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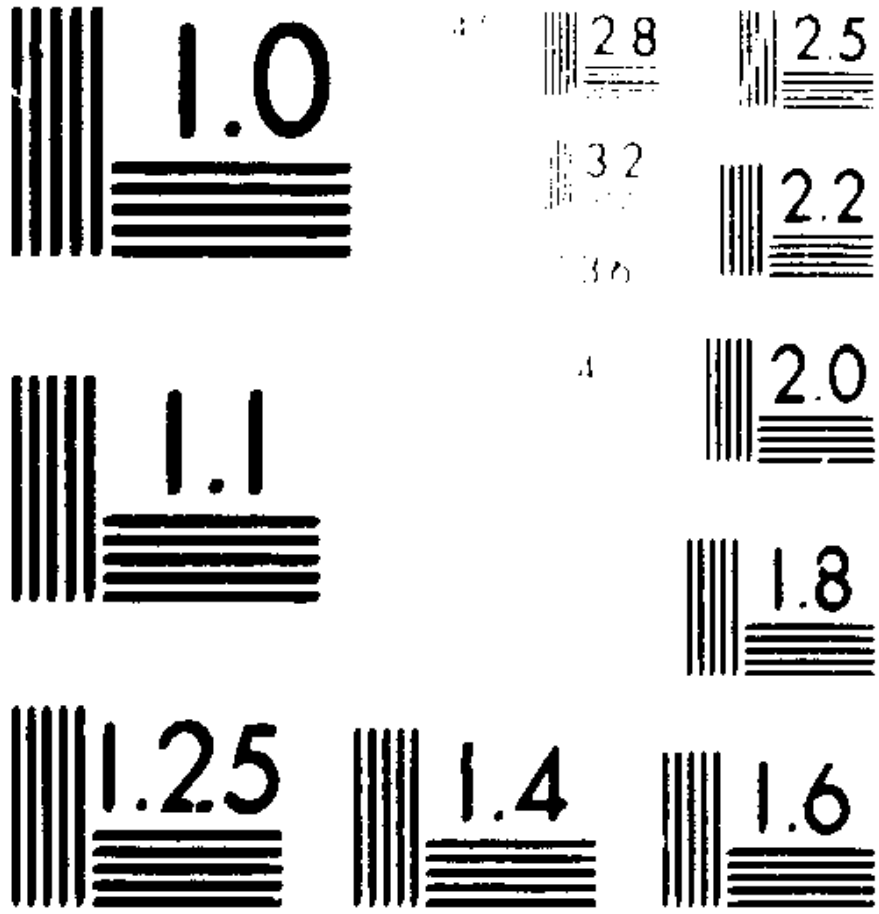
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APPLICATION FOR SPECIAL INDUSTRIAL SERVICES

SI/STP/81/801

SAO TOME AND PRINCIPE

Priorities and criteria for the establishment of an electromechanical maintenance network able to ensure the functioning of local industries and services under all circumstances

Final report on the electrical sector*

Prepared for the Government of the Democratic Republic of Sao Tomé and Principe
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of P. DE GROOTE, industrial maintenance expert, Director of D G S INTERNATIONAL S.A.

United Nations Industrial Development Organization
Vienna

* This document has been translated from an unedited original.

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EXPLANATORY NOTE

Local currency: Dobra

100 Dobra = US$ 2.5

Abbreviations:

DRSTP : Democratic Republic of Sao Tomé and Principe

DCC : Directorate of Civil Construction

Definitions

The following terms are used in this report:

Production unit: Plantation, small and medium-sized industry, factory

a maintenance and repair workshop is a workshop which may either belong to a production unit or may be a totally independent workshop.

FOREWORD

Title of the project: Application for special industrial services made by the Government of the Democratic Republic of Sao Tomé and Principe.

Project No: SI/STP/81/801/11-01/31.9.C

Aim of the project: The defining of priorities and criteria for the establishment of an electromechanical maintenance network able to ensure the functioning of local industries and services under all circumstances.

This report covers all electrical equipment in the production units and the electro-mechanical workshops of the Democratic Republic of Sao Tomé and Principe. The mechanical equipment is covered in a separate report. (UNIDO project ST/STP/81/801/11-02/31.9.C).

This report has been written following a series of surveys, carried out over a period of two weeks, on the condition of technical equipment and the present situation with regard to its maintenance. For this purpose a detailed analysis was made of the organization of maintenance, the personnel, the availability of spares, the equipment in the maintenance and repair workshops, etc.

This analysis shows that urgent measures are necessary, firstly to avoid increasing deterioration of production facilities and secondly to ensure the future reliability which is necessary for the country's economy.

This report also contains a series of recommendations for improving the present situation together with concrete measures proposed under the UNIDO programme.

These recommendations relate to training personnel, providing maintenance facilities and creating a logistical base, as well as sending out technical assistance and purchasing tools and spares.

It is to be hoped that they will lead to the better maintenance and use of the production capacities.

Ghent, Belgium
September 1981.

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LIST OF ANNEXES

INTRODUCTION

Since its independence, the Government of the DRSTP has had to face a great challenge in the economic field. There are some 35 plantations covering 90% of the cultivable land, growing virtually only cocoa; this accounts for about 90% of the total exports of the country, leaving it at the mercy of fluctuations in the world cocoa market. In addition the importance placed on cocoa has meant that virtually nothing else was grown there, and therefore all food products had to be imported.

The mass exodus in 1975 of almost all the white colonists left the administration of the plantations in chaos. As a result of this state of affairs not only did production drop appreciably but it became more difficult to maintain the equipment used for production in a good condition and state of repair. This was mainly due to the fact that the colonists had not left behind any human or physical infrastructure able to support the plantations or other industrial activities.

Most of the large plantations devised their own maintenance and repair systems for the equipment they owned. Since there was little exchange of information between these plantations, each workshop had to become self-sufficient. The workshop run by the Department of Civil Construction in town is the only one of national status, and this is due to its wider scope of action.

Virtually all the equipment in operation on the island is obsolete and in urgent need of maintenance, or else has broken down and needs repairing. The Government is now gradually installing new equipment, mainly in the fields of transport and civil construction, but this is only on a modest scale and depends on the foreign currency available. In addition the reorganization of industry has begun, in parallel with measures to replace equipment. These measures are being concentrated on the first priority, which is the setting up of a national electro-mechanical maintenance and repair network.

The present situation regarding the maintenance and repair of equipment is such that the existing workshops (most of which are still only equipped with primitive equipment) are making a considerable effort to repair even the irrepairable. A small number of these workshops are equipped with old foundries made up of small vertical furnaces with a capacity of 20 to 30 kg producing bronze castings (plain bearing bushings, etc.). In addition there is a great need for welding and oxygen cutting equipment throughout both islands.

It is virtually impossible to obtain spares for reasons of isolation, inexperience and lack of foreign currency. These problems, as well as the not very successful efforts at carrying out repairs, have seriously hampered development. This situation will continue if measures are not immediately taken to set up a maintenance and repair network, supported by an integrated spares depot. To get some idea of the size of the maintenance and repair network and the spares depot we have taken into account the fact that the island of Sao Tomé has a population of 70,000 and the island of Principe a population of 10,000.

In addition provision has been made for future purchases of several items of equipment, especially in the field of civil engineering or the plantations.

The forecast demand in 1982 for cars, buses, motor-cycles, various items of road building equipment, plantation equipment and fishing equipment is enormous. The maintenance and repair infrastructure described in this report has been designed to be of a size sufficient to cover 25 vehicle or heavy equipment units, 160 medium-sized vehicles or road units, 300 lorries and buses of all sizes and at least 2,000 private cars.

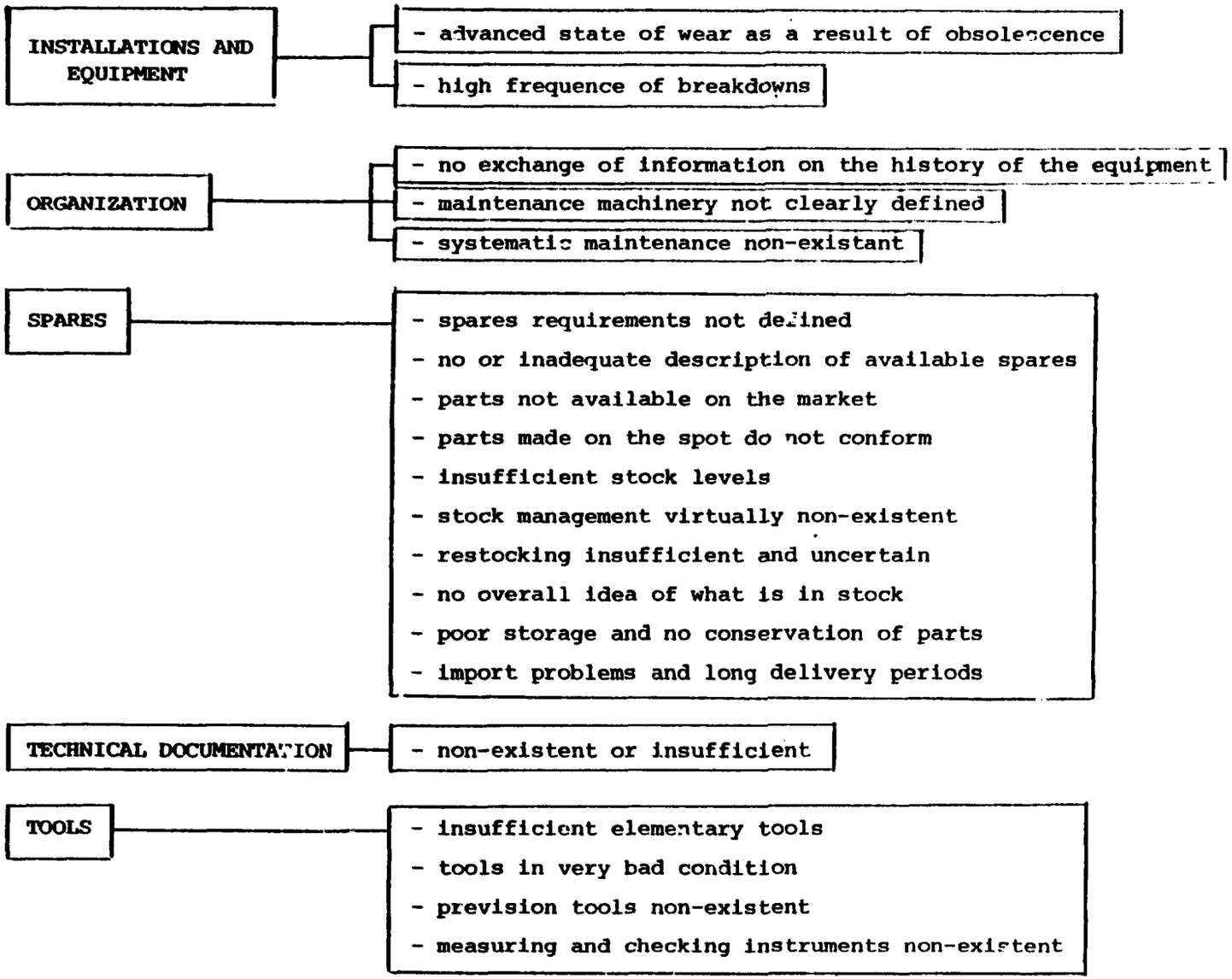
In addition this infrastructure is designed so as to meet the needs of an increasing volume of industrial equipment for about 30 small and medium sized industries, together with a fishing fleet for which an increase of 650 outboard and 30 inboard motors is expected in 1982.

On the following page we have drawn up a schematic outline of the problems found during the surveys.

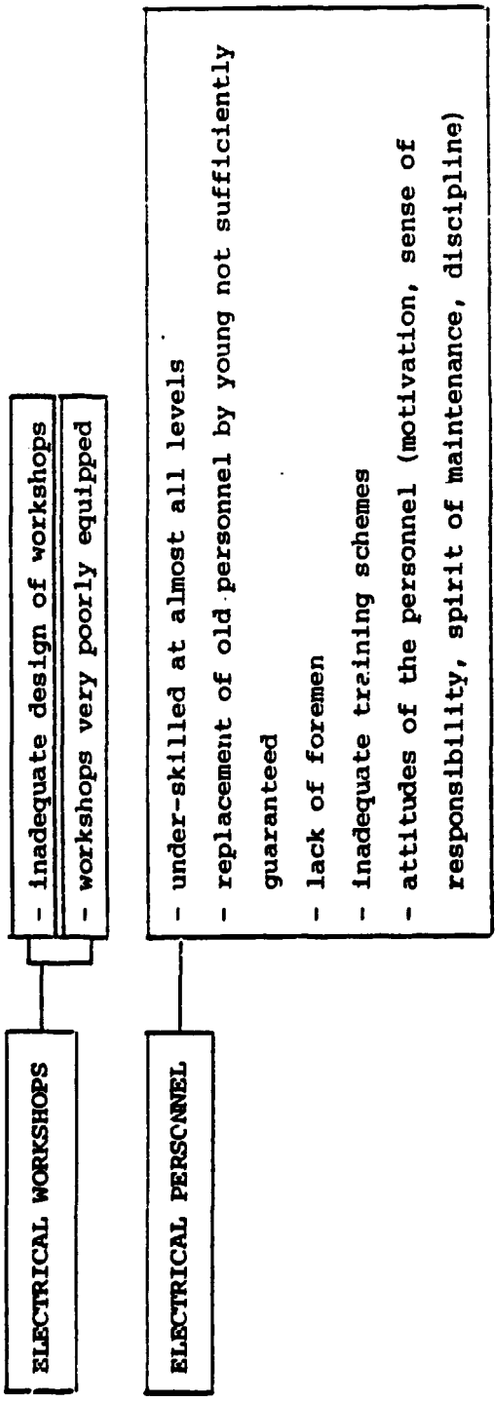
The objective of the project, which is to determine the criteria and priorities for setting up a reliable electro-mechanical maintenance and repair network, has been achieved in this mission. However, the original idea of setting up a chain of maintenance and repair workshops has been abandoned, since it was found that the best solution would be to set up a logistical base with a number of workshops and a central spares depot. A parallel scheme to improve the situation of the workshops in the production units (especially by buying tools and spares) has been proposed. In addition, a mobile technical assistance team, enabling the shortcomings of the existing workshops to be overcome in the short term, should contribute towards ensuring the continuous functioning of local industries and services under all circumstances.

As regards training we did not find that any action has been taken in the electrical field in the past.

The measures which we recommend in this report must be considered as starting from zero.


INSTALLATIONS AND EQUIPMENT
- advanced state of wear as a result of obsolescence
- high frequence of breakdowns
ORGANIZATION
- no exchange of information on the history of the equipment
- maintenance machinery not clearly defined
- systematic maintenance non-existant
SPARES
- spares requirements not defined
- no or inadequate description of available spares
- parts not available on the market
- parts made on the spot do not conform
- insufficient stock levels
- stock management virtually non-existent
- restocking insufficient and uncertain
- no overall idea of what is in stock
- poor storage and no conservation of parts
- import problems and long delivery periods
TECHNICAL DOCUMENTATION
- non-existent or insufficient
TOOLS
- insufficient elementary tools
- tools in very bad condition
- prevision tools non-existent
- measuring and checking instruments non-existent

SURVEY OF THE EXISTING MAINTENANCE PROBLEMS (cont'd)



Fields	Recommendations and actions to be undertaken	By		Planning	
		DRSTP	UNIDO	Short-term	Long-term
Organisation of electrical maintenance	- setting up a mobile assistance team		X	X	
	- setting up a Logistical Secretariat	X			X
	- setting up a logistical base with central spares depot		X		X
	- setting up an organization based on the principle of client-service	X	X		X
	- defining the mechanism between the logistical base and the branch workshops in the production units and the electro-mechanical workshops	X	X		X
Spares	- establishment of a list of first necessity spares by ABC analysis		X	X	
	- purchase of urgently required spares		X	X	
	- systematic study of component parts of the equipment	X	X	X	
	- establishment of a list of spares needed for one year's operation		X	X	
	- purchase of spares for one year's operation	X		X	
	- setting up a central depot at logistical base level		X		X
	- preparation of a uniform system for describing and coding spares	X			X
	- carrying out a general study to define spares requirements so as to establish the normal stock level	X			X
	- purchase of parts to establish the normal stock level	X			X
	- setting up a system for an exchange of information on the consumption of spares	X			X
	- setting up a rational stock management system	X			X
	- continuous reordering of spares	X			X
	- reorganization of stores in the production units and electro-mechanical workshops	X			X

Fields	Recommendations and action to be undertaken	by		Planning	
		DRSTP	UNIDO	Short-term	Long-term
Technical documentation	- establishment of a list of first necessity technical documentation		X	X	
	- purchase and/or collection of urgent documentation		X	X	
	- systematic study of missing technical documentation	X			X
	- purchase and/or collection of missing technical documentation	X			X
	- establishment of specifications for technical documentation when purchasing new equipment	X		X	
	- establishment of central archives with reproduction room at logistical base level		X		X
Electrical workshop/ logistical base	- purchase and dispatch of mobile electro-mechanical workshop		X	X	
	- construction and provision of buildings for logistical base	X		X	
	- purchase of equipment for logistical base		X		X
	- commissioning logistical base		X		X
Tools and measuring instruments	- purchase of complete tools and measuring instruments for the mobile workshop		X	X	
	- purchase of tools and measuring instruments for the electrical units of the workshops in the production units and electromechanical workshops		X	X	
	- purchase of basic tools and measuring instruments for the electrical workshop at the logistical base		X		X
Electrical-technical assistance	- sending out an electrical-technical assistant to help for 12 months		X	X	
	- sending out an electrical-technical assistant for the logistical base for 24 months		X		X

Fields	Recommendations and action to be undertaken	by		Planning	
		DRSTP	UNIDO	Short-term	Long-term
Training of electricians	- training a coil-winder in Europe		X	X	
	- training scheme for electricians in training centres				
	- supervisory staff (electrical fitter)	X		X	X
	- operatives	X		X	X
	- lower operatives	X		X	X
	- on-the-job training, by technical assistance, of men for certain specific tasks		X	X	
	- on-the-job training, by technical assistance, in the electrical workshop		X		X

II. SURVEY

A. Units and workshops visited

Annex 1 gives a detailed list of the production units (plantations and others) and maintenance and repair workshops covered by the survey.

These involved:

- 1 school furniture factory with sawmill, foundry and forge;
- 3 maintenance workshops for rolling stock;
- 1 garage for private cars;
- 1 maintenance workshop for buses;
- 1 repair workshop for boats;
- 2 quarries;
- 3 sawmills;
- 4 maintenance workshops in "empressas";
- 1 palm-oil mill;
- 1 thermal electric power station;
- 2 hydro-electric power stations;
- 1 brewery.

These units and workshops may be considered as a representative sample of the technical equipment on the islands of Sao Tomé and Principe. For information a rough estimate of the production units and maintenance workshops existing on the islands is given in Annex 2.

The maintenance workshops available to the units visited are listed in a table in Annex 5.

The machine tools and maintenance equipment in these workshops is listed in a table in Annex 4.

