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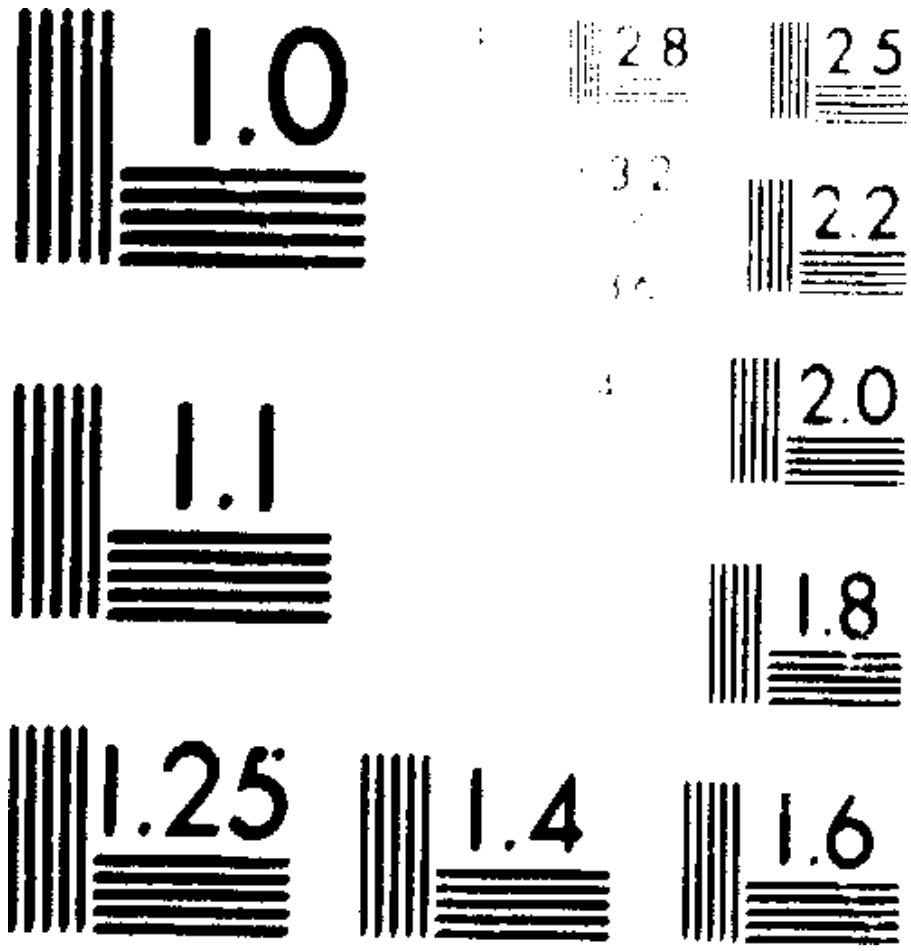
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org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30 May 1982

UNITED NATIONS DEVELOPMENT PROGRAMME

Project of the Government of the
DEMOCRATIC REPUBLIC OF THE SUDAN

SUD/73/045 - Sudan.
Central Instrument Repair Workshop.

Terminal Report

Prepared for the Government of the
DEMOCRATIC REPUBLIC OF THE SUAN
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of S. Deri, expert engineer
in Maintenance, Repair and Calibration of
Electric and Electronic Instruments and Apparatus

United Nations Industrial Development Organization
Vienna

This report has not been cleared with the United Nations Industrial Development Organization which does not, therefore, necessarily share the views presented.

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I N T R O D U C T I O N

Every branch of industry, every technical field uses a great number of instruments. Likewise the Sudan industry has a considerable quantity of instruments, millions of dollars worth, especially the sophisticated electronic instruments, and many of them are lying unused due to the lack of maintenance, when perhaps just a simple repair would be necessary.

The previous practice of maintenance was in Sudan that instrument-manufacturers sent their employees to inspect and maintain the electronic instruments manufactured by them every second year (or when it was needed). About 8 years ago this situation has changed, the maintenance-people have not come repeatedly. To send the faulty equipment to the manufacturers, it could cost twice the price of the whole equipment.

Then the National Council for Research (NCR) and the Industrial Research and Consultancy Institute (IRCI), as deeply interested parties in maintenance of electronic equipment, decided to establish the Central Instrument Repair Workshop (CIRW) and requested the air of UNDP/UNIDO through the Sudan Government. The agreement protocol was signed on May 1975 between the Sudan Government and UNIDO about the project Central Instrument Repair Workshop SUD/73/045.

According the protocol, the project has 3 Phases, Phase One covers electronic instruments and equipment; Phase Two is to cover mechanical, optical and biomechanical instruments and a library; Phase Three is to extend capacity in o mobile workshop and the training of instrument operators and technicians.

It was agreed that for Phase One the UNDP's contribution would be US$153,450,— and the Sudan Government's contribution would be LS33,260,— for the salaries of staff-members and material contribution providing a new building for the project.

The original objectives (see Annex VI) of the project were:-

- long range objectives: to promote the economic development of the Sudan by improving the effectiveness of scientific and industrial research and test;
- immediate objectives: to establish an initial nucleus for maintenance and repair of scientific instruments as a running operation; to improve the capacity of the counterparts' staff of this nucleus; to lay the foundation for an autonomous fullfledged Central Instrument Repair Workshop.

The project became operational with the UNIDO-expert's arrival mid-1980, beginning Phase One, the objectives of his mission (see Annex VII) are in good harmonization with the project's objectives. The objectives of the project were attained during the reported period, (a detailed analysis can be found in the report;) by performing real repair, maintenance, and calibrating work for the industry (both the private and governmental sector), for the medical and educational institutions, and for the applied-research laboratories. Training services of the project, including the Technical Manual Vol. 1 and Vol. 2, which contain technical programmes and special knowledges, help to fill up the empty-space of emigrated technicians in the field of maintenance of electronic equipment.

Taking the opinion of national-counterpartner into consideration the project began its operational work with Phase One, planned for two years.

At the beginning of 1982 there was planned a new Country Programme for Sudan and because of scarcity of funds the Sudan Government and UNDP agreed to cancel the Phase Two and Three of the project. This is the reason that this Terminal Report deals only with Phase One. (The mentioned Projects' Review has found that CIRW fulfilled completely the objectives and the Review - preparer, Mr. Raman was impressed at the good progress that has been made in establishing on Electronic Workshop with a quite impressive "order-book").

Abstract

A) The projects outputs are:-
- Systematically repaired, maintained, and calibrated electronic and electric instruments in the nucleus of CIRW;
- Formal training personnel in repair and maintenance;
- Proposal on Future Expansion of the CIRW;
- Technical Manual Vol. 1 and Vol. 2;

B) The inputs of the project was made of:-
- sophisticated electronic and electric instruments mainly out of work;
- uses of these instruments; and
- the national staff of the project.

C) Resources for the project from the Sudan Government:-
- institutional frame;
- laboratory-room;
- fellowships and study tours.

From UNDP/UNIDO
- test instruments and tools;
- assignment of an international expert.

D) Constraints:-
- lack of money;
- difficulties in communication with manufacturers

E) Strategy was:
project must be actice in Khartoum in the direct repair, maintenance, and calibration.

F) Evaluation:
although the implementations of project have not been always perfect, but they have been satisfactory enough.

G) Recommendations:
about Service Manuals collection, acquisition of electronic components' Catalogues;
about the new building, new staff-members, and about the Proposal on Future Expansion of CIRW.

I. REVIEW OF THE PROJECT

For reviewing the project it seems useful the system-approach method, enumerating and explaining the main components as follows:-

A- Output;

B- Input;

C- Resources;

D. Constraints;

E- Strategy;

F- Evaluation;

G- Recommendations.

A. Outputs

The project's outputs are:-

- Systematically repaired, maintained, and calibrated electronic and electric instruments and apparatus in the nucleus of CIRW: (Annex I).
- Formal training personnel in repair and maintenance;
- Proposal on future expansion of the CIRW; (Annex II).
- Technical Manual Vol. 1 and Vol. 2; (Annex III),
- Preparation of lists of spare-parts; (Annex IV).
- Reports produced on the project; (Annex V).

Repair.

From the beginning of the operational period of the project, i.e. from mid 1980, there was an urgent and heavy demand for practical repair of sophisticated electronic instruments. After organizing the administrative and the technical program of repair (Annex II. p.3) the project was giving valuable help through instrument-repair for the industry (governmental and privat sector as well), for the applied-research laboratories, for the educational institutions, and for the medical institutions.

The detailed technical program of repair one can find in the Technical Manual Vol. 1 p. 19-30.

Maintenance.

This expression generally means the preventive maintenance, which begins with the acquistion of the instrument. Properly selected instruments for the environment of Sudan will have long working-life. Technical Manaual Vol. 2 contains a chapter: "Some hints for instrument-buyers in Sudan" on pages 69 - 75.

The instrument-operators with proper use can also extend signfically the trouble-free life of instruments. The recommended duties of instrument-operators one can find in Technical Manual Vol. 1 p. 3 - 12.

The scheduled maintenance is very important, too. Some sophisticated instruments have such instructions, but mainly they don't. In connection of each repaired instrument the project has drawn the owners' attention to it or performed short consultancy regarding to it.

The project gave short courses about the right usage of special instruments at:-

Geological and Mineral Resources Laboratory
Tabaldy Battery Factory
Faculty of Pharmacy
Faculty of Medicine
Sudanese Chemical Industries
Veterinary Research Center

In addition, maintenance refers of storage and transportation of instruments, as well. Poor storage can make shorter an electronic equipment life than the everydays' usage (e.g. because of trats). Unthoughtful transportation can make several damages, too. In connection with each repair the project drew the owners' attention to them, besides the Technical Manual Vol. 2 deals with these problems detailed on pages 75 - 77.

Calibration.

It is a concomitant procedure of repair and maintenance, and in the case of simple instruments it can be done fairly easily: such calibrations need no much time and no special preparations.

But in the case of sophisticated analysing instruments the preparatory works and the calibration itself need a certain type of research-work.

Some instruments need regular calibration-procedure and reasonable it must be done by the instrument-operator.

The project gave short courses with practical demonstrations about calibrating so special instrument at:

Geological and Mineral Resources Laboratory
Faculty of Pharmacy
Sudanese Chemical Industries
Food Research Center
Soil Conservation Laboratory
National Health Center.

The nucleus of CIRM.

After arranging the workshop and doing the preparatory works the project was able to begin the repair in September 1980, in its original place, with the national staff. On-the-job was evoluted the administrative organization, the work-organization, and the technical program.

The main steps of the systematic work : (Annex V - d)

- ordering letter from the client to the IRCI;
- permission for the work from IRCI's managment;
- inspection of instrument to be repaired;
- filling in the Preliminary Report;
- repair and calibration work;
- filling in the Final Report and the first part of Feedback of Information; (Annex X)
- final checking in the presence of owner;
- note to the administrative section of IRCI for preparing the bill.

This process is written in Annex II very detailed. The National Staff has the basic knowledge of electronic instruments, but the speciality of repairing technology has to be acquired on-the-job. How to use measuring instruments, how to find faults, how to make a real repair, and such questions are discussed in connection of the everyday work. Many times special themes are treated.

Until now CIRW has got 62 orders of which 40 were repaired, 12 are under repair, 5 were rejected and in 5 cases consultancy or short course was held. (At a rough guess the value of these handed equipment is minimum US$150,000,— without counting the extremely high values of large machines and devices).

The test-instruments and tools of CIRW, supported mainly by UNIDO, proved useful for repair and calibration.

Formal training.

In the University of Gezira is a Technological Faculty setting up to support and serve the needs of Sudanese industry. By means of co-operation of industrial organizations it provides training with practical experience under real conditions. This year the Industrial Liaison Unit of University of Gezira asked the CIRW to perform the formerly mentioned industrial training for two of students in the field of electronic instrumentation.

During this training-course a member of the Faculty is going to visit CIRW to see the progress of students. According to the agreement CIRW has to send a brief report to the University on attendance and performance of students.

Proposal on future expansion.

In this document project proposed three step for the future action of CIRW (at its own expense):

(a) to continue CIRW's activities at present level;

(b) to consolidate CIRW's progress; and

(c) to develop CIRW into Central Laboratory of Industrial Electronics.

The last step has technical, economic, and psychological reasons. Detailed conditions for each step one can find in Annex II.

Technical Manual Vol. 1 and Vol. 2

These manuals essentially contain all technical problems and knowledges which are (or were) close connected to the project. In such a way the special knowledge, trained to the people on-the-job, is securing for others who are not able to participate in the present work of CIRW. Technical Manual Vol. 1 deals with the basic knowledge of technical program of maintenance, the technical steps of repair work, the instruments-components, first of all from practical point of view. One can find in it such practical data which are not possible to find in general technical books. Technical Manual Vol. 2 treats with instrument-units, from the special aspects of CIRW. The spectrophotometers are treated detailed, because these instruments made the major part of CIRW's work. Safety precautions for people and for devices are very important in such work. Typical faults common in Khartoum are analysed in some pages. Some other interesting themes: Noises; Performance check; Storage of instruments; Transportation of instruments; CIRW services.

The Technical Manual is not perfect, but is satisfactory as a support for CIRW. It was not edited or corrected for publishing because of lack of time.

Both the Volume 1 and Volume 2 are given to the Library of IRCI.

List of Spare-parts.

In connection with repair and maintenance it is mentioned repeatedly (and terrifying) the problem of spare-parts. It is worth to study it in the field of electronic instruments and equipment, handled by CIRW.

In an electronic instrument the manufacturers use standard components and special components.

All the standard components, as a resistor, capacitor, coil, semiconductor or standard mechanical component may be replace with a similarly valued part, obtainable from the local market. So, in the case of replacing a standard component it is not reasonable to emphasise the problem. Gaining local experiences during the two years of project-activity, it is better not to store standard components as spare-parts in this stage of CIRW from economic and technical reason. (E.g. without improving the store-facilities it would be only wasting money to store electrolyte condensers, IC-s and special semiconductors).

List of standard spare-parts are prepared by assessment logistics for the future development of CIRW (Annex IV - c).

List of recommended standard spare-parts for the CIRW's test-instruments are prepared and can be seen in Annex IV - d. But to purchase these components is recommended only (if any), when CIRW will be placed in its new premises!

The special components of an electronic instrument are manufactured (or selected) by the instrument-manufacturers, so they are obtainable only from them. (How to order a special component to ensure receiving the proper part, one can find advices in Technical Manual Vol. 1 p. 31)

Instrument-manufacturers in a tacit understanding are storing special spare-parts only for four years after finishing the production of a certain instrument. When the instrument is very old, practically it is impossible to obtain special spare-parts. The project tried to acquire special spare-parts for Mettler balances, but the attempts failed. Fortunately, special components rarely are going wrong. Among the 62 instruments handled in CIRW there are only five without repair because of lack of special spare-parts.

In each case of repair the recommended spare-parts were specified for the instrument-owners.

A list of these recommendations can be seen in Annex IV - a

with a sample of such specification. The instruments 36.) 37.) 40.) 44.) and 45.) need special spare-parts to complete their repair.

Reports produced on the project (see Annex V.)

(a) Preliminary Report 28/8/80
deals with initial project-work and problems;

(b) Three bi-monthly report 28/10/80 29/12/80 26/2/81
in them there are reported periodic progress and problems;

(c) Report # 1 on Progress 12/3/81
it was advised by ARR in charge not to prepare reports bi-monthly, but for longer period. This Report gave a comprehensive review of progress to date and plans for the future period;

(d) Report # 2 on Progress 6/11/81
it was prepared as a background paper for the tripartite review;

(e) Report of the Triparite Review 19/12/81
deals with the discussion done on the Review, and contains a list of instruments repaired by CIRW;

(f) Report about Summary of Project Implementation 12/4/82
it was prepared by the request of Mr. P.A. Harju, SIDFA, summaring of project implementation for the period July 1980 - March 1982, giving a brief account of project activities and major problems.

D. Inputs.

The input of the project was made of:-

- sophisticated electronic and electric instruments and apparatus, mainly out of work;
- users of these instruments; and
- the national staff of the project.

Electronic and electric instruments.

These are essential in the factories, laboratories for applied research, in education and in medical service. It is possible to classify them according their employment as chemical, biological, telecommunicational, etc. instruments, but from the viewpoint of repair and maintenance the natural classification is according to the kind of their electronic components. In this way they can be called first -, second -, third -, or fourth - generation of electronic equipment. The repair and maintenance technology depends on the class of generation, CIRW is fit to handle mainly first -, and second - generation, and in some cases the third - generation of electronic equipment, but usable for the fourth - generation handling. (More detailed in Technical Manual Vol. 1 p. 16 - 18).

Among the instruments handled by the project, there were only five (5.) 31.) 45.) 49.) 59.) from the third - generation, the others were from the first and second - one.

Generally, the instruments handled by CIRW were out of work. The main causes of faults:-

- the age of instrument;
- wrong installation (e.g. lack of ventillation);
- abuse of instrument;
- the severe environment;
- unsuitable transportation;
- unsuitable storage; and
- lack of regular maintenance.

A lot of cases the fate of instrument is determined by unproper selection. (E.g. a recorder uses colored ribbons for printing, and was out of work for a long time because of dried ribbons).

Sometimes the real cause of defects is a supplementary device. (E.g. the brand-new high-power battery charger became wrong three times. Studying thoroughly the operation-conditions it was discovered that $H_2 SO_4$ acid was dripping out from the batteries under charge, and made an unwanted electrical short to the earth, although the charging circuit was "floating", and this caused the faults).

