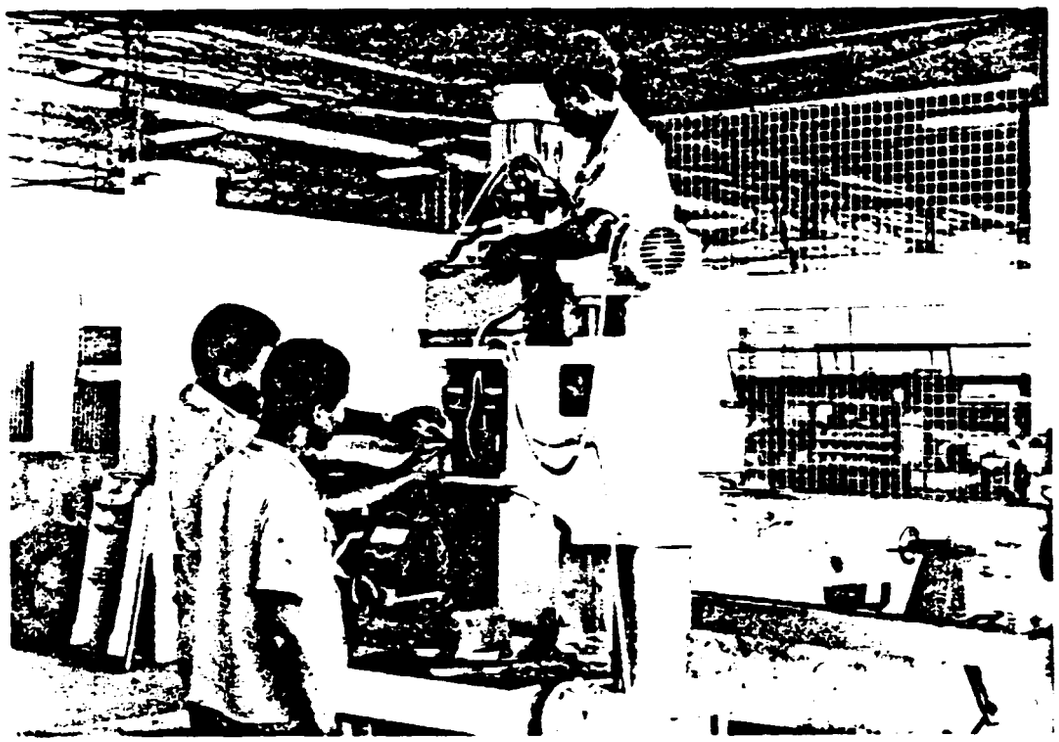
WORKING ACTIVITIES

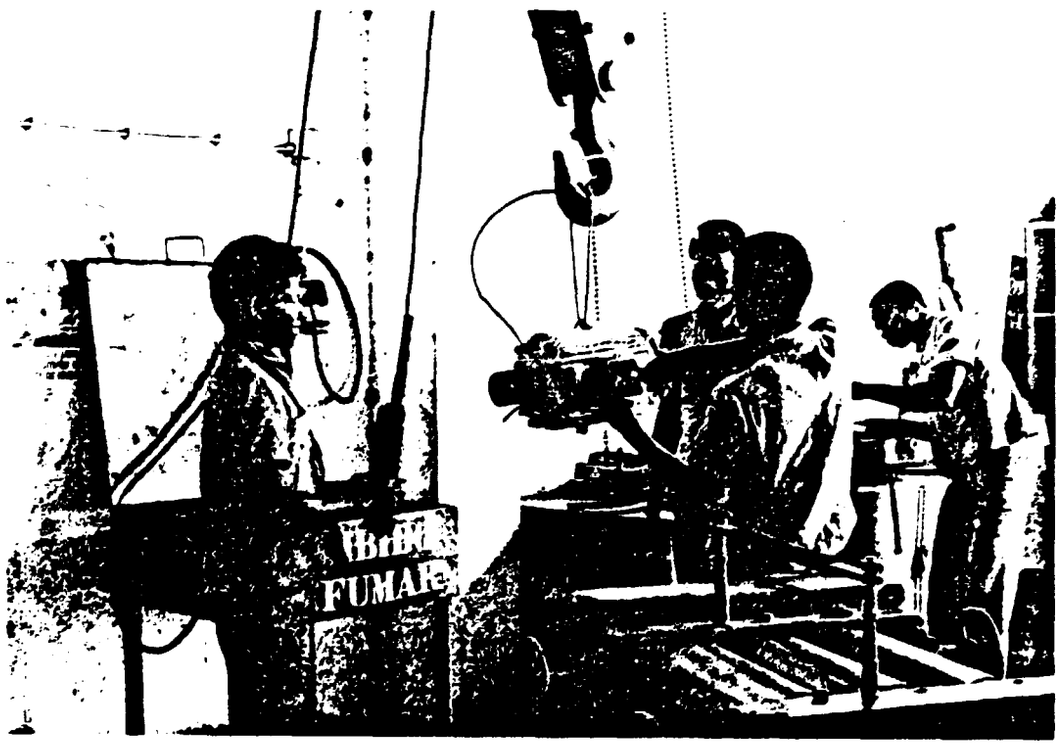
d) Repair of electrical panels



WORKING ACTIVITIES

e) Installation of electrical motors



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