A table listing the rolling stock maintained by the workshops concerned is given in Annex 3.

B. The progress of the surveys

The surveys were carried out in the form of inspections of equipment and meetings with those in charge.

The surveys covered electrical maintenance and related principally to:

- the organization of the electrical unit;
- the technical facilities;
- the technical level and number of electrical personnel;
- the electrical-technical documentation;
- the preparation, planning and follow-up of maintenance;
- the flow of information;
- the problems of electrical spares;
- initial and further training schemes for personnel.

The results of the survey are given in a table set out in Annex 6, and are as follows:

- the first column gives the fields of the survey:

    1. state of the electrical installations and equipment
    2. the efficiency of electrical maintenance
    3. electrical spares
    4. technical documentation
    5. electrical workshop
    6. tools for electricians
    7. electrical measuring instruments
    8. electrical personnel

- for each unit or workshop the replies obtained, or the findings made, are represented by a code. This code is explained in Annex 7.

III. ANALYSIS AND EVALUATION OF THE SURVEYS

A. Analysis table

The information set out in the table in Annex 6 has been analysed and evaluated in the table and paragraphs below.

The following table gives the percentages relating to the units or workshops concerned for each field of the survey; the evaluation corresponds to the explanations in Annex 7:

Evaluation / Field of survey	good	fair	poor	very poor
1. State of equipment and electrical installations	28%	11%	61%	0%
2. Efficiency of electrical maintenance	17.5%	29.5%	41%	12%
3. Electrical spares	0%	17.5%	29.5%	53%
4. Technical documentation	0%	6%	29.5%	64.5%
5. Electrical workshop	12.5%	0%	50%	37.5%
6. Tools for electricians	0%	6%	70.5%	23.5%
7. Electrical measuring instruments	0%	6%	12%	82%
8. Electrician personnel	0%	53%	47%	-
Situation of electrical maintenance				
Weighted average	**7.04%**	**17.3%**	**42.19%**	**33.56%**

B. Analysis of the present situation

The state of the electrical maintenance machinery and equipment is in general poor because the equipment is so obsolete. The state of the rolling stock is good in some cases (new equipment), but in most cases it is poor and this is due mainly to a lack of spares and secondly a lack of technical knowledge by the electrical personnel.

The advanced state of wear of the equipment leads to unexpected breakdowns. Some parts of the equipment need complete renewal or must be overhauled if these installations are to be kept in acceptable working order for as long as possible.

The problem of the lack of spares as well as the low technical level of the personnel are the major reasons for a low average efficiency of electrical maintenance. Added to these reasons is the problem of a lack of complete technical documentation, adequate tools, technical equipment for electrical maintenance and measuring instruments.

The problems relating to spares are very serious. They are partly linked to the age of the installations and their unavailability on the international market, and partly to reasons of organization and methods inherent in the unit or workshop visited (description of parts, spares management and reordering). The present stock cover is insufficient in all fields, and this situation is further aggravated by the lack of systematic studies of the equipment to define the spares requirements. The storage of parts needs reviewing in all cases: everywhere there is a lack of space, a lack of storage facilities, and very poor preservation of the parts. Stock management just does not exist. Only in a few cases were we able to find any coding of parts, but there is no continuous follow-up of consumption resulting in systematic reordering. In addition, the delivery dates for spares are extremely long: wrong or incomplete descriptions cause needless exchanges of correspondence with the manufacturer,

parts out of stock with the manufacturer, administrative constraints (budgets, payment, banks, etc.).

We found that electrical technical documentation was non-existant or inadequate in virtually all cases. Even for new equipment the electricians rarely have any diagrams or drawings available, which makes repair work almost impossible. In addition, the lack of a technical library means that the electricians do not have access to some important information. For this reason, a lot of electrical work is carried out in a haphazard fashion, which not only means that repairs are not reliable but also brings with it the risk of seriously reducing the useful life of the equipment. This lack of technical documentation leads to a lack of information when choosing spares to keep in stock, and also jeopardizes the safety of the workman when working on the equipment.

The electrical workshops cannot carry out their real function because of a lack of equipment, tools and measuring instruments. In several cases the electrical workshop is located within the mechanical workshop and electrical work is carried out in a very disorganized manner. In general the electrical workshops are inadequately designed (work stations, storage facilities, working surfaces, general layout).

The electrical personnel is firstly too small in numbers and secondly not sufficiently skilled. The vocational skills of the electrical personnel are no higher than grade one specialist (OS1). Most of the units or workshops only have unskilled electricians.

C. Conclusions

The analysis of the present situation in the above section gives an idea of the multitude of factors which hamper efficient electrical maintenance.

To solve the problems of Sao Tomé it will not be sufficient to provide parts or train personnel. Integrated action in all

fields will be necessary, and the measures we recommend should lead to action being taken at the following levels:

- personnel (numbers, skills, motivation, discipline);
- spares (description, coding, management, basic stock, storage facilities, reordering);
- technical documentation;
- tools and measuring instruments;
- electrical maintenance workshops;
- organization of electrical maintenance.

IV. RECOMMENDATIONS FOR RELIABLE ELECTRICAL MAINTENANCE

A. Introduction

The analysis of the present situation regarding electrical maintenance in Sao Tomé and Principe has shown that urgent action is necessary, not only in order to reduce the frequency of breakdowns, but in particular to preserve new equipment from premature wear and deterioration.

In the following paragraphs we have assembled our recommendations regarding measures to be taken in the following fields:

- organization of electrical maintenance;
- electrical spares;
- technical documentation;
- the electrical workshop;
- vocational training of electricians.

It should be noted that the recommendations included in the following paragraphs should be regarded as additional to the mission report and recommendations of the UNIDO mechanical engineering expert (SI/STP/81/801/11-02/31.9.C)

B. Organization of electrical maintenance

Given firstly that the DRSTP does not have a sufficient number of skilled electricians, and secondly that a good deal of time will be required to train personnel, we think that consideration should be given to a centralized maintenance structure, on which branch workshops in the various production units or repair workshops will depend.

A centralized structure can be formed by setting up an integrated electromechanical workshop, supplemented by a central store for spares. This central workshop, together with the store, could be considered as a kind of logistical base, dealing with difficult

breakdowns, repairs, overhauls, carrying out small new work and producing certain spares. Its field of activity will cover all the technical equipment of the DRSTP and will therefore be directed both at the Ministry for Industry and the Ministry for Agriculture or the Transport Secretariat. The logistical base should therefore depend on a body independent of the ministries or secretariats concerned by its field of activity. We suggest the creation of a Logistical Secretariat.

The logistical base will include various sections (see paragraph V.B.) including an electrical workshop (see paragraph V.B3).

The electrical workshop will not only have a repair and reconditioning function but must also have at its disposal a mobile team which can be sent out to the units or workshops for urgent or difficult work (see paragraph V.A). In addition each production unit or repair workshop must have at its disposal an electrical maintenance section (even if this is only one person for small concerns) which will call in the logistical base if necessary.

C. Electrical spares

1. Study of the component parts of the equipment

The problems of spares are the major cause for concern for maintenance engineers. It was found that at least 65% of the cases where equipment is unavailable are due to the lack of parts. Great attention should therefore be paid to spares as soon as a piece of equipment is bought.

In order to remedy the present situation regarding electrical spares, we need to make a distinction between new equipment and old equipment.

Given that spares for the old equipment are certainly no longer on the market, it would be useless to start detailed studies on the component parts. The only solution is to make a detailed study of the

electrical assemblies and sub-assemblies so as to determine their characteristics and to enable them to be replaced by new equipment in case of breakdown.

As regards new equipment a systematic study of the electrical components must be initiated in order to determine those parts which must be kept in stock. This study will be carried out in stages:

- break-down of the equipment into assemblies and sub-assemblies;
- definition of the component parts of each sub-assembly;
- definition of the wearing parts of the component parts.

Thus the component part "switch unit" for example will be broken down into the following wearing parts: main contacts, auxiliary contacts, solenoids.

The study described above can only be carried out by electrical technicians on the basis of detailed technical documentation (see IV.D) or, if the technical documentation is missing, by carrying out surveys on the spot.

2. The choice of spares to be kept in stock

The consumption of materials and spares is influenced by a number of factors:

- the number of parts subject to wear;
- the stress imposed on the components of the equipment, depending on the nature of its use;
- the extent to which the equipment is used;
- the age of this equipment;
- the technical competence of the operating and maintenance personnel.

It is generally very difficult to determine the precise quantities of stock to be held. Annex 8 includes a table which gives a few empirical values relating to estimating spares requirements, together with the annual consumption in an environment such as that of the DRSTP. The figures are only given by way of a guide and can be used to create an initial supply of spares. These figures will have to

be modified according to the actual consumption.

3. Coding and description of spares

It is only possible to know exactly what parts are in stock if they have a uniform description. A uniform description enables a common language to be used for all production units and maintenance workshops, as well as ensuring the optimum stock level for each item.

Apart from the uniform description, coding of the parts will be necessary to make for easy management and follow up of consumption.

In addition, the way in which coding and description is carried out will be a decisive factor in the quality of the following operations:

- storage, and hence the service to users;
- determination of the requirements for each user;
- reordering by the purchasing manager;
- correct supply by the supplier.

The allocation of a code number and a description is subject to the requirements set out in Annex 9/1.

In Annex 9/2 we have given an example of a coding system based on coding by nature.

4. Spares stock management

To solve the problem of reordering it is absolutely vital that one accepts that future consumption must be based on past consumption. If one does not, initially, have data on past consumption an estimate of future consumption must be made by comparison with other similar cases. Of course past results can be adapted to correspond to considerations of a technical, economic or financial order. The most detailed historical information which will be used is monthly consumption.

In order to determine monthly consumption it is necessary to collect consumption data. To do this, the users would have to indicate their consumption of spares on suitable forms. These forms would then be sent to the central store at the logistical base which would be responsible for reordering.

In Annex 10 we have set out a few considerations on the type of management to be chosen for a particular article.

5. Storage

The setting up of a central store at the level of the proposed logistical base would not only permit complete control over stock management, but also avoid over-stocking or under-stocking in the units. This central store should be regarded as holding a buffer stock which would supply the branch stores in the production units or maintenance workshops. The articles would therefore be classed in two groups:

a) articles specific to a particular piece of equipment, and
b) standard articles, consumables and day-to-day maintenance articles.

A basic stock of the articles in the second group would be available in each unit or workshop, whilst the parts specific to a particular piece of equipment would only be stocked in a unit or maintenance workshop, provided that this equipment only existed in the unit or workshop concerned. In all other cases the specific article would be stocked in the central store.

The size of the store of spares, standard parts, consumables and day-to-day articles is determined by the number of items, the quantity per item, the size of the parts and their weight, as well as the type of the storage. Care should be taken to ensure that both the central store and the stores in the units and workshops are of the right size and that the shelving and racking is adequate. Shelving systems should be used for small parts and vertical racks for medium-sized parts. Heavy parts should be stored on a surface to which access by handling equipment is easy.

Small parts should be stored in a system of bins, with medium-sized parts on wooden pallets.

Special attention should also be paid to the maintenance and preservation of articles in stock. The following precautions should be taken:

- always retain the original packing for fragile parts (bearings, electronic components, etc.);
- make the maximum use of plastic bags to store articles which are no longer in their original packing (electronic components, bearings, special springs, gaskets, hydraulic and pneumatic equipment, etc.);
- never handle articles with sensitive surfaces (e.g. bearings);
- protect electrical parts and assemblies (contactors, relays, motors, etc.) from dust and damp;
- coat low tolerance surfaces (gears, tools, bushings, shafts, ball joints, etc.) with plastic;
- use bins in the racking instead of storing the articles one on top of the other;
- regularly dust and clean the racking.

D. Technical documentation

The technical documentation for a piece of equipment, being by definition all the drawings and documents necessary for good operation, contains vital information for operation, maintenance and for any modifications to be carried out under economic and safe conditions.

As regards technical maintenance, the following technical documentation is necessary:

- wiring diagrams;
- electrical power and drive diagrams;
- electrical control diagrams;
- where applicable, specific sequence diagrams;
- exploded views of the main electrical assemblies;
- electrical maintenance manuals;
- spares lists;
- a description of the circuit control tests;
- full information on rewinding electric motors, transformers and coils;
- the general manufacturer's catalogues for components (relays, circuit-breakers, contactors, fuses, lamps, electric motors, etc.).

The technical documentation is compiled as soon as the equipment is bought by asking the supplier for full documentation.

All too often not only is the technical documentation omitted when a piece of equipment is supplied, but the buyer does not know what to ask for. In order to obtain the maximum amount of documentation from the supplier, it is vital for full and detailed specifications to be available at the time of purchase, giving both the content and presentation of the technical documentation.

The originals of the technical documentation must be filed in a central place (e.g. central archives at the logistical base). A complete copy must be available at the places where the equipment is used (i.e. production units and maintenance workshops). The place where the originals are kept must be dry (masters soon become spoiled by damp) and protected from dust and light. Filing in drawers for drawings up to DIN AO format

and closed cylinders for the largest drawings is advisable. Closed cabinets which can take suspended files and jacket files are widely used. Open shelving should be avoided, except for displaying technical journals. The correct distribution of copies of the technical documentation is a pre-condition for quick and efficient work. Each maintenance team should have ready access to the documents relating to its field of specialization. Complete sets of drawings should be available near the installations, and each maintenance unit should itself look at the possibility of keeping the documents in a place which is accessible to the users.

Documents borrowed from the central documentation at the logistical base must be recorded on lending cards, and the return of the document in question must be followed up conscientiously. The documents may only be taken out against the signature of a responsible person, to avoid any losses or abuses. The sole copy of a document must never be kept permanently in any place other than central documentation.

The organization of this central section is simple, using a minimum of personnel:

1 archivist and one assistant are sufficient to run an extensive central documentation, provided documents are properly filed from the outset.

It should be remembered that a reproduction room will be needed (with photocopier and printing machine for drawings), located in the direct vicinity of the central archives.

E. The electrical workshop

In view of the remoteness of the DRSTP from any suppliers of electrical equipment, a very well equipped electrical workshop must be set up. This workshop must be able to repair electrical machines (rewinding motors, rewinding transformers, etc.), make electrical checks and measurements, carry out all electrical repairs and back up the electricians in the units and workshops.

A central electrical workshop attached to the logistical base would in our view be the best solution. In addition, the small electrical workshops in the production units and maintenance workshops must be reorganized and re-equipped. This reorganization and re-equipment will consist mainly of the purchase of basic tools for electricians and basic measuring instruments. The function of these small workshops will be to carry out emergency breakdown work and small repairs on the spot. Any large or difficult repair jobs must be carried out by the central electrical workshop at the logistical base. This central workshop would also have at its disposal a "flying squad" backed up by a mobile workshop, the details of which are given in paragraph V.A.

The design and inventory of the equipment in the central electrical workshop are set out in paragraph V.B.3.

F. Vocational training of electrical personnel

1. Introduction

The shortage and/or lack of skills of electrical workers and their training are the greatest problems relating to electrical maintenance which we encountered in the DRSTP, and an urgent solution is needed.

The lack of qualified personnel for electrical maintenance is further exacerbated since theoretical and practical training needs to be supplemented by considerable experience in a variety of fields.

2. Who to train, and in which fields ?

We can divide the men to be trained into three groups:

a) lower operatives (ordinary labourers, skilled labourers);
b) operatives (semi-skilled workers, skilled workers, fully trained workers, highly qualified and trained workers);
c) supervisory personnel (group leaders, team leaders, foremen, technicians).

Annex 11 gives an explanation of these levels.

As regards electrical maintenance the training or specialization schemes will be directed primarily at the following fields and for the following categories of qualification:

Fields of training	Lower operatives	Operatives	Supervisory personnel
Electrical installer	X	X	
Coil winder	X	X	
Electrical fitter	X	X	X
Vehicle electrician	X	X	

All the men being trained follow a basic training of 6 to 12 months, which is identical for all of them.

After the basic training the electricians begin their training in general electrotechnical knowledge, followed by specialization in the various trades. In order to have trained personnel available as soon as possible, it is advisable for the programme to be drawn up so that the most difficult and complex trades follow on from the simplest trades. After a period of, for example, two years training, the coil-winders and electrical installers finish their training. The electrical fitters and vehicle electricians, on the other hand, continue their training and do not receive their training certificate for three years.

The lack of qualified personnel in the electrical field is apparent at all levels. Men should therefore be trained for all categories. There are, however, some priorities. To get the installations into a healthy state, a sound base is essential: short but effective training at operative level is the most urgent.

Supervisory personnel, whose role as a provider of training is the very basis of on-the-job training, just do not exist in the electrical field. It would therefore be best to provide for the training of

electrical supervisory personnel as quickly as possible, starting initially with workers with good experience.

3. How to train ?

The vocational training covered here is limited to electricians in the fields mentioned above.

There are various opinions about the industrial trades, their content and training methods. There are doubtless various methods and paths which can lead to the same end. The important thing is, ultimately, to make a choice as to the content and methods of training. The success of training ultimately depends almost exclusively on the motivation of the candidate and his desire to achieve his objective.

In order to obtain skilled workers as quickly as possible, we feel that it is best to opt initially for on-the-job training. This on-the-job training should be geared towards apprenticeship, retraining and refresher courses for workers with some experience and training in certain specialist fields which are needed for electrical maintenance. In parallel to this on-the-job training a series of courses should be started in a training centre. The aim of these courses will be to give complete training to new men who have not yet got any experience. This training will then be more detailed and more universal and no results will be obtained for some years.

Training abroad is the subject of a good deal of discussion. Attention should be paid to the following points:

- selection of the men sent for training and the partner providing the training;
- fields and qualifications for which training is required;
- follow-up and supervision of training.

Too often the training period spent abroad, especially if this is a short one, is considered as a period of rest, or even tourism. The effectiveness of such training periods are therefore very doubtful.

We consider that the only electrical speciality for which training should be carried out abroad is that of coil-winder. Training for the other electrical specialities should be provided on-the-job for men with experience and in a training centre for the new recruits.

On-the-job training is a method where training is provided whilst work is being carried out. By a process of trial and error, the worker acquires a concrete knowledge of his trade. Various methods are used to achieve this training. One has to go back to the method of the Middle Ages: the master-craftsman, fellow workmen and apprentices. Here, too, technical assistance should be mentioned. Everything must be based on the "trinomial" and "binomial" technique. A fellow workman who knows his trade well, and who has two assistants who work with him every day and with whom he gets on well, quickly passes on his knowledge to them. Emphasis should be placed on this method, which is particularly fruitful for apprenticeship.

Practical on-the-job training will be supplemented by theoretical courses, which can be given during the day, once or twice per week or in evening classes or even weekend courses.

In the case of the training given in training centres, the trades mentioned in the previous paragraph will be covered by a training of the length stated below:

electrical installers	**2 years**
coil-winders	**2 years**
electrical fitters	**3 years**
vehicle electricians	**3 years**

In Annex 12 a description of the trades mentioned above is given, together with a general outline of the training programme for each trade. For each trade a basic training programme should be established.