It happened that a PH - mater for repeated measurements gave random results. The study of measuring-method revealed that the special fluorite-electrodes were keeping in "normal way" in a glass chemical beak, although there is antagonism between fluorite and glass.

In certain case the original Operational Instructions was wrong and caused the burn-out the electrometer tube two times. Changing two steps in the operational procedure, the equipment is O.K. more than one year.

Occurred that the equipment was O.K. only the measurement technique was not the best, In such cases the "repair-method" was giving a short course with practical demonstrations.

(These examples show clearly that sometimes it is not enough repairing the equipment. Getting a real success needs a wide-scope of activities).

Users of instruments.

In the man-machine connection the man is very important. A perfect equipment has no value because of misuse, or even becomes damaged because of abuse.

Studying this situation it was found a well-known fact; Sudan is lack of trained labor-assistants, and this is one of the reasons of frequent misuse of sophisticated equipment.

One can suppose that in case of a scientific instrument the

scientist knows well his equipment. But scientist of Sudan have got their graduation chiefly in highly developed countries, where the research institutes are plenty of laboratory - assistants. There the real operator of an equipment is a labor-assistant or labor-technician, while the researcher knows the equipment only from the viewpoint of its results.

The work of instrument-user is proper and efficient only when he understands thoroughly his instrument, knowing its possibilities and the basics of measurement-technique, as a first aid, CIRW tried to train the right use of equipment in short-course form. Among the sophisticated equipment handled by CIRW, the most frequent type was the spectrophotometer's. In the Technical Manual Vol. 2 it is prepared a very detailed program of their usage. The project utilised this program in the case of every spectrophotometer-repair. (The right use of an equipment is an important component of maintenance).

The National Staff.

This is also an important component of the input. The instruments are repaired, maintained and calibrated. The instrument-users are trained for the correct use of instrument. The national staff is trained to do the CIRW's activities . (Nevertheless, one of the best helpmates of the proj[illegible] an engineer who was not a member of the national staff

According to their graduation, the members of the national staff have their basic knowledge in the field of electronic instruments. Each member of the national staff took part in one or another form of education abroad. (Note: more suitable selection of such studies could make better results for the future).

The work of the national staff's member is a proper one. He has to do a highly classified theorethical work mixed physical activities, many times in a factory or in a plant. Besides he must know how to deal with clients gaining from them very precious informations regarding to the faults of the equipment to be repaired.

And he has not got always his due respect because repair and maintenance is considering as a supplying provision. Although, especially in such a developing country as Sudan, he must know his subject in designer's level; and to be really successful, he must have an interdiscipliner knowledge in the field of technology.

The basic knowledge is obtainable on regular courses, and from books and periodicals. The specialty of repairing technology everybody has to acquire himself: the theoretical part by reading, the practical part by experimenting. The national staff-member have the possibility to understand it through on-the-job training in CIRW.

A further essential factor is the development and maintenance of good working relationship and co-operation with the colleagues. And, last but not least, is to be aware of CIRW's role.

C. Resources

According to the agreement-protocol mentioned in INTRODUCTION, the Sudan Government supported the project with:-

- institutional frame;
- laboratory-room;
- assignment of national staff; and
- fellowships and study tours.

From UNDP/UNIDO the project was supported with:-

- test instruments and tools; and
- assignment of an international expert.

Institutional frame:-

The CIRW exists as a unit of the Engineering Department of the IRCI. (It is planned that CIRW will be a department in the new structure of the IRCI, but the new organization chart is not yet approved by the Ministry).

The Head of the Engineering Department is at the same time the Head of CIRW as the national counterpartner. Some national staff-members, as employees of IRCI-Engineering Department, are engaged out of CIRW, too.

The IRCI as an institutional frame provides CIRW with different services and gives official ways to the clients. The central administration section is very useful, but sometimes, because of inertia-effect of large institutions, moves with difficulty. Solving repair problems needs flexibility which can be assured by more frequent visits of top-executives in CIRW.

Laboratory-room.

Laboratory support for the project had been provided by adding a room to a converted domestic premises at Mogren. (This was a temporary expedient, and it was planned for CIRW to move into the new building of IRCI in Shambat).

The project has begun its operational activities in this place, arranging the laboratory-room. (Annex IX). Now it contains

five wooden benches on fixed places fitted with proper electrical connectors; one fixed bench for storing the equipment under repair, covered by a blackboard. This serves not only as a folding screen, but it is very useful for technical explanations during on-the-job training. In front of the blackboard there is a wooden table which makes the laboratory-room suitable for small conferences. The metal shelf as a store holds the test-instruments. Furthermore, there are in the room: a small desk for the labor-boy and two small holders for the voltage stabilizers.

The laboratory-room has a flat roof which radiates the heat into the room or sunny days (and through which the rain drips into the room when it is raining).

The natural light comes through two windows, the artificial light is always necessary for any work.

It is difficult to measure the effect of a brightly painted wall or clean offices on the project implementation. But one must never overlook the role of a pleasing environment in establishing good working morale and community relations. There is no doubt that an environment that encourages safety and promotes reasonable confort will help reduce personnel turnover and improve employee morale.

Assignment of national staff.

The national staff was appointed in 1975. Officially it consists of 4 engineers, 2 technicians, and 1 typist. Practically, at the mid of 1980 there were only 2 persons as availables, and these days one of the engineers is still in his fellowship, abroad.

Basic traits for a successful repair-man are:-

- high level of motivation;
- interest in the repairing work; and
- aptitude for the job.

The state of the candidate's health must be O.K. particularly the good eyesight is important. Recruiting personnel must be aware of the implications of employing people with defective colour vision.

In the electronics field, mistaken identity of colour could lead to serious accidents, not only to an individual but to all who subsequently operate the repaired equipment.

It is worth to note that unfortunately engineering schools graduate many men and women who have little aptitude for engineering and who will never be successful engineers. Nevertheless, CIRW needs persons having both enthusiasm and aptitude for their job in each level. (Sometimes these two features are more important than the officially certificated graduation). And the hired people must have their main occupation at CIRW.

Fellowships and study tours.

The Sudan Government supported several fellowships as training-tools for the national staff-members. Generally these fellowships proved useful (or will prove useful in the future), but there are some signs that they were not specific for the need of the project.

A study tour is justified economically when it is well prepared for studying the maintenance requirements or organizations engaged in maintenance in a developing country.

Test instruments and tools.

In 1976 a UNIDO-consultant compiled a list of required devices for the CIRW. These were ordered in 1979 and delivered and stored at the IRCI pending the arrival of the international expert until mid 1980. The list of these instrument can be seen in Annex V - c page 9.

The test instruments and tools proved generally useful for the project's work, albeit some of them are not necessary at all at this stage of CIRW. (E.g. the oscilloscope calibrating set).

Problems arisen: the Distortion Meter and the Rotek Adapter suffered damages during their transportation, (e.g. at the Distortion Meter all the knobs are broken), the HP-Test oscillator was wrong at the first check, the oscilloscope calibrat-

ing set had not its case (so, it was written a letter to UNIDO-HQ and the case arrived second half of 1981), the expensive DC Reference Standard was expensive because of its certificate traceable to the National Bureau of Standards in Boulder, U.S. but the validity of the certificate was completely out of date at the first checking, the same happenid in the case of Rotek Precision Calibrator, the chargeable battery inside one of the Digital Multimeters was out of work because of the long storage time.

The most useful equipment:

- Voltage Stabilizers (they were provided to protect the test instruments against the large and frequent voltage fluctuations from the main);
- Multimeters (for the everyday's work),
- Oscilloscopes (although they are sophisticated enough for this stage of CIRW),
- Rotek Precision Calibrator with the High Current Adapter (in the calibration service).

It would have been very useful for the project-work:

- a simple, portable oscilloscope,
- an AM-FM Signal Generator for the common frequency-bands,
- a Q - meter,
- a twin DC-power supply for IC-circuits.

Regarding to the tools, CIRW needs:

a handy driller-machine,

- a proper vice,
- different types of files,

because the electronic equipment' repair it is inevtable to do some mechanical work.

Assignment of an international expert.

In 1980 UNIDO assigned an international expert for one year duration. As his contract was extended for one more year, his mission will expire on 30 June 1982.

D. Constraints

CIRW is working in the industrial environment of Sudan, so the major factors effecting the Sudan Industry at the same time are seriously impeding its implementation. Some of them:-

- lack of money,
- frequent power-cuts,
- difficulties in public transportation.

Some typical CIRW's problems:-

- difficulties in communication with instrument-manufacturers, and
- lack of Service Manual and Catalogues.

Lack of money.

The most significant consequence of this constraint is the small size of the project. Although in the field of repair and maintenance the "critical mass" is of great importance. E.g. to consolidate the project-progress CIRW needs more personnel (4 more technicians as a minimum).

There are different types of incentives, but the most effective of them is the money, stimulating for better and more work.

By means of a lot of money it would be possible to have own proper building for the CIRW, furnishing it the most adequately, providing with well-trained people in sufficient numbers for designing and installing maintenance programms etc.

The lack of money constrained CIRW remaining its original place, having small number of personnel really not sufficient for the most urgent repair-work neither. (The lack of expensive mobile workshop is only mentioned).

Frequent power-cuts.

The hindering effect of this constraint is obvious knowing that CIRW needs electric power for its work.

A relatively silent, economical emergency-generator with

sufficient power for the work and automatized is expensive enough.

Lack of such a generator the workplan and program of CIRW must be very flexible. During the reported period the power-cuts' time were utilized for facts-finding visits, or for discussions about different problems. (Needless to mention that when power-cut, there is dark and very hot in the laboratory-room).

Difficulties in public transportation.

When the public transportation is completely or partially paralysed in Khartoum, the official working hours are illusory. To ward off this and such problems it seems the best method is the flexible work-time.

Communication with instrument-manufacturers.

Communication with instrument-manufacturers has vital importance for CIRW, because the special spare-parts and technical informations are acquirable only through it. Knowing it, project tried to get direct contact to the manufacturers, but all the attempts proved ineffective. There were attempts to get indirect contact to them through the local dealers and representatives, also without success.

Presumably an official contact through the Ministry will give satisfactory solution of this problem.

Lack of Service Manuals and Catalogues.

The project has experiences that in Sudan the majority of electronic equipment has no Service Manuals, although the repair adjustment and calibration without precise instructions is many times hopeless.

One of the solution of this problem is to employ engineers who know the equipment to be repaired in designers' level.

Another solution can be to get the Service Instructions from the instrument-manufacturers (but this version does not promise too much).

For the future it is worth thinking over that everybody who purchases sophisticated electronic instrument should ask, as a condition of sale, two copies of Service Manuals from the manufacturer, and one of them will be in custody of CIRW.

But the CIRW has to begin this Service Manual collecting just now. Every Service Manual passed through the workshop must be copied and put down to the SMC (Service Manual Collection).

To acquire proper catalogues about electronic components is also a very hard task. The project ried to ask components' manufacturers through the UNIDO-HQ, but until now not a simple catalogue arrived. Supposingly, the help of the Ministry, will be productive, and the most important basic-catalogues will promote CIRW's work.

Setting out from the results of facts-finding visits and the size of project it was clear that project must be active first of all in Khartoum in the direct repair, maintenance, and calibration. By optimization of resources it seemed possible to establish to nucleus of CIRW which served for dual purpose : as a channel of learning things that cannot be studied effectively by other methods, and as a place to practice use of knowledge.

Through the everydays' work it was a possibility to understand the material and personal constraints and fighting against them it was possible to gain very precious experience which could be useful in establishing a national-wide maintenance system.

The other method, namely studying the problems theoretically and preparing essay s and reports and plans, seemed plainly as a waste of time. In an average place, where sophisticated electronic instruments are used, there are about 50 different type of such instruments, without any technician well-trained in maintenance. To prepare maintenance-plans for 50 different type of instruments needs about 2 years for one trained person. And the problem of maintenance remains because at the users there are deficiencies of well-trained people in maintenance. (During the reported period five well-trained senior technicians left their employer, just CIRW's client , permanently leaving Sudan.)

F. Evaluation

Although the implementations of project have not been always perfect, but they have been satisfactory enough.

Arranging the laboratory-room it was possible to begin the CIRW's operational work.

Developing the appropriate reports' system CIRW now has its official-way for acting.

Facts-finding visits supplied a collection of data to make decisions about the practical work.

On-the-job training was held in connection of each repair work. Some special themes were discussed independently of everyday's work.

In each case of repair was a short consultancy with the user (or users) of the equipment about the routin and preventive maintenance.

On request the CIRW made consultancy, gave short courses about the instrument, its right use and its calibration procedure.

The Proposal on future expansion of the CIRW was prepared on the base of experiences gained during the reported period, and very thoroughly taking in consideration the possibilities.

G. Recommendations

1) The Head of CIRW take care of Service Manuals collection.
2) The Head of CIRW try to acquire catalogues of electronic components through the Ministry.
3) The Head of IRCI urge on m[illegible] CIRW into the new building in Shambat.
4) The Head of IRCI reinforce CIRW by new staff-members.
5) The Head of IRCI carry through the steps written in Proposal on Future Expansion of the CIRW.

ANNEX I

List of instruments handled by CIRW

1) Electronically regulated furnace (23 x 25 x 10)
   Geological and Mineral Resources Laboratory
   repaired : 26/10/1980
2) Unicam SP 600 Spectrophotometer Series 2
   Omdurman Hospital Bacteriology Dept.
   repaired : 28/10/1980
3) Electronically regulated furnace (23 x 25 x 21)
   Geological and Mineral Resources Laboratory
   repaired : 2/11/1980
4) Voltage Stabilizer T5-666 type No. 540251
   Geological and Mineral Resources Laboratory
   repaired : 24/11/1980
5) Beckman Liquid Scintillation Counter LS-255
   National Health Center Chemical Dept.
   repaired : 28/10/1980
6) Anhydro Spray Dryer Lab. 1.W.O. 67/5
   Food Research Center
   repaired : 28/12/1980
7) Beckman DU-2 Spectrophotometer
   University of Khartoum, Faculty of Pharmacy
   repaired : 18/1/1981
8) Pye pH-meter Mod. 292
   National Health Center Chemical Dept.
   repaired : 20/2/1981
9) Beckman DU-2 Spectrophotometer No. 81049
   Soil Conservation Laboratory
   repaired : 10/1/1981
10) AEG- charger D 415 type No. 308479
    Tabaldy Battery Factory
    repaired : 12/8/1981

11) Mettler Balance H 20 type No. 374068
Soil Conservation Laboratory
repaired : 20/9/1981

12) Voltage Stabilizer
Soil Conservation Laboratory
rejected : 14/12/1981

13) Autoclave (regulated)
Soil Conservation Laboratory
under repair

14) Electronically regulated furnace
IRCI Food Industries Dept.
repaired : 16/5/1981

15) Electronically regulated furnace
Soil Conservation Laboratory
repaired : 8/6/1981

16) Astell Cooled Incubator No. 497
Soil Conservation Laboratory
under repair

17) Pye - R Gas Chromatograph
Polytechnic of Khartoum
rejected.

18) Beckman DU-2 Spectrophotometer
University of Khartoum, Faculty of Pharmacy
repaired : 8/1/1982

19) Suction pump
Soil Conservation Laboratory
rejected.

20) Timer (part of a foundry-machine)
Foundary of Khartoum.
repaired : 13/3/1981

21) Polarograph type 5
University of Khartoum, Faculty of Engineering
under repair.

22) Recorder
University of Khartoum, Faculty of Engineering
under repair

23) Evans Suction pump 850/2418 type
Polytechnic of Khartoum
repaired : 18/3/1981

24) Philips Electron microscope
National Health Center
rejected

25) Liquid nitrogen equipment
National Health Center
rejected

26) Marconi Waveforms Generator
IRCI - CIRW
repaired

27) Test Oscillator HP 651 B
IRCI - CIRW
repaired : 16/8/1981

29) Integrator (part of a textile - machine)
Sudan Textile Industry
Consultancy

30) Timer (part of a lead-press machine)
Tabaldy Battery Factory
repaired : 8/9/1981

31) Mettler Electronic balance ME 22+DE 22 + BA 25
Geological and Mineral Resources Laboratory
repaired : 14/10/1981

32) Rotek High Current Adapter
IRCI - CIRW
repaired : 23/11/1981

33) Mettler P 162 balance
Polytechnic of Khartoum
repaired : 10/9/1981

34) Beckman DU-2 Spectrophotometer No. 110077L
Veterinary Research Center
consultancy

35) Reichert Stereo microscope No. 337490
Veterinary Research Center
repaired : 24/11/1981

36) Mettler H6T balance
Polytechnic of Khartoum
under repair

37) Mettler H6T balance
Soil Conservation Laboratory
under repair

38) Mettler K7T balance No. 154145
Soil Conservation Laboratory
repaired : 20/9/1981

39) Pye Atomic Absorption Spectrophotometer
IRCI - Chemical Indstries Dept.
under repair

40) Ether Thermocouple thermometers No. 20038; No. 20041
Foundry of Wad Medani
under repair

41) Recorder (for Fractional Analyser LKB)
Veterinary Research Center
repaired : 21/11/1981

42) Corning 400 Flame Spectrophotometer
Veterinary Research Center
repaired : 23/11/1981

43) CF-4A Spectrophotometer
Veterinary Research Center
repaired : 18/1/1981

44) VEMV-100V Universal Electron microscope
Veterinary Research Center
under repair

45) Gamma Radiation Detector EB - 8100
National Health Center - Radiation Centre
under repair

46) Temperature controllers (parts of a press-machine)
Tabaldy Battery Factory
repaired & 22/12/1981

47) Viscosimeter Ferranti LB - 4
University of Khartoum, Faculty of Pharmacy
repaired : 23/5/1981

48) Dalex SL 16 Spot-welder machine 61-065 type
IRCI- Engineering Dept.
repaired : 26/2/1982

49) Anal. Dev. Co. Infra-red analyser No. 6694-4348
Food Research Center
consultancy

50) Technicon Mult-test II analyser
Veterinary Research Center
repaired : 8/5/1982

51) Optical balance
Marples Ridgway Ltd.,
repaired: 12/4/1982

52) Mettler H 20 balance
University of Khartoum, Faculty of Pharmacy
repaired : 23/1/1982

53) Colorimeter
Veterinary Research Center
repaired : 23/1/1982

54) Thermo-controller
Tabaldy Battery Factory
repaired: 15/2/1982

55) Pye-Unicam SP 600 Spectrophotometer
University of Khartou, Faculty of Medicine
repaired : 18/4/1982

56) Corning PH-meter
University of Khartoum, Faculty of Medicine
Consultancy

57) Beckman DU-2 Spectrophotometer
University of Khartoum, Faculty of Pharmacy
consultancy

58) Beckman grating Spectrophotometer Mod. DB-G
University of Khartoum, Faculty of Pharmacy
repaired : 26/4/1982

59) Beckman Mod. 25 UV-Spectrophot. No. 1002105
Sudanese Chemical Industries
consultancy

60) Beckman Expandomatic SS-2 PH-meter
Sudanese Chemical Industries
repaired

61) Duplex Processor No. MD-103205D
Veterinary Research Center
installation : 6/5/1982

62) Precision Balance
Tabaldy Battery Factory
repaired : 2/5/1982

ANNEX II

United Nations Development Programme

Project of the Government of the
DEMOCRATIC REPUBLIC OF THE SUDAN

Proposal for the Future of Project
SUD/73/045 - Central Instrument Repair Workshop

Prepared for: Dr. Farouk El Tayeb
Acting Director of the IRCI

By: S. Deri UNIDO-expert

Khartoum
April 1982

This proposal has been prepared at the request of Dr. Farouk El Tayeb acting Director of the IRCI.

The purpose of the proposal is to give a draft of tasks necessary for following the successful advancement of CIRW in the field of electronic and small electric equipment after finishing the Phase One.

I. SUMMARY

Studying the present situation it is obvious that from every aspects it is worth to continue the CIRW's activities in present level and to try consolidating its progress.

To accomplish these objectives there are personal and material conditions.

1) For continuing the activities in present level:
   - to charge an electronic - instrument engineer (from the national staff) with the technical guiding of maintenance-work;

2) For consolidating the progress:
   - to charge an engineer - economist (from the national staff) with the technical and administrative dealing of commissions;
   - to charge a technician (from the national staff) with the technical and administrative work in the should-be instrument store;
   - to recruite minimun 4 technicians educated in electronics for the routine-part of maintenance-work;
   - it is required a new workshop-room as placed that the transportation of instruments can be safety and easily accomplished;
   - it is required an instrument-store with the same area as the workshop-room's;
   - it is required a "thinking-room" with separate writing desks for each member of the staff

3) For the distant future:-

in the view of the UNDP support it is advisable to transform the CIRW into Central Laboratory of Industrial Electronics (CLIE) with the possible aid of an UNIDO-expert. CLIE will be the official laboratory of maintenance of electronic equipment in Sudan, and will act as a centre for tests and studies on electronic and small electric devices for the whole of industry, for government organizations and for institutions both in Sudan and abroad.

A. General

The past two years' experiences of CIRW have proved that there is a definite need to services of CIRW regarding to sophisticated electronic and electric instruments in the governmental and private sector of industry, in the applied-research institutes, in health-organizations and in educational institutions.

Funding background is not subject of this report but it must be mentioned that CIRW had a certain UNDP/UNIDO support as SUD/73/045 project (which was planned for three phases) in the Phase One. According the common decision of Sudan-Government and UNDP, the international support of the project will be cancelled. However, there is a real possibility of future expansion of CIRW's activities in the field of electronic and electric instruments at its own expense.

On the base of two-years-experiences and understanding the present difficulties, the following steps are recommendable:-

- to continue CIRW's activities at present level,
- to consolidate CIRW's progress; and
- to develop CIRW into Central Laboratory of Industrial Electronics.

The staff, the instruments, and tools at the CIRW give the possibility to keep these steps without any larger investment.

B-CIRW's activities at present

The CIRW-services are:

- direct services (corrective maintenance, preventive maintenance, calibration of instruments);
- indirect services (consultancy, training, course giving);

Until now CIRW has got 60 orders. On the basic of them 38 equipment were repaired, 12 under repair, 5 orders were rejected, and in 5 cases consultancy or short courses were held.

CIRW exists as a unit of the Engineering Department of the IRCI. The IRCI as an institutional frame provides CIRW with different services and gives official ways to the clients through its central administration section.

CIRW's laboratory-room is located at Mogren. It serves not only as a workshop, but gives the opportunity of technical training and is suitable for some research-work, too. (The roof of the laboratory-room needs some maintenance urgent enough before the rainy-season!) It contains five workbenches, so, simultaneously 5 equipment can be under repair. But, the laboratory-room is very difficult of access, so, the transportation of instruments in and out is difficult, and possible only through other rooms. The area of the laboratory-room is small for an intensive work. There is no special instrument-store, which makes problems in systematic work.

There is a certain "thinking-room", but no exclusively for CIRW-members. The noise level is very high, disturbing the theoretical work of staff-members.

The electrical-power-support of the laboratory-room has the same problems as the other parts of Khartoum. During a power-cut it is impossible to do any work, because the excess-heat-radiating from the ceiling. A stand-by emergency-generator could be the possible solution, but for this it must be renewed the whole electric net of the building, which is very obsolete.

The staff has 4 engineers and 2 technicians. At present

one engineer and one technician are abroad for their study; and one engineer has a permanent occupation out of CIRW. The UNIDO-expert, according his job-description, takes part in the CIRW's work, guiding it from technical aspects, training on-the-job the staff-members, dealing and consulting with the clients. As his contract expires on 30 June 1982, he will part from CIRW.

The working organization of CIRW Is as follows:
Any work-request must be presented (or confirmed) in writing, addressed to administrative-section of IRCI. After the approval of IRCI a member of CIRW's staff checks the equipment filling out the Preliminary Report. He in common with the Head of CIRW decide whether the order will be accepted or rejected.

When the order is for consultancy, the Head of CIRW sends somebody to fulfill the job and gives the dead-line and the important viewpoints.

When the order is for repair, likewise the Head of CIRW tells off a person for duty, giving the deadline, the technical details, the possible need for special spare-parts and reminds him of importance of communications with one who ordered.

If there is a need for special spare-parts, these will be acquired by the owner of the equipment or by CIRW.

Finishing the technical procedure of repair, the repairer fills out a Final Report on Completion of Repair and the first part of an Information Feedback Questionnaire, and gives a notice to the administration including the repair-cost which contains a nominal fee plus cost of parts employed. The bill will be sent by the Administration.

The transportation of equipment is the owner's duty but CIRW has to draw attention to special aspects.

The technical delivery is performed in the workshop of CIRW or in the spot, when the delivery must be cancelled because of special reason (e.g. temporary power-cut) it will be fixed on other date by

mutual consent. At the delivery the owner (or the operator) is advised of the best usage, the speciality and the preventive maintenance of the equipment.

Six months after the repair one of the CIRW-staff goes to the sport, inspects the equipment and fills out the whole Information Feedback questionnaire. In such a way CIRW can have comprehensive informations about the reliability of its work, and can make the necessary corrections to systems and procedures.

The scientific part of work of CIRW contains the calibration procedure of electric and electronic instruments, investigations and studies of measuring methods, giving short courses to operators of sophisticated equipment consultancy about preventive maintenance.

The training of the CIRW-staff is organic part of work. The present CIRW-staff has the basic knowledge of electric and electronic instruments and acquiries the specialty of repairing technology on-the-job.

To secure the special knowledge for others not participating in the present work of CIRW, there were prepared Technical Manual Vol. 1 and Vol. 2, completed some other themes as how to store instruments, how to use instruments, etc.

C. Tasks for the near future

To continue CIRW's activities at present level it needs only to replace the leaving UNIDO-expert's work in the workshop-work. For this it is imperative to obrain a well-educated electronic engineer who knows electronic instruments at designer's level because of the lack of maintenance instructions for sophisticated equipment in Sudan. He will be the technical guide of CIRW, consulting, training and helping in practical maintenance.

It seems that a member of the national staff, an electronic engineer educated in electronic instruments, who is due to come home shortly from abroad, will be applicable for this job.

At this first step it is recommended to begin improving the working morale and community relations of the staff by means of more incentives and a pleasing environment. All the time, at each step is very important that the staff-members must have both enthusiasm and aptitude for their job in each level.

D. Consolidating CIRW's progress

The past two years was the time of establishing the nucleus of CIRW. The further life of it depends on condition of conscientions care. And the time is a very important factor of this process. The nucleus can vegetate for half a year (maximum one year!) without consolidating its progress. Taking good care the nucleus will begin developing for a bright future.

To consolidate the progress of CIRW has personal and material conditions.

The personal conditions to accomplish this task can be fulfilled partly from the present national staff, partly be recruiting new members.

It is needed a technically educated person with knowledge of electric and electronic instruments' basics and with good knowledge of economy and of administration.

He will deal with the clients, paying facts-finding visits, being present at the recipt and delivering of instruments, and arranging the occasional complains.

His duty will be to acquire the standard and special spare-parts, to be in communication with the local representatives of manufacturers (or directly with the manufacturers), to supervise the administration regarding to CIRW, to prepare the repair plans and to compute the repair-costs.

(Such a person can be find in the present national staff)

Furthermore, at this step there is a need of a technically educated person who will do all the technical and administrative

work in the instrument-store (will be mentioned further).

Under the guiding of the Head of CIRW and of the engineer-economist, he will do the taking in and out of instruments, he will arrange the transportations of instruments and repairers to the spot and back, he will be in charge of care of CIRW-reports, technical catalogues, instruction-manuals, etc.

(This person will be available after his home-return from the present national staff).

To consolidate the progress of CIRW it needs the recruitment of minimum 4 technicians educated in electronics. They will do the routine part of the maintenance work.

They must be familiar with the basics of maintenance, measurement technique, with knowledge of electronic components and with the ability of report-writing.

The training of CIRW-staff in this stage should be mainly self-study, organizing by the IRCI-management, as it was recommended in the Report No. 2 on Progress very detailed.

The present workshop-room was sufficient for creation of nucleus of CIRW, but it is completely unfit for consolidating the progress. The real remedy is to move into the new building which was already promised in the 1975 - contract.

In the new building the CIRW's workshop-room must be so placed that the in and out transportation of instrument should be accomplished safety and easily.

It will be required an instrument-store with the same area as the workshop-room for the instruments (before -, under -, and after repair), for the special spare-parts and for the expensive test-instruments of CIRW.

Further will be required a so called "thinking-room" with separate writing desks for each member of the staff.

The workshop-room must be equipped a main-switch and every

workbench must have its own local-switch for safety.

In each working-place is needed a good earthing (separately from the electric-net), for measurement purpose.

Every workplace needs local light (table lamp). Every work-place must have minimum one lockable drawer.

Every workbench needs a large plastic sheet for covering it at the end of the workday, in such a way protecting the gadgets on the bench from the heavy dust.

Regarding to the test-instruments and tools, it would be very useful for CIRW's work:-

- simple, portable oscilloscope for on-the-site work;
- an AM-FM Signal Generator for the common bands;
- a Q-meter;
- a twin DC-power supply for IC circuits, and
- a DC-AC power-meter; 0,5 class; max. 150VA; for the calibration work with adapters;

Further

- a handy driller-machine;
- a proper vice; and
- different types of files;

because during the electronic equipment' repair it is inevitable to do some mechanical work.

In connection with the standard and special spare-parts it is recommended from technical, economic, and moral aspects to purchase them when CIRW will be placed in its new premises. (Note: during the two years among the 60 handled equipment there was only one which repair was failed because of lack of a spare-part. Unfortunately, this spare-parts was not acquirable).

E. Tasks for the distant future.

After consolidating the progress the CIRW will have all the necessary conditions for further development. The highly qualified staff won't have occupied its whole time with maintenance, and on the

other hand a such a staff is worthy of other type of scientific work too.

But technical and economical aspects also show the demand of further developing. Such a development can be approx. in the year 1984.

Psychological and economical arguments recommend to alter the name also. Studying a lot of aspects, a proper name seems to be: CENTRAL LABORATORY OF INDUSTRIAL ELECTRONICS (CLIE).

With the aid of an UNIDO-expert, who already knows the conditions and habits of Sudan, the CLIE can be established during 2 - 3 years.

The assumed staff of an efficient CLIE at the beginning has to be the staff of CIRW increased successive to approx. 30 persons, of whom 6 will be electronic and electrical engineers. They will do their job in three groups : maintenance, test, studies and research.

The CLIE will be an official establishment which is non-prefit making and self-administering, in the frame of IRCI. Receiving no grant, it has to cover working expenses by the cost of its services. (However, at the beginning UNIDO can support the CLIE's expenditure on equipment, and after the state authorities can do the same.)

The role of CLIE will be two-fold:

- first, it will be the official laboratory of maintenance of electronic equipment in Sudan.
- secondly, it will act as a centre for tests and studies on electronic and small electric devices (appliances and equipment) for the whole of industry, for government organization, and for institutions both in Sudan and abroad.

It will accomplish, in addition, a certain number of special missions assigned to it by government request.

Having an efficient CLIE the Sudan can apply for acceptance of member of international Certification Body (CB). For request a committee from the headquarters of CB will make an inspection-visit at CLIE and for its recommendation CLIE will get the right to perform tests according to the CB specifications and to give certifications for a certain type of manufactured goods (e.g. electrical household appliances, portable tools, etc.)

At this stage of development the possible clients of CLIE will be : International Organizations in frame of CB system; Sudan and foreign manufacturers; Sudan Trade Companies; Ministry of Commerce; private manufacturers and companies. This state which will mean a lot of advantages in the international trade can be estimated for 1980.

The CLIE will be working on

- all electronic and small electric measuring instruments and devices for industrial use and for standardization purpose from DC to high frequency;
- electronic scientific and medical equipment for industrial and medical use, for applied research use from DC to high frequency;
- all types of passive and active (electronic and small electrical) components, including logic and linear integrated circuits;
- electrical household appliances with electronic control and regulation;
- seasors, components of measuring and automatic regulation systems, investers, stabilized power supplies, rectifiers.

What the CLIE will do:-

- scheduled preventive maintenance (on subscription);
- corrective maintenance;
- measurement, calibration, checking, testing of electronic and small electric appliances;
- testing, calibrating, selecting and setting into operation of electronic instruments;

- tests for compliance with Sudan-standards and international recommendations, safety tests;
- technical acceptance tests, promotion of products, insuring their characteristics and performance by means of impartial and official reports and certifications;
- contracts for investigations and studies (methods, new equipment, and applications), for special targets of research and developing (equipment, methods, etc.);
- working out special problems by consultancy, by technical assistance, or by research;
- training for specialised staff to carry out preventive maintenance, measurement and calibration.

Possible clients of CLIE:

- Sudan and foreign specialised manufacturers, users, commercial institutions, repairers;
- authorities, civil and military technical state establishments;
- governmental and private sector of industry;
- Universities, hospitals, medical users;
- all the present clients of CIRW.

ANNEX III - a

INDUSTRIAL RESEARCH AND CONSULTANCY INSTITUTE
P. O. Box 268, Khartoum

Central Instrument Repair Workshop

Technical Manual # 1

A guide to instrument components

Prepared by:

Mr. Sandor Deri,
UNIDO Adviser
UNDP/UNIDO Project SUD/73/045
Khartoum, 29 Sept. 1981.

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ANNEX III-b

INDUSTRIAL RESEARCH AND CONSULTANCY

INSTITUTE

P.O. Box 268, Khartoum.

Central Instrument Repair Workshop

Technical Manual No. 2

A Guide to Instrument Units

Prepared by:

Mr. Dandor Deri
UNIDO Adviser
UNDP/UNIDO Project SUD/73/045
Khartoum, 26 Feb. 1982.

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ANNEX IV-a

List of recommended spare-parts for the repaired instruments

1) * Nil
2) VA 50 S type photocell, Rank El. in U.K.
3) Nil
4) 3/transistor 3055 type; 30/Si diode p400 type;
   16/fuse 0,5A 20x5 slow; 16/fuse 1,25A 20x5 slow;
   3/PB AK 5558 (10) 11/14/T5-666;
5) 3/lamp with min sockel 24V; 0,04A;
6) 5/heater unit 220V; 1 KW;
7) 3/electrometer tube 2532 Beckman type
8) Nil
9) 3/electrometer tube 2532 Beckman type
10) 2/AEG Metal rectifier 3x24V; 0,5A
11) Nil
12) Nil
13) Coil for "long" relay 5000 ohm; 48V;
14) 6/panel-soldered glimm-lampe
15) 6/panel-soldered glimm-lampe
16) Nil
17) Nil
18) 3/electrometer tube 2532 Beckman type
19) Nil
20) 2/50 F; 70V; electrolyte Condenser
21) L 704 type IC
22) Nil
23) Nil
24) Nil
25) Nil
26) 4/Zener diode 5,6V; BZY 88type
    4/Zener diode 3,3V; BZY 88type

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* identifying number of instruments, corresponding to Annex I.