Annex 13 sets out a basic training programme in the case of an electrical installer.

In addition a carefully prepared training schedule will enable the training to be adapted to the specific needs of the DRSTP. As an example, a training schedule for an electrical installer is given in Annex 14.

After one year's training the candidate should pass an intermediate examination. At the end of the training, a final examination will show whether the man trained is able to begin his trade. Annex 15 gives an example of the requirements for the intermediate and final examinations for an electrical installer.

V. MEASURES PROPOSED UNDER THE UNIDO PROGRAMME

A. Short-term measures

1. Introduction

Given that the present situation as regards the maintenance of technical equipment in the DRSTP requires that urgent steps be taken, short-term measures are needed to safeguard or overhaul part of the technical equipment available, as well as medium-term measures to set up a lasting maintenance system.

In the following paragraphs we have first of all studied those measures which can be proposed for the short term.

Part of the equipment can be overhauled by competent personnel who have the basic tools at their disposal and by the delivery of urgently required spares. These measures could start up within the next few months and would extend over a period of a year.

In addition, and in order to prepare for the medium-term measures described in paragraph V.B., a training scheme should be started immediately for a coil-winder, to last one year.

The budget and execution schedule are described below.

2. Technical assistance

As regards the electrical field, an electrical assistant would be required over a period of 12 months. This assistant should be a person with solid experience of electrical maintenance and repair in countries with a difficult environment. Furthermore he should have a special knowledge of rolling stock electrics, and must be much more a man of practical action than a man of learning.

This technical assistant would be responsible for the following main tasks in the electrical field:

- select that equipment which can be put back into operation quickly;
- identify and order those parts necessary to put the equipment back into operation;
- ad hoc intervention for emergency repairs to equipment breaking down whilst he is present;
- draw up a list of technical documentation requirements enabling him to make a rapid survey of the spares necessary for one year's operation of the equipment mentioned above;
- preparation of a list of spares necessary for one year's operation of the same equipment;
- to train, as far as possible on the job, a few men for specific tasks (rewinding, choice and follow-up of consumption of spares, detection of electrical breakdowns);

The aim of his work: to repair some of the equipment which does not require any great resources, and to keep the equipment which is operating in working order.

3. Tools

The electrical technical assistant can only carry out his work where he has the basic tools and measuring instruments at his disposal. A selection of hand tools and a series of electrical measuring instruments should therefore be sent out immediately, namely:

- 1 electrician's tool-box, the composition of which is indicated in Annex 16;
- 1 multimeter.

In addition the existing electrical sections in the production units and maintenance workshops should be equipped with basic tools and measuring instruments. For this purpose, we suggest the purchase of 30 electrician's tool-boxes together with 30 voltmeter/ammeters. The composition of these tool-boxes corresponds to items 1 to 32 of Annex 16.

4. Mobile workshop

In order to enable the technical assistance team, composed of one electrician and a number of mechanics (see report of UNIDO mechanical expert), to work quickly and efficiently in various places in the DRSTP, we propose that a mobile electromechanical workshop with basic equipment be bought.

This mobile workshop would consist of a special trailer, one side of which can be folded back to extend the working area and to lay out the machine tools and workbenches so that they are readily accessible.

This mobile workshop would be equipped with a 3000 W generating set, together with the equipment listed in Annex 17. Annex 18 shows a sketch of a workshop of this type.

This mobile workshop would be provided without any haulage unit, and the maximum dimensions should not exceed 2.50 m x 5 m.

5. Technical documentation

One of the first tasks of the electrical technical assistant will be to draw up a list of the electrical technical documentation needed to make repairs to out-of-operation equipment and to determine which spares are urgently required.

To do this work a search will first have to be made to establish what technical documentation exists in the DRSTP.

In addition he will have to decide on the priorities: some equipment will be repairable very quickly with little documentation and a few parts, other equipment will require a more detailed study of the missing documentation. The aim of the operation is to achieve rapid results, and hence to avoid wasting too much time in defining the needs.

The electrical technical assistant must above all ensure that the electrical diagrams for repair work are available, together with the information needed to identify the spares.

The list he will draw up must be sent as a matter of urgency

tc a central office within UNIDO or to a specialist company, which will not only contact the manufacturers rapidly but will also follow it up and send it on quickly to the DRSTP. It will therefore be necessary to provide for a budget not only for work done outside the DRSTP but also to pay some suppliers so as to obtain the required documentation.

6. Spares

Given that it is impossible to repair the equipment without having wearing parts and spares available, the electrical technical assistant should as a matter of urgency take steps to build up a basic stock of the spares most used. To do this he will have to make a detailed analysis of the requirements by means of an ABC analysis. Annex 20 shows an imaginary distribution curve to illustrate this principle. Annex 20 illustrates the ABC analysis in a standard spares store intended for electrical maintenance. 20% of the articles, accounting for 75% of the consumption, are put in category A. The next 20%, making up 15% of the consumption, are put in category B, and 60% of the articles, making up 10% of the consumption, are put in category C. The work of the electrical technical assistant will consist of determining the parts to be put in category A.

In the electrical field we are thinking in particular of the following parts:

fuses of all sizes for vehicles, fuses of all sizes for industrial installations, carbon brushes for starters and dynamos, bulbs for vehicles, switches, relays, circuit-breakers and certain basic materials such as electric varnishes, a selection of flat and round wire to rewind dynamos and starters, together with a selection of cable lugs, electric cables, terminal blocks, etc.

In addition he will have to provide a basic stock of bearings for engines, starters, alternators and dynamos together with a selection of small nuts and bolts.

This selection must be made on the same basis as the selection of technical documentation, and the list of requirements must also be sent to the central office responsible for follow-up and delivery.

7. Training of a coil-winder

So as to have personnel available for the logistical base, as described in paragraph V.B., the training of a coil-winder must be started in the short term.

As the training of a coil-winder is aimed almost exclusively at practical experience we would advise that this training be given by sending the man to a motor rewinding workshop in Europe.

The practical work in the workshop will be supplemented by basic theoretical training.

The man sent for training must be chosen from electrical workers who already have experience in rewinding. This is due to the fact that a normal training for a coil-winder lasts at least two years. The man must therefore already have had some experience of the trade to enable him to be trained in one year. When selecting the training workshop it should be borne in mind that the rewinding of industrial motors requires a different technique to the rewinding of dynamos and starters for vehicles. If necessary the man should be sent to two different workshops, each specializing in its own field.

The success of this training will largely depend on continued supervision of the man. This supervision may be carried out by the central office, mentioned in the previous paragraphs, and would be carried out by means of weekly "lessons". The results of these lessons, and the result of the quarterly examinations, will, where applicable, allow the content of the training to be reoriented or adapted more to the needs of the person involved. Emphasis should above all be placed on the quality of the man's practical work.

8. Budget

In order to carry out the short-term measures successfully a sufficiently large budget must be set aside for it.

In Annex 21 a detailed budget for the measures in the electrical field has been calculated, and a general outline is given below. This budget will be supplemented by the budget for the mechanical expert (UNIDO SI/STP/81/801/11-02/31.9.C).

Item	Amount in US$
1. Technical assistance	89,000
2. Tools	13,800
3. Mobile workshop	67,500
4. Purchase of electrical spares	75,000
5. Technical documentation	25,000
6. Training of coil-winder	193,500
7. Follow-up and supervision	110,000
TOTAL	573,800

9. Execution (see Annex 29)

The short-term measures proposed above for a period of one year can only be carried out successfully where continuous follow-up and rapid response to the needs are ensured.

In addition the electrical technical assistant must be able to establish rapid contact with an office which can back him up both with regard to information on certain equipment and also with contacts with suppliers who can make recommendations on stocks of spares and technical documentation.

Having said this, it is vitally important for the follow-up and supervision office to be composed of men who have already had similar experience in countries where conditions are difficult.

The central office in question will be the only body to whom the technical assistant reports, and this will facilitate the exchange of information and ensure complete consistency in the measures to be undertaken.

To this end D.G.S. INTERNATIONAL S.A.[1], to which the writer of this report belongs, takes the liberty of proposing its services. This Company has very good experience in the field of maintenance in African countries, and has been working for years in the field of determining requirements for spares and technical documentation for these countries.

B. Setting up a logistical base

1. Introduction

The setting up of a logistical base should enable the following objectives to be met:

- technical back-up for maintenance teams in the production units and maintenance workshops;
- own manufacture of spares;
- complete overhaul of mechanical and electrical machinery;
- rapid intervention for breakdowns and repairs;
- centralized control of spares requirements for the DRSTP;
- rational stock management and the optimum reordering of spares;
- centralization of technical documentation requirements;
- adequate organization of the maintenance of technical equipment in the DRSTP;
- coordinated and coherent vocational training schemes, aimed at the requirement for the adequate maintenance of technical equipment.

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In order to satisfy those conditions which would enable the logistical base to play its real part, it must be provided with the necessary facilities such as:

- technical equipment for the electromechanical workshop;
- storage and spares management facilities;
- filing and duplicating facilities for the technical documentation;
- skilled personnel;
- sites and buildings.

The setting-up of a logistical base is extremely important for the economy of the country; it will enable many of the present breakdowns of equipment to be avoided, repairs to be carried out in accordance with the art of the trade, and equipment to be preserved to give it a longer life. The following paragraphs only relate to the electrical part of the logistical base. The recommendations will of course be supplemented by those proposed by the UNIDO mechanical expert in project SI/STP/81/801/11-02/31.9.C.

2. Description of the logistical base

The logistical base should include the following items:

- mechanical workshop with forge and foundry sections,
  boiler-making, sheet-iron and metal structures,
  mechanical machining,
  surface treatment,
  repairs to combustion engins,
  test benches for diesel pumps,
  repair and overhaul if machinery and assemblies;
- mechanics' office;
- electrical workshop;
- electrician's office;
- archives room (technical documentation);
- reproduction room (photocopier, printing room for drawings);
- office for administrative personnel;
- central spares store;
- office for stock management and stores personnel;

- garage with sections:
  - oil changing and lubrication;
  - vulcanization;
  - bodywork and painting;
  - various adjustments, tuning of engines, tests.

The physical design of the logistical base depends on the buildings which can be made available for this project. Care should, however, be taken that sufficient area is available for the different units. Below are some empirical figures for these units as far as the electrical part is concerned:

a) offices: 8 m^2 per person

b) toilets, showers and cloakrooms: 1.25 m^2 per person

c) central spares store:

- working area in relation to part value: 0.12 m^2/$300
- area for entering and withdrawing parts: 50 m^2
- working areas:
  - bins: 15 to 20% of total working area
  - pallets: 40 to 45% of total working area
  - special storage: 35 to 40% of total working area
- floor area in relation to working area:
  - bins: 0.30
  - pallets: 0.50
  - special storage: 0.75

d) archives room with reproduction section:
estimated area: 75 m^2

e) garage, test and various adjustments section: 150 m^2

f) electrical workshop: 250 m^2

As regards the location of the various units care should be taken to position the offices and archives in areas away from noise. The central spares store should be in as central a location as possible. The same applies to the garage unit. Particular care should be taken that there is a clear physical separation between all the sections of

a single workshop so that the workmen do not get in one another's way, and so to ensure safety during work. In addition attention should be paid to the removal of all waste.

The total personnel of the logistical base will be determined with the mechanical expert. However, we can put forward a few empirical figures for the breakdown of personnel by skills, expressed as a percentage in relation to the total staff of the workshop:

- managers: 1%;
- supervisory staff: 35%
- skilled workers: 52%
- unskilled workers: 11%.

3. The electrical workshop

The electrical workshop is designed firstly to carry out electrical repairs and secondly to rewind electrical machines up to 100 HP.

The electrical workshop consists of the following areas and sections (see Annex 22):

- storage, on shelving, of electrical machinery to be rewound or repaired;
- storage, on the ground (pallets), of heavy electrical machinery to be rewound;
- dismantlement, cleaning and assembly area;
- preparation area;
    - removal of old coils;
    - cleaning of commutators slots;
    - preparation of papers, cardboard and blocks
- winding area;
- coil assembly area;
    - inserting paper in the slots;
    - winding the coils;
    - making the electrical connections;
- impregnation and drying area;

- electrical testing area;
    - tests before impregnation;
    - operational tests;
- machine-tool section;
- electrical repair area;
- storage of rewound or repaired machinery;
- storage of raw materials and spares;
- offices;
- compressed air generator.

Annex 23 gives a detailed layout with an inventory of the equipment in the electrical workshop.

Annexes 25 and 26 include a selection of tools and small equipment, whilst Annex 27 gives a selection of raw materials and a selection of basic spares to be kept in stock. This selection should be considered as a starting point, and must be supplemented in accordance with the results of the equipment studies (identification of spares).

The personnel required for a workshop like this would be as follows:

- 1 foreman, workshop manager (electrical fitter) + 1 assistant electrician;
- 1 coil-winder + assistant;
- 1 electrical installer + assistant;
- 1 car electrician + assistant, allocated to the garage (see paragraph V.B.4).

The electrical installer and the car electrician may, if necessary, be sent out from the workshop to the production units or maintenance workshops with the mobile team, as described in paragraph V.A.

4. Garage

It is assumed that the car electrician will work in the garage section of the logistical base.

For this purpose, he may use the tools of the electrical workshop (electrician's tool-box) and the special measuring instruments for

engine diagnosis and work in the garage (see item 44 in Annex 24).

5. Organization and operation

The electrical workshop must be considered as a supplier of services to clients who are the production units and the maintenance workshops. The supply of services is requested on a work request form, drawn up by the unit or workshop making the request. On the work request form the action requested must be briefly described. This form is sent to the electrical workshop. The workshop manager issues a work sheet on which he describes the work to be carried out in detail, and on which the workers tick off the work done. This work sheet will then be used to prepare the invoice for the work.

All requests for spares are made on a stores issue form and sent to the central store. The electrical workshop does, however, have a basic stock (listed in Annex 27) enabling it to work for a certain period without being obliged to call upon the central store for day-to-day parts and materials.

6. Electrical technical assistance

In order to develop the operation of the electrical workshop and to ensure the continuous training of the workers, electrical technical assistance will be needed.

We propose sending out an electrical technical assistant for a period of 24 months. The assistant will have the task of being responsible for the day-to-day running of the workshop and mobile team, as well as for on-the-job training of electricians in the workshop. In addition he will set up a rigid organization backed up by a system of printed forms and a continuous exchange of information with the central store, the archives and the mechanical workshop.

The choice of the technical assistant must take into account the fact that the work requires someone with considerable practical experience in the field of electrical workshops in developing countries. In addition, the person in question should speak good Portugese and must be friendly when dealing with people. A person of between 35 and 45 years of age should be selected who has had experience of rewinding as well as electrical repairs and breakdown detection.

7. Training of the electrical personnel

As we mentioned in paragraph V.A., we advise sending a man to be trained in winding for a period of one year. This should be done in the short term (in the phase described in paragraph V.A) so that a coil-winder will be available as soon as the electrical workshop becomes operational.

The electrical installer, electrical fitter and car electrician are to be trained firstly in training centres in the theory of electricity and secondly on-the-job by the technical assistant. It would therefore be necessary for these three men to begin their theoretical training at least one year before the electrical workshop goes into operation. This training must be given in the DRSTP.

As soon as the personnel is operational their theoretical knowledge must be supplemented by a further training and refresher course given by the technical assistant at fixed times on a few days a week.

8. Budget

In Annex 28 an estimate has been given of the budget for each item. This budget does not take into account the construction of the workshop, since we have assumed that the buildings would be provided by the DRSTP. In addition, the budget does not take into account the theoretical training in a centre, which will be borne by the DRSTP.

Nor does the budget take into account any customs clearance charges, which are also to be borne by the DRSTP.

Having said that, the budget is broken down as follows:

1. Technical assistance	US$ 164,500
2. Equipment	47.000
3. Tools	6,000
4. Raw materials and spares	20,500
5. Installation of equipment and commissioning	80,000
6. Transport of the equipment	25,000
7. Follow-up and supervision	175,000
TOTAL	US$ 518,000

9. Execution (see Annex 29)

The execution of a project of this kind will require careful preparation and careful selection of the equipment, tools and raw materials to be bought. In addition careful selection of the technical assistance will be necessary.

We feel that a period of one year should be allowed for preparing and sending out the equipment, then a period of 6 months for the installation and commissioning of the equipment. It is only at this point that the 24 months of technical assistance will commence.

In order to ensure coordinated and consistent progress we suggest that UNIDO subcontract the follow-up and supervision of the entire project to a specialist firm, as we mentioned in section V.A.

The D G S INTERNATIONAL S.A.[1] takes the liberty of offering its services for this.

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VI. ANNEXES

ANNEX 1

List of workshops and production units visited

1. Civil Construction Directorate (DCC): school furniture factory with small sawmill, foundry and forge.
2. Civil Construction Directorate (DCC/EE): vehicle maintenance workshop.
3. CONSTRUCTORA Quarry 1
4. CONSTRUCTORA Quarry 2
5. AMARAL sawmill
6. FURTUOSO sawmill and joinery works
7. Garage and vehicle repair workshop (Sao Tomé town)
8. Transport Secretariat: Boat repair workshop
9. Transport Secretariat: Bus repair workshop (TRANSCOLMAR)
10. AGOSTINHO NETO Company
11. AGOSTINHO NETO Hydro-electric power station
12. APUYO LOGISTICO: Vehicle section
13. APUYO LOGISTICO: Machinery section (VIGOSO)
14. AGUA ISE Company
15. COLONIE ACORIANA Company
16. RIBEIRA PEIXE Company
17. DONA AGUSTA Thermal electric power station (Diesel sets)
18. CONTADOR Hydro-electric power station
19. CETO Brewery, Neves
20. BOA ENTRADA Palm oil mill.