27) Nil
28) electric clutch; 40 mm diameter; 24V; 0,1A;
29) Nil
30) Nil
31) 2/200 F; 16V; Al-Elce.Siemens
32) Nil
33) 6/adjusting screws for knife-edge
34) Nil
35) Nil
- 36) and 37) 50/short ball-chain (Mettler)
50/long ball-chain (mettler)
20/spec. micrometer-disc (Mettler)
38) Nil
39) Nil
- 40) tips with thermocouples
41) Nil
42) Nil
43) Sliding-wire unit
- 44) Special bellows
- 45) KITT 5 Type IC; (553 op. amp.);
46) Nil
47) pivot plus jewelry
48) Nil
49) Nil
50) Nil
51) 4/Zafir bed for knife-edge
52) Nil
53) Nil
54) Nil
55) Nil
56) fluorite electrodes; plastic dishes;
57) 3/electrometer tube 2532 Beckman type;
58) 10/RCA-IC

Note: the (-) signed items are under repair because of lack of the mentioned spare-part(s).

59) Nil

60) Nil

61) plastic tubes, adapters, membranes.

62) knife-edge bearings.

ANNEX IV - aa

Sample of specification of spare-parts for the instrument-owners.

LIST OF SPARE PARTS

FOR AUTOMATIC VOLTAGE STABILIZER IN

MINISTRY OF MINING

DESCRIPTION	TYPE	QUANTITY
1- Transistor	3055	3
2- Diode, Silicon	General Instrument P 400, IN 5060	30
3- Fuse 1/2A 20mmx5mm	"Slow Blow" Bulgin F 286	16
4- Fuse 1.25 A 20mmx5mm	"Slow Blow" Bulgin F 286	16
5- Printed Boards	AK 5558(10) 11/74	3

ANNEX IV-b

Recommended standard spare parts for CIRW's Test instruments

Rotek: Precision Calibrator

Transistors	2N4248 PNP	NAT	2 piece(s)
	2N3643 NPN	NAT	2
	2N3019 NPN	Fairchild	1
	2N4033 PNP	Fairchild	1
	2N2946 A PNP	TI	2
	2N4859 FET	NAT	1
Integrated Circuits			
	U7B 93L22 59x	Fairchild	1
	MC 846 P	MOT	2
	SN 74L00N	TI	2
	LM 301 AH	NAT	1
	LM 301 AL	Analog Devices	1
	MC 1814 P	MOT	1
	PM 725C	Pre Monolithic	1
Diodes	1N4002	MOT	2
	1N914	Fairchild	2
Relays	62R2T-24VDC	Sigma	2
	62R4T-24VDC	Sigma	1
	GP3R231ND2000	C.P.Clare	2
	AZ430-06-1 (310)	Amer.Zettler	1
Indicators	521-[illegible]	Dialight	1
	28ESB	Sylvania	2
Fuses	1,5 Amp. 31301.5	Littlefuse	5
	3,0 Amp. 313003	Littlefuse	5

Retek : High Current Adapter

Transistors	2N3019	NPN	Fairchild	1
	2N3643	NPN	NAT	1
	2N4248	PNP	NAT	1
Integrated Circuits	LM 301 AL		Amalog Devices	1
Diodes	1N914		Fairchild	1
	1N4002		MOT	1
Relays	62R2T-24VDC		Sigma	1
Fuses	1 1/2 Amp. 31301.5		Littlefuse	2
	15 Amp. 313015		Littlefuse	5

Ballantine: Digital Multimeter

Transistors	NSD135	NPN	NAT	2
	2N4126	PNP	MOT	2
	2N4124	NPN	MOT	6
	2N5416	PNP	MOT	1
	E211	JFET-N	MOT	1
	2N4918	PNP	MOT	1
	CA3081	NPN	RCA	1
Integrated Circuits				
	CA3140E	FET-OPAMP	RCA	2
	LD 120 CJ	MOD-DVM	Analog Devices	1
	LD 121 CJ	MOD-DIG	Analog Devices	1
	REF-02C	24-10256-0A	Ballantine	1

Diodes	FD 300	SI	Fairchild	2
	1N4005	SI	MOT	3
	1N4571	SI ZENER	MOT	1
	1N4151	SI	GE	2
	MDA920A-2		MOT	1
	1N4934	SI	Fairchild	2
	1N759	SI ZENER	MOT	1
Transformers	TRX 3036A	DC/DC	CONV. BALLANTINE	1
Fusos	2,0 Amp.			
	1,0 Amp.			

Ballantine : Counter-Timer

Transistors	2N3640	PNP	Fairchild	5
	2N3646	NPN	Fairchild	3
	2N4124	NPN	MOT	10
	2N4852	UNI	MOT	1
	2N1613	NPN	MOT	1
	MJE 520	NPN	MOT	1
	2N3955	JFET	MAT	2
	2N5179	NPN	MOT	2
	2N4126	PNP	MOT	2
	MPS 4355	PNP	MOT	4
	2N4403	PNP	MOT	8

Integrated Circuits

ICP 8290	TTL DEC-COUNTER		Signetics	1
SN7400N			TI	5
MC 10216L	HI Speed Amp.		MOT	1
SN7473			TI	1
LM340T-15	Reg.		NAT	2
78M05C 1/2 A	Reg.		Fairchild	1

Diodes	1N4151	SI	GE	5
	1N281	GE	ITT	15
	5082-2800	Schottky	HP	3
	1N758A	SI ZENER	MOT	1
	1N746 A	SI	MOT	1
	1N753 A	SI ZENER	MOT	1
	1N4999	SI POWER	MOT	2
	W005 1 Amp.	Bridge	FI	2
	1N4003	SI POWER	MOT	1
Fuses	1/2 Amp. 313.500	3AG	Littlefuse	1
Lamps	73/4 6V 60 MA	MIN	SYL	

H-P : Distortion Measurement Set

Transistors	VCR2N	FET	H-P	1
	2N3054	NPN	RCA	2
	2N4392	J-FET	MOT	2

Integrated Circuits

1826-0487	OP-AMP	H-P	12
1826-0315	OP-AMP	H-P	6
1826-0021	OP-AMP	H-P	2
1826-0109	OP-AMP	H-P	2

LM 325H	Reg.	MOT	2
LM 348N	Reg.	MOT	6
LM 318	OP. Amp.	MOT	5
LM 310 H	Reg.	MOT	2
MC 1496 G	MOD.	MOT	3
Diodes 1901-0040	Switch	H-P	30
1901-0518	Schottky	H-P	5
1901-0535	Schottky	H-P	1
1901-0025	Gen.	H-P	10
1902-0029	Zener	H-P	3
1902-0938	Zener	H-P	9
1902-3128	Zener	H-P	1
1902-0554	Zener	H-P	3
1902-0933	Zener	H-P	3
1902-1335	Zener	H-P	4
1902-3149	Zener	H-P	3
1902-3062	Zener	H-P	2
1906-0096	Bridge	H-P	3
Photomodule			
1990-0644	Connect.	H-P	3
1990-0630	Connect.	H-P	1
Fuses 0,062 Amp. Normal (1,25x0,25)		Littlefuse	5
Relay 0490-1137	Reed	H-P	3
0490-0563	12VDC	H-P	1

H-P Legging Multimeter

Transistors	2N30538	NPN	SI	MOT	3
	2N4917	PNP	SI	MOT	2
	1853-0419	PNP	SI	H-P	15
	1854-0071	NPN	SI	H-P	5
	1855-0222	JFET		H-P	1
	1855-0270	JFET		H-P	3
	1853-0086	PNP	SI	H-P	1
	2N3439	NPN	SI	MOT	1
	2N3055	NPN	SI	MOT	3
	2N2904A	PNP	SI	MOT	1
	1855-0308	JFET		H-P	1
Integrated Circuits					
	MC 1458 G	Op. Amp.		MOT	3
	SN 74L8139N	Decoder TTL		TI	1
	1818-0730	ROM		H-P	1
	1818-0695	Comp.		H-P	1
	1820-1742	Gate		H-P	1
	1820-1672	Gate		H-P	1
	1813-0096	Input Hybird		H-P	1
	1826-0421	AC Conv.		H-P	1
	1813-0097	Integr. Hybird		H-P	1
	CD 4077BF	Gate CMOS		RCA	1
	MC 140025 BCP	Gate CMOS		MOT	1
	MC 14001 BCP	Gate CMOS		MOT	1
	CD 4013 BAE	FF CMOS		RCA	5
	MC 14528 BCP	MV CMOS		MOT	1
	MC 14049 BCP	INV CMOS		MOT	1
	ML 14042 BCP	QUAD CMOS		MOT	1

Diodes

	MR 751	Rect. 100V 6A	MOT	3
	1901-0028	Rect. 400V 0,75A	H-P	17
	1901-0029	Rect. 600V 0,75A	H-P	1
	1N3997AR	Zener 5,6V	MOT	1
	1902-0766	Zener 18,2V	H-P	1
	1902-1329	Zener 6,95V	H-P	1
	1902-3182	Zener 12,1V	H-P	7
	1902-3171	Zener 11V	H-P	1
	1902-0049	Zener 6,19V	H-P	1
	1902-1331	Zener 6,9V	H-P	1
	1901-0050	Switching 0,2A	H-P	10
	1901-0040	Switching 50mA	H-P	24
	2901-0518	Schottky	H-P	1
	1901-0376	Gen.	H-P	9
	DPAD 100	Dual 35V 50mA	Siliconix	1
Relays	0490-1187	Reed	H-P	10
Fuses	0,375 Amp 1x0,25 UL(IEC)		H-P	20
	0,125 Amp SLO-BLO 1,25x0,25 UL		Littlefuse	5
LED - VISIBLE	HLMP-0301		H-P	20

ANNEX IV - c

Standard Spare Parts

Metal-flim resisters 0,5W 5%.

50/1,5 OHM				50/4,7 OHM		
50/10 OHM		50/15 OHM		50/22 OHM		50/33 OHM
100/47 OHM		50/68 OHM		100/100 OHM		
from the following values 50 - 50 pieces:						
1,0 K	1,2K	1,5K	1,8K	2,2K	2,7K	3,3K
3,9K	4,7K	5,6K	6,8K	8,2K	10,0K	
12K	15K	18K	22K	27K	33K	39K
47K	56K	68K	82K	100K		
120K	150K	180K	220K	270K	330K	390K
470K	560K	680K	820K	1M		
20/1,2M	20/1,5M	20/2,2M	20/4,7M			
10/8,2M	10/10M					

Ceramic Condensers TK = ± 0

10/2,2 DF 10/4,7pF 20/10pF 20/15 pF

Ceramic Condensers TK = -750

20/22 pF 20/33pF

Ceramic Condensers TK = -1500

50/47 pF

Ceramic Condensers TK = -3300

20/68 pF 50/100pF 50/120 pF

Ceramic Condensers TK = -5600

20/150 pF 20/270 pF

Ceramic Condensers TK = ± 3300

20/330 pF 20/470 pF 20/680 pF 20/820pF

Ceramic Condensers TK = ± 12000

20/1000 pF 20/1500 pF 20/200 pF 50/4700 pF

Ceramic disc capacities 60V

10/0,022	F	10/0,047	F	10/0,068	F
100/0,100	F	20/0,470	F		

Electrolytic condensers

10/680	F	6,3V
5/2200	F	6,3V
5/680	F	16V
5/1000	F	16V
5/2200	F	16V
10/100	F	63V
10/1000	F	63V

ANNEX V-d

Date: 28/8/1980

Mr. V. Ivanov
Engineering Industries Section,
Industrial Operations Division of UNIDO,
Vienna International Center

UNIDO D-1166
A-1400 Vienna /AUSTRIA

Dear Mr. Ivanov,

Ref: DP/SUD/73/045 - Central Instrument Repair Workshop

According to our discussions, I am sending this letter to inform you about the project-situation as I found it, and about my preliminary work.

On the occasion of the introduction visit to Mr. Abdel Rahman Ahmed Elagib, Director Council for Scientific and Technological Research of National Council for Research, and to Dr. Farouk ElTayeb ElHadi, Acting Director of the Industrial Research and Consultancy Institute, we looked through the history and the present situation of the project. Mr. Peter Quennell, Assistant Resident Representative of UNDP at Sudan, gave me the project-file to understand all the historical details, and to elaborate a working-plan-draft. With the help of Dr. Mohamed Osman Abdalla Head of the Engineering Department of the IRCI, I became acquainted with the national staff of the CIRW (Central Instrument Repair Workshop). We paid a number of visits to places such as research laboratories, workshops, and Universities, where there are electronic instruments of interest to the project.

I have checked the instruments and tools ordered by UNIDO, according to the Terminal Report prepared by the UNIDO consultant Mr. Westh. All have been received, although some are unsuitable.

As a result of observation, I have arrived at the following findings:-

1) The CIRW is still situated in its original place, namely in one of the sections of the old building of the Engineering and workshop Department of the IRCI.

It seems to be acceptable for the beginning of the project activities, after certain preparations like setting sockets, arrangement of benches, have been completed. However, by all means possible, UNIDO and UNDP must press for completion of the new building, which is extremely overdue.

2) We have to take great care for the instruments because of the tropical conditions rains, sand-storms, and the extreme heat. We are now ever more than the half of the operational preparatory works, despite the almost daily shortage of the electricity.

3) The assigned material staff of the CIRW, according to Dr. Mohamed Osman Abdalla, consists of 5 engineers, 2 technicians and 1 typist. They had attained experience in the administrative work of the CIRW, like inventories, forms to fill in, etc. Now we must follow up this work with useful hints and information for the operators of the electronic instruments. It is regrettable that presently only two engineers from the national staff are available, but I have pleasure in informing you that both of them are full of enthusiasm as regards the CIRW.

4) Most of the instruments and tools provided by UNIDO are very suited for the beginning of the programme. By

means of their, we are able to provide two working places fit to mending and calibrating electronic instruments. But among the instruments there are some unsuitable for using because of the lack of the complementary units. Concerning the hand-tools, there are also some items to complete. We have begun to inventory them from this point of view, and to prepare lists for the most important additional instruments and tools urgently needed.

5) Although the national staff is highly educated in its field, there is a certain need to learn the special practical and theoretical knweledge of repairing scientific and industrial instruments, the tradeoff will be the on-the-job training. I have begun this work, supervising the national staff on the practical work for instrument - repairing. But the regular training-course is expected to begin in September for the whole staff, and for some guests from other institutes and workshops.

You can see from the above that the important technical prerequisites satisfy the demands of the present work of the project. It seems to me that I can continue my assignment in the frame of my job-description. In this moment there is no need to modify or to complete it.

The UNDP Resident Representative has suggested that I follow the course of actions indicated below:-

a) Factual report and short-term workplan.
b) Factual survey of the instrumentation in Khartoum, and repair facilities available.
c) Proposals for the development of the CIRW in the next 2 - 3 years.

d) Tripartite review in October or November to review our proposals, and to make decisions for the future of the project. (UNDP would like UNIDO Headquarters to be represented. Please cable concerning this).

e) Revision of the project-document, and preparation of detailed workplan.

ANNEX V-b 1

Date : 25, October 1980

INTERNAL

UNIDO

Central Instrument Repair Workshop
DP/SUD/73/045
Project in The Democratic Republic of the Sudan.

Report On Recent Progress:

The preparatory works mentioned in the Preliminary Report (dated : 28/8/1980) now are finished and the CIRW began his duties Until now we have repaired:

- Two Electronically regulated furnaces at the Ministry of Mining (MM);
- A Spectrophotometer for the Omdurman Hospital;
- The Liquid Scintillation Counter at the National Health Center (NHC) eliminating lot of troubles:

Now we are dealing with a pH-meter of the NHC.
Meanwhile a practical and theoretical training was completed Concerning this.

To get preliminary informations about the equipment to be repaired Questionnaire was elaborated and proved in practice. The first user of it was Mr. Abdel Rattah with connection of a 3-phase stabilizer at the MM.

At the end of October our staff has grown: after his two-years study in England Mr. Yasour Ahmed Suliman came home and joined to us, and Mr. Abdel Rattah, a young engineer became also a member of our staff. Both of them are highly educated persons. We look forward to their participation at CIRW.

As per information of UNDP, the project - budget for 1980 - 1981 years is $40.000,- in the Equipment item.

Short-Term Workplan (November - December 1980):-

- To execute the repairing-work of the pH meter of the NHC;
- To commence the repairing-work of the 3-phase stabilizer at the MM;
- To begin the collection of facts concerning the equipment out of work at the Food Research Centre (FRC) by means of the above mentioned Questionnaire.
- To arrange the repairing-work program at the FRC and at the IRCI.
- To elaborate a list for ordering equipment and tools to complete the laboratory.
- It is essential an immediate assignment of two technicians for the CIRW-Staff.
- To elaborate the job-descriptions for staff members, particularly in terms of availability level for the CIRW-work.
- It is important to try to find the co-operation possibilities with other repair-workshops.
- It is mandatory to follow the visits at the future "clients" of CIRW, namely at the industry sector, to get informations and to give possible advices concerning the equipment and instruments.
- For this it is very important to follow the completing of the Guide Book for Scientific Instruments and Measuring Equipment in Sudan.
- To study the organizing problem of the tripartite review mentioned in the preliminary report.

ANNEX V - b 2

Date: 28, December 1980

INTERNAL

UNIDO

Central Instrument Repair Workshop
DP/SUD/73/045
Project in the Democratic Republic of the Sudan.

Report on Progress / November - December 1980.

During the period November - December we have repaired:

- a 3-phase stabilizer at the Ministry of Mining;
- Anhydro spray-dryer at the Food Research Centre;
- Spectrophotometer at the Soil Preservation Institute.

As a result of our visits the CIRW has got commissioned for repairing instruments and equipment from

- Tabaldy Factory
- Faculty of Pharmacy
- Food Research Center
- Ministry of Agriculture.

To elaborate the list for ordering equipment and tools to complete our laboratory is being made continuously. Detto : list of spare-parts.

The course of checking equipment of CIRW was continued.

A continuous practical and theoretical on-the-job training was completed.

There were changes at CIRW-staff:

Mr. Abdel Fattah mechanical engineer left us;
Mr. Elshiekh Abdelgadir electronic engineer and
Mr. Abdel Moneim electronic engineer are new staff-members.

Short-Term Workplan / January - February 1981.

- To continue the repairing work satisfying the commissions.
- To follow : a) the collection of facts concerning the equipment out of work;
  b) the completing of the Guide Book for Scientific Instruments and Measuring Equipment in Sudan;
  c) elaborating the job-descriptions for staff-members;
  d) checking of equipment of CIRW;
  e) the on-the-job-training-
- To make proposals for study tours.

ANNEX V -b 3

Date: 25 February 1981

UNIDO
Central Instrument Repair Workshop
DP/SUD/73/045
Project in the Democratic Republic of the Sudan.

Report on recent progress

We have been continuing the repairing work satisfying the commissions.

We prepared a "Final Report" -form concerning with the equipment repaired, which contains item "Recommendations". Many times we are not able to make an exact repair, e.g. because of lack of original spare parts. In such a case we suggest recommendations and the owner of the equipment has to make decisions concerning the way of maintenance. Such happened repairing a 3-phase stabilizer for the Ministry of Agriculture. The analysis of the equipment showed that stabilizer has not enough reliability, and only one unit of the three is worth economically for repairing. So we wrote down our recommendations and the owner had to decide whether to repair all the three units or only the one suggested.

The practical and theoretical on-the-job training was continued.

Short-Term Workplan / March - April 1981.

- To continue the maintenance-work satisfying the commissions.
- To make proposals for study tours.
- To find a possibility for rewinding middle-sized electrometers and transformers.
- To elaborate a summary-report about the past months.

ANNEX V -c

UNITED NATIONS DEVELOPMENT PROGRAMME

Project of the Government of the
DEMOCRATIC REPUBLIC OF THE SUDAN

SUD/73/045 - Central Instrument Repair Workshop (Phase One)

Report on Progress to Date and Plans for the Future Period

Section 1.	Short History of the Project
Section 2.	Technical Programme
	A. Inventory
	B. Organization
	C. Buildings
	D. Policy Decisions
	E. Systematic Work
	F. Training
ANNEX I	LIST OF INSTRUMENTS ON PROJECT
ANNEX II	CIRW "CLIENTS" LIST
ANNEX III	QUESTIONNAIRE FOR THE CIRW GUIDE BOOK
ANNEX IV-a	JOB DESCRIPTION OF NATIONAL STAFF MEMBER # 1 (SAMPLE)
ANNEX IV-b	JOB DESCRIPTION OF NATIONAL STAFF MEMBER # 2 (SAMPLE)
ANNEX IV-c	JOB DESCRIPTION OF NATIONAL STAFF MEMBER # 3 (SAMPLE)
ANNEX V	SURVEY OF ELECTRONIC INSTRUMENTATION
ANNEX VI	FINAL REPORT ON COMPLETION OF REPAIR
ANNEX VII	INVENTORY OF THE INSTRUMENTS SO FAR REPAIRED (OR UNDER REPAIR).

Khartoum
March 1981

1. Short History of the Project

In the year 1976, the National Council for Research (NCR), in collaboration with the Industrial Research and Consultancy Institute (IRCI), decided to establish the Central Instrument Repair Workshop (CIRW) with technical support by UNDP/UNIDO.

Short-term UNIDO consultants visited the Sudan, and found that the country has a considerable quantity of sophisticated instrument. A lost of them are even left idle, or are scrapped for lack of maintenance. There was prepared a list of electronic instruments and handy tools necessary for the CIRW. In accordance with it instruments and tools were delivered to the IRCI (See annex I).

On 1st of July 1980, the UNIDO expert in maintenance, repair and calibration of electric and electronic instruments, arrived, and the preparatory work has begun to establish an initial nucleus for maintenance mainly for electronic equipment.

After visits to various places (See Annex II), the CIRW started to maintain equipment of diverse owners, like Ministry of Industry; Ministry of Mining; Ministry of Agriculture; Ministry of Health, the University; and the private sector. Gaining experiences in such a way now we are prepared to give maintenance services to such partners as:-

- the industry and industrial research institutes;
- agricultural related industries;
- health related laboratories;
- universities;
- private sector

Any work-request must be presented or confirmed in writing. (An ordinary letter is adequate for making an order for work).
Our address:-

Industrial Research and Consultancy Institute
Central Instrument Repair Workshop
P.O. Box 268,
Khartoum, Sudan.

2. Technical Programme

Long-range objective

The long-range objective of the project is to promote the economic development of the Sudan through good maintenance which is the key to sound development of industry. It will be performed in three phases; the deadline for the first phase, i.e. the establishment of a small maintenance unit for electronic equipment, is the end of 1982.

It requires management as well as technical skills and technical knowledge, besides measuring instruments and tools.

Immediate objectives for the first phase

A. To have an up-to-date inventory of electronic equipment in the Sudan.

B. To have an organization suitable, at least as a nucleus.

C. To have suitable buildings.

D. To have suitable policy-decisions.

E. To have a systematic work according to short term workplans.

F. To have training for the staff in all levels.

A. Inventory.

An inventory of electronic equipment in the Sudan has been started, in the Guide Book for Electronic Instrument and Measuring Equipment in Sudan, elaborated in the frame of the CIRW.

The first version of this book will contain about 60 pages, collecting the informations from 54 places (the data-collecting work begun in 1978 by means of a Questionnaire, see Annex III). This first version must be followed by other versions in future, because the informations of this Book are essential regarding maintenance, calibration and standardization. (For this we need the help of our partners). This book should be the base of the systematic maintenance and consultancy work.

B. Organization

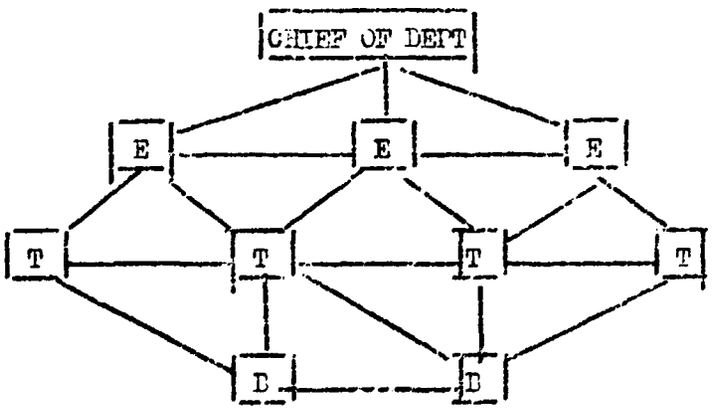
The organization chart of the IRCI is not yet approved by the Ministry.

It is planned that the CIRW will be a Department (instead of a Unit) in the IRCI structure.

The working organization of CIRW suitable for Sudan is taking its shape.

It seems that the mixed-matrix-organization (based on the principle that each person is assumed to alternate between different roles, and each person is assumed to cover more than one work-role) would be the best, because of the large variety of the maintenance problems. But the overlapping between roles must be limited, because some degree of specialization is required. The organization is "mixed", so the technicians and labour-boys have their hierarchical system relative to the engineers, but among themselves they also must have a pure matrix-organization.

The Working-Organization Chart of CIRW's Electronics Division.



E - Engineer

T- Technician

B - Labour-boy

A very important part of organization is the development of the national staff. In a developing country such as the Sudan, it is not reasonable to have a narrow specialization for repairing. However, even in the classification of equipment, it is not possible to say that this equipment is pure-electronic or pure-mechanic (or optic, etc.) According to this, the members of the national staff must have sufficient knowledge in different themes, meanwhile they have their basic studies in the electronic-electric field, and they have different tasks also, as is seen in Annex IV.

Our linkage to NCR is economical and scientific. The NCR gives the salary for CIRW-members and sometimes NCR gives us advices evaluating our policy decisions.

We can get a hand from other departments of IRCI, such as the mechanical workshop and the administrative section.

At the beginning of the first phase this structure works well, but after a short period we will need our own administrative section and our own precision-mechanic workshop.

Linkages to consumers we have to build up. First of all it must be technical one, but we cannot neglect the human links as well as the business links.

C. Buildings

The CIRW is located within the IRCI at Mogren, in one of the old buildings.

It has a separate laboratory (about 7m x 5m x 2.75m) equipped with 7 workbenches, 3 cupboards, and a shelf for instruments.

Because of the changing electricity-supply we use electro-mechanical stabilizers to have 220V constantly.

The air-conditioner is not a question of luxury. Almost all of the equipment have their technical parameters specified at 20°C ambient temperature.

The maintenance-work is partly practical, partly theoretical work. So, the members of the board need a so-called "thinking room" with separate writing-desks, the same way as the administrative section needs (or more exactly will need) office-room. Also, from the beginning, the maintenance work needs stores. It is the nature of such work, that many times the equipment under repair must be retained for a certain time, e.g. waiting for special parts or special co-operative works. Generally, the needed area of stores are equal to the needed area of laboratories.

Now we have the most necessary testing instruments, but there are some special instruments which we need also. In the near future we will prepare requisitions and specifications for them. The same we can say about the tools.

For our administrative section we will need some basic office machines, IRCI has a library and many books in it are very useful for our purpose, but we need some special booklets, and catalogues for our work. To get them it seems advisable to be contacted with Technical Information Bank (INTIB) of UNIDO.

The UNDP-budget gives us the possibility to procure equipment and spare parts. Within its limits we want to get what seems to be the most important in this phase: to solve our transportation problems. Our "clients" are located in different places of Khartoum (and of the Sudan). Most of the items of equipment to be repaired are very large, so the repairers have to work in the field, carrying their measuring instruments and tools. Another problem is that the repaired equipment needs a very careful transportation because of its high sensitivity for shocks. So, without solving our transportation problems sufficiently, the CIRW will not be able to work.

D. Policy Decisions

Policy decisions are needed regarding priority of maintenance itself in the various sectors of industry of Sudan. But at present, the management of CIRW makes such decisions, taking into consideration technical and economic parameters only. To have a fairly correct decision we use a Questionnaire, elaborated not long ago (see Annex V).

E. Systematic Work.

Systematic work is the backbone of good maintenance, involving the calibrations of instruments and safety tests on measuring instruments and equipment.

At the very beginning we made visits to our "clients". As a result of these we have found the most frequent faults are cause by excess heat. According to it, we begun the repairing work eliminating this.

We keep laboratory-note-books, recording all technical events and problems concerning with our work. Beside it we have files for each equipment repaired, containing the preliminary report (Annex V) and the final report (Annex VI), including the special spare-parts's list. The analysis of the repairing-cost is also to be found in the file.

In a lost of cases the owners of equipment have no manuals or descriptions of the equipment. It makes large difficulties, but we try our best to get technical informations on equipment. It seems advisable to contact the formerly mentioned INTIB in this matter too.

The problem of effective communications with foreign manufacturers and companies is also an important part of systematic work. Very often we need e.g. special spare-parts from them. During the past six months we have found that the indirect connection through local dealers is very difficult and ineffective. So we have to set up a section for direct contract with foreign manufacturers.

The statement of the instruments repaired, and under repair, (Annex VII) shows the effectiveness of our work.

F. Training

In CIRW the training is a function of work-process. Generally, it has the "on-the-job" form, but also we have discussions about interesting technical questions regarding our daily work.

Some instrument-manufacturers have special training material for their technical staff. For a long period it seems to be useful to study such training material. The Hewlett-Packard firm, one of the famous instrument-manufacturers, sent us a proforma-invoice about their training-material on video-tapes which deals with the semi-conductorized instruments. It would be very useful for training purposes for us (and for other technical staff), because in the Sudan there are a lot of H-P instruments.

We are in the possession of another useful training-tool; the study-trips. The UNIDO budget has a certain amount of money for it. Having six months' experiences we are able to make recommendations for short study-trips.

ANNEX I

LIST OF INSTRUMENTS ON PROJECT

No.	Description	US Dollar Equivalent
1.	STEREOMICROSCOPE M3	1,673.—
2.	SERDEX HYGROTHERMOGRAPH 7 DAY	558.—
3.	VOLTAGE STABILIZER TYPE VS-2	1,849.—
4.	VARIABLE TRANSFORMER "REGAVOLT" MODEL 403 C-PTV (S) COMPL.	633.—
5.	DECADE INDUCTOR BOX D1-4	1,209.—
6.	CALIBRATION GENERATOR TYPE PG-506	1,695.—
7.	TIME MARK GENERATOR TEKTRONIC, RTPW TG 501	1,302.—
8.	LEVELED SINE WAVE GENERATOR, TYPE SG 503	1,302.—
9.	OSCILLISCOPE DUAL TRACE 465	5,050.—
10.	PULSE GENERATOR, TYPE PG 508	1,329.—
11.	INSULATION TESTER C1-500C, COMPLETE	1,307.—
12.	LOGIC KIT 5P21A	476.—
13.	COMPARATOR 10529A	588.—
14.	WIDE BAND OSCILLATOR, TYPE 651B	1,120.—
15.	LOGGING MULTIMETER 3467A	2,464.—
16.	PULSE GENERATOR	728.—
17.	DISTORTION FACTOR METER 339A	2,128.—
18.	DECADE CAPACITOR BOX TYPE 2975	300.—
19.	VALVE CHARACTERISTIC METER MODEL VCM 163	1,178.—
20.	COIL WINDING MACHINE, MODEL CW 1	978.—
21.	DIGITAL MULTIMETER MODEL 13036 4-05-31	886.—
22.	DIGITAL FREQUENCY COUNTER MODEL 5500B	1,235.—
23.	WIDE BAND VOLTMETER MODEL 3045A	605.—
24.	LOW DISTORTION AUDO OSCILLATOR, TYPE J3B	778.—
25.	MULTIMETER, UNICOR 3N COMPLETE	896.—
26.	FARNELL HT POWER SUPPLY, TYPE E350	382.—
27.	FARNELL BENCH POWER SUPPLY, TYPE L30-2	268.—
28.	FARNELL BENCH POWER SUPPLY, TYPE L12-10C	350.—
29.	ROTEK PRECISION CALIBRATOR, MODEL 320	5,775.—
30.	HIGH CURRENT ADAPTER, MODEL 350	1,645.—
31.	DC REFERENCE STANDARD MODEL 731-B	1,007.—
32.	INDUSTRIAL VACUUM CLEANER MODEL NILFISK GS 80 SPECIAL	442.—

ANNEX II

CIRW " CLIENTS" LIST

The following institutions have been visited by CIRW staff:

1. Laboratories of Geology and Mineral Resources (Ministry of Mining)
2. Tabaldy Battery Factory (private sector)
3. Industrial Research and Consultancy Institute Laboratories (Ministry of Industry).
4. Central Electricity and Water Corporation Laboratories (Ministry of Energy).
5. Food Research Centre Laboratories (Ministry of Agriculture).
6. Soil Conservation land-use and Water Programme (..."....)
7. Biological Laboratories (National Health Centre).
8. Chemical Laboratories (...."....)
9. Bacteriology Laboratories (Omdurman Hospital).
10. Applied Research Laboratories (University of Khartoum, Faculty of Science).
11. Applied Research Laboratories (University of Khartoum, Faculty of Pharmacy)
12. Applied Research Laboratories (University of Khartoum, Faculty of Agriculture).
13. Sudan Soap Company (Ministry of Industry).
14. Sudan Textile Factory (Ministry of Industry).

Most of the laboratories referred to have applied technological research or industrial programmes of activities.

ANNEX XXI

QUESTIONNAIRE FOR THE CLRW GUIDE BOOK

INSTRUMENT RECORD CARD

User Name: .....

Address: .....

Instrument Name: .....

Manufacturer's Name: .....

Manufacturer's Address: .....

Serial No. : ..... Model No. : .....

Purchase Price : ..... Date of Purchase: .....

Any additional technical data: .....

.....

Function: .....

.....

.....

Present condition of Instrument working or not working; If not, why?

.....

.....

.....

Is Service Manual/Circuit diag, available with you?

Yes/No

Repair History:

Nature of Defect	Date	Action taken spare parts (If any)
.....	.....	.....
.....	.....	.....
.....	.....	.....
.....	.....	.....

ANNEX IV-a

Sample

Job Description of national staff member No. 1

Title:

Age:

Education:

Other qualifications:

Work experience:

Aims of job: Take part in the work of CIRM staff as an electro (electronic) engineer, charged with

- To liaise with the "clients",
- To organize co-operation with other institutes and maintenance groups;
- To locate faults in equipment to be repaired working DC and very low-frequency range;
- To keep the laboratory-noter book;
- To take part in the staff-training course;
- To make technical and periodic reports.

ANNEX IV-b

Sample

Job Description of national staf ember # 2

Title:

Age:

Education:

Other qualifications:

Aims of job: Take part in the work of CIRW staff as an electro (electronic) engineer, charged with:

- To prepare the preliminary reports of equipment to be repaired working on low-frequency range;
- To study the basic theories related to electronic components (tranistors, diodes, resistors, capacitors, etc.);
- To take part in the staff-training course;
- To give an on-the-job training for the technicians;
- To make technical and periodic reports.