Summary of workshops and production units having technical equipment available

Unit or workshop	Sao Tomé	Principe	Total	Number visited
Stationery crushing unit	5	-	5	2
Mobile crushing unit	2*	2	4	2*
Sawmill	7	1	8	3
Boat repair workshop	3	-	3	1
Bus repair workshop	1	-	1	1
Companies	13	2	15	4
"Rosas"	85	17	102	1
School furniture factory	1	-	1	1
Vehicle workshops				
DCC/EE	1	1	2	1
Apuyo Logistico	2	-	2	2
Miscellaneous	unknown	unknown	unknown	1
Hydro-electric power station	"	"	"	2
Thermal power station	"	"	"	2
Brewery	1	-	1	1
Oil mill	unknown	unknown	unknown	1
Ceramics works	1	-	1	-
Manufacturing workshop	1	-	1	-
Rum factory	1	-	1	-
Soap factory	1	-	1	-

* Located at DCC/EE workshop

Summary of vehicles to be maintained by the production units and workshops visited

Unit or workshop	Lorries	Road rollers	Jeeps	Unimogs	Buses	Bull-dozers	Loaders	Motor cycles	Graders	Tractors	Cars	Asphalt-laying machines
DCC/EE	43	10	13	-	-	11	10	-	2	-	3	3
TRANSCOLMAR	-	-	-		34	-	-	-	-	-	-	-
AP. LOGIST. VEHIC.	13	-	28	-	2	-	-	4	-	-	9	-
VIGOSO	-	-	-	-	-	17	-	-	-	14	-	-
AGOSTINHO NETO	2	-	-	-	-	-	-	-	-	12	-	-
AGUA ISE	2	-	-	-	-	-	-	-	-	16	-	-
ACORIANA COLONY	2	-	3	2	-	-	-	-	-	5	-	-
RIBEIRA PEIXE	3	-	3	-	-	-	-	-	-	5	-	-
TOTALS	65	10	47	2	36	28	10	4	2	52	12	3

Maintenance equipment and machinery in the units and workshops visited

	Large lathes 500 x 1500	Medium or small lathes 500 x 1500	Column or bench drilling machines	Milling machines	Shapers	Grinding lathes	Metal saws	Presses	Bending machines	Hand drills	Hand lathes	Binding-moulding machines	Compressors	Arc-welding equipment	Oxy-acetylene welding units	Forges	Foundries	Cement-makers' shears	Plate shears	Elec motor drying ovens	Battery chargers
DCC/Furniture	-	2	1	1	-	1	1	1	1	2	2	-	-	-	-	2	2	-	1	-	-
DCC/EE	-	-	1	-	-	-	-	-	-	3	1	-	1	7	-	-	-	-	1	-	2
CONSTRUCTORA 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CONSTRUCTORA 2	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	1
AMARAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FURTUOSO	1	-	1	-	-	1	-	1	-	-	-	-	1	1	-	-	-	-	-	-	1
Garage in town	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	2
Boat rep. shop	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-
TRANSCOLMAR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
AGOSTINHO NETO	2	1	3	-	1	1	-	-	1	-	-	1	-	1	1	1	1	1	1	-	1
Ap. logist. vehic.	-	-	1	-	-	1	-	-	-	-	-	-	2	2	1	1	-	1	-	-	1
VIGOSO	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
AGUA ISE	2	-	2	-	1	2	1	-	1	-	-	1	-	1	1	2	2	1	1	-	-
ACORIANA COLONY	-	1	1	-	-	1	-	-	-	-	-	-	1	1	-	-	-	-	-	-	1
RIBEIRA PEIXE	1	1	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
DONA AGUSTA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CONTADOR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CETO	-	1	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	1	-
BOA ENTRADA	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	6	7	10	1	2	8	2	2	3	5	3	2	9	17	4	7	5	3	4	1	12

Nature of workshops in units visited

Unit	Forge + Foundry	Boiler-making	Metal tooling workshop	Electrical section or workshop	Joinery	Garage	Notes
DCC/furniture	yes	no	yes	no	yes	no	Maintenance provided in part by DCC/EE
DCC/EE	see DCC/ furniture	yes	See DCC/ furniture	yes	See DCC/ furniture	yes	
CONSTRUCTORA 1	no	no	no	no	no	no	Maintenance provided by DCC/EE
CONSTRUCTORA 2	no	no	no	no	no	no	" " "
AMARAL	no	no	no	no	no	no	
FURTUOSO	no	no	yes	no	yes	no	
Garage in town	no	yes	no	yes	no	yes	
Boat rep. shop	no	no	no	no	yes	no	
TRANSCOLMAR	no	yes	no	yes	no	yes	
AGOSTINHO NETO	yes	yes	yes	yes	yes	yes	
Ap. logistico veh.	no	yes	no	yes	no	yes	
VIGOSO	no	no	no	no	no	yes	
AGUA ISE	yes	yes	yes	yes	yes	yes	
Acoriana Colony	no	yes	yes	no	yes	yes	
RIBEIRA PEIXE	no	yes	yes	yes	no	yes	
DONA AGUSTA	no	no	no	no	no	no	
CONTADOR	no	no	no	no	no	no	
CETO	no	no	yes	yes	no	no	
BOA ENTRADA	no	no	yes	no	yes	no	

Summary table (electrical part)

Field of survey \ Units or workshops (1)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1- state of electrical installations and equipment	1.3	1.3	1.2	-	1.2	1.1	1.3	1.3	1.3	1.3	1.1	1.3	1.3	1.3	1.3	1.3	1.1	1.1	1.1	-
2- efficiency of electrical maintenance	2.3	2.3	2.2	-	2.2	2.2	2.4	2.3	2.3	2.2	2.1	2.3	-	2.3	2.4	2.3	2.2	2.1	2.1	-
3- electrical spares	3.3	3.3	3.4	-	3.3	3.3	3.4	3.4	3.4	3.4	3.2	3.4	-	3.4	3.4	3.4	3.3	3.2	3.2	-
4- technical documentation	4.3	4.2	4.4	-	4.4	4.4	4.4	4.4	4.3	4.4	4.3	4.4	-	4.4	4.4	4.4	4.4	4.3	4.3	-
5- electrical workshop	-	5.2	-	-	-	-	5.2	-	5.2	5.2	-	5.3	-	5.3	-	5.3	-	-	5.1	-
6- tools for electricians	6.3	6.3	6.3	-	6.4	6.3	6.3	6.4	6.3	6.3	6.3	6.3	-	6.3	6.4	6.3	6.4	6.3	6.2	-
7- electrical measuring instruments	7.4	7.3	7.3	-	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	-	7.4	7.4	7.4	7.4	7.4	7.2	-
8- electrical personnel	8.3	8.2	8.2	-	8.3	8.2	8.3	8.3	8.3	8.2	8.2	8.2	-	8.2	8.3	8.3	8.3	8.2	8.2	-

(1) The figures in the table heading refer to the production units and workshops visited and correspond to those in Annex 1

(2) The code in the columns is explained in Annex 7

(3) The units which are not concerned by the field of the survey (either because there is no electrical equipment, or electrical maintenance is not carried out there) are indicated by "-".

ANNEX 7/1

Explanation of the replies and findings set out in Annex 6

1. State of electrical installations and equipment

1.1. go

Working order ensured, no abnormal wear

1.2. average

Working order ensured, but wear and ageing visible

1.3. poor

Frequent breakdowns and stoppages, too old to ensure operation under acceptable conditions.

2. Efficiency of electrical maintenance

2.1. good

Electrical maintenance and repair work is carried out well and is up to the standard

2.2. average

The electrical maintenance and repair work is not always done well, but is not a major cause of stoppages of the equipment.

2.3. poor

The electrical maintenance and repairs are done badly, causing frequent stoppages.

2.4. very poor

A team of electricians either does not exist or is insufficiently skilled. Electrical work is only done when there is a breakdown, and repairs are not carried out by workers who are qualified to do the job.

3. Electrical spares

3.1. good

A sufficient stock of electrical spares is available. Spares control is carried out efficiently. Spares are obtained in good time.

3.2. average

The stock available enables breakdowns to be repaired in most cases. However, spares management is not carried out in an efficient manner, and the obtaining of parts does not work well.

3.3. poor

The lack of electrical spares is one of the reasons for prolonged stoppages of electrical equipment. There is no stock management and no re-ordering.

3.4. very poor

The lack of electrical spares is the major cause of prolonged stoppages of electrical equipment. Stock management is non-existant, and there is no reordering.

4. Technical documentation

4.1. good

The technical documentation available is complete, containing information both for maintenance and repair and for spares.

4.2. average

The technical documentation is sufficient for most work and for identifying parts.

4.3. bad

The technical documentation is lacking for much of the equipment, or is insufficient as regards information on maintenance, repairs or spares.

4.4. very poor

Technical documentation is non-existant.

5. Electrical workshop

5.1. good

Electrical workshop with basic equipment for repairs and rewinding. Shelving and work-benches are available.

5.2. poor

Electrical workshop with insufficient equipment available for repairs and rewinding. Poor spares facilities. Work benches are available.

5.3. very poor

Electrical workshop having no technical equipment available and very badly equipped as regards storage facilities and work benches.

6. Tools for electricians

6.1. good

Complete tools, including special tools. Sufficient in quantity and quality.

6.2. average

Tools available and sufficient for normal maintenance work.

6.3. poor

Maintenance work is hindered by tools which are insufficient or in poor condition.

6.4. very poor

No tools are available which can be used by electricians.

7. Electrical measuring equipment

7.1. good

Basic electrical measuring instruments are available. No special instruments.

7.2. average

Availability of at least one multimeter, one tester and one checking lamp.

7.3. poor

Availabibity of a voltmeter and ammeter. No other measuring facilities available.

7.4. very poor

No measuring instruments are available except in some cases a checking lamp.

8. Electrical personnel

8.1. good

Personnel sufficient in number and skills to ensure the normal maintenance of electrical equipment. In addition, this personnel enables day-to-day electrical repairs to be carried out.

8.2. average

The number and skills of the electrical personnel does not enable maintenance and day-to-day repairs to be carried out within a reasonable time and up to the expected standards. However, the team of electricians does contain at least one person whose experience enables most electrical problems to be solved.

8.3. poor

The number and skills of the electrical personnel does not in any way enable correct maintenance and lasting repairs of the electrical equipment to be carried out.

ANNEX 8

ESTIMATED AVERAGE ANNUAL REQUIREMENTS AND CONSUMPTION OF SPARES[1)]

	Estimate of requirements for spares to be kept in stock, expressed as % of replacement value of the equipment	Estimate of the annual consumption of spares expressed as % of replacement value of the equipment
Specific parts (safety parts included)	8%	6%
Standard parts	1.4%	1%
Day-to-day maintenance parts	1.6%	1.2%
TOTAL	11%	8.2%

1) These figures are based on the results of about fifty technical audits of factories in developing countries.

ANNEX 9/1

CODING OF SPARES

1. Allocation of a code number

The allocation of a code number and a description is subject to the following requirements:

- the code number must be specific in two respects:
  . only one article may correspond to any one code number;
  . only one code number may correspond to any one article;
- the code number must be definitive. Changing a code number which is already known by the users, is already being used in the stores, and is already registered for management and purchasing, would lead to a considerable work load and to many risks of error;
- the code number must be ideclogical. It is allocated in accordance with a coding pattern which takes into account the main characteristics of the articles to be coded;
- the description must be carefully considered:
  . it must be complete and not permit any ambiguity;
  . it must be clear and comprehensible to all users;
  . it must be known by all users;
  . it must fit in with the requirements of the purchasing process.
- the nomenclature (description + code number) for a specific article should be the only one used at all levels. It would therefore be best to introduce a single coding system for the DRSTP.

2. Coding system

The coding system we propose here is based on coding by kind; it is a morphological codification. As an example, we give below the composition of an 8-figure code, based on a classification of products where they are sorted so as to bring into one "class" all products of the same kind or with certain affinities.

ANNEX 9/2

General articles

class 0 materials
class 1 assembly and mechanical transmission parts
class 2 electrical and electronic equipment
class 3 mechanical machinery
class 4 electrical machinery
class 5 tools and equipment

Specific machinery and parts

class 6 principal production machinery
class 7 auxiliary product production machinery
class 8 handling machinery
class 9 miscellaneous

To establish the nomenclature, which analyses the object in its ultimate individual form, the class first has to be divided into "sub-classes". Applying this to class 2 we obtain:

sub-class 0 erection equipment
sub-class 1 high voltage distribution
sub-class 2 low voltage distribution
sub-class 3 electric motor controls
sub-class 4 electronics
sub-class 5 small telecommunications equipment
sub-class 6 lighting
sub-class 7 accessories for electrical machinery
sub-class 8 small electrical measuring and control instruments
sub-class 9 miscellaneous

This sub-class is in turn sub-divided into "groups" and "sub-groups", for example, sub-class 4 is divided into the following *groups*:

group 1 electronic valves
group 2 resistors
group 3 capacitors
group 4 semi-conductors
group 5 fuses
group 6 integrated circuits

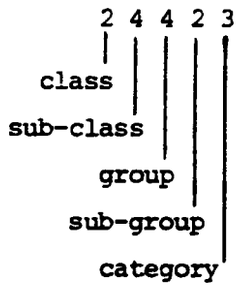
Group 4 would be divided into sub-groups:

sub-group 1 diodes
sub-group 2 transistors
sub-group 3 thyristors
sub-group 4 rectifiers

The transistors (sub-group 2) are brokwn down into 5 categories:

category 1 germanium NPN transistors
category 2 germanium PNP transistors
category 3 silicon NPN transistors
category 4 silicon PNP transistors
category 5 miscellaneous transistors

One can now locate a silicon NPN transistor in the coding system described above by forming the coding pattern, grouping together the figures of the various phases explained:



Having located the transistor in question, the code has to be further detailed for a transistor corresponding to precise electrical characteristics.

For this purpose, a further 3 figures are provided after the first 5 figures of the code already obtained; these are called the random figures. The "random" radical will be attributed chronologically, as new articles in a family are coded. When an article falls within a standard fixing a series of possible grades and dimensions, a code number should be provided for each grade and dimension corresponding to the standard. The code will only be allocated when the part has to be processed. The random figures will have a dimensional sense in such a case, which means 1000 possibilities (from 000 to 999) when giving a code to a particular transistor. For example a silicon NPN transistor whose voltage CE (V_{ce}) is 20 V would bear the following code number 244 23 024 (the allocation of the last 3 figures is purely indicative).

ANNEX 10/1

GENERAL PRINCIPLES FOR STOCK MANAGEMENT OF SPARES

The type of management chosen for any article will depend on the type of article, and the frequency with which it is consumed is the first factor in this decision. In general a distinction may be made between two large groups:

- consumables and wearing articles, day-to-day stores articles, standard parts, certain specific parts: these are articles which are used frequently, which have a limited life, and which are subject to wear;
- articles which are hardly ever needed, but which must be kept in stock because if there were an unexpected breakdown, accident or wear, a long stoppage could result.

It will be appreciated that the stocks in the first group are used in large quantities, whilst those in the second group will lie idle. The criterion for classifying an article into one of the two groups will be its monthly consumption. An article for which the monthly consumption is greater than 0.25 will come into the first group and one for which the monthly consumption is less than or equal to 0.25 will come in the second group.

The management of articles for which the monthly consumption is greater than 0.25 will be the subject of a number of considerations:

- there should not be too few articles in stock.
  The determination of a minimum stock will take into account abnormal consumption or abnormal delivery dates;
- reordering must be carried out in good time. First one has to determine the order point for each article. The order point will depend on the quantity in stock, the quantity on order ("waiting for stock to come in") and the quantity requested. The order point is defined as the sum of consumption during the reordering period + consumption during the delivery period + the minimum stock.

- there should not be too many articles in stock, so a maximum stock must be determined. This is the sum of the stock at the order point + the quantity on order.

These considerations enable an economic order quantity to be determined after a few calculations, taking into account the utility price (Pu) of the article (unit price plus transport costs, etc.), the interest on the capital invested (i) and miscellaneous costs (d) (storage, personnel, etc. expressed as a % of the average stock). The economic quantity to be ordered is expressed by the WILSON formula:

$$Q_e = \sqrt{\frac{24\ C_M \times C_A}{I \times Pu}} = t\sqrt{\frac{C_M}{Pu}} \quad \text{where} \quad t = \sqrt{\frac{24 \times C_A}{I}}$$

Q_e : economic quantity

C_M : average monthly consumption

C_A : administrative cost of ordering

I : capitalization rate (I = i + d)
= 15% of the average value of the stock

Pu : utility price of the article.

It should be pointed out that the use of formulae for recording can only give a guide. They are aimed at helping the stock manager, who will decide on the basis of all the factors in his possession. A considerable number of these cannot be expressed in formulae. This is the reason why continuous follow-up and up-dating of the file must be maintained.

The use of the formula does not cover articles with a low monthly consumption. The formula is based on the fact that one has a sound estimate of the average monthly consumption.

The management of articles for which the monthly consumption is less than or equal to 0.25% covers mainly safety parts or parts for which the wear is low. This is therefore a safety stock "in case" unexpected breakdowns should occur.

Determination of the quantity of these articles to be put in stock depends on the answers to two questions:

- what is the effect on production if the part is missing ?
  - . no effect
  - . reduces production
  - . stops production
- what is the possibility of on-the-spot repair ?

Depending on these data and taking into account the price of the part, it is possible to decide on the quantity to be kept in stock. It often happens that one can work with a zero quantity kept in stock, where a repaired part can be used if the frequency of the incident permits this.

Various modes of reordering are possible both for articles with a monthly consumption of > 0.25 and for those whose monthly consumption is ≤ 0.25:

- reordering at order point: each time the stock reaches a level equal to the sum of consumption during the reordering period + consumption during the delivery period + the minimum stock, an order is placed for a quantity equal to the economic quantity defined by the WILSON formua. For this mode of management, consumption is constantly monitored:
- periodic reordering: the fact that orders are placed on variable dates, determined only by the order point being reached, has the disadvantage that it is necessary to look at each article separately. It is always helpful to be able to group the reordering of articles so as to reduce the number of orders to be dealt with. The two criteria for grouping involved are the supplier and the geographical area. After grouping, orders can also be placed on fixed dates;
- reordering by allocation: when consumption gets very low, meaning less than one unit per delivery period, an allocation corresponding to the probable consumption for the period between two deliveries is calculated;
- reordering by contract: this is more a purchase technique than a type of stock management. It consists of signing a supply contract with a supplier for a fixed quantity and period of time. The contract specifies all the purchase conditions, including, in particular the price and delivery period.

ANNEX 11/1

CLASSIFICATION OF JOBS

CATEGORY	FUNCTION	DEFINITION	LEVEL REQUIRED
GROUP 1		LOWER OPERATIVE PERSONNEL	
1	Ordinary labourer Service hand	Person carrying out elementary work not requiring any special knowledge, previous adjustment or great effort.	None
2	Skilled labourer Heavy labourer Skilled ware-houseman Caretaker	Person carrying out simple work requiring only brief instructions or involving physical effort or special attention	Can read
GROUP 2		OPERATIVE PERSONNEL	
3	Skilled worker OS1 - assistant	Person who, after an introduction period, carries out work which does not require any special vocational training	Can read and write
4	OS2 Van driver Switchboard operator	Skilled person with greater experience and exhibiting vocational skill	
5	Skilled production worker HGV driver	Person with sound vocational experience of the work entrusted to him and with a training lower than or equal to that of a vocational worker who does not hold a certificate	Vocational training certificate (CAP) or 3rd class. Vocational experience in branch. Further training course

ANNEX II/2

CATEGORY	FUNCTION	DEFINITION	LEVEL ACQUIRED
6	Vocational worker OP1	Person with a full knowledge of their trade, acquired by long apprenticeship or training for which CAP or equivalent certificate is awarded	CAP, BEG or equivalent vocational experience
7	Vocational worker OP2 Typist Assistant bookkeeper	Person of above category with long experience in their trade who has gained a skill and thorough vocational knowledge	CAP or BEG. Vocational experience in the branch
8	Vocational worker OP3 Shorthand typist	Person meeting the above definition carrying out work which requires high vocational qualifications, working without supervision	CAP or BEG Very long experience in their occupation
9	Vocational worker HQ Principal employee	Persons who, in addition to a qualification certifying their theoretical knowledge and experience of the trade, have sufficient vocational experience to give them a high qualification, being able to carry out the work given to them efficiently in accordance with a schedule or overall instructions without the presence of a supervisor	

ANNEX II/3

CATEGORY	FUNCTION	DEFINITION	LEVEL ACQUIRED
GROUP III		SUPERVISORY STAFF	
10	Group leader Team leader	Person responsible, in addition to his own work, for holding authority over a group of skilled workers. Also classed in this group are workers of a higher level than that required for the previous category	BET 1st level or equivalent vocational experience
11	Foreman	Persons carrying out a function requiring thorough and extensive vocational knowledge. Responsible for the discipline of the personnel whose work they control. They are responsible under a supervisor or manager for the proper functioning and improving the output of their sector	Higher school certificate final class of grammer school or equivalent vocational experience
12	Technician Chief foreman Head of section	Person capable of coordinating the work of other supervisory or highly qualified personnel	BT School leaving certificate or equivalent vocational experience
13	Senior technician Office manager	Person having theoretical and practical knowledge or definite vocational experience enabling him to take authority. He generally comes under a manager	BTS Degree

ANNEX 12/1

DESCRIPTION OF TRADES[1)]

DESCRIPTION OF THE TRADE OF ELECTRICAL INSTALLER

Apprenticeship period: 2 years

Field of work:

- the work of an electrical installer consists of:
  Construction, maintenance and repair of lighting and power installations, together with the distribution installations forming part of them;
- For this he carries out precise instructions;
- He carries out simple inspections and may assist in more difficult measuring and inspection work;
- He may also be responsible for the following:
  Repair of the whole structure and component parts of installations in accordance with detailed instructions, together with simple maintenance work;
- The electrical installer works on the erection sites and in firms' workshops.