ANNEX IV-c

Sample

Job description of national staff member # 3

Title:

Age:

Education:

Other qualifications:

Work experience:

Aims of job: Take part in the work of CIRW staff as an electronic (electro) engineer, charged with

- To perform checkout procedures on the repaired equipment;
- To study the basic theories related to regulated and control circuits;
- To give on-the-job training for the technicians;
- To make official reports concerning repaired equipment at the beginning and at the end of the repairing work;
- To do repairing work on equipment of audio-frequencies.

ANNEX V
Page 1

SURVEY OF ELECTRONIC INSTRUMENTATION

QUESTIONNAIRE

DATE: .....

DONE BY : .....

NAME OF THE OWNER:

PLACE:

NAME OF THE EQUIPMENT:

PRICE: DATE OF INSTALLATION:

MANUFACTURER:

TYPE:

MANUAL:

THE IMPORTANCE OF THE EQUIPMENT TO THE OWNER:

SPECIFICATIONS:

INPUT:

OUTPUT:

POWER:

IMPORTER:

Present Condition:

(1) BROKEN PARTS:

(2) RUST:

(3) MISSED COMPONENTS:

(4) TRANSISTORISED OR VACUUM TUBES:

(5) HOW LONG IS IT OUT OF WORK:

(6) WHAT IS THE FAULT ACCORDING TO OPERATOR?

QUESTIONS TO OPERATOR:

1. WORKING HOURS PER DAY:

2. ENVIRONMENT OF WORK AND PROBLEMS:

3. IS THERE ANY REGULAR MAINTENANCE?

4. NO. OF OPERATORS AND THEIR QUALIFICATIONS:

5. WAS IT REPAIRED BEFORE?

6. THE LAST TIME IT WAS REPAIRED AND THE POSSIBILITY OF TALKING WITH THE REPAIRMAN:

ANNEX VI

Page 1

FINAL REPORT ON COMPLETION OF REPAIR

Done by: Job no.:

Name of the equipment:

Date in: Date out:

First inspection:

Disconnections:

Broken/missed components:

Excess heated areas:

Tested results after 1st inspection:

Condition:

Recommendations:

Fault tracing:

Final test: Working/Not working:

Results:

Spare parts used/needed:

Final recommendations for the owner:

Dated: Signature:

ANNEX VII

Inventory of the instruments so far repaired (or under repair)

1. Electronically regulated furnaces (Ministry of Mining)
2. Spectrophotometer (Omdurman Hospital)
3. 3-phase stabilizer (Ministry of Mining)
4. Liquid scintillation counter (National Health Centre)
5. A hydro Spray-Drier (Ministry of Agriculture)
6. Spectrophotometer (University of Khartoum)
7. Spectrophotometer (Ministry of Agriculture)
8. AEG Charger (Tabaldy Factory)
9. Autoclave (Ministry of Agriculture).
10. Oven (Industrial Research and Consultancy Institute).
11. Oven (Ministry of Agriculture).
12. 3-phase stabilizer (Ministry of Agriculture).
13. Incubator (Ministry of Agriculture).
14. Autoclave (Food Research Center)
15. Gas-chromatograph (Polytechnic of Khartoum).

ANNEX V-1

UNITED NATIONS DEVELOPMENT PROGRAMME

Project of the Government of the

DEMOCRATIC REPUBLIC OF THE SUDAN

SUD/73/045 - CENTRAL INSTRUMENT REPAIR WORKSHOP (Phase One).

Report 2 on Progress to Date and Plans for the Future Period

Prepared for the Tripartite Review
by

the UNIDO Expert

S.DERI Dipl. EE

KHARTOUM
NOV. 1981

SUD/73/045 - Central Instrument Repair Workshop (Phase One).

Report 2 on Progress to Date and Plans for the Future Project

Section 1, Introduction

Section 2, Summary of Reporting Period (Jan. Dec. 1981)

Section 3, Technical Programme

- a- Systematic repair, maintenance and calibration programme for electronic instruments
- b- Suitable Organization
- c- Suitable Buildings
- d- Policy decisions
- e- Systematic work
- f- Staff Training.

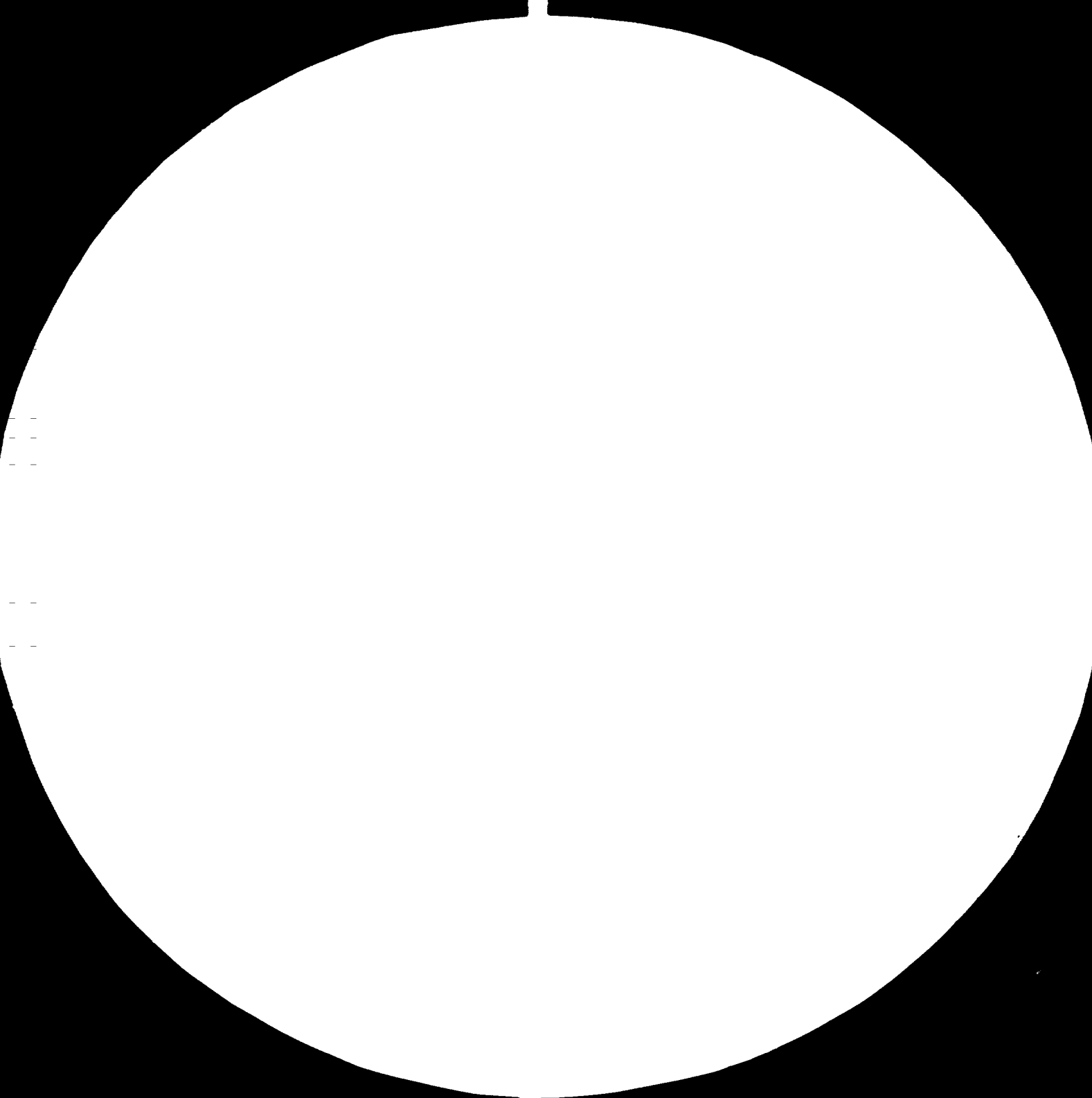
Section 4, Conclusions and recommendations

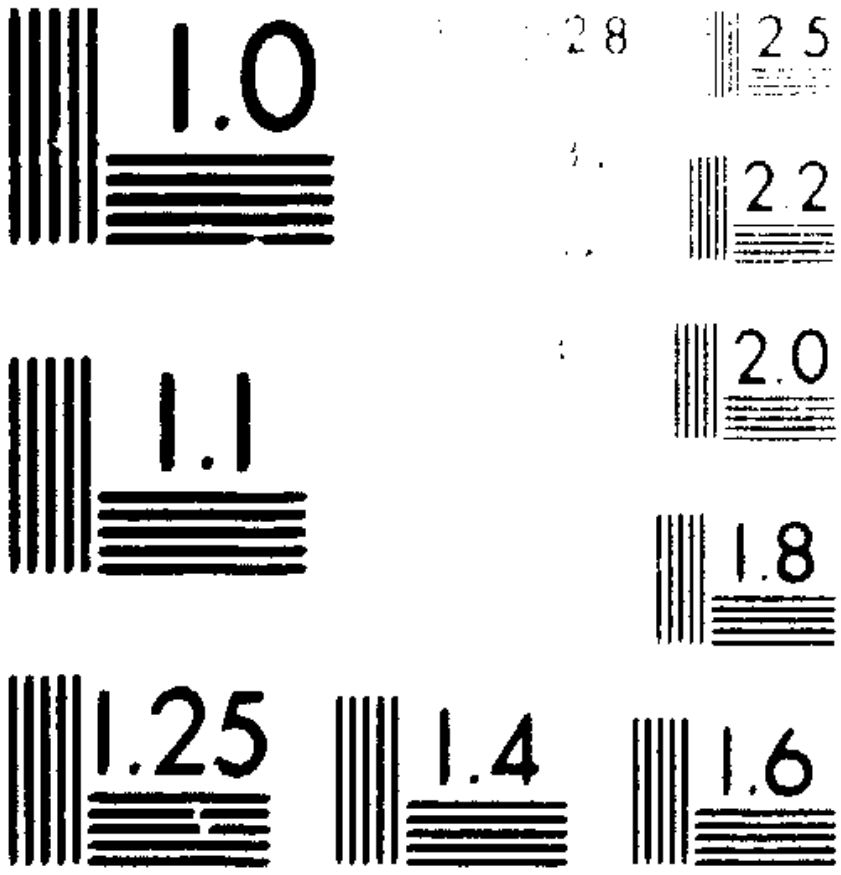
Section 5, Workplan for the immediate future.

1. INTRODUCTION

The Central Instrument Repair Workshop (CIRW) project has an implementation history from 1 July 1980. The first six months period was reported on in Report # 1, while this Report # 2 contains a factual account of the further progress of project implementation and an identification and analysis of major problems and achievements. At the same time it acts out a workplan for the immediate future.

This report is prepared as a background paper for the project's tripartite review which is tentatively scheduled to take place in December or January, according to convenience of the participating parties.




2.8
2.5
1.0
2.2
2.0
1.1
1.8
1.25
1.4
1.6

2. Summary of Report # 2, covering the Reporting Period January - December 1961.

This report deals with the progress of project implementation and with the identification and analysis of major problems and achievements during the reporting period.

Overall Status of Project:- The nucleus of the Central Instrument Repair Workshop (CIRW) is now well established.

Major Problems: The new premises of the workshop are not yet completed. There are difficulties in direct contacts with instrument-manufacturers, and a lack of service manuals for instruments to be repaired.

Project Activities: Good progress is reported on organized repair-methods. The Technical Manual 1 ("A guide to instrument components") is ready, and under preparation is the Technical Manual 2 (Instrument units; instruments"). There have been repaired 11 instruments completely; and 7 more instruments are under repair.

Work Programme for the Immediate Future:

To carry on the organizing work and instrument repairs; to pursue the training and consultancy; to elaborate an information feed-back system about repairs, to improve the reliability of the work.

3. Technical Programme:

Long-range Objective: There is no change in the long range objective development of the workshop. The deadline for the first phase will be, very likely, the middle of 1982, at which time the workshop will not be fully established; further phase will be required.

Immediate Objectives:- to produce:

A. A systematic repair, maintenance and calibration programme for electronic instruments;
B. suitable organization;
C. suitable buildings;
D. policy decisions;
E. systematic work;
F. staff training.

In the Report # 1 were listed the same immediate objectives. The triparititie review will check whether they are obtained or not. Drawing on implementation experience, the review will made an assessment of the immediate objectives of the project, too, and whether they remain feasible and valid.

A. Systematic Repair, maintenance and calibration programme for electronic instruments.

As described in Report # 1, the project is undertaking an up-to-date inventory of electronic equipment in the Sudan, as the basic for the systematic maintenance and calibration work. The Guide-Book for Electronic Instruments and Measuring equipment in Sudan (elaborated within the framework of the CIRW's terms of reference) has not yet come out. Now it is clear that it will not contains enough parameters to be exhaustive about the real condition of each instrument. In any case, it must be published as soon as possible, because of the very important basic information contained in it. This first edition must be followed by other edition in future supplemented by new date.

Still retained is the method of fact-finding visits as adopted in the beginning. During such a visit it is easy to make suitable checking and gathering of essential information about electronic instruments out of work, and to have adequate notes to prepare the Inventory. (The Survey of Electronic Instruments (See Annex I) will be very useful for those notes).

This work, especially the evaluation of the data, demands a will prepared instrument-repair engineer. The methods and techniques of selecting the proper instrument for a correctly scheduled repair, maintenance and calibration programme are described in the Technical Manual 1 (CIRW) from page 12 - 17 -

Without doubt, safety (in all respects) has priority among them. Byt also very important are the economic aspects, the complexity of required repairs; time needed for repairs; required special spare parts; the repairing facilities of CIRW.

B. Suitable Organization:-

At the beginning, it seemed that a mixed-matrix organization scheme was suitable for the CIRW. This working organization chart is seen in Report # 1 page 4. But in practice, the project has developed a more flexible work-organization scheme. According to it, the Head of the CIRW has direct contact with each member of the group, the usual organization of small teams. But the basic principle of the mixed-matrix scheme (each person to alternate between different roles, and each person assumed to cover more than one work-role) has remained unmodified as a target.

Regarding the job-descriptions for national staff members, it is very important to have basic theoretical knowledge in the electronic/electric field, and some knowledge of technology.

Only the simplest instruments are purely electronic, or mechanical, etc. ... The more sophisticated equipment often contains mixed units. (E.g. the light receives of spectrophotometer need sufficient theoretical and practical knowledge in different specialization from the repairer,) But the basic trait for a successful repair man is:-

a high level of motivation and interest in the repairing-work

It is advisable to meditate whether today linkage between CIRW and the Industrial Research and Consultancy Institute (IRCI) is the best, from point of view of incentives, of motivation, and of interest in the repairing work for CIRW-members.

At the beginning of this project the concept that CIRW might receive a hand from other departments of the IRCI, worked well. But now, especially since the administration unit of the IRCI has moved away from the Workshop, the CIRW needs its own administrative section. The lack of its own administrative facilities (e.g. CIRW has no typewriters or typist) definitely prevents the systematic integrated development of the Workshop.

Organized repairing offers considerable variety to the repairer, "depending on" the conditions. This is referred to in detail in Technical Manual # 1. One thing is common in all methods to keep correctly a laboratory NoteBook. It is not enough to just write down data-information has to follow some form that will enable anyone reading that information to understand just what it means. A well-kept, dated, and signed notebook is a document of proof (which incidentally is admissable before a court of law). The project has produced some results in this direction but not enough for a well organized CIRW.

C. Suitable Buildings:-

One of the major problems is that the new premises of the Workshop at Shambat are not completed yet. The CIRW is still located in an old building, where the working conditions are often difficult. (E.g. when it is raining, inside the workshop drips the rain through the ceiling. During the reported period three times it was necessary to drain water out of every previous test instruments, dry and maintain them).

At the beginning of the project a proposal for a proper earthing was declined because of the forthcoming moving into the new building. Eventually, a provisional earthing was made but it is not reliable enough for the work being carried out. For the same reason a main switch for the whole workshop was not installed. The real remedy for those (and for other such problems) is of course to move into the new building. In this case the required "quiet-room", office-rooms and stores will also be available for the project.

D. Policy-Decisions:

As originally conceived, the project has three phases, and the achievements during the reporting period are parts of the first phase (i.e. the establishment of an electronic instrument division). It may be that theoretically the project is in the first phase, but practically it is repairing mechanical instruments such as precision balances, etc, which truly belong to the second phase.

It would be very useful at this point to revise the overall objective of the entire project, altering the dominations. (E.g. at the Symposion of the Modern Science-Based State, in Khartoum, organized by the National Council for Research, was used the expression: Maintenance of mechanical and electrical machines and appliances and fine-measurement equipment).

At the same time it is recommended to check the effectiveness of a large central repair workshop, comparing it to the effectiveness of various smaller ones.

As the present building has no security locks, the project has postponed the ordering of certain standard spare parts and instrument accessories until the move into the new premises.

The ordering of new types of testing instruments depend decisions about the future development of the CTRW.

E. Systematic Work:-

The CIRW is now prepared to provide maintenance services to industry and industrial research institutes, universities and the private sector.

Any work request must be presented or confirmed in writing. (An ordinary letter is adequate for making an order for work).

After the work-ordering, a member of the CIRW-staff checks the equipment, filling out the Survey of Electronic Instruments. After discussions with the Head of CIRW, the order will be accepted (or not accepted).