Basic knowledge and skills required for the manual trades

Basic knowledge of electrical engineering:

General knowledge:

- Materials and auxiliary materials;
- Reading technical drawings;
- Familiarization with tables and technical manuals;

Art and knowledge of the machining of materials:

- Measurements and checks;
- Tracing, plotting, marking;
- Filing;
- Sawing;
- Drilling, chambering, boring;
- Tapping;
- Sharpening;
- Cutting up, shearing, piercing;

- Trimming;
- Bending;
- Turning.

Art and knowledge of assembly techniques:

- Soft soldering;
- Bonding;
- Riveting;
- Screwing.

Knowledge of electrical engineering:

- Conducting and non-conducting materials;
- Reading wiring diagrams;
- Introduction to the study of electricity;
- Electrical and electromechanical components.

Art and knowledge of electrical engineering:

- Preparation and adjustment of conductors;
- Simple windings;
- Preparation of electrical components for assembly.

Art and knowledge of assembly, wiring and connection:

- Wiring, connection, assembly of components with their wiring and connection.

Art and knowledge of measurement and inspection:

- Measuring electrical quantities;
- Checking circuits.

Knowledge of protection at work and prevention of accidents:

Special knowledge and skills required of an electrical installer:

Improvement of knowledge of electrical engineering and its use in the construction of electrical installations:

- Reading assembly drawings;
- Continuing study of electricity;
- Electrical and electromechanical components;

- Protection at work and prevention of accidents.

Improvement of the art and knowledge of assembly techniques:

- Brazing;
- Welding.

Art and knowledge of assembly, erection and installation:

- Assembly of operating equipment;
- Erection and installation of power equipment.

Art and knowledge of transfer, wiring and connection:

- Preparation and adjustment of conduits and cabling up to 1 kilovolt (1 kV);
- Laying cables and conductors.

Art and knowledge of measurement and inspection:

- Measurement of electrical quantities;
- Checking electrical functions;
- Measurement of non-electrical quantities;
- Art and knowledge of maintenance and repair of electrical installations;
- Repair of electrical installations;
- Maintenance of electrical installations.

DESCRIPTION OF TRADE OF COIL WINDER

Apprenticeship period: 2 years

Field of work:

- the work of a coil-winder consists of the production of coils and

windings, the assembly and connection of windings for electrical appliances, machines and transformers. The coil-winder must adhere to drawings and precise details. He will be able to carry out simple checks when assisting with difficult measuring and inspection work;

- Coil-winders are employed principally in forms which produce and repair electrical machinery.

Basic knowledge and skills for the manual trades

Basic knowledge of electrical engineering

Special knowledge and skills required of a coil-winder:

Improvement of knowledge of electrical engineering and its use in the construction of electrical machines:

- Continuation of study of electricity;
- Main kinds of windings used in electrical machines.

Improvement of art and knowledge of assembly techniques:

- Brazing;
- Bonding.

Art and knowledge of the production of windings for electrical machines:

- Handling of insulation material;
- Production of coils from wires, bars, strips and plates;
- Assembly and connection of windings for electrical machines;
- Impregnation and stoving of windings;
- Tightening rotors.

Art and knowledge of measuring and inspection:

- Measuring and checking windings.

Art and knowledge of repairing windings.

ANNEX 12/5

DESCRIPTION OF THE TRADE OF AN ELECTRICAL FITTER

Apprenticeship period: 3 years

Field of work:

- The work of an electrical fitter consists of producing, assembling, testing, repairing and checking electrical machines;
- He is responsible for:
  direct, alternating and three-phase current motors and generators, various sizes of transformers, the magnetic components for electron accelerators and for other fields of use of atomic technology;
- In addition to the production, assembly and connection of windings for electrical machines, he is also responsible for the assembly of mechanical parts and windings, the complete testing of machines and appliances, for making them work and writing out test reports;
- The electrical machines in the factory are checked by the electrical fitter. If there is a defect in a machine, he detects the place where the breakdown has occurred and deals with its repair;
- The electrical fitter may also be employed in the production industry as well as by users of electrical machines.

Basic knowledge and skills required for the manual trades

Basic knowledge of electrical engineering

Special knowledge and skills required for the electrical fitter

Improvement of knowledge of the construction of electrical machines:

- Preparing technical support;
- Mode of operation and assembly of electrical machines.

Improvement of the art and knowledge of working materials

Improving the art and knowledge of assembly techniques

Art and knowledge of assembly:

- Stacking and pressing of rotor plate packs;
- Production of commutators;
- Balancing rotors and fans;
- Assembling electrical machines.

Art and knowledge of the production of windings for electrical machines

- Further work in the use of insulating materials;
- Production, installation and connection of special windings.

Art and knowledge of measuring, control and commissioning:

- Checking of mechanical functions;
- Checking of electrical components and groups of components;
- Measuring, inspection and commissioning of electrical machines.

Art and knowledge of repairing electrical machines

Art and knowledge of maintaining electrical machines

DESCRIPTION OF THE TRADE OF CAR ELECTRICIAN

Apprenticeship period: 3 years

Field of work:

- Repair of electrical installations of vehicles;
- Detecting breakdowns and damage;

- Maintenance and checking of electrical and electronic installations;
- Wiring and suppression of electrical installations;
- Assembly and adjustment of electrical and electronic mechanisms;
- Maintenance and repair of working tools, machines and installations.

Basic knowledge and skills for the manual trades

Special knowledge and skills required for a car electrician

Measurements to detect breakdowns:

- Measuring with comparator, compression measuring instrument, injection pump, stroboscope, instruments for testing and measuring ignition, oscillograph, exhaust gas analyzer;
- Measurement of acidigy;
- Measurement of electrode gaps in spark plugs;
- Measurements with ammeter, voltmeter and ohmmeter;
- Measurements on electrical systems of the electrical and electronic installation of a vehicle.

Repair of vehicles:

- Knowledge of the vehicle and its component parts;
- Knowledge of the operation and assembly of electrical and electronic installations;
- Reading and drawing simple wiring diagrams;
- Maintenance and inspection of the electrical and electronic installations;
- Inspection, repair and adjustment of electrically or electronically controlled aggregate parts, installations and mechanisms;
- Installation of electrical and electronic fittings;
- Wiring and suppression of electrical installations.

ANNEX 13/1

OUTLINE TRAINING PROGRAMME

ELECTRICIAN INSTALLER

The knowledge to be imparted may be broken down into the following fields:

General knowledge:

This knowledge, which also forms part of the basic teaching material in the trade schools, will be imparted on the basis of practical experience.

Principal and ancillary materials:

- Nature, properties, use and standardization of the main materials generally used in electrical engineering;
- Nature and use of the ancillary materials currently used.

Reading industrial drawings:

- Basic concepts, in particular types of lines, views, illustrations, tolerances, sections, symbols for the quality of surfaces, scales;
- Drawings of parts, general drawings, nomenclatures;
- Representation by symbols;
- Corresponding standards;
- Making simple manual sketches.

Familiarization with tables and manuals.

Art and knowledge of the machining of materials:

Measurement and inspection

Skills required:

- Measuring and checking lengths with simple graduated measuring instruments, instruments with internal and external slides and with external micrometer (calliper);

- Measuring and checking angles with a protractor and set squares to an accuracy of 1°;
- Checking the flatness of surfaces with simple measuring tools, mainly with rulers and flat squares;
- Maintaining, handling and storing measuring instruments.

Knowledge:

- Units of the metric measurements system;
- Conversion of fractions and multiplication of units;
- Calculation of lengths, areas, volumes;
- Assembly of measuring instruments, measurement errors;
- Angles and angle units;
- Visual inspection process.

Tracing, plotting, marking

Skills required;

- Tracing reference lines, distances between axes, contours, section lines and curves, from pencil drawing, with scriber, dividers;
- Plotting centres and contours;
- Marking with punch, colours;
- Maintenance of instruments.

Filing:

Skills required:

- Filing to size to the mean degree of accuracy prescribed by DIN 7168;
- Fettling;
- Chamfering, reworking unfinished parts;
- Filing rounds with simple flat files and simple shapes until the surfaces are completely smooth.

Knowledge:

- Shapes, design and types of files;
- Formation of filings when filing;
- Criteria for recognizing surface qualities up to "fine".

Sawing:

Skills required:

- Fixing parts and tools;
- Sawing metals and insulating materials into sheets and shapes with a hand saw;

Knowledge:

- Types and use of saw blades for different materials;
- Formation of chips and cutting process;
- Types and use of vices as clamping devices.

Drilling, chambering, boring:

Skills required:

- Fixing parts and tools;
- Execution of drilling using fixed drills and electric hand drills in various working positions;
- Working with bit, chambering blade and circular cutting out with a fretsaw (?);
- Chambering with blades and cone countersinks;
- Boring with a hand borer.

Knowledge:

- Types and use of bits, drills, blades and borers;
- Cutting procedure, square to the tool;
- Concept of cutting speed;
- Choice of speed of rotation and feed-rate;
- Lubrication techniques.

Tapping:

Skills required:

- Tapping using a screw tap and a hand die.

Knowledge:

- Types of measurements of screw pitches for metric screw pitches;
- Screwing and tapping tools;
- Lubrication techniques.

Sharpening:

Skills required:

- Sharpening simple hand tools on a grinder;

Knowledge:

- Sharpening.

Cutting up, shearing, pressing:

Skills required:

- Cutting up with hand shears and chisels;
- Piercing with a punch;
- Making channels in sheet-metal.

Knowledge:

- Cutting up and shearing procedure;
- Types and use of tools.

Trimming:

Skills required:

- Cold trimming sheet and section parts;
- Work carried out on the trimming table.

Knowledge:

- Types and use of trimming tools;
- Behaviour of materials.

Bending:

Skills required:

- Cold bending of sheet and section parts;
- The parts are placed in the vice and bending tools are used;

Knowledge:

- Types and use of bending tools and auxiliary tools.

Turning:

Skills required:

- Fixing parts and tools;
- Carrying out simple turning work in a mandrel and clamp, in particular

cylindrical and flat exterior, cutting up, immersing, centring and piercing, with or without automatic feed to the mean accuracy of DIN 7168.

Knowledge:

- Types and use of the main turning tools;
- Forming of chips;
- Concept of cutting speed;
- Number of revolutions, feed, feed per revolution;
- Lubrication techniques.

Art and knowledge of assembly techniques

Soft soldering:

Skills required:

- Tinning and soft soldering mechanical components with a soldering iron;
- Maintenance of tools.

Knowledge:

- Soldering process, make-up metals, fluxes, soldering temperatures;
- Preparation for soldering;
- Types and use of soldering irons.

Bonding:

Skills required:

- Bonding together assemblies of materials of the same and different types, using various adhesives and according to the bonding specifications.

Knowledge:

- Principal adhesives and their use, taking into account their instructions for use.

Riveting:

Skills required:

- Execution of simple cold riveting work.

Knowledge:

- Riveting procedure;
- Types and materials used for rivets;
- Types and use of riveting tools.

Screwing:

Skills required:

- Mechanical assembly using screws;
- Self-locking screws.

Knowledge:

- Types, standardization and use of screws, nuts, washers and safety pins;
- Types and use of special tools for this work.

Knowledge of electrical engineering:

This knowledge, which generally forms part of the basic teaching material in the trade schools, will be imparted on the basis of practical knowledge:

Conducting and non-conducting materials:

- Types, electrical and thermal properties, use and standardization of the principal conducting and insulating materials.

Reading of wiring diagrams:

- Types use and standardization of main symbols and the connection indices to describe the electrical structural parts and wiring diagrams;
- Reading simple wiring diagrams for construction and current circuit diagrams; producing hand sketches and simple drawings.

Introduction to electricity:

- Composition of the subject;
- Electrical charge, switching of load;
- Electrical field, electric voltage;
- Electric current and its heating and lighting effects, magnetic and

chemical effects, effects on the human body, justification for accident prevention measures;
- Electrical resistance;
- Ohm's law;
- Thermal and field-dependent lighting resistances;
- Mechanical and electrical energy;
- Energy, output and loss of energy;
- Distribution of voltage, branching of current, Kirchhoff's Law;
- Voltage drop;
- Power generators, primary and secondary elements;
- Conduction of current in liquids and effects of this electrical conduction;
- Electric field;
- Magnetic field.

Electrical components:

Types, erection, simple technical connection properties, with the characteristics of the breaking equipment, manipulators, fuses, sockets, lamps, resistors, capacitors, coils, switches, relays, time relays or other electrical or electromechanical components.

Art and knowledge of electrical engineering:

Preparation and adjustment of conduits:

Skills required:

- Preparing and adjusting conduits ready for connection, including conduits similar to the cables;
- Making cable connections, fixing rings, sockets, or other connecting parts by bending or soldering them, by clamping or crimping.

Knowledge:

- Assembly, types, standardization and use of bare cables, together with simple insulated conduits with one or more conductors;

- Identifying colours of conduits and wires;
- Types, standardization and use of connecting parts;
- Types, use and properties of assembly techniques in electronics.

Production of simple coils:

Skills required:

- Hand production of simple windings from details, especially for resistances, mains transformers, switches and relays;
- Stacking simple ferrous cores.

Knowledge:

- Assembly and mode of operation of simple windings.

Preparation of electrical components for assembly:

Skills required:

- Preparation before connection of conduits, resistances, coils, condensers or other electrical components by cutting them to length, bending them, tinning them, or fixing connecting pieces;
- Fixing insulating sheaths, insulating sheets, insulating tape or other items.

Art and knowledge of assembly, wiring and connection:

Assembly of component parts:

Skills required:

- Assembly of electrical and electromechanical parts to make circuits in series, parallel or mixed, voltage or current, live permanently, temporarily, in surges or any other basic assembly.

Knowledge:

- Construction and mode of operation of the basic assemblies listed above.

Wiring and connection:

Skills required:

- Wiring of basic assemblies mentioned above, fitted with simple single or multiple wire conduits, and connection of the conduits by crimping, clamping or soldering them, according to the assembly and current circuit diagram;
- Fixing the conduits by using in particular the following processes: attaching, fitting clips and rings;

Knowledge:

- Types and use of main fittings for laying and fitting the line.

Art and knowledge of measurements and inspection:

Measurement of electrical quantities:

Skills required:

- Measuring voltage, current and resistance in direct and alternating current circuits using direct reading instruments;
- Measuring resistances using simple Wheatstone bridges;
- Connecting simple measurement circuits;
- Maintenance, handling and installation of measuring instruments;

Knowledge:

- Type and use of direct reading instruments for voltage, current and resistance;
- Types and use of simple bridges;
- Measuring units, basic electrical units, transformation of fractions and multiplication of units;
- Measurement errors.

Checking currents in circuits and conduits:

Skills required:

- Checking circuits in assemblies, switches, relays, conduits or other electrical components, using a line tester;

Knowledge:

- Type and use of current checking instruments and conduits; these instruments are fitted with a signal lamp or audible signal.

Knowledge of protection at work and accident prevention:

This knowledge, which also forms part of the basic teaching material in the trade schools, will be imparted on the basis of practical experience:

- Laws and regulations for protection at work;
- Clauses of the legal insurance against accidents, especially provisions for accident prevention, directives and information sheets;
- Measures to be taken in the event of accidents, first aid;
- Need for and importance of labour hygiene.

Improvement of knowledge of electrical engineering and its use in the construction of electrical installations:

This knowledge, which also forms part of the basic teaching material in the trade schools, will be imparted on the basis of practical experience:

Reading wiring diagrams:

- Type, use and standardization of the main symbols to represent electrical components on wiring diagrams;
- Types of lines, standard connection signs, in accordance with DIN 40719;

- Execution and use of circuit operating and installation diagrams;
- Reading simple installation drawings;
- Preparing simple installation drawings.

Continuation of study of electricity:

- Magnetic fields, magnetic circuits, hysteresis;
- Induction, inductance;
- Basic principles of alternating current, production of alternating current, sine curves, frequency, actual and reactive power;
- Resistors, capacitors and inductances in an alternating current circuit, useful resistance and reactance, dephasing;
- Inductive components: coils, self-inductance transformers, measurement converters;
- Rectification;
- Basic principles of three-phase current: production of three phase voltage, star and delta connections, rotating fields;
- Alternating current rotating machinery with no special construction;
- Direct current rotating machinery;
- Protection measures against too high a galvanic voltage in accordance with VDE 0100.

Electrical and electromechanical components:

- Forms of design, simple technical connection properties and marking of resistors, capacitors, coils, transformers, rectifiers, dry cells, accumulators, switches, current connections, circuit-breakers, fuses, lamps, pilot lights, moving and fixed frame indicators, and other electrical components;
- Diodes, transistors and other semi-conductors.

Protection at work and prevention of accidents:

- Laws and instructions for protection at work;
- Clauses of legal insurance against accidents, in particular provisions for accident prevention, directives and information sheets;
- Measures to be taken in the event of accidents, first aid;
- Need for and importance of labour hygiene.

Improvement in the art and knowledge of assembly techniques:

Brazing:

Skills required:

- Execution of brazing for mechanical and electrical loading of steel, copper and brass;

Knowledge:

- Make-up material, fluxes, brazing temperatures, and source of heat during brazing, influence on quality of solders, in particular mechanical strength and electrical conductivity;

Welding:

Skills required:

- Execution of simple autogenous and arc welds on sheet parts and metal sections with no special requirements for measuring the parts to be assembled;

Knowledge:

- Autogenous and arc welding procedures;
- Mode of operation and handling of welding equipment.