On several occasions, the customer refused to pay for the cost of repairs when invoiced. Accordingly, the customer is now warned in advance that payment is a condition of acceptance for repair. Work begins only after agreement on these conditions or payment is reached.

The steps of technical procedures of repair one can be found in the above mentioned Technical Manual # 1.

The effectiveness of the CIRW can be judged by its contacts with the clients. Without exaggerating one can tell that most of the clients appeal to CIRW repeatedly with their repair problems.

The statement of the instruments repaired or under repair, and the consultancy assignments for the reporting period can be seen in Annex II.

It has occurred that the client has needed training for his operaters. As an important stage of the preventive maintenance, the project has carried this out as a consultancy or short course.

After first inspections the CIRW rejected 3 orders because the repair would not have been economical for the owners. (Another

reasons when the equipment is too old, it is impossible to get special spare parts from the manufacturer).

Two of the under-repair equipment need special spare parts. The project has ordered them from the manufacturer (Mettler precision balances: special discs and ballchains).

Finishing a repair, the repairer fills out the Final Report on Completion of Repair (See Annex III). In this report, the most important paragraph is the Recommendations. The environment, the operation, the future necessity of spare parts, and the next checking-time of the repaired equipment are the main sections to be completed.

Finally, an information-feedback system will complete the procedure of systematic repairing work. There was some discussion on the project about which is the best method of gaining information feedback on the repairs. Is it enough to send a form to fill out to the owner of the instrument, or is it better to go there and made an inspection. We agreed that the best method is, in the Final Report to be written "next checking-time" to give an opportunity for the repairer to fill out a (later to be developed) from. In such a way the project will have comprehensive information about the reliability of the repairing work, to make the necessary corrections to systems and procedures.

F. Staff-Training:

In a repair workshop the training is an integral part of the work-process. Not only the innumerable types of up-to-date components need a material knowledge, but the equipment repair itself needs a thorough study.

The basic knowledge, everybody may obtain on regular courses, and from books and periodicals. But the specialty of repairing technology one has to acquire hiself. The theoretical part by reading, the practical part by experimenting (and reading the very few Technical Mnmuals available on this matter).

A workshop management, which is not only competent and experienced, but is also familiar with and actively interested in the project, has to prepare a training-plan (See Annex IV) for each member of the group. Such a training plan is a form which contains information about the education level and post-graduate courses of the member, his instructer's name, and the topics of self-study. (The instructer should be a specialist in the topics of self study).

The instructer must be a qualified person, his task will be to propose the subject-matter for self-study, and monthly to consult with the trained about it. (One person could be an instructor for more than one person, and at the same time one could be trainee and instructer, too.)
The followings are the main means of self-training:-
- have a good handbook
- read periodicals regularly
- take advantages of libraries
- take advantages of using a laboratory Notebook.

But in the actual training there is no substitute for personal contact with the instructor.

A further essential factor is the development and maintenance of good working relationship and cooperation with the colleagues. And, last but not least, is to be aware of CIRM's role.

Practical overseas training(on-the-job) is possible, but it is economically justified only in special cases when the person has already been well prepared for it.

4. Conclusions and Recommendations:-

The nucleus of the Central Instrument Repair Workshop is now well established.

The management is familiar with and actively interested in the project.

The national-staff, especially theoretically theoretically, in well prepared. (The everyday-repair will be done as a routine work). They are able to participate in the future development of the CIRW.

But they can not produce at their maximum in the present workshop building.

It is recommended:

That the managment study the earlier possibility of moving into the new building.

5- Workplan for the Immediate Future:-

A.	To carry on the organizing and instrument repairs	deadline:contimuous
B.	To pursue the training and consultancy	deadline:contimuous
C.	To finish the Technical Manual # 2 about instrument	deadline:March 1982
D.	To prepare a proposal about the future of CIRW.	deadline:April 1982
E.	To elaborate an information feedback system about repairs.	deadline:April 1982
F.	To prepare the project-final report draft.	deadline:May 1982

ANNEX I

Page 1

SURVEY OF ELECTRONIC INSTRUMENTS

Date: .....

Done by .....

NAME OF THE OWNER:

PLACE:

NAME OF THE EQUIPMENT:

PRICE: DATE OF INSTALLATION:

MANUFACTURER:

TYPE

MANUAL:

THE IMPORTANCE OF THE EQUIPMENT TO THE OWNER:

SPECIFICATIONS:

INPUTS:

OUTPUT:

POWER:

IMPORTER:

Present Condition:

(1) BROKEN PARTS:

(2) RUST:

(3) MISSED COMPONENTS:

(4) TRANSISTORISED OR VACUUM TUBES:

(5) HOW LONG IS IT OUT OF WORK:

(6) WHAT IS THE FAULT ACCORDING TO OPERATOR:

QUESTIONS TO OPERATOR:

1- WORKING HOURS PER DAY:

2- ENVIRONMENT OF WORK PROBLEMS:

3- IS THERE ANY REGULAR MAINTENANCE:

4- NO. OF OPERATORS AND THEIR QUALIFICATIONS:

5- WAS IT REPAIRED BEFORE:

6- THE LAST TIME IT WAS REPAIRED AND THE POSSIBILITY OF TALKING WITH THE REPAIRMAN:

ANNEX II

List of Instruments:

(rop- repaired; under rep. = under repair)

1.	Suction pump	(Soil)	rejected
2.	Suction pump	(Poly)	rep
3.	Polarograph	(univ)	under rep
4.	Recorder	(univ)	under rep
5.	Electron Microscope	(NMC)	rejected
6.	Liquid Nitrogen equipment	(NHC)	rejected
7.	Timer	(F,K.)	rep
8.	Integrater	(Tex)	consultancy
9.	Balance K/T	(Soil)	rep
10.	Balance P162	(Poly)	rep
11.	Chrono-Scin	(IRCI)	rep
12.	Balance H6T	(Poly)	under Rep
13.	Balance H6T	(Soil)	under rep
14.	Test Oscillator	(IRCI)	under rep
15.	Marconi Waveforms Gen.	(IRCI)	rep
16.	Balance H?O	(Soil)	rep
17.	Timer	(Tab)	rep
18.	Spectrophot	(Univ)	rep
19.	Rotok Hi[illegible] Ad.	(IRCI)	rep
20.	Electronic balance	(MIN)	rep
21.	Atomic Absorption Spect.	(IRCI)	under rep
22.	Thermocomple thermometer	(F.W.)	under rep

Soil = Soil Conserv. Dept.;
Tab = Tabaldy Fact.;
Poly = Polytechnic of Khartoum;
Univ = University of Khartoum;
NHC = National Health Centre;
F.K. = Foundry of Khartoum.
Tex. = Sudan Textile Fact.
Min. = Ministry of Mining;
F.W. = Foundry of Wad Medani

ANNEX III

Page 1

FINAL REPORT ON COMPLETION OF REPAIR

Done by : Job No.

Name of the equipment:

Date in: Date out:

First Inspection:

Disconnections:

Broken/missed components:

Excess heated areas:

Tested results after 1st. inspection:

Condition:

Recommendations

ANNEX III

Page 2

Fault tracing:

Final Test: Working / Not working:

Results

Spare parts used/needed:

Recommendations for the Owner:

Dated: Signature:

Next checking time:

ANNEX IV

Training Plan:

For : ..... (name)
..... (Title)

Instructor's name and title .....
.....
.....

The trainee's job: 1) to have a good knowledge about gigital voltmeter
.....
.....
2) how to evaluate the measuring
.....
error in temperature measurement
.....

Justifications of meetings with the instructor:

I, II, III, IV, V, VI, VII,
VIII, IX, X, XI, XII,

1982

1983

Special remarks:

Khartoum, 8 December, 1981 Signature.

ANNEX V -- e

Project of the Government of the
DEMOCRATIC REPUBLIC OF THE SUDAN

SUD/73/045 - Central Instrument
Repair Workshop (Phase One)

Report of the Tripartite Review of
19 December 1981

Present

Dr. Farouk El Tayeb (Chairman)	Director, IRCI.
Dr. Mohamed Osman Abdalla	Head of CIRW.
Dr. Omer Rufaie	National Council for Research
Mr. Garth ap Rees	UNDP Resident Representative
Mr. Sandor Deri	UNIDO Expert
Mr. Peter Quennell	UNDP Assistant Resident Representative.

Introduction

This was the first tripartite Review since the UNIDO Expert arrived in mid-1980. The project Document was, in fact, signed in 1975, but implementation had to be delayed for several years as a result of financial constraints upon UNDP. In 1976, a UNIDO consultant compiled a list of electronic test and repair equipment, which was ordered in 1979 and (except for a vehicle) delivered and stored at the IRCI pending the arrival of the Expert in 1980.

Background documents for the review included the Project Document, and the two reports (copies attached) prepared by the Expert in 1981.

Summary of Discussion

Dr. Farouk began by welcoming participants, and providing a resume of the IRCI's history and terms of reference. The IRCI was created in 1965, when the Government, UNIDO and UNDP signed a plan of action for a technical assistance project to develop the IRCI's managerial and technical capability. Phase One lasted from 1965 to 1969, Phase Two from 1969 to 1973. UNIDO provided various experts to head the Departments, and equipment for the testing laboratories, workshops and pilot plants. The UNDP budgets totalled $880,000 for Phase One, and $529,000 for Phase Two.

The IRCI's institutional objectives are to undertake research for industry for (a) new industrial projects: economic and technical evaluations, including studies of markets, local raw materials, production technologies, capacity and type of manufacturing processes, machinery required, investments required costs, and profits anticipated; (b) existing industrial projects: trouble-shooting, controls for production, financial systems, and upgrading of plant. Also, laboratories for quality control have been set up, and a standards-specifications department. Different materials are tested -

foods, leather, textiles, etc; and research into new materials, such as Balanites (a fruit being analysed under a UNIDO sub-contract) is undertaken.

The IRCI still has accommodation problems. The CIRW occupies the best of five Government houses now being used by IRCI. To speed completion of the new IRCI Headquarters Laboratories at Shambat (Khartoum North), an energetic young engineer has been appointed, and a further £1.25 million allotted. Part-occupancy will take place in March or April 1982. The IRCI is covered by a new Act; and a Board of Directors will be appointed reporting directly to the Minister of Industry.

When the CIRW project was developed, in 1975 it was agreed that the National Council for Research (NCR) would pay the staff salaries, and the IRCI would provide the accommodation and the administration; the NCR and IRCI would share the costs of materials. The project began well (when it finally began) with the Expert's arrival, several fellowships, the commissioning of the equipment, and the initiation of the technical programme of electronic repair and calibration. The CIRW is proving to be highly useful to the IRCI, the University, Ministry of Health, Ministry of Agriculture, Geological Survey, and the private sector. Nominal fees plus cost of parts are charged for repairs. A Manual of Instruments has been prepared, but not as yet published - This is the NCR's responsibility. Phase One of the project covers electronic instruments; Phase Two is to cover mechanical, optical, and bio-mechanical instruments, and a library; Phase Three is to extend capacity into mobile repair-workshops and the training of instrument operators and technicians. Main difficulties include a lack of spare parts, and the delays in the NCR contributions to the CIRW's recurrent costs.

Mr. Ap Rees enquired about the CIRW's dual role, in serving the Ministry of Industry and the NCR. Dr. Farouk indicated that no difficulties have arisen, that all the IRCI's work is by contract, and that they are kept informed. The IRCI will be requesting a UNIDO mission to evaluate the CIRW project's progress to date and its possible future development. The IRCI will also request replacement by UNDP of the $20,000 not committed for equipment in 1981. From the NCR, £11,000 is awaited for salaries. More staff will be required as the CIRW expands in the future.

Mr. Ap Rees felt that this Review's main concern should be: where does the project go to from its present good position? The first major advance should of course be the new building, which the IRCI can now push for completion of more strongly, as the new Minister is personally interested. Then there will be a settling-in- period. With regard to future technical assistance. UNDP has again come under severe financial constraints, the main reasons being a reduction in global contributions, and a particular problem of overcommitment in the Sudan. He would like to suggest ways of seeking alternative future funding, as it is required so immediately. The project's present progress is good justification, as is the new building, and the IRCI's and NCR's good support - especially in the Decade of the Modern Scientific State proclaimed by HE the President. The parties to the project should remain positive, and prepare a good proposal for prospecting for funding. Unless the Ministry of Industry has considerable pull in the Ministry of Finance and Economic Planning (MFEP) and the Council of Ministers, the 1982-86 UNDP Country Programme would not include provision for Phases Two and Three. He regretted that, due to pressure of work, the MFEP was unable to attend all scheduled tripartite reviews, this one included, but the Ministry of Industry and the NCR are welcome to discuss proposals for Phases Two and Three.

Mr. Deri enquired about UNESCO funding possibilities, as the project is in the area of science. Mr. ap Rees replied that UNESCO has little Regular Programme funding, certainly less than UNIDO. One possibility might be the Interim Fund for Science and Technology; another, UNIDO multi-bi arrangements for further equipment and consultants. The fact that new premises were forthcoming, the presence of highly-trained counterparts, and an obvious end-point to the project, would impress both UNDP and other possible donors.

Dr. Farouk indicated that he would like UNIDO's early help in preparing a Phase Two/Three Project Document; and the replacement in 1983 of the $20,000 required for more equipment and study-tours. These are the two urgent priorities. Mr. ap Rees endorsed the proposal for a UNIDO evaluation mission, preferably a Headquarters mission as costs would be much less than for an outside consultancy. He advised Dr. Farouk to inform the Ministry of Finance and Economic Planning of any actions the IRCI envisaged in developing new proposals. He added that he was most impressed at the value of the equipment already repaired by the CIRW (list attached), and at the quality of IRCI participation in the project. He endorsed Dr. Farouk's warm appreciation of the hard work put in by the Expert, Mr. Deri, in the last 18 months. (Mr. Deri completes his assignment in mid-1982).

Dr. Farouk raised the final matter of study-tours for national staff of established workshops in similar countries (viz; Algeria), which Mr. ap Rees much favoured, and hoped to see organized in 1982.

Dr. Farouk thanked all participants and closed the Review.

LIST OF INSTRUMENTS REPAIRED BY CIEW

Instrument repaired	Org.	Status	Value US$
1. Electron. reg. furnace(23x25x10)	MIN	rep.	1,200.-
2. Spectrophotometer (SP 600)	OH	rep.	800.-
3. Electron. reg. furnaces(23x25x21)2 pos	MIN	rep.	3,600.-
4. Voltage stabilizer (3 phases)	MIN	rep.	2,500.-
5. Liquid Scint. Counter(computer reg.)	NHC	rep.	(nigh)
6. Spray Dozer	FRC	rep.	14,500.-
7. Spectrophotometer (DU-2)	UK	rep.	7,000.-
8. PH-meter (Pye)	NHC	rep.	400.-
9. Spectrophotometer (DU-2)	SC	rep.	7,000.-
10. MEG-charger (3 phase)	TF	rep.	35,000.-
11. Balance (H 20)	SC	rep.	600.-
12. Voltage stabilizer (3 phase)	SC	rjd	———
13. Autoclave (regulated)	SC	u/rep.	2,000.-
14. Electron. reg. furnace	IRC	rep	800.-
15. Electron. reg. furnace	SC	rep.	800.-
16. Incubator (cooled)	SC	u/rep.	500.-
17. Gas chromatograph	PK	rjd	———
18. Spectrophotometer (DU-2)	UK	rep	7,000.-
19. Suction pump	SC	rjd	———
20. Timer (part of a foundry machine)	PK	rep	(high)
21. polarograph	UK	u/rep	1,200.-
22. Recorder	UK	u/rep	300.-
23. Suction pump	PK	rep	200.-
24. Electron microscope	NHC	rjd	———
25. Liquid nitrogen equip.	NHC	rjd	———
26. Marconi Waveforms Gen.	IRC	rep	1,200.-
27. Test Oscillator	IRC	u/rep	1,120.-
28. Chromo-scan	IRC	rep	25,000.-

LIST OF INSTRUMENTS REPAIRED BY CIRW (Cont'd)

	Instrument repaired	Org.	Status	Value US$
29.	Integrator (part of textile machine)	TEX	con	(high)
30.	Timer (part of press-machine)	TF	rep	(high)
31.	Electronic balance (TE22+B125)	MIN	rep	5,000.-
32.	Rotek High Curren Adapter	IRC	rep	1,600.-
33.	Balance (P162)	PK	rep	1,200.-
34.	Spectrophotometer (DU-2)	VR	con	7,000.-
35.	Stereo microscope	VR	rep	1,000.-
36.	Balance (H6T)	PK	u/rep	300.-
37.	Balance (H6T)	SC	u/rep	300.-
38.	Balance (K7T)	SC	rep	800.-
39.	Atomic Absor. Spectrophotom.	IRC	u/rep	8,000.-
40.	Thermocouple thermometer	FW	u/rep	80.-
41.	Recorder (for Fractional Analyser)	VR	rep	800.-
42.	Flame Spectrophotom.	VR	u/rep	1,800.-
43.	CF-4A Spectrophotom.	VR	u/rep	2,000.-
44.	Electron microscope	VR	u/rep	(high)
45.	Gamma radiation det.	NHC	u/rep	(high)
46.	Temperature controller (part of a press. mach.	TF	rep	
				142,600.-

Abbreviations:

rep	=	repaired	TF	=	Tabaldy Fact.
u/rep	=	under repair	IRCI	=	Industrial Res. Cons. Inst.
rjd	=	rejected	PK	=	Polytechnic of Khartoum
MIN	=	Ministry of Mining	FK	=	Foundry of Khartoum
OH	=	Omdurman Hospital	TEX	=	Sudan Textile Fact.
NHC	=	National Health Centre	VR	=	Veterinary Res. Centre
FRC	=	Food Research Centre	FW	=	Foundry of Wad Medani
UK	=	University of Khartoum.	con	=	consultancy
SC	=	Soil Conserv. Dept.			

ANNEX V - f

UNDP / UNIDO

CENTRAL INSTRUMENT REPAIR WORKSHOP

SUD/73/045

(Phase One)

12/4/1982

To: Mr. P.A. HARJU
Senior Industrial Development Field Adviser

From: S. Deri

Subject: Summary of Project Implementation.

This report has been prepared as the request of Mr. P.A. Harju, SIDFA. The purpose of the report is to summarize of project implementation for the period July 1980 - March 1982, giving a brief account of project activities and major problems. (This report does not include the figures of the project Budget).

1) The Project Document was signed in 1975. In 1976 a UNIDO Consultant compiled al list of required equipment and tools, which was ordered in 1979 and delivered and stored at the IRCI pending the arrival of the expert in 1980, who arrived in mid - 1989.

2) The CIRW is still situated in its original place in one of the Sections of the old building of the Engineering Department of the IRCI.
The national staff has 3 engineers and 2 technicians as availables.
The instruments and tools proved generally useful for repair.

3) After the operational preparatory works the project was able to begin the repair in September 1980. Paying facts-finding visits to factories, laboratories and workshops it was easy to make suitable checking and gathering of essential information about electronic instruments out of work. At the beginning the equipment to be repair were chosen from didactic aspects, but now the date of ordering determines the sequence of repair (except the case of emergency).

4) The training is an integral part of the work-process in CIRW. The national staff has the basic knowledge of electronic instruments, but the speciality of repairing technology has to be acquired on-the-job. How to use measuring instruments, how to find faults, and such questions are discussed in connection of the everyday work, many times special themes are treated. These, completed some other themes, are included in TECHNICAL MANUAL VOL. 1 and VOL. 2 securing in such a way the special knowledge for others who are not able to participate in the present work of CIRW.

5) The documents relating to maintenance are very important both technical and official reasons. Any work-request must be presented (or confirmed) in writing. After the approval of administration a member of the CIRW-staff checks the equipment, filling out a "SURVEY OF ELECTRONIC INSTRUMENT". He in common with the Head of CIRW decide whether the order will be accepted or rejected. (The payment is also a condition of acceptance, so works begin only after agreement on it). Finishing the technical procedure of repair, the repairer fills out a "FINAL REPORT on COMPLETION OF REPAIR". At the same time he sends a short "REPORT" to the administration section remarking the repair-cost which contains a nominal fee plus cost of parts employed, from where the "INVOICE" will be sent to one who ordered. An "INFORMATION FEEDBACK" questionnaire is under prepare now. It will help to improve the reliability of CIRW's work.

6) According the nature of maintenance, CIRW gives short courses to operators of sophisticated equipment, consults with the owner of equipment about preventive maintenance, studies (and corrects if necessary) the measuring methods, etc. The calibration-procedures are also to be mentioned among these scientific services.
The CIRW has got some experiences regarding to electronic equipment purchase, transport, storage and installation, being all these important parts of maintenance.

7) Until now CIRW has got 58 orders of which 36 repaired, 12 are under repair, 5 were rejected and in 5 cases consultancy or short course was held. At a rough guess the value of these handled equipment is minimum US$180.000,- without counting the extremely high values of large machines and devices.

8) Major problems which were seriously impeding project implementation:

a) The new premises of the CIRW are not yet completed; (it was mentioned in each Report and discussions, last at the Tripartite Review).

b) difficulties in acquiring special spare parts; (it was tried to overcome by direct contact with equipment-manufacturers and their local representatives);

c) Lack of Service Manuals and Catalogues, (detto as in case b.) last by help of UNIDO HQ.)

Perturbing factors of Project Implementation:

- frequent power cuts,
- difficulties in public transportation,
- lack of pick-up car for the CIRW,
- large geographical distance between the CIRW and the administration section.

9) Tasks for the near Future:

a) to elaborate the "INFORMATION FEEDBACK" questionnaire

b) to prepare a proposal about the future of CIRW;

c) to complete the study-tour arrangement;

d) to prepare the Project-Final Report draft.

10) Written Documents coming out until today:

a) Preliminary Report to Vienna	28/8/80
b) Bimonthly Report to Vienna	28/10/80
c) " " " "	29/12/80
d) " " " "	26/2/81
e) Report on Progress	12/3/81
f) Technical Manual # 1	29/9/81
g) Report # 2 on Progress	6/11/81
h) Report of the Tripartite Review	19/12/81
i) Technical Manual # 2	26/2/82

ANNEX VI

INDUSTRIAL RESEARCH AND CONSULTANCY
INSTITUTE

PROJECT SUD/73/045

THE CENTRAL INSTRUMENT REPAIR WORKSHOP

FOR

"The repair and maintenance of all types of electronic, electrical, electro-mechanical, Optical, medical, textile and chemical engineering Instruments etc."

INDUSTRIAL RESEARCH AND CONSULTANCY
INSTITUTE
P. O. BOX 268
KHARTOUM SUDAN.

C O N T E N T S

I Introduction

II Objective of the project

III Project Activities

a. Phase I
b. Phase II
c. Phase III

1. Introduction:

For some time it has been realized in the Sudan that measuring and control instruments in industry and science do not find the required repair, maintenance and calibration for normal and efficient performance. They are even left idle or are scrapped for lack of only minor repairs.

For this reason the Industrial Research and Consultancy Institute (I.R.C.I) incollaboration with the National Council for Research (N.C.R), has decided to establish a central Instruments repair workshop.

As a first step to assess the extent of the problem a short term consultant visited the Sudan under the auspices of the I.R.C.I. The expert found:

1. The country has a considerable quantity of sophisticated instruments in the following Categories: electronic, chemical engineering, textile, optical, mechanical.

2. Among these Instruments there is a great variety in brands, specifications, design and country of origin.

3. These instruments are repaired and maintained in a haphazard way by a variety of agents, small workshops, etc. In many cases there are no maintenance facilities at all. In other cases the techniques and skills involved are entirely beyond the existing level of facilities. There is a vertually complete absence of scientifically trained staff, with users, and with the agents and workshops which should provide the repair and maintenance.

4. As a result, an inordinate amount of instruments lie idle. Not only does this represent much unutilized capacity, but this situation leads to unnecessary waste of foreign currency, because of the tendency to replace indispensable units by new ones.

The previous observations make it necessary to consider the establishment of a central repair and maintenance body. Consequently the Industrial Research and Consultancy Institute and the National Council for Research have approached international agents for assistance in establishing a nucleus for repair and maintenance of scientific instruments.

II. Objective of the Project.

a. Long range objectives

The long range objective of the project is to promote the economic development of the Sudan by improving the effectiveness of scientific and Industrial research and tests.

b. Immediate objectives

The immediate objectives are

1. to establish an initial nucleus for maintenance and repair of scientific instruments as a running operation.
2. to improve the capacity of the counterparts staff of this nucleus.
3. to lay the foundation for an autonomous fullfledged central instruments repair workshop.

III. Project Activities:

Due to the limited resources, the development of the workshop has been divided into three phases.

a. Phase 1.

The UNDP has already contributed to the establishment of phase 1 which is the electronic division. The project executing agency is UNIDO in consultation with UNESCO. The project calls for one expert for two years. His main tasks will be to build up a small repair and maintenance unit which will be able to give services to a limited number of users. He is also expected to draw up a programme for the expansion of the unit into a central workshop able to cater nationwide for users of scientific instruments. This implies specifying detailed needs in terms of staff, accommodation and equipment.

This division will be the largest one of the workshop, comprising sections of laboratory instruments, chemical engineering instruments, textile instruments, medical instruments and electro-mechanical instruments. This division will be equipped with a complete set of electronic test instruments that are needed to check and service all types of electronic instruments including medical electronic appartuses.

b. Phase II

In this phase it is planned to establish the following divisions which are essential to the different instruments field.

1. Mechanical instrument and workshop division
2. Optical instruments and Glass blowing division
3. Spare parts division.
4. Library and Information services division,

c. Phase III

This phase constitutes the complementary stage for a well integrated central unit providing highly technical and engineering service to the economy. The major divisions are.

1. Mobile servicing division.
2. Training of service personal division
3. Consultancy planning and Installation division.

The first phase however, will be covered by UNIDO and UNESCO. Establishment of the other phase by foreign aids is foreseen simultaneously.

ANNEX VII

25 May 1979

UNIDO
JOB DESCRIPTION
DP/SUD/73/045/11-01/31.9.C

Post Title: Engineer in Maintenance, Repair and Calibration of Electronic Instruments and Apparatus.

Duties: The expert will be attached to the Electrical Division of the IRCI and will specifically be expected to:-

1. Organize a systematic repair, maintenance and calibration programme for electric and electronic instruments and apparatus.
2. Supervise the administrative and commercial aspects of the programme.
3. Train the counterpart personnel in instruments repair and maintenance.
4. Take part in and supervise the work in the workshop.
5. Prepare a procurement programme for the required basic spare-parts urgently needed for the setting up of maintenance and repair services.
6. Prepare requisitions and specifications for the most important spare-parts urgently needed for the setting up of maintenance and repair services.
7. Assist and advise on setting up the plans on future expansion of the CIRW.

The expert will also be expected to prepare a final report, setting out the findings of his mission and his recommendations to the Government on further action which might be taken.

ANNEX VIII

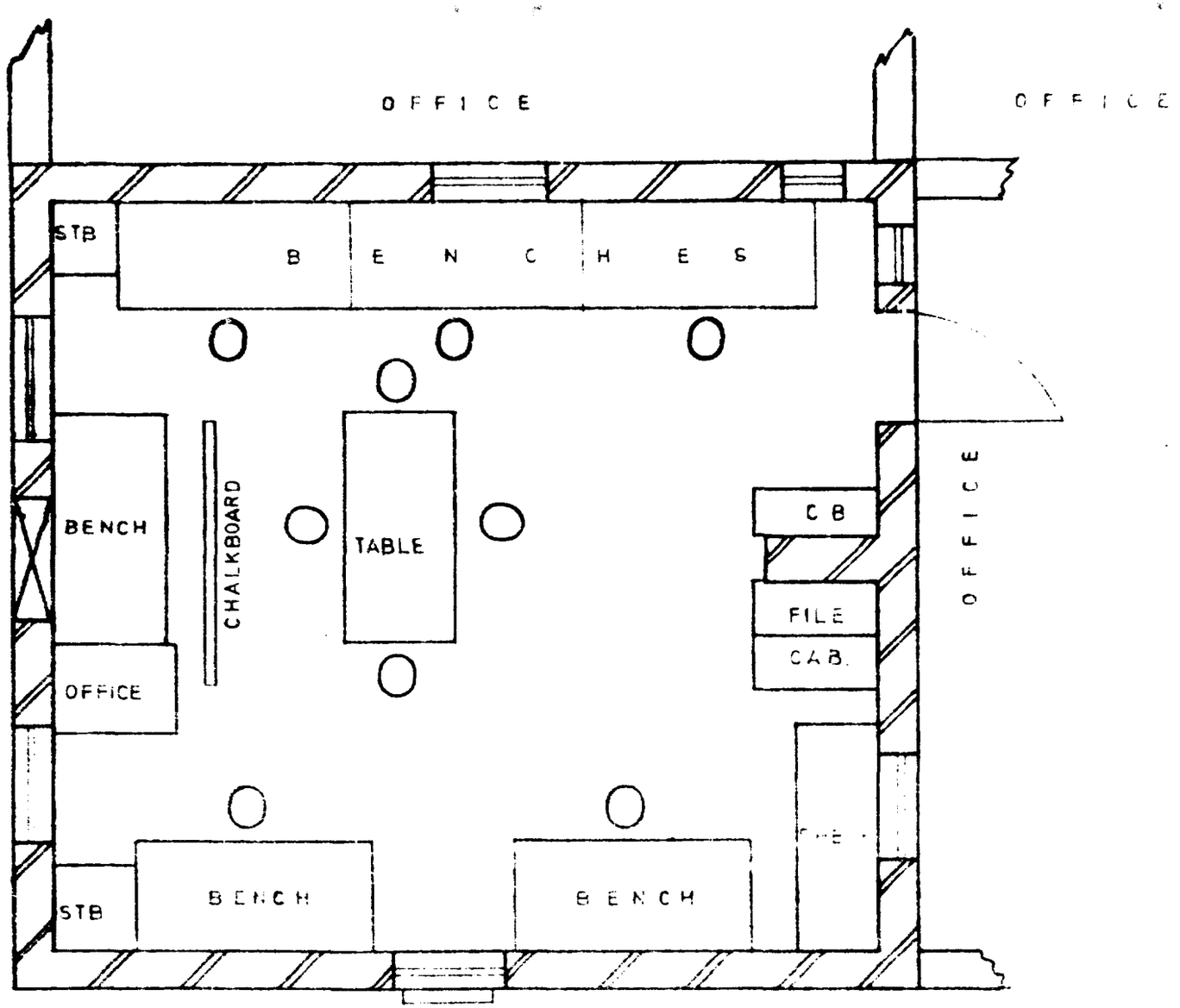
Work Plan

Long Range Objective: (1985)	Setting up a nationalwide central instrumentation repair workshop (CIRW) in the frame of the Industrial and Scientific Organizations of Sudan.
Immediate Objectives: (1982)	Establishing a real nucleus for maintenance and repair of industrial and scientific instruments at the IRCI. Organizing the nationalwide instrumentation-repair system for the industrial and scientific equipment.

For these I have to:

(continuous)	- assist and advise on the setting up of the electronic-instruments repair workshop at the IRCI.
(by January 1981)	- find and visit the electronic-instruments repair workshops existing in Sudan.
(by April 1981)	- Make recommendations on coordinating the activities of these with this project;
(continuous)	- assist and advise in imporving of their maintenance and repair work;
(by June 1981)	- conduct on-the-job training for the national staff of the CIRW and other specialists on maintenance and repair techniques;
(by October 1981)	- prepare requsitions and specifications for the instruments and tools urgently needed for the CIRW;
(by June 1982)	- Organize a systematic repair, maintenance and calibration programme for the national wide system;
(by June 1982)	- assist and advise on setting up the plans on future expansion of the CIRW.

28/8/1980



LAY OUT OF C.I.R.W. LAB

TOTAL AREA 6 76 6 30 = 42.58 M^2

A. B. FILIPINAS

ANNEX IX

ANNEX X

Feed-back information

(about forner repair)

Date: .....
Done by: .....

Name of Equipment:

Type:

Serial number:

Name of the owner:

Address:

Date of Last Repair:

Repaired Faults:

Present condition of equipment : good; satisfactory; wrong

Remarks: (accuracy; difficulties in operation; blown fuses, etc.)

ANNEX XI

LIST OF INSTRUMENTS ON PROJECT

No.	Description	US Dollar Equivalent
1.	STEREOMICROSCOPE M3	1,673.-
2.	SERDEX HYGROTHERMOGRAPH 7 DAY	558.-
3.	VOLTAGE STABILIZER TYPE VS-2	1,849.-
4.	VARIABLE TRANSFORMER "REGAVOLT" MODEL 403 C-PTV (S) COMPL.	633.-
5.	DECADE INDUCTOR BOX DI-4	1,209.-
6.	CALIBRATION GENERATOR TYPE PG-506	1,695.-
7.	TIME MARK GENERATOR TEXTRONIC, RTPW TG 501	1,302.-
8.	LEVELED SINE WAVE GENERATOR, TYPE SG 503	1,302.-
9.	OSCILLOSCOPE DUAL TRACE 465	5,050.-
10.	PULSE GENERATOR, TYPE PG 508	1,329.-
11.	INSULATION TESTER CI-500C, COMPLETE	1,307.-
12.	LOGIC KIT 5P21A	476.-
13.	COMPARATOR 10529A	588.-
14.	WIDE BAND OSCILLATOR, TYPE651B	1,120.-
15.	LOGGING MULTIMETER 3467A	2,464.-
16.	PULSE GENERATOR	728.-
17.	DISTORTION FACTOR METER 339A	2,128.-
18.	DECADE CAPACITOR BOX TYPE 2975	300.-
19.	VALVE CHARACTERISTIC METER MODEL VCM 163	1,178.-
20.	COIL WINDING MACHINE, MODEL CW 1	978.-
21.	DIGITAL MULTIMETER MODEL 13036 A-05-31	886.-
22.	DIGITAL FREQUENCY COUNTER MODEL 5500D	1,235.-
23.	WIDE BAND VOLTMETER MODEL 3045A	605.-

LIST OF INSTRUMENTS ON PROJECT (Cont'd)

No.	Description	US Dollar Equivalent
24.	LOW DISTORTION AUDIO OSCILLATOR, TYPE J3B	778.-
25.	MULTIMETER, UNICOR 3N COMPLETE	896.-
26.	FARNELL HT POWER SUPPLY, TYPE E350	382.-
27.	FARNELL BENCH POWER SUPPLY, TYPE L30-2	268.-
28.	FARNELL BENCH POWER SUPPLY, TYPE L12-10C	350.-
29.	ROTEK PRECISION CALIBRATOR, MODEL 320	5,775.-
30.	HIGH CURRENT ADAPTER, MODEL 350	1,645.-
31.	DC REFERENCE STANDARD MODEL 731-B	1,007.-
32.	INDUSTRIAL VACUUM CLEANER MODEL NILFISK GS 80 SPECIAL	442.-