Art and knowledge of assembly, erection and fixing:

Assembly of electrical operating facilities:

Skills required:

- Assembly of prefabricated mechanical parts, detached parts, components,

appliances and machinery for simple structural groups;

Erection and installation of electrical power generation facilities:

Skills required:

- Working with fixed drills and portable percussion drills, with chain saws and grinding wheels or with other electrical or pneumatic assembly tools;
- Positioning of pins, extending pins and other means of fixing;
- Use of plaster, mortar and concrete;
- Assembly and fixing of connection and distribution installations, lighting appliances, small machines and instruments or other installation materials and electrical generation facilities, in accordance with specific details, part or general installation diagrams;

Knowledge:

- Type, possibilities of action, maintenance and use of erection tools;
- Type, properties and use of construction materials and means of fixing;
- Types of protection, categories of protection.

Art and knowledge of laying conduits, wiring and assembly:

Preparation and adjustment of power conduits and cables up to 1 kV:

Skills required:

- Positioning terminal and connection blocks and end plugs up to 1 kV.

Knowledge:

- Erection, preparation and standardization of cables with one or more wires, sheathing, protection from corrosion, screening and marking.

- Types and use of insulating pastes and resins, taking into account special provisions for use and safety.

Laying of conduits and cables:

Skills required:

- Preparation of routes for conduits underground, in the open and in closed spaces, in channels, in buildings and on buildings, on walls and built-in;
- Laying of installation and protection pipes, cable routes and other means of fixing;
- Laying and fixing of conduits and cables, rails and earths by means of clips and other fixings, in accordance with installation drawings and other precise working instructions;

Knowledge:

- Type and use of major fittings for line-laying and for fixing conduits, coloured marking of conduits and wires;
- Laying specifications.

Execution of conductor connections;

Skills required:

- Connection of conduits, cables, rails to connection installations, appliances and machines by screwing, riveting, wedging, crimping, soldering, in accordance with connection, laying, general, circuit operation drawings and plans.

Art and knowledge of measurements and inspection:

Measurements of electrical values:

Skills required:

- Simple measurements of alternating and direct voltages.

- Measurement of resistance;
- Measurement of insulation;
- Measurement of power in direct current circuits or measurement of effective power in alternating current circuits;
- Extending the range of galvanometers and voltmeters;
- Read indicators;
- Measure earth connection resistances.

Knowledge:

- Assembly and mode of operation of instruments giving direct readings of current, voltage, resistance and power.

Checking electrical functions:

Skills required:

- Checking insulation resistances;
- Check current and voltage in simple circuits using measuring instruments, in accordance with wiring diagrams and instructions;
- Check the phases in three-phase circuits;
- Setting safety and protection devices;
- Checking state and electrical function of operating facilities and parts of installations, in accordance with instructions;
- Cutting off current and checking the absence of voltage in accordance with VDE 0105 standard.

Knowledge:

- Use of current and voltage measuring instruments;
- Use of direction of rotation field indicators;
- Assembly and mode of operation of thermal and magnetic protective installations;
- Protective measures against excessive galvanometric voltages.

Measurements of non-electric values:

Skills required:

- Measure speeds of revolution and temperatures.

Knowledge:

- Types and use of electric and mechanical tachometers;
- Liquid thermometers and electric instruments for measuring temperature.

Art and knowledge of maintenance of electrical installations:

Repair of electrical installations:

Skills required:

- Use of measuring and control methods by means of instruments and appliances when looking for errors;
- Detection of simple breakdowns;
- Replacing defective parts, appliances and assemblies;
- Marking to ensure reassembly is carried out in order;
- Use of appliances, tools and other corresponding means for dismantlement and assembly;
- Choice of spares, overhaul or making of parts.

Knowledge:

- Simple electrotechnical relations to detect causes and possible sources of breakdowns.

Maintenance of electrical installations:

Skills required:

- To carry out cleaning, preservation, maintenance and greasing work;
- Use of installations, appliances and instruments provided and installed for control;
- Execution of simple checking work, including replacement of parts, in accordance with instructions and the maintenance schedule;
- Re-obtain, by adjustment, the set data for simple appliances;
- Fill in the maintenance files, enter the work on cards or job lists;

Knowledge:

- Solvents, detergents and lubricants;
- Simple measurement connections, provided these are used in maintenance work;
- Maintenance provisions for spares and for small complete installations.

ANNEX 14/1

TRAINING SCHEDULE[2)]

ELECTRICAL INSTALLER

The technical knowledge imparted will be scheduled on the basis of the following guidelines:

TRAINING SECTOR	DURATION OF TRAINING (indicative times)
1. General knowledge[1)]	52 weeks (1st year)
2. - Principles and practice of the machining of materials (except turning)	12 weeks
- Turning	2 weeks
3. Principles and practice of assembly techniques.	3 weeks
Practice and in-depth study of the principles and practice cited under 2 and 3, taking into account the difficulties of the factory	5 weeks
4. Knowledge of electrical engineering[1)]	52 weeks (1st year)
5. Principles and practice of electrical engineering.	4 weeks
6. Principles and practice of erection, wiring and assembly.	8 weeks
7. - Principles and practice of measurement and inspection.	4 weeks
- Practice and in-depth study of the principles and practice cited under 5, 6 and 7, taking into account the difficulties relating to the type of firm.	10 weeks

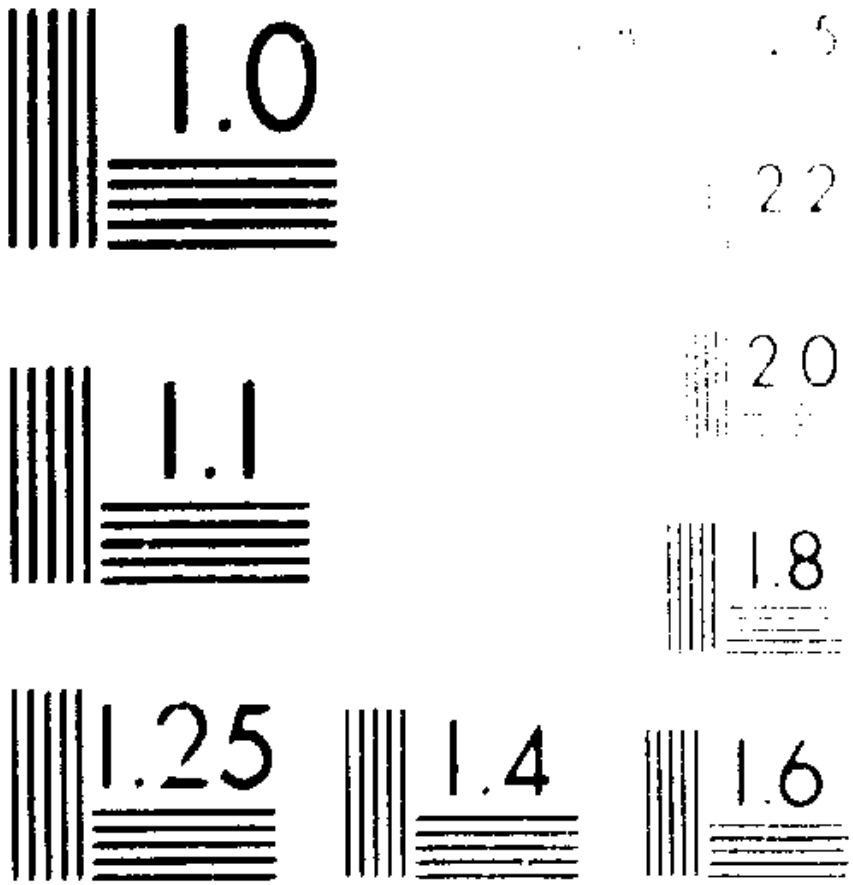
1) Must be imparted on the basis of practical experience.

2) BWF (Bundesministerium für Wirtschaft und Finanzen) West Germany.

TRAINING SECTOR	DURATION OF TRAINING (indicative times)
8. Knowledge of the protection at work and accident prevention. [1) 2)]	52 weeks (1st year)
9. Further knowledge of electrical engineering and its use in the construction of electrical installations.[1)]	52 weeks (2nd year)
10. Further principles and practice of assembly techniques.	4 weeks
11. Principles and practice of erection, installation and fixing.	6 weeks
12. Principles and practice of the laying of conduits, wiring and connection. Machining and adjusting conduits and cables of a power up to 1 kV. Laying conduits and cables and the execution of conductor connections.	12 weeks
13. Principles and practice of control measurements.	4 weeks
14. Principles and practice of the repair and maintenance of electrical installations[1)]	
Further principles and practice as cited under points 10 to 14, taking into account the difficulties relating to the type of firm.	10 weeks

1) Must be imparted on the basis of practical experience

2) Especially for the introduction to 5, 6 and 7 (Familiarization with electrotechnical components and appliances - work on electrotechnical installations).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EXAMINATIONS[1)]

INTERMEDIATE EXAMINATION

ELECTRICAL INSTALLER

After teaching covering the knowledge mentioned in Annex VI/12/1 up to page VI/12/2, the first intermediate examination will be taken. This will take place after the first year of training.

The intermediate examination covers both the Principles and practice mentioned in Annex VI/12, and the material included in the standard curriculum of the trade schools, where this material is important for trade training.

The candidate will in particular have to carry out the following practical work, in accordance with precise instructions and information:

1. A simple examination test will be taken, according to a schedule. For this, the candidate must be able to prove that he has acquired the following skills (working time up to 4 hours).

- Measurement and checking lengths and angles;
- Checking the quality of the surface and inherent flatness;
- Tracing, plotting;
- Sawing, filing;
- Drilling, chambering, boring, hand tapping;
- Bending, rectifying;
- Assembling by screwing, riveting, soft soldering;

2. A test piece of work will be carried out, with the purpose of proving that the following skills have been acquired: (duration of examination up to 3 hours).

- Fixing connecting pieces by soft soldering, clamping, crimping;
- Connection of conductors by soldering, crimping, screwing;

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1) BWF (Bundesministerium für Wirtschaft und Finanzen) West Germany.

- Laying and fixing conduits in accordance with a diagram;

The candidate must be able to prove he has acquired knowledge in the following branches of examination:

1. Technology

- Machining of materials;
- Electrical engineering:
  - Types, installation and properties of electrical and electromechanical components;
  - Basic connections;
- Protection at work and accident prevention.

2. Industrial drawing

- Reading simple workshop drawings.

FINAL EXAMINATION

ELECTRICAL INSTALLER

Requirements for the final examination for the training of an electrical installer.

The examination covers the Principles and practice cited in the standard training schedule, together with the material included in the standard curriculum of the trade schools, where this material is important for trade training.

The candidate must in particular carry out the following work, in accordance with precise instructions and information:

1. A simple examination piece will be carried out according to a drawing (working time up to 4 hours)

- When selecting this the following may be included:
  - connection tables;

- protective caps;
- assembly parts;
- equipment bases.

- During the test the following work in particular will be involved:
  - measurement and checking of lengths and angles;
  - tracing, plotting;
  - sawing, filing by hand;
  - hand tapping, chambering and boring;
  - rectifying and bending;
  - assembly of parts using detachable and undetachable procedures.

2. A test piece of work covering the technique of electrical installation will be carried out (duration of examination 10 hours)

- The following are involved in the selection:
  - lighting installations;
  - electrical motor control installations, with switches and driving mechanisms.
- During the test, the following work in particular will be involved:
  - application of various techniques for laying and wiring using normal conduits and cables up to 1 kV.

3. Cabling and measurement tests will be carried out on a training installation (for one hour)

The candidate must, in particular, prove that he has mastered the following examination subjects :

1. Specialization

- Machining metals:
- Nature, principal properties and use of materials, auxiliary materials and insulating materials normaliy used in electrical engineering;

- types, and use, of tools and measuring instruments, manual preparation with cutting and forming tools, machining by drilling and turning.

- Electrical engineering:
  - Basic principles of electricity, especially voltage, current, resistance, energy, output;
  - Power generation, drop and distribution of voltage, connecting current;
  - capacity, frequency;
  - electro-magnetism, induction, inductance;
  - power installations, principally erection, adjustment and inspection.
  - Protection at work and accident prevention.

2. Technical calculations:

  - Calculation of lengths, areas, volumes and weights relating to the trade;
  - Conversion of measuring units;
  - Ohm's law, division of voltage, connecting current, voltage drop;
  - electrical power.

3. Industrial drawing;

  - reading and completing simple general and parts drawings
  - reading and completing installation drawings, operating and circuit drawings;
  - making simple sketches of spares and connection drawings.

4. Economics and sociology:

References for the progress of the examinations in scheduled form:

- technology (1 hour)
- technical calculations (1½ hours);

ANNEX 16

COMPOSITION OF AN ELECTRICIAN'S TOOL BOX

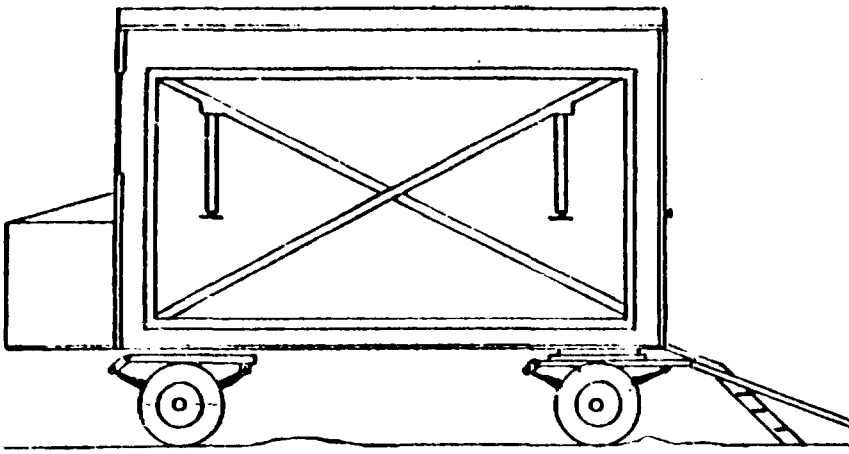
Qty	Description
1	Set of 6 flat spanners, sizes 3.2 to 13
1	Adjustable spanner
1	Vice clamp
1	Insulated adjustable pliers
1	Insulated cross-cut pliers
1	Insulated flat pliers
1	Front insulated cutting pliers
1	Insulated round-nosed pliers
1	Pliers for scraping varnished wires
1	Stripping pliers
3	Insulated blade screwdriver, sizes 3, 5-4 and 5.5
1	Square blade screwdriver, size 6
2	Philips head screwdrivers, Nos. 1 and 2
2	Posidriv screwdrivers, Nos. 1 and 2
2	Elbow screwdrivers, sizes 6 and 8
1	Voltage detecting screwdriver
1	Screw-retaining screwdriver
1	Voltage detecting screwdriver
1	Lamp socket pliers
1	Riveting hammer
1	Electrician's hammer
1	Bradawl
1	Centre punch
1	Cold-chisel
1	Contact file
1	Saw mounting
10	Saw blades
1	2-metre rule
1	Magnetic finger
1	Electrician's knife
1	Electrician's scissors
3	Pin-punch
1	Soldering iron
1	Side-edge chisel
1	Insulated universal pliers
1	Set of 25 sockets, sizes 5.5 to 14.

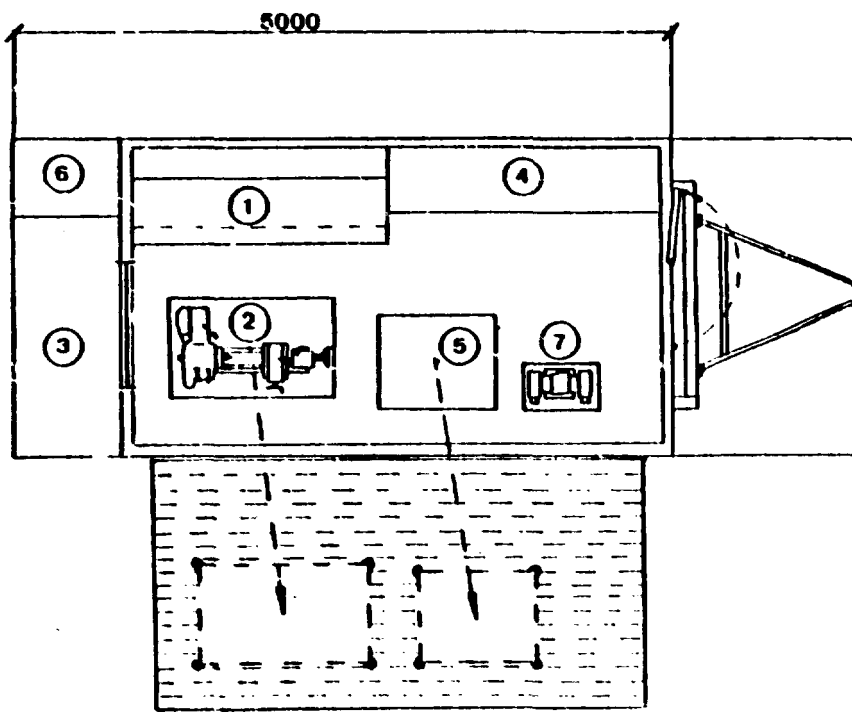
ANNEX 17

EQUIPMENT FOR A MOBILE ELECTROMECHANICAL WORKSHOP

- 1 3kW generating set
- 1 portable single-phase welding machine for repair work (160 Amp) with accessories
- 1 cabinet-workbench
- 1 hand grinding machine + set of corundum disks
- 1 hand chain saw = set of corundum disks
- 1 complete set of basic equipment for mechanic (see details of tools in Annex 19)
- 1 electrician's multimeter
- 1 battery tester
- 1 cabinet with plastic bins
- 1 series of plastic bins in 3 sizes:
  - 105 x 105 x 50
  - 254 x 204 x 180
  - 417 x 420 x 292
- 1 fitter's case 400 x 150
- 1 lathe Ø 200 x 500 + set of cutting tools
- 1 grease gun
- 1 grinding lathe
- 1 drill on work-bench + set of bits
- 1 cable puller 1.5 t + 20 m of cable
- 1 mobile car jack 1.5 t
- 1 hand drill + set of bits

Note: The above equipment needs to be checked against the equipment proposed by the mechanical expert (UNIDO SI/STP/81/801/11-02/31.9.C), and if necessary supplemented.

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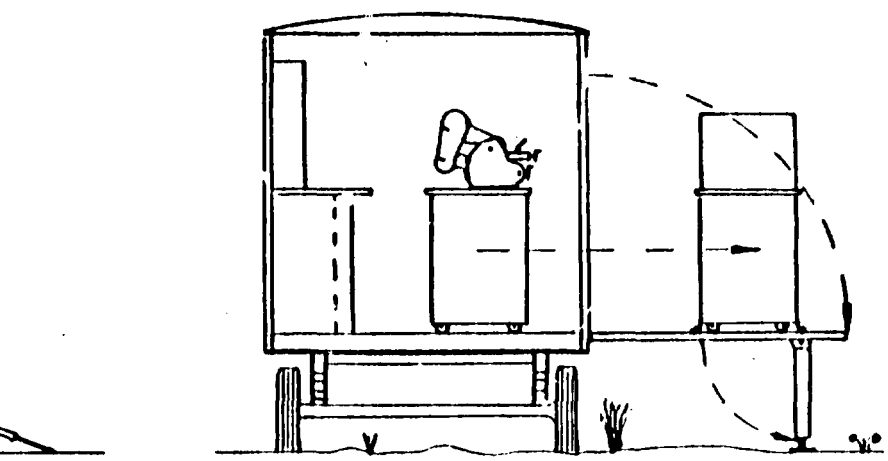
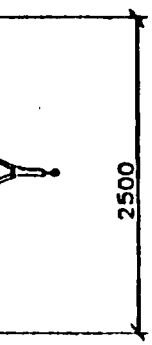




ELECTRO-MECHANICAL
MOBILE WORKSHOP

ANNEX 18/2

KEY

1. Cabinet-workbench

2. Lathe

3. 3 kW generating set

4. Cabinet with plastic bins

5. Drill on workbench

6. Grinding lathe

ANNEX 19/1

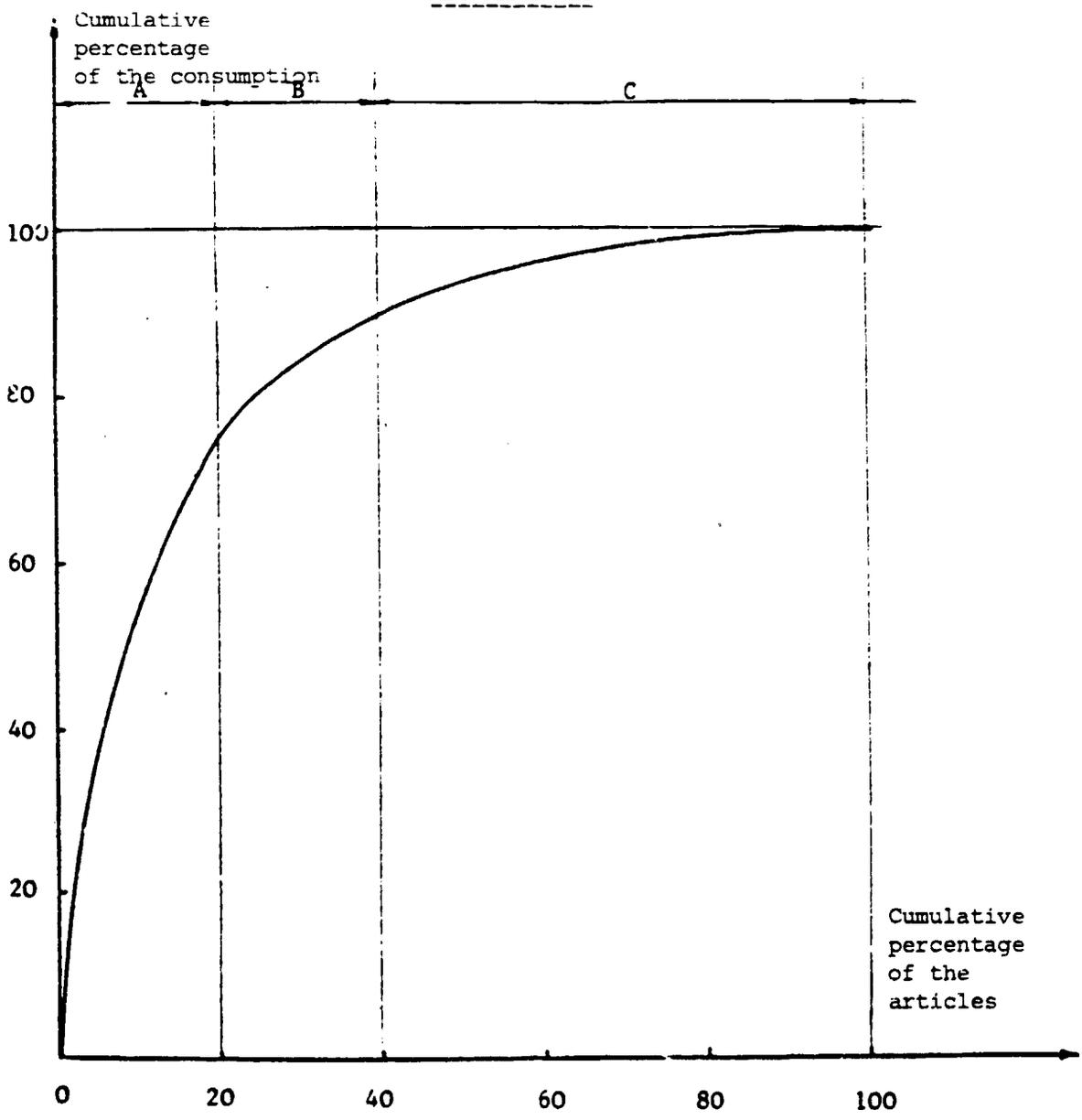
DETAILS OF THE EQUIPMENT IN THE CABINET-WORKBENCH FOR MOBILE WORKSHOP

Qty	Description
1	25 Socket spanners and fittings, sizes 5.5 to 14
1	21 Socket spanners and fittings, sizes 8 to 23
1	Torque wrench
1	Set of 16 mixed spanners, sizes 8 to 24
1	Set of 16 pipe spanners, sizes 8 to 24
1	Set of 6 jointed socket spanners, sizes 8 to 19
1	Set of 7 Cardan keys, sizes 8 to 14
1	Set of 10 male keys, sizes 2 to 10
1	Adjustable spanner
1	Adjustable pliers
1	Vice clamp
1	Insulated universal pliers
1	Insulated cross-cut pliers
1	Insulated front cutting pliers
1	Garage mechanic's insulated straight pliers
1	Insulated flat-nosed pliers (?)
1	Insulated round-nosed pliers
1	Brake spring grippers
1	Set of 2 circlip pliers with removable ends
1	Round plade screwdriver, size 4
3	Forged blade screwdrivers, sizes 5.5, 6.5 and 8
1	Short screwdriver, size 5.5
1	Insulated round blade screwdriver, size 3.5
2	Posidriv screwdrivers, Nos. 1 and 2
2	Philips screwdeivers, Nos. 1 and 2
1	Flexible screwdriver
1	Flexible screwdriver
2	Pin-punches
1	Centre-punch
1	Chisel
1	Riveting hammer
1	Flat-faced sledgehammer
1	Shears
1	2-metre rule
1	Thickness feeler
1	Slide calipers
1	Scriber
1	Saw mounting
10	Saw blades
1	Spark-plug brush
1	Contact file
1	Magnetic finger
1	Stand for 5 pin extractors
1	Extractor
1	Universal ball-joint puller
1	Oil filter spanner
1	Plug spanner

Qty	Description
1	Plug spanner
1	Plug spanner
1	Hose for spark-plugs
1	Battery terminal cleaner
1	Battery carrying strap
1	Magnetic inspection lamp
1	Disk brake pliers
1	Ignition adjustment spanner
1	Polygonal brake adjustment spanner
1	Oil-can
1	80 mm hub remover

ANNEX 20

ABC ANALYSIS

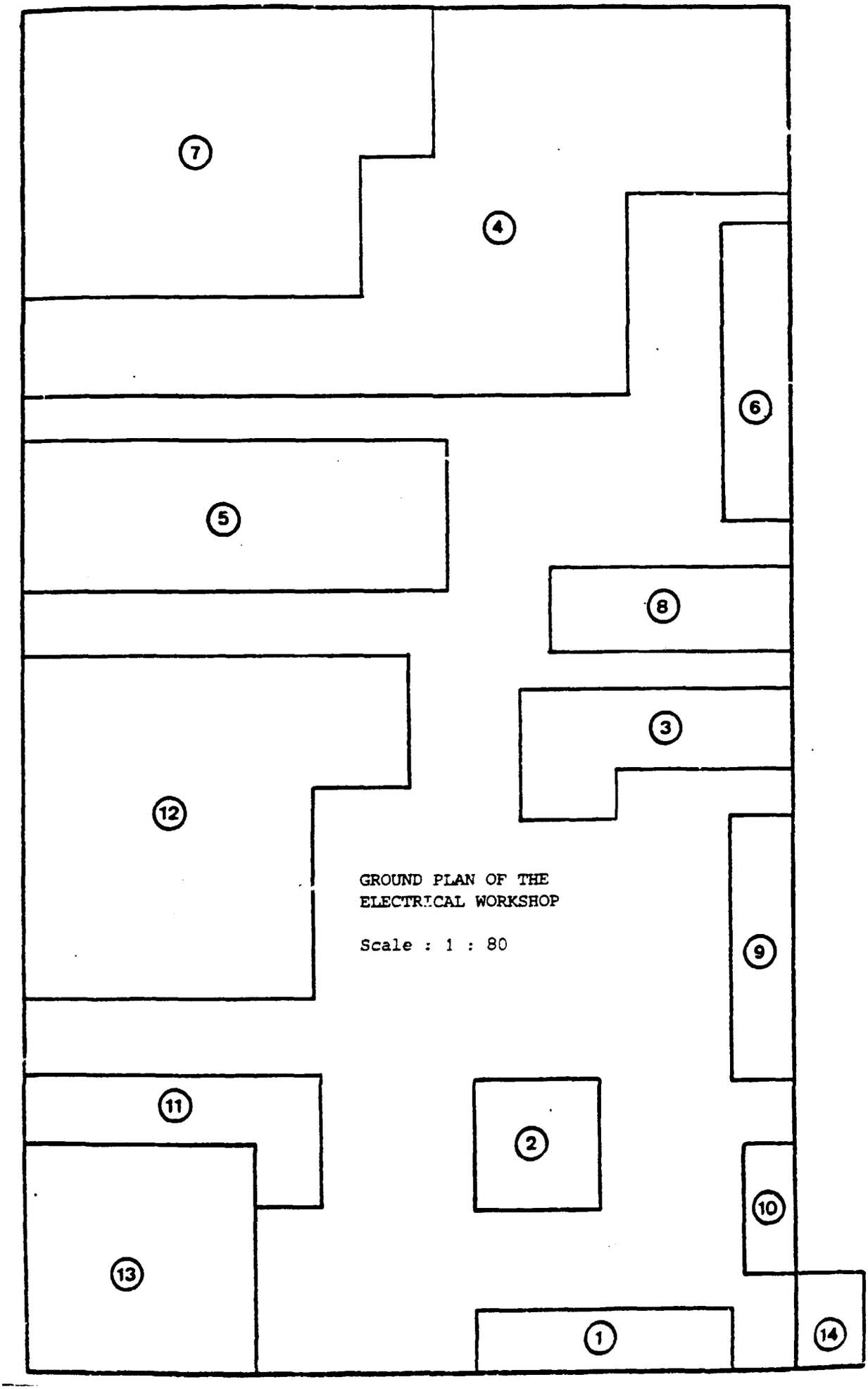


BUDGET FOR SHORT TERM MEASURES

Item	US$	
1. Technical assistance		
- wages and allowances (12 man-months)	70,000	
- travelling	15,000	
- removal expenses	2,000	
- miscellaneous expenses	2,000	
- accommodation and transport provided free by DRSTP		
Sub-total		89,000
2. Tools		
- 1 tool box for technical assistant + multimeter (see Annex 16)	500	
- 30 standard electrician's tool boxes (items 1-32 of Annex 16)	10,000	
- 30 VA meters	1,500	
- transport costs	1,800	
- customs clearance borne by DRSTP		
Sub-total		13,800
3. Mobile electromechanical workshop		
- equipment for workshop according to list in Annex 17	17,500	
- trailer	40,000	
- transport costs	10,000	
- customs clearance borne by DRSTP		
Sub-total		67,500
4. Purchase of electrical spares		
- overall estimate including transport	75,000	
- customs clearance borne by DRSTP		
Sub-total		75,000

Item	US$	
5. Electrical technical documentation		
- overall estimate		25,000
6. Training of coil-winder		
- training costs	150,000	
- teaching aids	1,500	
- accommodation and pocket money	30,000	
- travelling	2,000	
- miscellaneous costs	10,000	
Sub-total		193,500
7. Follow-up and supervision of entire project		
- project management	25,000	
- follow-up and purchase of spares	35,000	
- follow-up and renewal of technical documentation	10,000	
- follow-up and supervision of training	30,000	
- overheads	10,000	
Sub-total		110,000
8. Total		573,800

ANNEX [illegible]



GROUND PLAN OF THE
ELECTRICAL WORKSHOP

Scale : 1 : 80

KEY

1. Storage, on shelving, of electrical machines to be rewound or repaired

2. Storage, on the ground, of electrical machines to be rewound

3. Dismantling, reassembly and cleaning area

4. Preparation area
   - removal of old coils
   - cleaning of commutator slots
   - preparation of paper, cardboard and blocks

5. Coil-winding area

6. Coil assembly area
   - inserting paper in the slots
   - inserting the coils
   - making the electrical connections

7. Impregnation and drying area

8. Electrical testing area
   - tests before impregnation
   - operational tests

9. Machine-tool section

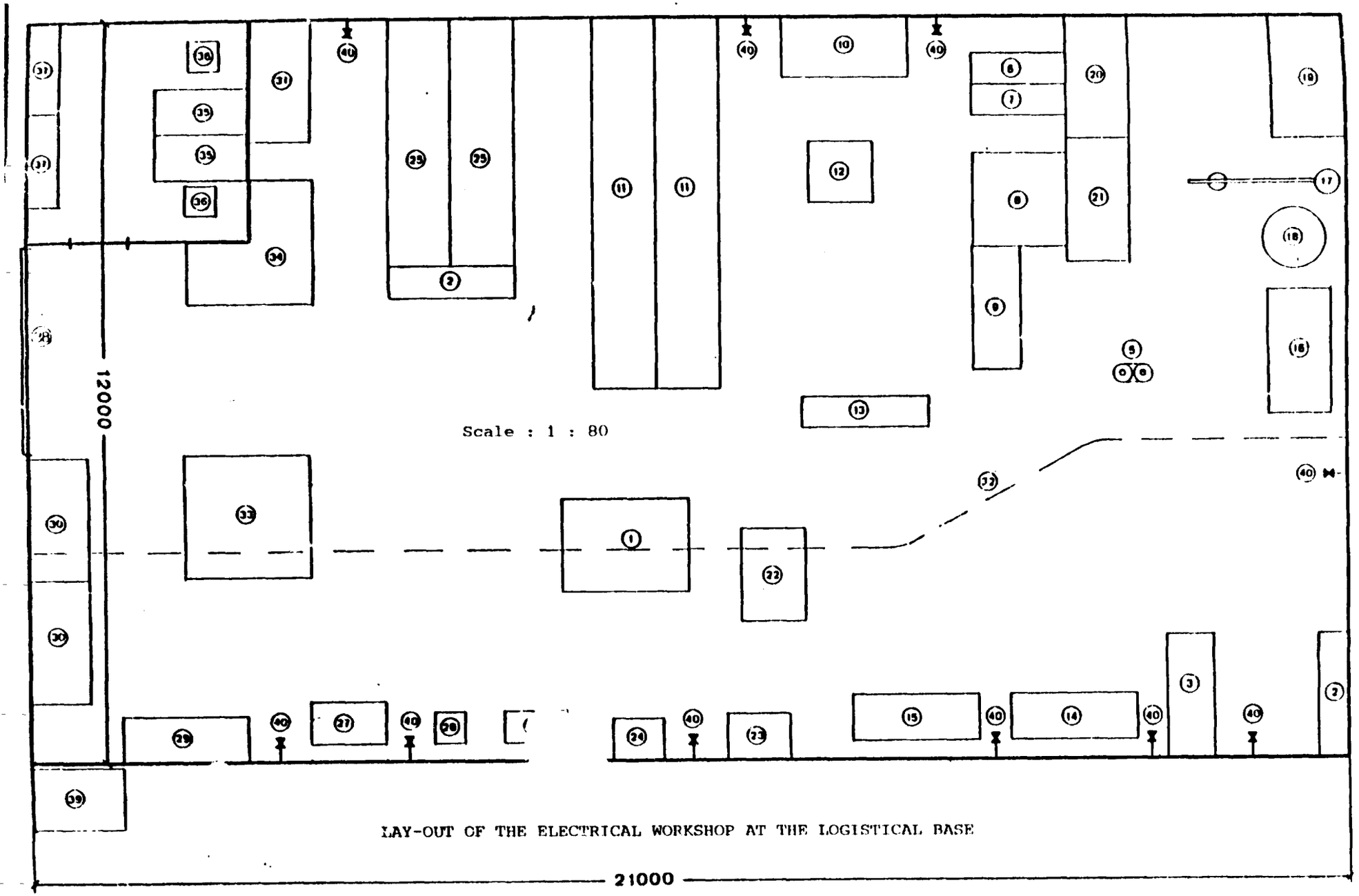
10. Electrical repair area

11. Storage of rewound electrical machines

12. Storage of raw materials and spares

13. Office

14. Compressed air generator.



LAY-OUT OF THE ELECTRICAL WORKSHOP AT THE LOGISTICAL BASE

ANNEX 23.1

KEY

1. Workshop bench for assembly and dismantling
2. Cabinet containing plastic bins with fittings
3. Workshop bench
4. Working area for extracting stator coils
5. Acetylene/oxygen cylinders
6. Shelves with stock of plastic cables
7. Shelves with stock of wooden blocks
8. Shelves with stock of paper
9. Paper cutter
10. Rack for copper wire reels
11. Shelves with stock of copper wire reels and fittings for coil-winding machine
12. Coil-winding machine
13. Shelves for storing coils
14. Benches for cutting papers and blocks
15. Place for assembling coils
16. Shelves for motors being impregnated
17. Pivoting crane with hoisting gear
18. Impregnation bath
19. Drying oven
20. Shelves for dry motors
21. Shelves with stock of varnish
22. Test bench
23. Test table
24. Cleaning stand
25. Shelves for storing motor spares and miscellaneous materials
26. Grinding lathe
27. Lathe
28. Column drill
29. Work bench
30. Storage of electrical machines for rewinding
31. Storage of rewound electrical machines
32. Electrical hoisting gear
33. Place for electrical machines for rewinding (on ground)
34. Place for rewound electrical machines (on ground)
35. Desk
36. Office chair
37. Office cabinet
38. Sliding door
39. Compressed air generator
40. Compressed air connections.

SPECIFICATION FOR EQUIPMENT IN THE ELECTRICAL WORKSHOP

Item	Qty	Item Annex 23/1	Description
1	2	3-29	Workshop bench with two sets of drawers and intermediate shelf 2000 x 750 with vice 150 x 170
2	3	14-1	Workshop bench with 1 set of drawers with intermediate shelf 2000 x 750, one with vice 125 x 150
3	2	15-22	Workshop bench without drawers, with intermediate shelf 2000 x 750
4	1	12	Coil winding machine, diameter of plate 300 mm, driving force 8 kg/m, speeds 1600-750-470-292-146-91 rpm, power 1 HP, 220 V
5	2	2	Metal cabinets
6	16	16-20-11-25-30-31-21	Modular shelves (with wooden pallets, metal shelves on levels) 2000 x 1000 x 3000 with 7 levels
7	100	2-25	Plastic bins for small parts 105 x 105 x 50
8	50	2-25	Plastic bins for small parts 254 x 204 x 180
9	30	2-25	Plastic bins for small parts 457 x 420 x 292
10	1	19	Drying oven 1000 x 800 x 1000, 10 kW, 2 heating units
11	1	18	Impregnation bath with pump Ø 800 mm, 100 litres of varnish
12	1	17	Pivoting crane, span 2m with manual hoisting gear 1.5 t
13	1	27	Lathe Ø 500 x 750, 16 speeds + fittings and cutting tools
14	1	26	Work-bench lathe 200 mm, 2 grinders, 580 W, with protective glasses
15	1	28	Workbench drill 25 mm + 1 set of bits
16	1	5	Oxygen cutting equipment with reducing valve and fittings
17	1	-	Protective clothing and equipment for welders (round glass goggles, apron, shoes, gloves)
18	2	6-7	Storage shelves with small partitions, 1500 x 500
19	1	8	Storage shelves for paper and insulating board
20	1	9	Paper shears on 1100 mm table
21	1	10	Stand for copper wire reels
22	1	13	Low shelf for storing wound coils on 2 levels

ANNEX 24/2

Item	Qty	Items Annex 23/1	Description
23	1	23	Test bench with - insulation tests (0-5000V) - stator and rotor tests (generator and test probe) - transformer 110V-220V-380V-500V for motors up to 100 HP - Wheatstone bridge 0.01 to 1000
24	1	24	Mobile cleaning equipment, 50 litres, 2.5 bars with pump
25	1	32	Electric hoisting gear, 1.5 t with rail
26	2	35	Desk 1500 x 750
27	2	26	Office chair
28	2	37	Metal office cabinets
29	1	-	150A welding machine with fittings (pick-hammer, brush, hand screen, welding cable, earth cable, earthing piece, electrode holder)
30	1	-	Cylinder jack, 3 t
31	1	-	Cylinder jack, 5 t
32	1	-	Jack, 30 t
33	1	-	Mobile workshop vice
34	1	-	Pallet truck
35	14	-	1000 x 1000 pallets
36	1	-	1 hand drill
37	1	-	1 hand grinder
38	1	-	Compressed air set, 7 bars, with 0.15 m^3/min + oil-separator and dehumidifier
39	1	-	Universal set of fittings for coil-winding machines: - 1 graduated 530 mm beam - 1 graduated 330 mm beam - 2 graduated 270 mm cross-beams - 1 complete set of coil heads
40	5	-	Hoses with quick connections for compressed air
41	2	-	Compressed air cleaning guns
42	10	-	Work stools
43	3	-	Small ladders
44	1	-	For the garage section: - 1 control lamp - 1 stroboscope - 1 set of measuring instruments for motor diagnosis

ANNEX 25

LIST OF SPECIFICATIONS FOR TOOLS FOR THE ELECTRICAL WORKSHOP

Item	Qty	Description
1	4	Electrician's tool boxes, as detailed in Annex 16
2	2	Sets of a selection of tools for general mechanics, as detailed in Annex 26
3	1	1 set of 4 curved flat-headed chisels for removing coil heads (width 18-21-23-27 mm)
4	1	Welding kit with fittings
5	1	Torque wrench, ½", 5-23 mkg
6	2	Hub remover, 80 mm
7	1	Hub remover, 160 mm
8	2	Slide calipers, reading to 1/2o mm, depth gauge
9	1	Box of metric taps and dies, 3 to 12 mm, with fittings in high-speed steel
10	1	Box of inch taps and dies 1/8" to 1/2" high-speed steel
11	20	Sets of hammers with handles of 300-500-1000
12	1	Grease gun
13	1	Paint gun
14	1	Set of 6 notched files 300 x 10 x 2.8 - 400 x 12 x 3 - 400 x 16 x 4 - 400 x 20 x 4
15	1	Set of 8 metal hand brushes (Ø 5-6-8-10-15-20-25-30 mm)
16	1	Set of 9 tools for threading wire into notches (width from 2 to 10 mm)
17	1	Set of 10 tools for pressing wire into notches (3 to 12 mm)
18	1	Set of 6 tools for filing down notches (width 290-320-355-415-500-580 mm)
19	2	Multimeters
20	1	Pliers for cable eyelets
21	1	Terminal pliers
22	100	Hand saw blades (12 teeth par mm/13 x 0.65 x 300)
23	10	Corundum disk for hand grinder
24	1	Set of bits for hand drill

SELECTION OF TOOLS FOR GENERAL MECHANICS

Qty	Description
1	Socket, 21 long
1	Jointed handle
1	28 sockets with fittings, sizes 8 to 32
1	Set of 10 male wrenches, sizes 2 to 10
1	Set of 8 polygonal wrenches, sizes 8 to 24
1	Set of 12 forked spanners, sizes 6 to 32
1	Adjustable spanner
1	Insulated adjustable pliers
1	Vice clamp
1	Insulated universal pliers
1	Insulated cross-cut pliers
1	Insulated flat pliers
1	Insulated round-nosed pliers
1	Round bladed screwdriver, size 3.5, insulated
3	Round bladed screwdrivers, sizes 4, 5.5 and 6.5
2	Square bladed screwdrivers, sizes 6 and 8
2	Posidriv screwdrivers, Nos. 1 and 2
2	Philips head screwdrivers, Nos. 1 and 2
1	Chisel
2	Pin-punches
1	Chisel
1	Mortise
1	Centre-punch
1	Riveting hammer
1	Plastic-headed sledgehammer
1	Shears
1	Bradawl
1	Contact file
1	Plug brush
1	Tool for repairing threads
1	Electrician's knife
1	Magnetic finger
1	Drill holder
1	2-metre rule
1	Thickness feeler
1	Slide callipers
1	Saw mounting
10	Saw blades
1	Extractor
1	Stand of 5 pin extractors
1	Valve lifter
1	Set of 5 files
1	Chatterton roller
1	Oil-can

LIST OF A BASIC STOCK OF RAW MATERIALS AND SPARES FOR THE ELECTRICAL WORKSHOP

1. Terminal plates

40 x 25 x 10	50 off	70 x 45 x 13	25 off
44 x 28 x 29	50 off	82 x 52 x 15	25 off
50 x 32 x 11	50 off	95 x 60 x 17	20 off
56 x 36 x 12	50 off	114 x 70 x 81	20 off
64 x 40 x 12	85 off		

2. Polypropylene fans for motors

Ø 99	50 off	Ø 166	25 off
Ø 115	50 off	Ø 185	10 off
Ø 130	50 off	Ø 209	10 off
Ø 145	25 off		

3. Cable eyelets

For screw/cable cross-section	2.5/1	1000 off	5/1.5	500 off
	3/1	1000 off	5/2.5	500 off
	3/5.1	1000 off	6/2.5	500 off
	4/1.5	1000 off	6/4	500 off
	4/2.5	1000 off	8/2.5	500 off

4. Notch insulation paper, width 900 mm

Class F (155°C)

thickness 0.19 mm 30kg

thickness 0.29 mm 30kg

5. Insulation board between phases

Class B (130°C)

thickness 0.15 mm 20kg

thickness 0.25 mm 20kg

6. Impregnation varnish

Class F (155°C)

20 drums of 10.1

7. Notch blocks

In polyester Class 5

Dimensions:				
	2.5 x 10	100m	5.5 x 17	100m
	3 x 12	100m	6 x 18	50m
	3.5 x 13	100m	7 x 20	50m
	4 x 14	100m	8 x 22	50m
	4.5 x 15	100m	9 x 24	50m
	5 x 16	100m	10 x 26	50m

8. Half-round beech blocks

Dimensions:				
	3 x 1.5	100m	6 x 3	100m
	3 x 2	100m	6 x 4	100m
	4 x 2	100m	6 x 5	100m
	4 x 3	100m	6 x 6	100m
	4 x 4	100m	7 x 4	100m
	5 x 3	100m	8 x 3	100m
	5 x 4	100m	8 x 5	100m
	5 x 5	100m		

9. Enamelled wire - Grade 2

Ø 0.10	10kg	Ø 0.335	20kg	Ø 0.85	40kg
Ø 0.125	10kg	Ø 0.40	20kg	Ø 0.90	40kg
Ø 0.14	10kg	Ø 0.45	20kg	Ø 0.95	40kg
Ø 0.16	10kg	Ø 0.50	40kg	Ø 1.00	40kg
Ø 0.18	10kg	Ø 0.56	40kg	Ø 1.06	40kg
Ø 0.20	20kg	Ø 0.60	40kg	Ø 1.12	40kg
Ø 0.224	20kg	Ø 0.63	40kg	Ø 1.18	40kg
Ø 0.25	20kg	Ø 0.67	40kg	Ø 1.25	40kg
Ø 0.28	20kg	Ø 0.71	40kg	Ø 1.32	30kg
Ø 0.30	20kg	Ø 0.75	40kg	Ø 1.40	20kg
Ø 0.335	20kg	Ø 0.80	40kg		

10. Wrapping tape

Class F

width:				
	2mm	100m	8mm	25m
	4mm	100m	10mm	25m
	5mm	100m	11mm	25m
	7 mm	100m		

11. Cable for connecting to terminal box

Insulated flexible core cables with 2 coates of polyester tape and 1 polyester braid coated in class F varnish.

Cross-section mm^2	
	0.50 x 100m
	0.75 x 100m
	1.00 x 100m
	1.50 x 100m
	2.00 x 100m
	2.50 x 100m
	4.00 x 100m

12. Sleeving

Class F (155°C)

Diameter	
	0.50 x 100m
	0.80 x 100m
	1.00 x 100m
	1.50 x 100m
	2.00 x 100m

diameter	
	2.50 x 100m
	3.00 x 100m
	3.50 x 100m
	4.00 x 100m
	5.00 x 100m

13. Bearings

SKF characteristics

6000 Z	40 off	6304 Z	40 off	6308 Z	15 off
6200 Z	40 off	6205 Z	20 off	6209 ZC3	15 off
6300 Z	40 off	6305 Z	20 off	6309 ZC3	15 off
6002 Z	40 off	6206 Z	20 off	6210 ZC3	15 off
6202 Z	40 off	6305 Z	20 off	6310 ZC3	15 off
6302 Z	40 off	6207 Z	15 off	6211 ZC3	15 off
6004 Z	40 off	6307 Z	15 off	6311 ZC3	15 off
6204 Z	40 off	6208 Z	15 off		

14. Bolts and nuts - screws & fittings

1) Hexagonal head screws to DIN 933-8.8

M4 x 12	500 off	M5 x 8	500 off
x 20	500 off	x 12	500 off
x 30	500 off	x 20	500 off
		x 30	500 off
		x 40	500 off

M6 x 12	500 off	M8 x 16	200 off
x 20	500 off	x 20	200 off
x 30	500 off	x 40	200 off
x 40	500 off	x 60	200 off
x 60	500 off	x 80	200 off
M10 x 20	200 off	M12 x 20	100 off
x 40	200 off	x 40	100 off
x 80	200 off	x 80	100 off
x 100	200 off	x 100	100 off
M16 x 20	100 off		
x 40	100 off		
x 80	100 off		
x 100	100 off		
x 120	100 off		

2) Hexagonal nut to DIN 934-8

M4	400 off	M10	400 off
M5	400 off	M12	400 off
M6	400 off	M16	400 off
M8	400 off		

3) Cheese-head screw, hexagonal keyed to DIN 912-8.8

M4 x 12	500 off	M5 x 8	500 off
x 20	500 off	x 12	500 off
x 30	500 off	x 20	500 off
		x 30	500 off
		x 40	500 off
M6 x 12	500 off	M8 x 16	200 off
x 20	500 off	x 20	200 off
x 30	500 off	x 40	200 off
x 40	500 off	x 60	200 off
x 60	500 off	x 80	200 off

M10 x 20	200 off	M12 x 20	100 off
x 40	200 off	x 40	100 off
x 80	200 off	x 80	100 off
x 100	200 off	x 100	100 off

M16 x 30	100 off
x 60	100 off
x 80	100 off
x 100	100 off
x 120	100 off
x 140	100 off

4) Spring washers to DIN 127 Shape B

size 4	1000 off	size 10	1000 off
5	1000 off	12	1000 off
6	1000 off	16	1000 off
8	1000 off		

5) Stop washers to DIN 6798 Shape A

size 4.3	1000 off	size 10.5	1000 off
5.3	1000 off	12.5	1000 off
6.4	1000 off	14.5	1000 off
8.4	1000 off	16.5	1000 off

6) Grease nipples, to DIN 71412

1/8"	250 off
1/4"	250 off
M8 x 1	100 off
M10 x 1	100 off

7) Carbon brushes and brush-holders

A basic selection of brushes and brush-holders, to be made by the technical assistant after determination of the various types of motors, dynamos and starters involved.

8) Sheets for gaskets

Type It 400 (to DIN 86075)

sheet 1500 x 1000 x 1.5	10 off
sheet 1500 x 1000 x 2	10 off

9) Plain cast bronze nozzles, RG7

Ø 13mm	1m	Ø 46mm	1m
Ø 19mm	1m	Ø 56mm	1m
Ø 26mm	1m	Ø 61mm	1m
Ø 36mm	1m	Ø 71mm	1m

10) Self-lubricating rings

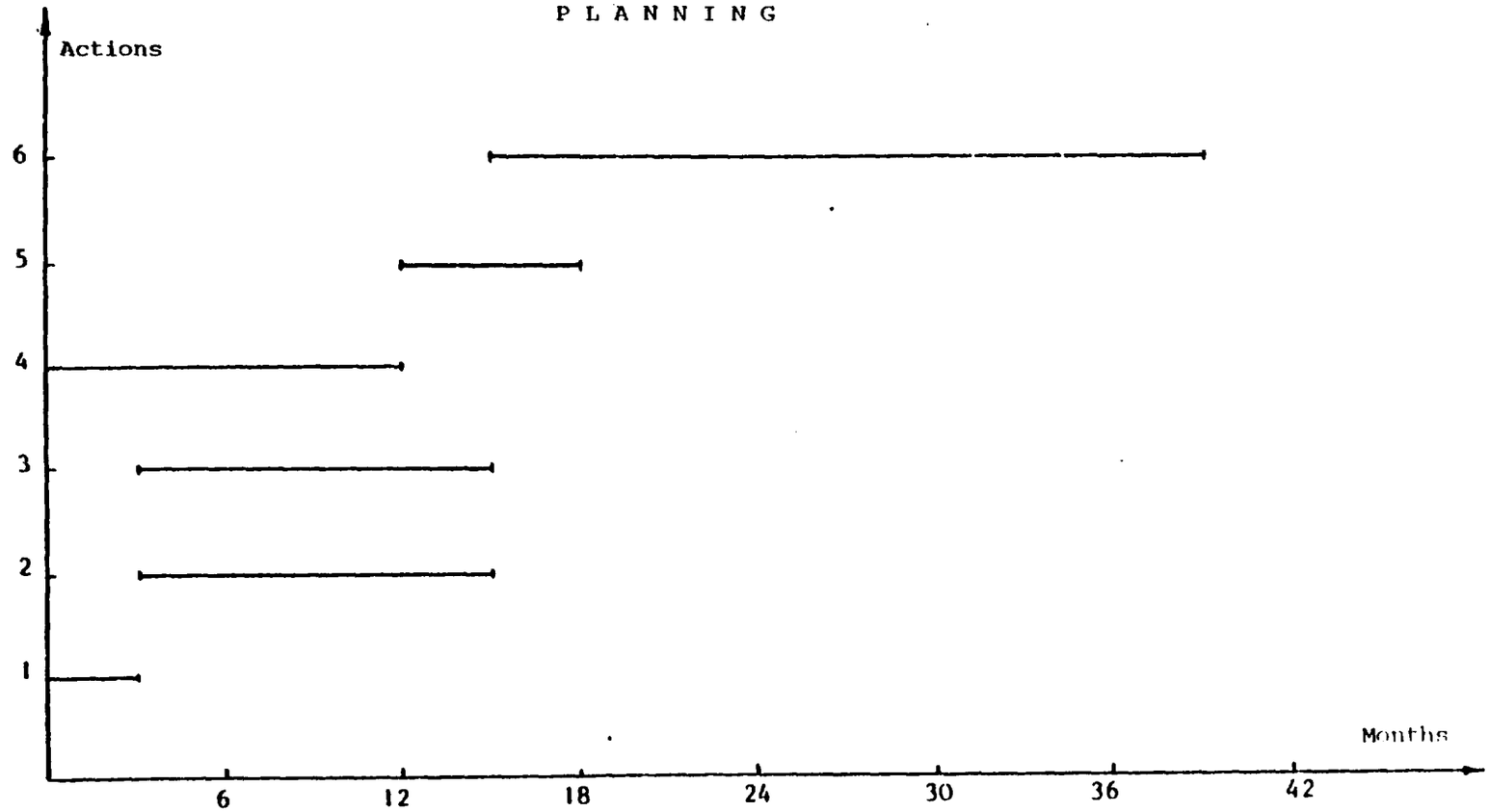
A basic choice of self-lubricating rings for electrical equipment for cars, to be made by the technical assistant after determining the various types of dynamos and starters involved.

BUDGET FOR EQUIPPING AN ELECTRICAL WORKSHOP

Description	US$	
1. Technical assistance		
- wages and allowances (man-months)	140,000	
- travelling	20,000	
- removal expenses	2,500	
- accommodation and transport provided free by DRSTP		
Sub-total		164,500
2. Equipment (see details in Annex 24)		
- Coil-winding machine, oven, impregnating bath	15,000	
- Machine-tools, pivoting crane and hoisting gear	6,000	
- Shelving, cabinets, desks	8,500	
- Test bench and cleaning equipment	5,000	
- Fittings for machines	3,000	
- Compressed air generator + fittings	1,500	
- Miscellaneous	8,000	
Sub-total		47,000
3. Tools		
- in accordance with details set out in Annex 25		6,000
4. Raw materials and spares		
(in accordance with details set out in Annex 27)		
- materials for rewinding	7,500	
- basic stock of spares and consumables	13,000	
Sub-total		20,500

Description	US$	
5. Installation of equipment and commissioning		
2 people for 6 months		80,000
6. Transport (estimate)		25,000
7. Follow-up and supervision of the project (for 2½ years)		
- preparation and purchasing of equipment and tools	25,000	
- project management	50,000	
- follow-up and purchase of spares	60,000	
- follow-up and renewal of technical documentation	20,000	
- overheads	20,000	
Sub-total		175,000
8. Total		518,000

P L A N N I N G



KEY

1. Preparation for short-term measures:
   - recruitment of electrical technical assistant
   - purchase of mobile workshop
   - purchase of tools
   - preparation for coil-winders' training

2. Electrical technical assistant

3. Training of coil-winder

4. Preparation for setting up the logistical base
   - recruitment of technical assistant
   - purchase of equipment
   - purchase of tools and spares
   - despatch of equipment

5. Erection and commissioning of the logistical base

6. Technical assistance in logistical base